VOLUME I

NUMBER 1

PROCEEDINGS

Casualty Actuarial and Statistical Society of America

INAUGURAL MEETING

November 7, 1914

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FIRST DINNER OF THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA

(See account of the dinner, page 6)

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PRESS OF THE NEW ERA PRINTING COMPANY LANCASTER, PA.

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CONTENTS

OF THE

INITIAL NUMBER OF THE PROCEEDINGS

	PAGE
Officers and Council of the Society Charter Members	v vii
Minutes of the Inaugural Meeting, and Account of the First Dinner A Letter of Historical Interest	1 8
 Papers presented November 7, 1914: Scientific Methods of Computing Compensation Rates. M. RUBINOW How Extensive a Payroll Exposure is Necessary to Give a Dependable Pure Premium. Albert H. Mowbray Valuation of the Death Benefits Provided by the New York Compensation Law. WINFIELD W. GREENE Reviews of Statistical Publications 	10 24 31 49
Bibliographies: Recent Articles Dealing with Casualty and Social Insur- ance, in Current Periodicals Recent Books and Pamphlets	59 69

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- S. Milligan, Metropolitan Life Insurance Company, 1 Madison Avenue, New York City.
- J. F. Mitchell, Secretary, Maryland Casualty Company, Baltimore, Maryland.
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VOLUME I.

NUMBER 1.

PROCEEDINGS

NOVEMBER 7, 1914.

MINUTES OF THE FIRST MEETING OF THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA.

The first and organization meeting of the Casualty Actuarial and Statistical Society of America was held at the City Club, New York City, on November 7, 1914, in the afternoon.

Dr. I. M. Rubinow was elected temporary chairman and C. E. Scattergood, temporary secretary.

The temporary secretary read the call for the meeting, as follows:

"Organization Committee of the Casualty Actuarial and Statistical Society of America. 92 Liberty St., New York City,

July 27, 1914.

"Dear Sir: You are desired as a founder and charter member of an association to be formed and known as the Casualty Actuarial and Statistical Society of America.

"At a meeting of the Statistical Committee of the Workmen's Compensation Service Bureau on May 28, 1914, it was proposed to organize an association of casualty actuaries and statisticians. Dr. I. M. Rubinow, Chief Statistician of the Ocean Accident & Guarantee Corporation, was elected temporary chairman and Mr. C. E. Scattergood, Assistant Secretary of the Fidelity & Casualty Company of New York, in charge of the statistical department, was elected temporary secretary and by vote of the meeting authorized to issue this call looking toward a permanent organization. "The object of the Casualty Actuarial and Statistical Society is the promotion of the study of statistics and actuarial science as applicable to the lines of insurance business included in the "miscellaneous" annual statement uniform blank at present in use, and approved by the National Association of Insurance Commissioners. The lines included in this blank are those known as "casualty insurance."

"In furtherance of these ends, it is proposed to establish a library and to hold meetings from time to time, at which papers contributed by members of the society will be read and discussed. These papers with other contributions by members and others will be published from time to time in the proceedings of the Society.

"The society will be composed of *individuals*, who will act in their individual capacity and not as representatives of any organization. It is hoped that the leading students of casualty experience will become members. It is believed that the conclusions of a society organized along these lines will be recognized as authoritative by all who are or all who may become interested in the administration of insurance companies, in legislative action or the administration of laws concerning casualties and accident prevention, and those who individually or through organization seek to reduce the waste due to casualties.

"It is proposed to have two classes of members.

1. Members.—Those who are and who have been in charge of actuarial, mathematical or statistical departments of insurance companies or of organizations or associations connected with casualty experience. In this class shall also be included those who have made contributions to actuarial science or statistics as related to casualty experience.

2. Associate Members.—Anyone in an actuarial, mathematical or statistical department of an insurance company, or any other person who evinces a desire to study actuarial science and statistics as related to casualty experience.

"At the organization of the society there will be but the first class of membership.

"The dues of the society will be nominal.

"With the recent greater development in interest concerning casualties there is need for a society such as this, and it is believed that the society will soon take its position among the academic societies of our country. "This is the first organized invitation for members that has been made. As we have met men interested in casualty actuarial science and statistics we have inquired if they would become members but only as opportunity arose. Those who have stated that they would become members are:

Mr. B. D. Flynn, Assistant Secretary, Travelers Insurance Company.

Mr. H. Furze, Comptroller, Globe Indemnity Company.

Mr. T. E. Gaty, Secretary, Fidelity & Casualty Company.

Mr. W. W. Greene, Assistant Actuary, New York Workmen's Compensation Commission.

Mr. C. M. Hansen, Secretary Department of Accident Prevention, Workmen's Compensation Service Bureau.

Mr. R. J. Hillas, President, Fidelity & Casualty Company.

Mr. F. E. Law, Vice-President, Fidelity & Casualty Company.

Mr. W. B. Marsh, Market World and Chronicle.

Mr. J. F. Mitchell, Secretary, Maryland Casualty Company.

Mr. G. D. Moore, Statistician, Royal Indemnity Company.

Mr. S. L. Otis, Actuary, Workmen's Compensation Service Bureau.

Dr. I. M. Rubinow, Chief Statistician, Ocean Accident & Guarantee Corporation, Ltd.

Mr. C. E. Scattergood, Assistant Secretary, Fidelity & Casualty Company.

Mr. E. Scheitlin, Statistician, Globe Indemnity Company.

Mr. A. W. Whitney, Manager, Workmen's Compensation Service Bureau.

Mr. H. R. Woodward, Vice-President, Fidelity & Casualty Company.

Mr. J. H. Woodward, Actuary, New York Workmen's Compensation Commission.

Mr. L. J. Wolfe, Consulting Actuary, New York City.

Mr. S. H. Wolfe, Consulting Actuary, New York City.

"Will you kindly write to the temporary secretary and let him know if you are willing to become a member? At a later date in the near future, you will be advised as to the date of the organization meeting for the adoption of a constitution and by-laws. In the meanwhile the organization committee would appreciate your suggestions concerning such a society and request that you send in names of those you think desirable for membership, giving their addresses and experience in casualty actuarial science and statistics. "Will you kindly answer this letter by August 1, 1914.

"Yours very truly,

"C. E. SCATTERGOOD," "Temporary Secretary."

A constitution and by-laws prepared by the organization committee were read, and upon motion adopted by unanimous vote of those present with the exception of Article 12, which article restricts freedom of amendment, and with change of Article 5 as proposed; said change being to make the number of members of council, outside of the officers and ex-presidents of the Society, four instead of three, their terms to be two years, except that at the time the first four were elected two should serve for one year and two for two years. Before adoption, also, the word "Transactions" in Article 3 of the By-Laws was changed to read "Proceedings."

The roll of founders and charter members was read, and the following fellows were recorded as being present:

Messrs. Roland Benjamin, William Breiby, George B. Buck, W. A. Budlong, E. E. Cammack, R. V. Carpenter, A. H. Craig, Miles M. Dawson, Elmer H. Dearth, Lester Egbert, Edward B. Fackler, E. S. Fallow, Henry Farrer, Benedict D. Flynn, Harry Furze, E. S. Goodwin, W. W. Greene, W. H. Gould, F. L. Hoffman, Charles Hughes, W. I. King, Frank E. Law, T. A. Lehmann, W. B. Marsh, George D. Moore, A. H. Mowbray, F. R. Mullaney, E. Olifiers, R. K. Orr, Stanley L. Otis, Edward B. Phelps, Charles H. Remington, I. M. Rubinow, Claude E. Scattergood, E. Scheitlin, R. J. Sullivan, John L. Train, L. J. Wolfe, S. H. Wolfe, and J. H. Woodward.

There were no associates in the membership at this meeting. Mr. A. R. Marsh, editor of the *Market World and Chronicle*, and Mr. Floyd F. Brown, of the Frankfort General Insurance Company, were present as visitors.

Mr. S. H. Wolfe moved that the temporary chairman appoint a nominating committee of three to present candidates for the offices of the society and for the council. Motion being carried, the temporary chairman appointed Messrs. S. H. Wolfe, J. H. Woodward, and Frank E. Law.

Mr. L. J. Wolfe moved that a recess of fifteen minutes be taken to await the report of the nominating committee. Carried. At the conclusion of the recess, the meeting having been called to order, the nominating committee presented the following candidates:

For President-Mr. I. M. Rubinow.

For Vice-Presidents-Mr. B. D. Flynn and Mr. A. H. Mowbray. For Secretary-Treasurer-Mr. C. E. Scattergood.

For Editor-Librarian-Mr. W. W. Greene.

For Members of Council (one year term)-Mr. J. D. Craig and Mr. R. K. Orr.

For Members of Council (two year term)-Mr. F. L. Hoffman and Mr. A. W. Whitney.

Upon a call for further nominations, none being presented, Mr. S. H. Wolfe moved that the temporary secretary be instructed to cast a ballot for each candidate presented by the nominating committee. Carried. The temporary secretary cast the ballots as instructed and the candidates above mentioned were declared elected to the offices for which they were nominated.

The following names were presented by various Fellows for Fellowship:

Mr. E. C. DeKay, New York Insurance Department.

Mr. J. F. Larkin, Statistician, Fidelity & Deposit Company of Maryland.

Mr. David Miller, Statistician, Prudential Casualty Company.

Mr. S. Milligan, Metropolitan Life Insurance Company.

Mr. C. G. Reiter, Assistant Actuary, Metropolitan Life Insurance Company.

Mr. J. S. Thompson, Mutual Life Insurance Company.

Mr. Stanley L. Otis moved that the men whose names were presented be admitted to charter-membership. Carried.

Upon invitation from the president, Mr. A. B. Marsh, editor of the *Market World and Chronicle*, addressed the society and drew some outlines of the important mission it was capable of fulfilling.

The secretary read a letter from Mr. F. E. Law advocating the establishment of a library for the society. Upon carried motion of Mr. J. H. Woodward the establishing of a library was referred to the council to report at the next meeting of the society.

The secretary read a letter from Mr. F. E. Law, suggesting that the society study methods of reserving for Liability and Compensation losses.

Upon carried motion, the president was authorized to appoint a

committee of three fellows to undertake the revision of the constitution and by-laws.

Upon carried motion of Mr. W. H. Gould, the president was authorized to appoint three fellows to prepare individual papers on methods of reserving for Liability and Compensation losses.

The president asked vice-president Flynn to occupy the chair while he read the paper he had prepared for the meeting. The president then read his paper entitled "Scientific Methods of Computing Compensation Rates."

The president reassuming the chair, Mr. A. H. Mowbray gave an abstract of the paper he had prepared, entitled "How Extensive a Payroll Exposure is Necessary to give a Dependable Pure Premium."

Mr. W. W. Greene gave an abstract of his paper entitled "Valuation of the Death Benefits Provided by the New York Compensation Law."

Upon motion the meeting adjourned.

FIRST DINNER OF THE SOCIETY.

Dinner was served at the City Club at 7:00 P. M. The following Fellows were present (see photograph to which the number after each name refers):

Roland Benjamin (36), William Breiby (41), W. A. Budlong (38), E. E. Cammack (18), R. V. Carpenter (19), A. H. Craig (20), A. B. Dawson (33), M. M. Dawson (32), Elmer H. Dearth (43), L. D. Egbert, E. B. Fackler (40), Henry Farrer (29), B. D. Flynn (11), Harry Furze (28), E. S. Goodwin (1), W. H. Gould (34), W. W. Greene (3), C. M. Hansen (7), F. L. Hoffman (12), Charles Hughes (15), Arthur Hunter, W. I. King (14), F. E. Law (24,) T. A. Lehmann (30), W. B. Marsh (23), G. D. Moore (35), A. H. Mowbray (9), F. R. Mullaney (26), E. Olifiers (2), Robert K. Orr (22), S. L. Otis (13), Edward B. Phelps (16), C. H. Remington (17), I. M. Rubinow (10), C. E. Scattergood (8), E. Scheitlin (37), L. S. Senior (27), J. L. Train (6), L. J. Wolfe (5), S. H. Wolfe (21), J. H. Woodward (31).

Our guests were Messrs. F. F. Brown (4), Statistician, Frankfort General Insurance Co., A. B. Graham (42), A. R. Marsh (25), Editor *Market World and Chronicle*, and T. F. Treovett (39), Chief Adjuster, Commercial Travelers Mutual Accident Association of America.

After dinner speeches were made as follows:

Mr. M. M. Dawson, "Various Aspects of Social Insurance."

Mr. Elmer H. Dearth, "The Mutual Compensation Insurance Companies."

Mr. F. L. Hoffman, "Statistics in General."

Mr. Charles Hughes, "State Insurance Departments."

Mr. Arthur Hunter, as a former Vice-President of the Actuarial Society of America, congratulating the new actuarial society.

Mr. Frank E. Law, as one of the earliest casualty actuaries, on "Pioneering in the Casualty Actuarial Field."

Mr. Stanley L. Otis, as one who some years ago took steps to form a similar society.

Mr. E. B. Phelps, "The Mission of Statistical Journalism."

Mr. C. E. Scattergood, "Present Plan of Securing and Compiling Statistics by the Workmen's Compensation Service Bureau."

Mr. J. H. Woodward, "State Insurance Funds."

A LETTER OF HISTORICAL INTEREST.

Some five years ago, Mr. Stanley L. Otis, then actuary of the Bureau of Liability Insurance Statistics, sent the following letter to the heads of the companies transacting liability insurance in the United States.

At the recent inaugural dinner of the Casualty Actuarial and Statistical Society of America, Mr. Otis read this letter in response to the toast "As one who, some years ago, took steps to form a similar society."

"October 27, 1909.

"Dear Sir:

"Re: Proposed Society of Actuaries and Statisticians of Liability Insurance Companies.

""For upwards of twenty years the business of liability insurance has been actively prosecuted in the United States until today there are twenty three companies writing this kind of insurance with annual premiums of \$23,500,000. The keeping of companies' experience on their risks and their statistics have been in the hands of men termed actuaries or statisticians. These gentlemen have had quite largely to do with the making of rates for the companies besides having general supervision over the compilation and tabulation of the companies' statistics. Entering an entirely unknown field, the system or method of keeping the statistics has been gradually developed without a comprehensive plan and largely as some new situation made necessary an extension of the system. Thatthe methods adopted by the companies should be more or less unscientific without mathematical precision is not to be wondered at. On the contrary that such good systems have been evolved is cause for congratulation. To my knowledge there has never been any concerted or organized action by the actuaries and statisticians looking to improved methods or the efficiency of the ones employed.

"I propose that a meeting be called of the actuaries and statisticians of the several companies for the purpose of considering the advisability of forming a society of actuaries and statisticians of

Liability Companies. I believe such a society would be most useful and helpful to its members. Neither the American Mathematical Society, the Actuarial Society of America nor the American Statistical Association, in their Bulletins or Transactions, covers a field beneficial to the mathematical men of the Liability Companies. What is needed is a society of our own dealing with subjects of direct interest to us. The questions of uniformity of keeping companies' statistics, method of compiling statistics on which to base Workmen's Compensation rates, methods of computing liability loss reserves and other equally pertinent subjects are of prime importance and could be studied by the collective body of actuaries and statisticians with great profit. Such a society would not only stimulate thought and arouse increased endeavor among its members but would put the whole liability business on a higher plane. The effect of such a society rightly conducted for the betterment of the business can hardly be estimated.

"I suggest that you take up with your statistical department the matter of calling a meeting for the purpose outlined. I have mentioned the advisability of having an informal gathering of actuaries and statisticians to a number of the men in the several companies and believe if such a call was issued a representative from all or nearly all of the statistical departments of the companies transacting liability insurance would be present.

"Liability insurance is not only in the formative period,—it is in the transition period and its immediate future no one can read. It will need all the combined wisdom and help from every source that can be obtained. Industrial problems of far reaching importance are pressing for solution with an untold effect on liability insurance as transacted today. Great Britain and Continental Europe are deeply interested. America, not Germany, England or France, should lead the world and of necessity the actuaries and statisticians of the liability companies will play an important part. A society of these gentlemen would be productive of much good and mutual helpfulness.

"Yours very truly,

"STANLEY L. OTIS."

Scientific Methods of Computing Compensation Rates.

I. M. RUBINOW.

Theoretically the problem of compensation rates does not differ from that of rates in many other forms of insurance. The formula for premiums in any classification appears as $(\frac{payroll}{losses})$ plus any loading for commissions and expenses agreed upon or found necessary. There is only one difficulty about this formula—we do not know the numerator of this fraction, under which condition it is not quite an easy matter to compute its value.

The same formula is the basis of liability insurance, and time is relied upon to furnish the necessary volume of exposure, without which the results of the fraction are likely to be purely accidental and subject to violent fluctuations. That a large exposure is necessary to produce a true average, or in other words, that the fluctuations will be in inverse proportion to the size of experience is a truth which does not require any proof before a body of insurance men. It is quite evident, therefore, that it will take a long time under compensation experience before that necessary volume of exposure shall have been gathered.

It is obvious, however, that compensation rates must be quoted as soon as a compensation law goes into effect, and for some time after that while the necessary volume of experience is being accumulated. This presents the first difficulty.

It is true that the United States is not a pioneer in compensation insurance. In various countries experience has been accumulating for many years, up to as long as thirty years in Germany. The question is often asked by many persons outside of the insurance circles why the result of European experience in regard to pure cost cannot be utilized in this country. There are a good many reasons for this. The one that is mentioned first of all is perhaps the least important one. It is argued, and with a good deal of justice, that industrial conditions in Europe and in this country are not similar, that accidents happen more frequently in the United States, and, therefore, the pure premiums would not be equal. While this is undoubtedly true in a great many industries, it is by far not the greatest difficulty. More important are the differences in the compensation scales, of which the losses are results. And finally, there is the greatest handicap which statisticians will especially appreciate.

European statistics are seldom published, or even prepared in such detail as to give the necessary data for each separate classification. We have in our manual approximately 1,500 different classifications, and their number is rapidly growing. This results from the praiseworthy effort to do justice to each line of industry, to charge it no more than its hazard requires. It is almost impossible to oppose this tendency towards fine distinctions, for if rough grouping were insisted upon, the way would be open to the competitor to select the least hazardous subdivisions of each classification, and underbid on them. It is useless to look in European statistical sources for the pure premiums on any of the subdivisions of "Concrete Work" or "Masonry" or such odd classifications as "Military Goods Mfg."

Proceeding from the formula Pure Premium $= \frac{\text{Losses}}{\text{Payroll exposure,}}$ therefore, we seem to be thrown back upon our resources, upon the necessity of compiling our own experience which requires time before the necessary experience is accumulated. At first glance, it would seem that the greatest difficulties are already behind us.

In New Jersey, compensation is nearly three and a half years old; in Illinois, some two and a half years old; in Massachusetts, twenty-eight months, and so on.

But that only slightly relieves, and does not altogether abolish all difficulties. As against these two or three states, we have states like New York, or Iowa, where compensation is only four months old, Maryland, in which the compensation went into effect a week ago, Kentucky and Louisiana, where January 1 is the fateful date, and about a score of states in which the compensation acts are in various stages of preparation or contemplation. In all of these states compensation rates have to be quoted to-day, or to-morrow, or in the very near future. And yet no experience exists. It is not too much to say that no other country in the history of the compensation movement presented a problem of similar complexity, since none had an avalanche of compensation acts, no two alike, no two coming in at the same time. As a result, while the situation becomes somewhat simplified in some states, because of the accumulation of experience, it arises in all its difficulties in other states, and relief is not yet in sight.

Moreover, there remains the greatest, most fundamental difficulty in applying this method, which even years of experience may not eliminate. Because of the existing division of the country into some fifty independent legislative units, the possible exposure in one classification will be insufficient in one state to produce an average, except in so many years, that meanwhile conditions may entirely change, and make the accumulated experience entirely useless. That unfortunately is true of the greatest number of classifications. Of course, there are exceptions, in states as well as in New York, industrially, is an empire of itself. classifications. The exposure in most classifications will be so large that in comparatively few years a true average will have been obtained. In other smaller states, the exposure may be sufficiently great in a few industries, for which the state may be famous. Massachusetts does not need the aid of other states to obtain a true broad experience in boots and shoes. The same may be true in cotton spinning and weaving in South Carolina, or beer brewing in St. Louis or Milwaukee.

But how about the vast majority of diversified industries? The readiness to go by a small volume of experience is one of the peculiar errors of early underwriting in this country. When the Massachusetts Insurance Department compiled and published its famous schedule Z, for 1913, showing the compensation experience for separate classifications, it very wisely decided that below a certain minimum of exposure the experience was not worth presenting. The accepted minimum was very small—only \$500,000, and yet only 134 out of the possible 1,500 were able to pass that test. But such an exposure is hopelessly inadequate to produce even an indication of an accurate rate.

The average pure premium in Massachusetts was some 36 cents. Let us assume that an ordinary fatal accident would cost \$2,400. One fatal accident, therefore, in a certain classification represents a pure premium of 48 cents on half a million of exposure, 24 cents on a million of exposure. One fatal accident, therefore, may double the pure premium in many a class. The purely accidental fact that

of two fatal accidents in two different classifications, one happened to a married employe, and another to an unattached bachelor, may produce a wide margin between the two costs and two premiums. Only then may we begin to speak of a dependable experience when at least one accident will not seriously disturb the average pure premium. If a certain classification has a pure cost of \$1, then an exposure of \$10,000,000 may be sufficient, because one \$2,000 or \$3,000 loss will not affect the pure premium more than 2 per cent. or 3 per cent. But in less hazardous occupations, where the pure premium may be ten or twenty cents, a very much larger exposure will be necessary to produce results that are actuarially dependable. And if that is so, how long will it take some of the smaller states to accumulate such volume of experience? For instance: When will Nebraska be able to determine its pure premium on "suspenders without buckles," or Rhode Island on "butchers' supplies"? And yet rates must be quoted for either, and moreover they must be adequate and equitable.

Some two years ago I pointed out this difficulty in an article in The Market World and Chronicle, and suggested the necessity of grouping the numerous classifications. In fact, I had the temerity to announce that in my leisure hours, and after burning a good deal of midnight oil, I had prepared a tentative grouping of classifications. Immediately numerous requests from state departments and casualty companies arrived for copies of this grouping. The state of Wisconsin adopted it with some modifications.

The Massachusetts Insurance Department now very anxiously urges such grouping into some 150 groups according to similarity of hazard. The Bureau has recently adopted this suggestion, and a tentative grouping of classifications has been prepared by several members of its statistical committee which finds expression in the mysterious classification numbers found in the Basis Manual. The need for such grouping is well illustrated by the fact that the chief of the Federal Bureau of Labor Statistics has expressed his anxiety to publish it as an official document. Nevertheless, too much reliance must not be put on it in the beginning. Its aim is to group together classifications of similar hazard—but what do we know of exact measurements of hazard? That is the very thing that experience must in the future produce. For hazard is not to be measured by the likelihood of producing accidents, but by the actual causation of such hazards. Theoretically, equal hazard is to be defined as the factor which produces the same number of accidental injuries, and also the same distribution of accidental injuries per equal exposure in different classifications. At present the measurement of hazard is only an opinion, euphoniously called underwriting judgment, while actuarial science as well as sound business requires that rates be based on *facts*. The grouping of classifications must, therefore, be tested by actual experience, and again a sufficient volume of exposure is necessary for such testing.

The conclusion is inevitable, therefore, that some method of combining experience of different states is absolutely necessary, if we are to arrive at scientific rates within a reasonable time. That is true even after compensation has been written for some years. And in the beginning it is doubly necessary that some method be devised other than that of actual experience under each separate act, so that some use be made of every scrap of information both American and European.

I hope that I shall not be charged with undue pride for stating that nearly two and a half years ago I outlined the elements of such a method, which was further developed by such well known actuaries as Professor A. W. Whitney and Mr. A. H. Mowbray, and though it met with a considerable opposition in the beginning, succeeded in becoming the foundation upon which all the present compensation rates are built. In an article published in *The Market World and Chronicle* (June 22, 1912), I indicated that the compensation pure premium for any classification resolved itself into three factors: first, the accident rate; second, the distribution of accidents according to gravity, or according to the nature and duration of the injury, and third, the compensation scale. Knowing these three factors, we could compute the cost of a hundred or a thousand accidents, or what amounts to the same, the average cost of an accident, and apply it to the accident frequency for each classification.

This is the bare outline of the plan as suggested at the time. The compensation scale is known—it is stated in unmistakable terms in the law. American students approaching the problem usually assumed that there were no definite data in regard to the other two factors, accident frequency and accident gravity. It appeared then to me that the problem was not an impossible one. The insistence of American casualty companies upon receiving reports of all accidents to employes if assured is well known. Accidents are reported in this country to casualty companies very much better than, for instance, in England, as personal inquiries have convinced me. An evidence is the very much smaller proportion of claims to accidents in this country than in England. I hoped at the time that perhaps casualty companies might see their way to undertake such an investigation in their files. It has never been done, and, therefore, this part of the plan has a purely historical interest at present. But since it was argued at the time that such an investigation was altogether impossible, I want to point out that it is being done now on a very much smaller scale every day in the compilation of experience for merit rating, and will be done at the very much greater rate from now on.

It was argued at the time that liability accident reports were worthless even for obtaining accident frequency only, but now they are being used for accident gravity as well.

The main contribution of my plan was contained in the suggestion that European experience might be utilized for the purpose of distributing accidents into groups according to gravity. Though an extremely simple and almost obvious suggestion to any one who has made any study at all of foreign accident statistics and couldnot fail to be struck by the identical results in all countries, it appeared like a new scientific clue to many actuaries who were groping for some practical method of computing the cost of compensation. Professor A. W. Whitney was the first, I believe, to apply it. Mr. A. H. Mowbray tested it critically and found a good deal of evidence to corroborate what he was kind enough to designate as "Mr. Rubinow's hypothesis." I believe for some time it was even goodnaturedly referred to as "Rubinow's law."

While both these students could not use the methods outlined for the purpose of computing actual rates (because the necessary factor of accidental frequency was lacking) they both, entirely independently of each other, utilized it for a somewhat more modest purpose of measuring the comparative costs of different compensation acts and bills. Justice requires me to state, therefore, that the Rubinow hypothesis became a workable instrument of actuarial science only after the application made by Professor Whitney and Mr. Mowbray.

The first official sanction was given to the method by the New York Insurance Department in the work of establishing the basis Does this refer to the new york experience rating plan? Ifs perhaps the plan was in effort hepre for 191 the date we used in the actua's histor of experience rating plans. for New York compensation rates.* No one interested in compensation matters needs be reminded of the brilliant work done so recently by Mr. W. W. Greene. The disputable question as to final differential need not be gone into here, lest this peaceful meeting break up in a riot, but the final triumph of the method used by him (of measuring the comparative values of compensation scales by applying a standard table of accident gravity) cannot now be disputed.

The material which Mr. Greene and the department was forced to use for lack of time was not the very best. The Massachusetts distribution of accidents was highly unsatisfactory, the Austrian figures used, without any correction, may have been somewhat onesided, nevertheless it was the first large effort in the preparation of law differentials.

The problem which the New York Insurance Department had to solve was that of differentials only. But the casualty companies and the assured needed something vastly more difficult-they needed actual rates. The methods by which they were computed are recent history, and need not be described in any great detail. The formula used was:

Basic Pure Premiums \times loading for underestimates \times law diffor expenses $= 1 \times 1.08 \times 2.00 \times 1.50 = 3.24$.

The basic pure premium was obtained from the original formula Losses but since the payments had not all been made, and there

payroll,

was reason to believe that the estimates on outstanding payments were somewhat insufficient, these were loaded by an arbitrary amount. The law differential and the expenses for loading were equally results of compromises.

Our judgment of the value of the formula must be entirely independent of our opinions as to accuracy of the individual factors. It clearly appeared that some such formula was necessary so long as rates had to be quoted for some states for which experience did not exist at all, or was altogether insufficient.

In this process of adaptation the question of a proper law differ-

* Since this has been written, my attention was called to the fact that in 1913 Mr. E. H. Downey and Mr. J. Black used this method for the purpose of computing differentials for Illinois, Iowa, Michigan and Minnesota, as compared with the Wisconsin Act. (See "Workmen's Compensation, Second Annual Report, July 1, 1912 to June 30, 1913," published by the Industrial Commission of Wisconsin, 1913.)

ential was of paramount importance. At this juncture Professor Whitney conceived the fruitful idea of appointing a differential committee to devise a method of computing law differentials, and actually to compute such differentials which should be acceptable to all because of their evidence of scientific impartiality, if not absolute accuracy.* How successful this proposal was can be proven by the remarkable fact that the differential committee was able to make unanimous reports of all differentials which they prepared including some fifteen states. As compared with acrimonious discussions following the New York law differential this represents a noteworthy achievement. It may be designated as the first victory of the principle upon which this society is built—the principle of unbiased scientific inquiry applied to casualty problems.

Law differentials had been used before in the preparation of compensation rates, but represented rather crude guesses or estimates. It is a comparatively easy problem to measure the comparative provisions of the law in regard to a certain group of accidents. If, for instance, the New Jersey Act grants 50 per cent. and the New York Law $66\frac{2}{3}$ per cent. in certain cases, then they will cost one-third more in New York than in New Jersey.

The difficulty arises in trying to measure the differential for all the provisions of the law, when each particular difference must be carefully weighed. Evidently this will depend upon the distribution of accidents according to gravity or severity. The statisticians of the Wisconsin Industrial Commission, who have endeavored to compute a few law differentials, recognize this, and use the distribution of accidents in Massachusetts and in Wisconsin adding the data together, and obtaining a total of some 115,000 accidents. But while the results obtained were fairly satisfactory this method suffers from all the shortcomings of the statistics used. Massachusetts included all notices; Wisconsin, largely only accidents over seven days' duration. The systems of distribution were different in the two states, and unsatisfactory in either; especially in regard to accidents resulting in permanent disability, are these data faulty, because the condition of permanency cannot be ascertained in the short time within which both Massachusetts and Wisconsin data were compiled. Furthermore, in regard to several problems, such

* The committee consists of Mr. B. D. Flynn, Mr. Stanley L. Otis, Mr. C. E. Scattergood, and the writer.

as the number of dependents or the influence of limits, no information at all was available.

At this point the usefulness of the "Rubinow hypothesis," or "Rubinow Law" came in. Briefly, it may be stated thus:

Given a sufficiently variegated industrial activity, the distribution of accidents according to their physical results will be fairly uniform anywhere.

With the help of this hypothesis, the following method for computing law differentials was agreed upon:

Construct a standard accident table, showing such distribution by severity in all necessary details. Compute the value of compensation for this standard series under any law, and the ratio of this cost will be the law differential. As the basic premiums were thus obtained from Massachusetts experience, the Massachusetts value of the table was the basis for computing differentials.

The first step in this method was the construction of the standard table, a duty which I was fortunate enough to be entrusted with.

Popular fancy is a very mysterious thing. One never knows what may or may not please it. The 100,000 accidents of the Standard Table have quite unexpectedly for its author acquired quite a little reputation for themselves. Both the roundness and the bigness of the number seemed to impress popular imagination. In his article in the Survey, Mr. Benedict speaks of them as 100,000 accidents actually gathered from European experience. As a matter of fact, that is not accurate. The 100,000 is simply an extension of the percentage method. It seems preferable to use whole numbers rather than decimal fractions, carried out three places beyond the decimal point. The large number seemed necessary in order to permit their distribution in sufficient detail. The entire statistical material used in its preparation is too voluminous for presentation here. It is hoped that it will be possible to publish it in some other Moreover, the details are of purely statistical and of slight form. actuarial interest. It is sufficient to state that statistics of accidents in Germany, Austria, France, Belgium, Italy and Russia, in Massachusetts, Washington, California, and other states was utilized in The total number of accidents included in the this connection. data analyzed literally runs into millions. The following questions require an answer (in each case per 100,000):

1. The number of fatal accidents.

2. The number of cases of total permanent disability.

3. The number of dismemberments, distributed according to their exact nature.

4. The number of cases of permanent partial disability, other than dismemberments.

5. Their distribution according to degree of impairment of earning capacity.

6. The number of cases of total temporary disability.

7. Their distribution according to duration of disability (by weeks intervals).

8. The duration of total temporary disability in cases which result in dismemberments, or in other forms of permanent partial disability.

9. The number of fatal cases leaving total, partial or no dependents.

10. The number of widows, children, or other dependents surviving in those states where the death compensation is made dependent upon the number or kind of dependents surviving.

Briefly the standard table accepted by the committee embodies the following facts:

Fatalities	932
Total permanent disability	133
Dismemberments	2,300
Other permanent partial disability	2,442
Total temporary cases	94,193

Before any criticism of this distribution is offered, it is very important to remember that almost for the first time in American statistical literature, it has been based upon a very definite interpretation of an accident. This definition adopted by the Statistical Committee of the Bureau, and promising to become the standard definition through the United States, excludes all accidents where the injured person loses no time except on the day of injury; and according to the Massachusetts report, some 40 per cent. of accidents reported are of such trivial character. Naturally this increases the proportion of the serious accidents in the table.

To return to the actuarial problems. The standard table, or the 100,000, was taken through the mill of the compensation law of each state. Since the benefits almost universally are stated in proportion to week's wages, it was found convenient to utilize week's wages as a unit of measure rather than dollars and cents. It is but fair to add that in this the committee utilized the precedent established by Mr. Greene. In a few cases where the benefits are measured in money units, it was therefore necessary to reconvert these into week's wages by an assumption of an average weekly wage. That was true of funeral expenses and medical aid. Where long term payments are granted it was decided to utilize commuted values in the computation. Since a true differential between states was required, it did not seem scientific to disregard the factor of commutation, especially because in certain acts and for certain benefits the facts of mortality had to be taken into consideration. Annuities certain were used where the provisions of the law made probable that the total benefits would be paid to dependents even if one of them died during the time. Term annuities were used in most cases; life annuities where life pensions were granted, and deferred annuities in a few cases where the benefits consisted of a preliminary larger, and a deferred smaller annual amount. The effect of limit was measured by obtaining statistics of wages of injured persons and computing the cost of compensation both with and without limits.

For the computation of the cost of medical aid, no theoretical method presented itself, but fortunately experience data as to proportion between compensation and medical cost were available for a few states, and from these fairly reasonable estimates could be made for other states with slightly different provisions. The methods as thus recited appear complex. The committee would readily admit that they are not simple. While the computation of the first state differential took nearly a week, recently two differentials were computed in one day, and that, we feel, is a record that cannot be very much improved upon. Are the rates based upon these differentials absolutely right? That is the question that is most likely to be asked. No one is so little inclined to make this claim as the committee. Yet I am sure that I voice the conviction of all its members in stating that barring possible individual errors, the rates are, on the whole, the most scientific that ever were compiled in this country, and the best that could be compiled with the material as yet available.

While I am willing to stand by this claim, I am equally convinced that they are temporary only, and that possibly in two or three years, a complete revision, or readjustment will be necessary, and also possible, if meanwhile accurate statistical data are accumulated by the casualty companies.

Let us, therefore, frankly, though briefly, enumerate the elements of weakness in the method of rate computation: 1. The Basic Rate.—It is a trite observation that a chain is no stronger than its weakest link. As I have explained earlier in this paper, one year's experience in one state is not enough. When the Massachusetts experience, under the older law, is revised for the entire period, July 1, 1912–October 1, 1914, substantial changes will be made in most, if not all pure premiums, and further changes may become necessary if the experience of the states is combined.

2. The Law Differential.—This may have to be changed somewhat because of errors found in the Standard Table. As soon as records of a few hundred thousands of accidents are carefully studied in this country, the necessity for a hypothetical standard table will have vanished. Personally, I cherish the hope that the errors disclosed will not be very essential. Naturally, I cannot believe that the "Rubinow Law" is all wrong. Yet there are factors in it that are not altogether physical, such as the determination of degree of disability. The California schedule for instance differs materially from the schedules used in Europe, and similar differences between states may develop.

3. The construction put upon certain provisions of the laws may not have been altogether accurate. In a few cases, the committee was not altogether certain of its interpretation, especially in cases where the Act had not yet gone into effect. It is necessary to add, however, that the members of the committee carefully watch decisions of commissions and courts as to such interpretations.

4. A bigger problem, however, is the fundamental accuracy of applying the same law differential to all classifications. As already explained, the law differential depends upon the distribution of accidents as to severity. But while such distribution must be uniform, on the whole, as between one state and another, it differs materially, as between industries. The proportion of accidents resulting fatally, for instance, will be greater in a coal mine than in a clothing shop. Theoretically different standard accident tables should be compiled for each classification, or at least, for each large industrial group. But altogether outside of the enormous labor involved in such an undertaking, there are no data from which such tables could be constructed. We may feel that we have accomplished a good deal in achieving justice as between one state and another, without claiming equal justice between classifications.

5. The Question of Comparative Accidental Frequency.—That the physical and moral hazard is not equal throughout our great coun-

try any one will readily admit, but no one has prepared the necessary material for a convincing measure of the extent of such differences. Most extravagant statements, as to these differences, are often made. It is almost impossible either to prove or to disprove them. In a very few cases small allowances were made for them in establishing rates. To some extent the methods of schedule rating and experience rating recently established will tend to discount these differences. But nothing less than trustworthy accident statistics can settle this question to the satisfaction of all. If errors have been made, their cost is but the inevitable price of obtaining valuable business experience.

6. Finally, we must come back to a point mentioned earlier. The basis of a true rate is the basic pure premium, and yet for most classifications no one state can ever expect to have sufficient experience to produce a true pure premium. Compensation rates throughout the country cannot indefinitely be depended upon Massachusetts pure costs. Moreover, compensation rates in Nebraska cannot depend upon pure costs in Nebraska only, nor rates in Maryland upon Maryland costs. For each classification the experience of the entire country will have to be utilized. In so far as this experience is physical, and expressed in terms of accident frequency and severity, it will be adapted to universal use. And in so far as that experience is expressed in dollars and cents, the methods of law differentials will enable us to bring together accidental losses in all states, make proper allowances for the differences in the law, deduce a basic pure premium from them, and from that basic pure premium, derive pure premiums for each state which may differ materially from the actual costs in these states, and yet represent a truer measure of hazard.

Time does not permit me to go into the further details of this larger plan, which is premature at the present moment, anyway. But the statement cannot be made too emphatic that while the present rates may be the best that could be, their subsequent improvement depends entirely upon the development of accident statistics. The Bureau's careful and comprehensive plan, recently adopted, is well known. As actuaries and statisticians, we all look forward to its realization. Perhaps the casualty companies do not quite realize its cost. The plan may call for a study of 500,000 accidents annually, and that represents a comprehensive statistical undertaking, requires a substantial force and an efficient statistical outfit. But the casualty business needs the results, and no other body is likely to furnish them. The hope that the industrial commissions and accident boards will furnish these data has been cherished by many. But a careful analysis of the reports as yet turned out by Massachusetts, Wisconsin, California, Washington, Ohio and other states shatters the hope, at least for some time. Each one of these reports is interesting and to some extent valuable, but an effort to bring them together produces a maze of dissimilar data, absolutely barren of any tangible actuarial results. Given the political organization of our country, a statistical union of casualty business is as yet the only hope of valuable statistics. It should be the function of our young organization to see that the qualitative results of such co-operation should be worthy of the effort and expense required in its realization.

How Extensive a Payroll Exposure is Necessary to Give a Dependable Pure Premium?

ALBERT H. MOWBRAY.

The answer to this question, of fundamental importance in dealing with compensation rates, depends upon the answer to two others: (1) What are the characteristics of a dependable pure premium? (2) What factors tend to make a pure premium derived from experience undependable?

A complete answer to the first question should take into consideration a variety of factors, such as surplus, loadings, character and distribution of business, etc. It is not our present purpose to consider these factors as to the proper allowance for which wide differences of opinion will probably be found. For the purposes of the present discussion the following definition will suffice. "A dependable pure premium is one for which the probability is high (at least equal to an assigned value) that it does not differ from the absolute (true) pure premium by more than an arbitrary limit which may be selected in view of the other factors referred to."

Among the factors to be enumerated in answer to the second question are: Chance variations in the incidence of claims, number, size and character of the establishments entering into the experience, changes in legal conditions, changes in moral conditions, age of the compensation act in question, etc. It is our purpose to consider only the first of these, or what is sometimes referred to as the element of mathematical risk. It would seem that this question must be settled before the others can be appropriately taken up and by confining our attention to it we are enabled to analyze it by mathematical methods free from the confusing applications which arise when the other factors are weighed and considered.

The subject of mathematical risk was among those discussed at the Sixth International Congress of Actuaries in Vienna in 1909, but the discussion was primarily from the life insurance point of view and centered around the question of reserves to be built up as a safeguard against misfortune from this cause.

Although the point is open to some question, for most purposes,
I think, we may properly consider the pure premium as made up of several elements, each having an independent probability of its own and each of which may therefore be properly considered, for purposes of discussion, alone and apart from the others and the results appropriately combined.

If it be assumed, for purposes of discussion, that in every case of fatal accident dependents are left of a certain degree of dependency, we then have a very simple case of an event which may or may not occur and when it does occur produces a certain cost. Such a case presents the problem under discussion in its simplest form. The principle having been developed under such conditions, approximations will suggest themselves for reaching such of the more complex cases as must be considered.

Let us assume that the unknown true probability of fatal accident in a given classification is q and that our experience includes n full time workers per year. Then from elementary probabilities the most probable number of fatal accidents will be the greatest integer in (n+1)q, which is generally the same as the nearest integer to nq. Likewise from the elementary probabilities if nqis an integer, the probability of exactly nq fatal accidents is

$${}^{n}C_{nq}p^{np}q^{nq}$$
,

according to the usual notation p being (1-q). Further the probability that the number of fatal accidents will lie within 10 per cent. of nq either way is

$$\sum_{r=0.9nq}^{r=1.1nq} {}^{n}C_{r}p^{n-r} \cdot q^{r}.$$

From this it follows that if l be the probability that the number of observed deaths arising out of a number of exposures under observation will not differ from the most probable by more than k per cent. the number of exposures under observation is given by solving for n the equation

$$\sum_{r=(1-k)nq}^{r=(1+k)nq} {}^{n}C_{r}p^{n-r}q^{r} = l.$$
 (1)

If it were necessary to solve this equation the determination of the problem under consideration would be little if any advanced. It can, however, be shown (e. g., see Bowley, "Elements of Statistics," p. 275 et seq.) that for a limited range and when the values of p and q are neither very small the expansion of the binomial $(p+q)^n$ for large values of n approximates very closely the normal error curve

$$y = \frac{h}{\sqrt{\pi}} e^{-h^2 x^2} \tag{2}$$

when the origin is placed at the most probable value.

In other words, for a limited range of values on each side of the most probable, departures from that value conform closely to the "law of error." Hence we may write in place of equation (1)

$$\frac{h}{\sqrt{\pi}}\int_{-knq}^{+knq}e^{-h^2x^2}dx=l.$$
(3)

In equations (2) and (3) h, the measure of precision, equals $\frac{1}{\sqrt{2npq}}$. If in (3) the variable be changed to t = hx the equation becomes

$$\frac{1}{\sqrt{\pi}} \int_{-khnq}^{+khnq} e^{-t^2} dt = l \quad \text{or} \quad \frac{2}{\sqrt{\pi}} \int_{0}^{khnq} e^{-t^2} dt = l.$$
(4)

This last integral is of sufficient importance in mathematical work of various kinds that its values have been calculated and are available in various places. For example, Bowley (opus cit., p. 281) gives a table of the values of

$$F(x) = \frac{1}{\sqrt{\pi}} \int_0^x e^{-x^2} dx,$$

for values of x differing by .01 up to 1.50, and by .02 up to 2.00 for which F(x) = .498, its maximum value being .5. More extensive tables are available if needed. By use of such tables a complete solution is possible. For example, let the value of l be .90, i. e., the probability being 9 in 10 that the variation k will not be exceeded, then

$$F(x) = \frac{1}{\sqrt{\pi}} \int_0^{khnq} e^{-x^2} dx = .450,$$
 (5)

from which by the table,

$$x = khnq = 1.16, \tag{6}$$

$$\frac{knq}{\sqrt{2npq}} = 1.16, \quad n = 2\left(\frac{1.16}{k}\right)^2 \cdot \frac{1-q}{q}, \tag{7}$$

and from this q being known and k, the admissible variation having been determined upon, n can be computed.

From equations (5), (6) and (7) the following conclusions may be drawn:

1. For any particular value of q, l being fixed, n the number of exposures which must be observed, varies inversely as the square of k, the limit of admissible variation.

2. For fixed values k and l, n varies approximately inversely with q.

3. Since (x) increased more rapidly than F(x) = l, for fixed values of k and q, n varies directly with l in a ratio exceeding the square.

4. The values fixed for the limit of admissible variation, and for the probability of confinement of variation within such limits as necessary to make the pure premium dependable, are of much greater weight in determining the extent of data required than the probability of occurrence of the event.

Up to this point our analysis has proceeded as though q were a known quantity when, in fact q is the value we seek from experience, and is the element itself whose accuracy, as given by such experience, we are testing. For the border line cases where it is a close question whether the observed data is or is not sufficient to give a pure premium which will be dependable within the limits adopted, this creates an awkward situation and light from other sources must be sought. For most practical work, I think the value of q derived from the experience under review will be a satisfactory first approximation for the purposes of the test proposed.

Since the probabilities of the several contingencies giving rise to compensation losses are mutually independent, it is as reasonable to suppose that chance variations such as we have under consideration will tend to offset each other as to suppose they will be cumulative. In order therefore that the pure premium for the combined elements be pronounced dependable it hardly seems necessary that the probability, that the pure premium for each element does not differ from the true pure premium for that element by more than k per cent., reach the required standard, but only that there be such a probability that the pure premium for each element does not differ from the true pure premium for that element by more than a figure which is rather less than k per cent. of the aggregate pure premium.

A few numerical examples will probably make the foregoing theoretical discussion clearer, and will illustrate the way in which this error may be properly applied:

In the Market World and Chronicle of November 30, 1912 (new series, Vol. IV, No. 22, p. 67), is given a hypothetical table prepared by Professor Whitney for the California Industrial Accident Board, according to which the probability of accident (all kinds included) is .06, that of fatal accidents .0006, and of temporary disability .0552.

If the standard of dependable pure premium is taken to be that there is a 90 per cent. probability that variations will be limited to within 10 per cent. of the most probable, the value of k in (7) is .1, and for temporary disability q is .0552, and (1-q) is .9448. Hence, the number of employees required to be observed to find such a pure premium for temporary disability only is 4,605. If the average annual wages are \$600 this means a payroll exposure of \$2,763,000. Using the same standard with reference to the cost of fatal accidents above n becomes 448,264, a payroll of approximately \$270,000,000.

Professor Whitney has determined the pure premium for the present California Act, on a hypothetical basis set up, as .5342 weeks' wages per man, of which .0883 weeks' wages are the fatal accident cost. A variation of 10 per cent. of the total pure premium (.05342) is about 60 per cent. of the fatal accident pure premium, hence, in (7) k may be taken as equal to .6, and n becomes 12,452, a payroll of approximately \$7,471,200.

Using this value of n, taking q as .06 and solving (7) for k we find that the probability is 9 in 10 that the total number of accidents will not vary more than about 6 per cent. from the most probable. This is probably too large a variation to be coupled with a variation in the death cost of 10 per cent. of the aggregate pure premium. Hence a considerably larger payroll than \$7,500,000 should be available to define a pure premium for these conditions with the limits set.

The theory here discussed may be applied in a different way to the following problem. Given a rate derived from experience with a certain number of exposures, what is the chance that the difference between such rate and the unknown true rate lies within certain limits? As an example the textile rate of \$0.23 on Massachusetts Schedule Z may be taken. This is based upon a payroll of \$86,339,122. The report of the Industrial Accident Board for

the first year estimates the number of employees in cotton mills and woolen and worsted mills at 166,632 which at \$10 per week would almost exactly give this payroll. Schedule Z combines death and dismemberment losses at \$43,195 out of total incurred losses of \$201.095. The Industrial Accident Board data shows 17 fatal accidents; 9 fifty week cases; 22 twenty-five week cases and 99 twelve week cases. This indicates that about \$32,000 was the cost of fatal cases and about \$11,000 of specified indemnities so that the total cost was about $6\frac{1}{2}$ times the cost of fatal acidents. Again using the Industrial Accident Board data, 17 fatal accidents among 166,632 employees gives a probability of fatal accident of .0001 = q, p = .9999, n = 166,632. Hence for any assigned value of k we can compute the limit of integration in (4) and from the table find the corresponding value of l, the probability that the variation in the number of fatal accidents will not cause a change in the pure premium exceeding k.

The following table shows the probability that variation in fatal accident cost will be confined within certain limits expressed as percentages of the total pure premium

Percentage limit (k).	khnq = (x).	2F(x) = probability variation is confined within selected limit (k) .
10.0	1.948	.994
5.0	.974	.832
2.5	.487	.509

As the weekly indemnity columns include payments and reserves on account of permanent disability as well as temporary disability, it is impossible to form such a table for any other element. It will be interesting however to form such a table for variation in the rate of accidents (all kinds included) which from the Industrial Accident Board data is approximately .06497.

Percentage limit (k).	khng.	2F(x) = probability variation is confined within selected limit (k).
10	7.610	Practically 1
5	3,805	Practically 1
2.5	1.903	.992
1.0	.761	.719

Even though from tests of this kind it be found that a pure premium, as for example, the textile pure premium in the Massachusetts Schedule Z, is dependable within a satisfactory definition, it should not be assumed that another experience will develop a pure premium not differing from that tested by more than the limit set or even that it will *probably* do so unless the conditions remain the same. A variation in excess of the limit would seem to be a warning that some change in underlying conditions has probably taken place, such, for example, as a gradually developing tendency to more fully claim compensation benefits.

The data in such cases should accordingly be carefully studied to see if other evidence pointing to such changed conditions can be found.

In closing it should perhaps be pointed out that according to the mathematical law of error the probability of catastrophic losses is infinitesimal. Hence pure premiums found by these tests as dependable cannot be considered to cover this risk, and the tests, unless greatly modified, are not available for dealing with such industries as coal mining, blasting, etc., where the catastrophe hazard is high.

Note.—Since this paper was written the author has found that there was a somewhat similar discussion of this problem in the paper "On the Philosophy of Statistics" by Woolhouse, J. I. A., XVII, 37.

VALUATION OF THE DEATH BENEFITS PROVIDED BY THE NEW YORK COMPENSATION LAW.

WINFIELD W. GREENE.

Death Benefits Provided by the New York Compensation Law.

The death benefits of the various compensation laws effective in the United States may be classified as follows:

I. Benefits limited as to the sum total of compensation payments. II. Pensions limited in duration to a stipulated period.

III. Pensions ceasing at the death of the beneficiary,—and, in case of certain classes of pensioners, terminating also either when the beneficiary attains a certain age, or when he remarries.

The benefits provided by the New York law for dependents of workmen fatally injured in the course of their employment belong in the third class, as is indicated by the following summary of Sec. 16:

(a) To surviving wife (or dependent husband) 30 per cent. of deceased's wages until death; or until remarriage, when the pension is terminated by a payment equal to 60 per cent. of the annual earnings of the deceased. To each child, 15 per cent. of the deceased's wages until age 18, except that during the lifetime of the surviving wife (or dependent husband) the child's pension is 10 per cent. instead of 15.

(b) To any of the following relatives of the deceased,—grandchild, brother, sister, parent or grandparent,—15 per cent. of deceased's wages. The pensions to the grandchildren, brothers and sisters are payable until age 18, while the pensions to parents and grandparents are payable for life.

(c) The total amount of compensation payable per annum is not to exceed 663 per cent. of the wages of the deceased. The wife and children of the deceased are a preferred class of claimants; their pensions are apportioned first, and any balance remaining is divided among the other dependents.

At least three other states in the Union have compensation acts with death benefits similar to those of the New York law. The West Virginia law provides \$20 per month to the widow until her death or remarriage, with \$5 per month additional for each child under age 14, total not to exceed \$35 per month; the Washington law has the same death benefits as the West Virginia law, except that the children's pensions continue until age sixteen; while the Oregon law differs only in fixing the widow's pension at \$30 per month, with \$6 additional for each child under sixteen, total not to exceed \$50 per month.

Although there are only a few statutes of what we may term "the life pension type" in this country, the majority of compensation laws effective on the continent of Europe follow that pattern. In fact, a solution of the problems of the New York Compensation Law will go far to solve many questions of actuarial principle involved in the compensation acts of Austria, Belgium, Finland, France, Germany, Hungary, Holland, Norway, Portugal, Roumania, Russia, Sweden and Switzerland, and, as we have already suggested, of West Virginia, Oregon and Washington as well.

FORMULAE FOR PRESENT VALUE OF DEATH BENEFITS IN SIMPLE CASES.

In order to calculate the present value of compensation payable to beneficiaries of the New York law in fatal cases, we must first equip ourselves with appropriate and practicable formulae. In many instances this is not a difficult task.

Assuming, for convenience, that the average annual earnings of the deceased were 100, the present value of compensation where a widow (x) is the only dependent may be written as follows:

$$30\bar{a}_{x'} + 60\bar{E}_{x''},$$

where $\bar{a}_{x'}$ indicates an annuity of 1 per annum, payable momently, and terminating at death or remarriage; and where $\overline{E}_{x''}$ indicates the present value of 1 payable at the moment of remarriage.

Where the only dependent is a child, grandchild, brother or sister (y) the present value equals

(2)
$$15\ddot{a}_{y} \frac{1}{18-y}$$
.

Where a father, mother, grandfather or grandmother (w) is the only person entitled to compensation the appropriate expression is

(3) $15\bar{a}_{\omega}$.

Where there are several dependents receiving in all less than 66³ per cent. of the deceased's wages, the total present value of compensation will be the sum of several expressions like the foregoing, corresponding to the particular dependents involved.

Where a widow (x) and child (y) of the deceased are both entitled to compensation, the expression for the child's interest becomes

(4) $15\bar{a}_{y\,\overline{18-y}|} - 5\bar{a}_{xy\,\overline{18-y}|}$ instead of merely

 $15\bar{a}_{y_{18-y_{1}}}$, as in (2).

The introduction of this negative term is due to the fact that during the lifetime of the widow the child receives 10 per cent. of the deceased's wages, instead of 15.

The following is a simple illustration of the foregoing principles:

Example.

	Widow,	age	35,
Demendente -	Child,	age	10,
Dependents	Child,	age	2,
	l Mother,	age	65.

- ..

Formula:

(5)

$$30\bar{a}_{35'} + 60E'_{35} + 15\bar{a}_{2\,\overline{18}} - 5\bar{a}_{35:2\,\overline{18}} + 15\bar{a}_{10\,\overline{3}} - 5\bar{a}_{35:10\,\overline{3}} + 15\bar{a}_{10\,\overline{3}} - 5\bar{a}_{35:10\,\overline{3}} + 15\bar{a}_{65}.$$

In the above example it has not been necessary to take account of the provision in the law (Sec. 16) that "the total amount payable shall in no case exceed 66²/₃ per centum of such wages," i. e., of the "average wages of the deceased." Had there been, in addition to the dependents assumed in the example, another dependent entitled to 10 or 15 per cent. of the deceased's wages, it is clear that the limitation imposed by the law would affect the aggregate present value of the benefits. Assuming this additional dependent to be a father 70 years of age and disregarding the limitation, the present value in the latter case would be $15\bar{a}_{70}$ plus the expression already obtained, or (6) $30\bar{a}_{35'} + 60\overline{E}_{35''} + 15\bar{a}_{2\,\overline{16}|} - 5\bar{a}_{35\,;\,2\,\overline{16}|} + 15\bar{a}_{10\,\overline{5}|} - 5\bar{a}_{35\,;\,10\,\overline{8}|} + 15\bar{a}_{10\,\overline{5}|} + 15\bar{a}_{70}.$

We will now derive a mathematical expression for the effect of the limitation in this particular case by determining to what extent the above formula conflicts with the maximum of 662/3 per cent. stipulated by the law.

In the first place, the above formula assumes that while all of the dependents remain entitled to compensation, an aggregate of 80 per cent. of the deceased's wages will be payable,—30 per cent. to the widow, 10 per cent. to each of two children, and 15 per cent. to each of two dependent parents. The limitation of 66³/₃ per cent. will accordingly effect a deduction which may be written as follows:

(7)
$$(80 - 66\frac{2}{3})\bar{a}_{35';2}\overline{16}_{;10}\overline{8}_{;65;70} = 13\frac{1}{3}\bar{a}_{35';2;10;65;70}\overline{8},$$

where the accent over the "35" indicates that with respect to this life (that of the widow) probabilities of surviving unmarried,—not of survival alone,—are taken into account.

The foregoing formula assumes further that after one of the children ceases to receive compensation, as long as all of the other dependents continue entitled to their pensions, compensation aggregating 70 per cent. will be payable. The limit of $66\frac{2}{3}$ per cent. will accordingly introduce a second deduction equal to

$$(70 - 66\frac{2}{3})[\bar{a}_{35':2}\overline{16}]:65:70 - \bar{a}_{35':2}\overline{16}]:10\overline{8}]:65:70] + (70 - 66\frac{2}{3})[\bar{a}_{35':10}\overline{8}]:65:70 - \bar{a}_{35':2}\overline{18}]:10\overline{8}]:65:70] = 3\frac{1}{3}[\bar{a}_{35':2}:65:70\overline{16}] + \bar{a}_{35':10:65:70\overline{8}} - 2\bar{a}_{35':2:10:65:70\overline{8}}].$$

As we have discussed all of the conditions in which the assumptions of our original formula conflict with the maximum stipulated in the law, we may now write a new formula which makes due allowance for the maximum by taking the difference between (6) and the algebraic sum of (7) and (8), as follows:

$$(9) \begin{array}{c} 30\bar{a}_{35'} + 6\overline{0}\overline{E}_{35''} \\ + 15\bar{a}_{2\,\overline{16}|} - 5\bar{a}_{35\,:2\,\overline{16}|} \\ + 15\bar{a}_{10\,\overline{8}|} - 5\bar{a}_{35\,:10\,\overline{8}|} \\ + 15\bar{a}_{65} + 15\bar{a}_{70} \\ - 3\frac{1}{3}[\bar{a}_{35':2:65\,:70\,\overline{16}|} + \bar{a}_{35':10:65\,:70\,\overline{8}|}] \\ - 6\frac{2}{3}\bar{a}_{35':2:10:65\,:70\,\overline{8}|}. \end{array}$$

The particularized method just employed cannot easily be extended to cases involving many dependents. In the first place, without the aid of a general rule it is extremely difficult in complicated cases to enumerate all the situations where the $66\frac{2}{3}$ per cent. limitation will affect the compensation payable. Moreover, since the number of terms in the algebraic expression corresponding to the deduction on account of the limit increases so rapidly with the number of dependents involved, that our formula soon becomes unwieldy and impracticable, it seems advisable to investigate some more general method.

A MATHEMATICAL EXPRESSION FOR THE DEDUCTION ON ACCOUNT OF THE 663 PER CENT. LIMIT AS TO COMPENSATION.

Where the Beneficiaries are a Widow and any Number of Children Whatsoever.

Let us assume that the victim of an industrial accident is survived by a widow (x), and children (y_1) , (y_2) , (y_3) , \cdots , (y_n) , where (y_1) is the youngest, (y_2) is next to the youngest, and so on. We shall first investigate the influence of the limit

While the wife survives, and has not remarried. The wife is entitled to 30 per cent., each child to 10 per cent., of the deceased's wages. While the widow and only one, two, or three children receive compensation, the amount payable will not be affected by the limitation, as this amount is always less than the maximum permitted by the law.

While the widow and at least four children receive compensation, the pensions payable, if there were no prescribed limit, would equal or exceed 70 per cent. of the deceased's wages (30 per cent. to the widow, and at least 40 per cent. to the children). Consequently, during this status the limitation of $66\frac{2}{3}$ per cent. will effect a deduction of at least $3\frac{1}{3}$ per cent. in the compensation payable. The deduction on account of the limit will therefore equal, or include, the following expression:

$$3\frac{1}{3}\bar{a}_{x'}\frac{4}{y_1\,\overline{18-y_1}\,:\,y_2\,\overline{18-y_2}\,...\,y_n\,\overline{18-y_n}},$$

where the temporary annuity represented is to run while (x) survives unmarried, and while at least four of the n children survive and have not attained age 18.

While the widow and at least five children remain beneficiaries, the total compensation which would be payable if there were no limit is equal to or greater than 80 per cent. During this latter status the limit will therefore effect a deduction of at least $13\frac{1}{3}$ per cent. or 10 per cent. in addition to the $3\frac{1}{3}$ per cent. deduction which obtains while the wife and four children continue to receive compensation. This deduction may be expressed algebraically as follows:

$$10\bar{a}_{x'} \frac{5}{y_1 \overline{18-y_1} : y_2 \overline{18-y_2} \dots y_n \overline{18-y_n}} \,.$$

By similar reasoning we may show that as long as a widow and six children are receiving compensation, there will obtain a further deduction of 10 per cent., which may be written

$$10\vec{a}_{x'} \frac{6}{y_1 \overline{13-y_1} : y_2 \overline{13-y_2} | \dots y_n \overline{13-y_n} |}$$

By use of the foregoing process we may obtain an expression in actuarial symbols for the total effect of the limit *while the widow remains entitled to compensation*. This expression may be extended indefinitely, but its significant terms will be limited by the actual number of children who are beneficiaries in any particular case. We may write this expression in the following perfectly general terms:

$$(10) \quad 3\frac{1}{3}\bar{a}_{x'}\frac{5}{y_1\,\overline{18-y_1}\,;\,y_2\,\overline{18-y_2}\,...\,y_n\,\overline{18-y_n}} + 10\bar{a}_{x'}\frac{5}{y_1\,\overline{18-y_1}\,;\,y_2\,\overline{18-y_2}\,...\,y_n\,\overline{18-y_n}} \\ + 10\bar{a}_{x'}\frac{6}{y_1\,\overline{18-y_1}\,;\,y_2\,\overline{18-y_2}\,...\,y_n\,\overline{18-y_n}} \cdot \cdots \cdot \\ \cdots + 10\bar{a}_{x'}\frac{n}{y_1\,\overline{18-y_1}\,;\,y_2\,\overline{18-y_2}\,...\,y_n\,\overline{18-y_n}} \cdot$$

We shall next consider the influence of the limit

During the lifetime of the wife but after her remarriage. The children are now the only beneficiaries, receiving 10 per cent. each, as before. While at least seven children are receiving compensation, the limit will effect a deduction of at least $(7 \times 10 \text{ per cent.})$

$$\begin{array}{l} - 66_3^2 \text{ per cent.}) \text{ or } 3_3^1 \text{ per cent., which may be written} \\ (11, a) \quad 3_3^1 \Big[\bar{a}_x \frac{7}{y_1 \overline{18-y_1} |: y_2 \overline{18-y_2} | \dots y_n \overline{18-y_n} |} - \bar{a}_{x'} \frac{7}{y_1 \overline{18-y_1} |: y_2 \overline{18-y_2} | \dots y_n \overline{18-y_n} |} \Big] \cdot \end{array}$$

As before, the total deduction takes the form of a series. Each term involves the difference between two temporary annuities, one payable during the lifetime of the widow, and the other payable until her death or remarriage; in this way the probability that the widow survives after having remarried is taken into account.

The second term is

(11, b)
$$10 \left[\bar{a}_{x} \frac{8}{y_{1} \bar{18} - y_{1} \right] : y_{2} \bar{18} - y_{2} \right] ... y_{n} \bar{18} - y_{n}} - \bar{a}_{x'} \frac{8}{y_{1} \bar{18} - y_{1} \right] : y_{2} \bar{18} - y_{2} \left[... y_{n} \bar{18} - y_{n} \right]}.$$

And the final significant term is

(11, c) 10
$$\left[\bar{a}_{x} \frac{n}{y_{1}\overline{18}-y_{1}}; y_{2}\overline{18}-y_{2}}, \dots, y_{n}\overline{18}-y_{n}}\right] - \bar{a}_{x'} \frac{n}{y_{1}\overline{18}-y_{1}}; y_{2}\overline{18}-y_{2}}, \dots, y_{n}\overline{18}-y_{n}}\right]$$

By a similar process we may write an expression for the effect of the limit

After the death of the wife. The children are now each entitled to 15 per cent. The compensation payable to five children will accordingly be affected by the limit to the extent of $(5 \times 15 \text{ per}$ cent. $-66\frac{2}{3}$ per cent.), or $8\frac{1}{3}$ per cent. The formula for this deduction will be

$$\begin{array}{c} (12) \ 8\frac{1}{3} \left[\left. \tilde{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n} \right]} - \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n}} \right] \\ + 15 \left[\left. \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n} \right]} - \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n}} \right] \\ + 15 \left[\left. \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n} \right]} - \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n}} \right] \right] \\ + 15 \left[\left. \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n} \right]} - \bar{a} \frac{5}{y_1 \overline{18-y_1} + y_2 \overline{18-y_2} + \dots + y_n \overline{18-y_n}} \right] \right] \\ \end{array}$$

In the foregoing expression, the coefficient of the second and of each subsequent term is 15, instead of 10 as in the other two series, because after the widow's death the compensation which would be payable if there were no limit is increased 15 per cent. by each additional child. The probability that the widow no longer survives has to be accounted for by making each term of the above series involve the difference between two temporary annuities, the one conditional upon probabilities of the widow's survival and the other independent of such probabilities.

The Text Book of the Institute of Actuaries (Part II, page 133) illustrates a method which we may extend to temporary annuities and thereby express

THE FORMULA FOR THE TOTAL DEDUCTION IN A COMPACT FORM.

If Z^r signifies the sum of the values of the temporary annuities on r joint lives for all the combinations of r lives that can be made out of n lives,—where for our purposes each life ceases at age 18, then

$$\bar{a}_{y_1\overline{18-y_1}:y_2\overline{18-y_2}|\dots y_n\overline{18-y_n}|}^r = \frac{Z^r}{(1+Z)^r}$$

where Z relates to temporary annuities which depend upon the lives (y_1) , (y_2) \cdots (y_n) only. We may employ the symbol Z_2 where (x), and Z where (x') is involved, so that (10) becomes

(13)
$$3\frac{1}{3}\frac{Z^4}{(1+Z)^4} + 10\frac{Z^5}{(1+Z)^5} + 10\frac{Z^6}{(1+Z)^6} \cdots + 10\frac{Z^n}{(1+Z)^n},$$

(11, a), (11, b) and (11, c) are replaced by

$$(14) \quad 3\frac{1}{3} \left[\frac{Z^7}{(1+Z)^7} - \frac{Z^7}{(1+Z)^7} \right] + 10 \left[\frac{Z^8}{(1+Z)^8} - \frac{Z^8}{(1+Z)^8} \right] \\ + 10 \left[\frac{Z^9}{(1+Z)^9} - \frac{Z^9}{(1+Z)^9} \right] \cdots \cdots + 10 \left[\frac{Z^n}{(1+Z)^n} - \frac{Z^n}{(1+Z)^n} \right],$$

and (13) becomes

By taking the sum of (13), (14) and (15), we may, after cancellation, write the following

Formula for the aggregate deduction on account of the 662/3 per cent. limit in compensation, where the only dependents are a wife and n children:

$$(16) \quad 3\frac{1}{3}\frac{Z^{4}}{(1+Z)^{4}} + 10\frac{Z^{5}}{(1+Z)^{5}} + 10\frac{Z^{6}}{(1+Z)^{6}} + 6\frac{Z^{7}}{3}\frac{Z^{7}}{(1+Z)^{7}} \\ - 8\frac{1}{3}\frac{Z^{5}}{(1+Z)^{5}} - 15\frac{Z^{6}}{(1+Z)^{6}} - 11\frac{2}{3}\frac{Z^{7}}{(1+Z)^{7}} \\ - 5\left[\frac{Z^{8}}{(1+Z)^{8}} + \frac{Z^{9}}{(1+Z)^{8}} + \frac{Z^{n}}{(1+Z)^{9}} + \frac{Z^{n}}{(1+Z)^{n}}\right] \\ + 8\frac{1}{3}\frac{Z^{5}}{(1+Z)^{5}} + 15\left[\frac{Z^{6}}{(1+Z)^{6}} + \frac{Z^{7}}{(1+Z)^{7}} + \frac{Z^{n}}{(1+Z)^{7}} + \frac{Z^{n}}{(1+Z)^{7}}\right] \\ \cdots + \frac{Z^{n}}{(1+Z)^{n}}\right]$$

It is very easy to pass from the foregoing formula to an expression involving joint temporary annuities ceasing at first death, —or ceasing either at first death or at the remarriage of one of the annuitants. As temporary annuities of this sort can readily be calculated, it is theoretically possible to determine the numerical value of the deduction by the use of the above formula, after substituting for the powers of

$$\frac{Z}{\frac{1}{(1+Z)}}, \frac{Z}{\frac{2}{(1+Z)}} \text{ and } \frac{Z}{\frac{3}{(1+Z)}}$$

their linear expansions.

To illustrate the practical obstacles in the way of the method just suggested, let us assume that the present value of the deduction on account of the $66\frac{2}{3}$ per cent. limit has to be computed where the dependents are a widow, and nine children less than 18 years of age. The following table shows the powers of Z, Z and Z which would have to be evaluated, and the number of joint temporary annuities which enter into the value of each of these powers, according to formula (16).

TABLE A.

EXHIBIT OF THE NUMBER OF TEMPORARY ANNUITIES TO BE CALCULATED BY FORMULA (16).

Powers of Z Appearing in Linear	Number of Temporary Annuities to be Calculated.		Summary.
Formula (16).	Symbol,	Actual Number.	
Z^5 1	9 ₆₈	126	
$\frac{Z^8}{1}$	9 ₆₆	84	Joint temporary
\tilde{Z}^{7}	9 ₆₇	36	annuities upon lives of chil-
\hat{Z}^{8}	9 _{c8}	9	dren only 256
29 1	9 _{c9}	1	
Z ⁵ 2	9 _{c6}	126	
Ž6	9 ₆₆	84	Joint temporary annuities upon
$ar{Z}^{ au}$	9 _{c7}	36	lives of chil- dren during
$ar{Z}^8_2$	9 _{e8}	9	lifetime of mother256
$ar{Z}^{9}$ 2	9_{c_9}	1	
Z ⁴ 3	9.04	126	
Z^{5}_{3}	9_{c_b}	126	Joint temporary
Z^6	$9_{c_{6}}$	84	annuities upon lives of chil- dren during widowhood of mother382
Z^{7}	9 _{c7}	36	
\tilde{Z}^{6}	9 _{c8}	9	
Ž9 3	9 _{cg}	1	
Total number of	temporary annuit	ies to be calculated.	. 894

Dependents-A Widow and Nine Children.

The above example suggests that in many instances it will be wholly impracticable to employ formula (16) as long as Z^r , Z^r and Z^r retain their original meaning. This remains true although the the number of temporary unities to be calculated drops rapidly with the number of children entitled to compensation. For instance, where the beneficiaries are a widow and seven children, formula (16) requires the calculation of 122 temporary annuities and, incidentally, the computation of equivalent equal ages for 122 different groups of lives. Accordingly it is desirable to investigate some method of reducing the number of equal ages and annuities to be calculated.

THE EFFECT OF DISREGARDING DIFFERENCES IN AGE AMONG THE CHILDREN, AS REGARDS MORTALITY.

With respect to temporary annuities, as well as whole life annuities, Z^r is the sum of the annuities for all the combinations of a given *n* lives taken *r* at a time. The *n* lives $(y_1), (y_2), \dots,$ (y_n) are respectively associated with the following terms, $\overline{18-y_1}|$, $\overline{18-y_2}|, \dots, \overline{18-y_n}|$. If n=9, and r=5, one of the annuities which form Z^r will be

 $\bar{a}_{y_1} \overline{1_{5-y_1}} : y_3 \overline{1_{5-y_2}} : y_4 \overline{1_{5-y_4}} : y_6 \overline{1_{5-y_6}} : y_7 \overline{1_{5-y_7}}$ which may be abbreviated to

$\bar{a}_{y_1:y_3:y_4:y_6:y_7}$

since the shortest term is the only one having any practical significance. As the oldest life in any group of children entitled to compensation fixes the term for which the annuity is to run, it is clear that whenever r is less than n, Z^r will include annuities for more than one term.

The longest term will be $18 - y_r$, and there will be one annuity for this term, as there can be but one group of r lives in which (y_r) is the oldest.

There will be $r_{c_{r-1}}$ groups of r lives where y_{r+1} is the oldest, as, with y_{r+1} a fixture in the group, there remain (r-1) places to fill from the r lives younger than (y_{r+1}) . Thus there will be rc_{r-1} annuities for the term of $(18 - y_{r+1})$ years.

Similarly, there will be $r^{+1}c_{r-1}$ annuities for the term of $(18 - y_{r+2})$ years.

If for the time being we disregard the particular ages involved in each annuity, and consider only the term for which the annuity runs, we may combine all annuities involving the same number of lives, and the same term. Then

(17)

$$\frac{?^{r}}{1} = \bar{a}_{1\overline{8}-\overline{y_{r}}|} + {}^{r}c_{r-1} \cdot \bar{a}_{1\overline{8}-\overline{y_{r+1}}|} + {}^{r+1}c_{r-1} \cdot \bar{a}_{1\overline{8}-\overline{y_{r+2}}|} \cdots + {}^{n-1}c_{r-1} \cdot \bar{a}_{1\overline{8}-\overline{y_{n}}|} + {}^{r+1}c_{r-1} \cdot \bar{a}_{1\overline{8}-\overline{y_{r+2}}|} + {}^{r}c_{r-1} \cdot \bar{a}_{1\overline{8}-\overline{y_{r+2}}|} + {}^{r}c_{r-1}$$

where the "r" under the " \bar{a} " indicates the number of lives (of children) upon which the annuity is based, and where the original value of Z^r will be preserved if we define $\bar{a} \ \overline{18-y_s}$ as the average of the temporary annuities for the term $(\overline{18-y_s})$ years, for all the groups consisting of r lives of which y_s is the oldest, which may be selected from the n lives $(y_1), (y_2), \dots, (y_n)$. Employing notation analogous to the above, we may write similar expressions for Z^r and Z^r .

The number of annuities to be calculated to obtain the value of Z^r has now been reduced from ${}^{n}c_{r}$ to (n-r+1). The deduction on account of the limit may now be obtained by computing 51 annuities in case of a widow and nine children, and 22 annuities in case of a widow and seven children.

THE DEDUCTION EXPRESSED AS THE SUM OF SEVERAL CONVERGENT SERIES.

The symbol $\frac{Z^r}{(1+Z)^r}$ stands for its expansion $r \cdot \overline{r+1}$

$$Z_1^r - rZ_1^{r+1} + \frac{r \cdot r + 1}{2}Z_1^{r+2} \cdots$$

Substituting for Z^r its value as shown in (17), we obtain

(18)
$$\frac{\frac{Z^{r}}{(1+Z)}r = \bar{a}_{\overline{13-y_{r}|}} + r(\bar{a}_{\overline{13-y_{r+1}|}} - \bar{a}_{\overline{13-y_{r+1}|}}) + \frac{r\cdot\overline{r+1}}{r} + \frac{r\cdot\overline{r+1}}{2}(\bar{a}_{\overline{13-y_{r+2}|}} - 2\frac{\bar{a}_{\overline{13-y_{r+2}|}}}{r+1} + \frac{\bar{a}_{\overline{13-y_{r+2}|}}}{r+2}).$$

For our purposes we may consider $\bar{a}_{\overline{18-y_*}|}$ as a function of r, so that $(\bar{a}_{\overline{18-y_*}|} - \bar{a}_{\overline{18-y_*}|})$ may be written $\Delta \bar{a}_{\overline{18-y_*}|}$, and $(\bar{a}_{\overline{18-y_{r+2}}|} - 2\bar{a}_{r+1}\bar{a}_{\overline{18-y_{r+2}}|} + \bar{a}_{\overline{18-y_{r+2}}|})$ may be written $\Delta^2 \bar{a}_{\overline{18-y_{r+2}}|}$ whereupon (18) becomes

(19)
$$\frac{\frac{Z^{r}}{(1+Z)^{r}}}{(1+Z)^{r}} = \tilde{a}_{\overline{13-y_{r}}|} - r\Delta \bar{a}_{\overline{13-y_{r+1}}|} + \frac{r\cdot\overline{r+1}}{2}\Delta^{2}\tilde{a}_{\overline{13-y_{r+2}}|} \cdots$$

By interpreting Z^r_{i} and Z^r_{i} as we have Z^r_{i} , we may expand for-

mula (16) as is shown in "Table B." The several expressions for $\frac{Z^r}{(1+Z)^r}$ have not been extended to include higher powers of Δ than Δ^2 . In cases involving seven or more children, some of these omitted terms become significant, but each such term may easily be deduced from the law of the series of which it forms a part. Moreover, it seems highly probable that no serious error will be introduced if we disregard Δ^3 and higher differences altogether.

If the higher differences are taken into account, the only error introduced by the use of the formula shown in "Table B" arises from combining annuities for the same term, and upon the same number of lives (of children), regardless of the different groups of ages upon which the annuities so combined depend. Where we employ a mortality table which follows Makeham's law from age "0" on, this error may be kept within narrow limits. By computing the present value of the deduction on account of the limit twice, first basing each temporary annuity $\bar{a}_{18-\nu_1}$ upon the r equal ages corresponding to the r lives y_{s} , y_{s-1} , y_{s-2} , \cdots , y_{s-r+1} , and the second time upon the r equal ages corresponding to the r lives y_1, y_2, y_3, \cdots , y_r , we obtain two values,—the true value of the deduction lying between the two, and nearer to the first than to the second. The first method yields a smaller present value for the deduction, and consequently a larger net present value of compensation.

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TABLE B.

REDUCTION IN PRESENT VALUE BECAUSE OF 663 PER CENT. LIMIT IN COMPENSATION.

Where the Dependents Are a Widow and Several Children.

Subtract value obtained by use of significant terms of this formula from present value of compensation which would be payable if there were no 663 per cent. limitation.

$$\begin{split} & 3\frac{1}{3} \left[\sqrt{4}\bar{a}_{x'1\overline{18-y_{4}}} - 4\Delta_{4}\bar{a}_{x'1\overline{18-y_{6}}} + \frac{4.5}{2}\Delta^{2}\sqrt{4}\bar{a}_{x'1\overline{18-y_{6}}} \cdots \right] \\ &+ 10 \left[\sqrt{5}\bar{a}_{x'1\overline{18-y_{6}}} - 5\Delta_{5}\bar{a}_{x'1\overline{18-y_{6}}} + \frac{5.6}{2}\Delta^{2}\sqrt{6}\bar{a}_{x'1\overline{18-y_{7}}} \cdots \right] \\ &+ 10 \left[\sqrt{5}\bar{a}_{x'1\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{x'1\overline{18-y_{7}}} + \frac{6.7}{2}\Delta^{2}\sqrt{6}\bar{a}_{x'1\overline{18-y_{6}}} \cdots \right] \\ &+ 6\frac{2}{3} \left[\sqrt{6}\bar{a}_{x'1\overline{18-y_{7}}} - 7\Delta_{7}\bar{a}_{x'1\overline{18-y_{8}}} + \frac{7.8}{12}\Delta^{2}\sqrt{6}\bar{a}_{x'1\overline{18-y_{6}}} \cdots \right] \\ &- 8\frac{1}{3} \left[\sqrt{6}\bar{a}_{x}\overline{18-y_{7}} - 7\Delta_{7}\bar{a}_{x'1\overline{18-y_{8}}} + \frac{7.8}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{7}} \cdots \right] \\ &- 15 \left[\sqrt{6}\bar{a}_{x}\overline{18-y_{6}} - 5\Delta_{5}\bar{a}_{x}\overline{18-y_{7}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{7}} \cdots \right] \\ &- 11\frac{2}{3} \left[\sqrt{7}\bar{a}_{x}\overline{18-y_{7}} - 7\Delta_{7}\bar{a}_{x}\overline{18-y_{8}} + \frac{7.8}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{8}} \cdots \right] \\ &- 11\frac{2}{3} \left[\sqrt{7}\bar{a}_{x}\overline{18-y_{7}} - 7\Delta_{7}\bar{a}_{x}\overline{18-y_{8}} + \frac{7.8}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{8}} \cdots \right] \\ &- 5 \left[\sqrt{6}\bar{a}_{x}\overline{18-y_{7}} - 7\Delta_{7}\bar{a}_{x}\overline{18-y_{8}} + \frac{8.9}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{8}}} \cdots \right] \\ &- 5 \left[\sqrt{6}\bar{a}_{x}\overline{18-y_{7}} - 8\Delta_{8}\bar{a}_{x}\overline{13-y_{9}} + \frac{8.9}{12}\Delta^{2}\sqrt{6}\bar{a}_{x}\overline{18-y_{1}}} \cdots \right] \\ &+ 8\frac{1}{3} \left[\sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 5\Delta_{5}\bar{a}_{\overline{18-y_{8}}} + \frac{8.9}{12}\Delta^{2}\sqrt{6}\bar{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ 15 \left[\sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 5\Delta_{5}\bar{a}_{\overline{18-y_{8}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ 15 \left[\sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ 15 \left[\sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ 15 \left[\sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ \sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ \sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ \sqrt{6}\overline{a}_{\overline{18-y_{6}}} - 6\Delta_{6}\bar{a}_{\overline{18-y_{1}}} + \frac{6.7}{12}\Delta^{2}\sqrt{6}\overline{a}_{\overline{18-y_{1}}} \cdots \right] \\ &+ \sqrt{6}\overline{a}_{\overline{18-y_{1}}} - 2\sqrt{6}\overline{a}_{\overline{18-y_{1}}} + \frac{6}\sqrt{6}$$

A WORKABLE FORMULA FOR THE REDUCTION IN PRESENT VALUE DUE TO THE $66\frac{2}{3}$ PER CENT. LIMIT AS TO COMPENSATION.

For calculations involving more than seven children it will be found desirable to modify the formula of Table B somewhat. A study of this formula indicates that where the present value of the deduction has been computed, assuming as dependents a widow and seven children, taking into account one more child, the oldest of the entire eight, will increase the deduction by the value of the following terms (disregarding Δ^3 and higher differences).

$$(20) \qquad -6\frac{2}{3} \cdot 7\Delta \bar{a}_{x'\overline{18-y_8}} + 10 \frac{6.7}{\underline{2}} \Delta^2 \bar{a}_{x'\overline{18-y_8}} \\ -5\bar{a}_{x} \frac{1}{\overline{18-y_8}} + 11\frac{2}{3} \cdot 7\Delta \bar{a}_{x} \frac{1}{\overline{18-y_8}} - 15\frac{6.7}{\underline{2}} \Delta^2 \bar{a}_{x} \frac{1}{\overline{18-y_8}} \\ + 15 \left[\frac{\bar{a}_{\overline{18-y_8}}}{8} - 7\Delta \bar{a}_{\overline{18-y_8}} + \frac{6.7}{\underline{2}} \Delta^2 \bar{a}_{\overline{18-y_8}} \right].$$

The last line of the above expression is symbolically equivalent to

$$15\bar{a}_{\frac{13-\gamma_{0}}{8}}\left[1-7\Delta(1+\Delta)^{-1}+\frac{6.7}{2}\Delta^{2}(1+\Delta)^{-2}\right]$$

on basis of our previous assumption that $\bar{a}_{1\overline{1}-y_{r}|}$ is a function of r. The expression within the foregoing brackets is the first three terms of the binomial expansion of $\left(1-\frac{\Delta}{1+\Delta}\right)^{7}$, that is, of $(1+\Delta)^{-7}$. As a convenient approximation, we may therefore write the last line of (20)

$$15\bar{a}_{18-y_8|}(1+\Delta)^{-7}$$

that is

$$15\bar{a}_{18-y_8}$$

which is equal to

$15\bar{a}_{y_8}\overline{_{13-y_8}}$

according to the definition of $\bar{a}_{\overline{18-y_{*}|}}$ already promulgated.

In general, we may, as an approximation, write the following:

(21)
$$K\left[\frac{\bar{a}_{1\overline{18-y_n}}-(n-1)\Delta \frac{\bar{a}_{1\overline{18-y_n}}}{n-1} + \frac{\overline{n-1}n-2}{\lfloor 2}\Delta^2 \frac{\bar{a}_{1\overline{18-y_n}}}{n-2}\right] = K\bar{a}_{y_n\overline{18-y_n}}$$

The same principle applies with respect to temporary annuities conditioned upon the survival, or upon the survival and continued widowhood of the wife of the deceased.

"Table C" which follows shows the formula of "Table B" amended in accordance with the foregoing principle. It is of interest that the formula for the deduction where the dependents are a widow and ten children,—according to "Table C,"—contains the following terms which would not appear if only nine children were entitled to compensation:

(22)
$$15\bar{a}_{y_{10}}\overline{}_{1\overline{s-y_{10}}} - 5\bar{a}_{xy_{10}}\overline{}_{1\overline{s-y_{10}}}.$$

It will be recalled that the above terms constitute the formula for the present value of the compensation due the tenth child in ascending order of age, where the deceased's widow is entitled to compensation at the date of valuation. Consequently it appears that for practical purposes we may disregard the tenth child and older children, as taking one or more of them into account would result in increasing both the positive and negative elements in our present value by the value of identical expressions of the form of (22). Where the number of children is eight or nine it will be found that certain terms in the formula of "Table C" are identical with, and therefore cancel, certain terms in the formula for the present value of compensation which would be payable if no limitation of 66²/₃ per cent. obtained, although this cancellation does not permit us to leave the eighth and ninth children out of our reckoning altogether.

It is quite clear that the true present value of compensation payable will be increased somewhat whenever we take an additional dependent into account. It is by no means surprising, however, that when this additional dependent is the oldest of ten children (whose mother is entitled to compensation) this increase will be small enough to neglect in practice. For in such a case the existence of the tenth child cannot increase the compensation actually payable except in the event of the occurrence of one of the following extremely remote contingencies.

TABLE C.

REDUCTION IN PRESENT VALUE BECAUSE OF 663 PER CENT. LIMIT IN COMPENSATION.

Where the Dependents Are a Widow and n Children.

Subtract value obtained by use of significant terms of this formula from present value of compensation which would be pavable if there were no 663 per cent. limitation.

$$\begin{split} & 3\frac{1}{3} \left[\left[{}_{4}\bar{a}_{x'1\overline{8-y_{6}}} \right] - 4\Delta_{4}\bar{a}_{x'1\overline{8-y_{6}}} + \frac{4.5}{12}\Delta^{2}{}_{4}\bar{a}_{x'1\overline{8-y_{6}}} \right] \right] \\ &+ 10 \left[{}_{5}\bar{a}_{x'1\overline{8-y_{6}}} \right] - 5\Delta_{5}\bar{a}_{x'1\overline{8-y_{6}}} + \frac{5.6}{12}\Delta^{2}{}_{5}\bar{a}_{x'1\overline{8-y_{6}}} \right] \\ &+ 10 \left[{}_{6}\bar{a}_{x'1\overline{8-y_{6}}} \right] - 6\Delta_{6}\bar{a}_{x'1\overline{8-y_{6}}} + \frac{5.6}{12}\Delta^{2}{}_{6}\bar{a}_{x'1\overline{8-y_{6}}} \right] \\ &+ 6\frac{2}{3} \left[{}_{7}\bar{a}_{x'1\overline{8-y_{6}}} \right] - 6\Delta_{6}\bar{a}_{x'1\overline{8-y_{6}}} + \frac{7.8}{12}\Delta^{2}{}_{7}\bar{a}_{x'1\overline{8-y_{6}}} \right] \\ &- 8\frac{1}{3} \left[{}_{5}\bar{a}_{x}\overline{18-y_{6}} \right] - 5\Delta_{5}\bar{a}_{x}\overline{18-y_{6}} + \frac{5.6}{12}\Delta^{2}{}_{5}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &- 15 \left[{}_{6}\bar{a}_{x}\overline{18-y_{6}} \right] - 5\Delta_{6}\bar{a}_{x}\overline{18-y_{6}} + \frac{6.7}{12}\Delta^{2}{}_{6}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &- 11\frac{2}{3} \left[{}_{7}\bar{a}_{x}\overline{18-y_{6}} \right] - 6\Delta_{6}\bar{a}_{x}\overline{18-y_{6}} + \frac{7.8}{12}\Delta^{2}{}_{7}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &- 5\left[{}_{8}\bar{a}_{x}\overline{18-y_{6}} \right] - 7\Delta_{7}\bar{a}_{x}\overline{18-y_{6}} + \frac{7.8}{12}\Delta^{2}{}_{7}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &- 11\frac{2}{3} \left[{}_{7}\bar{a}_{x}\overline{18-y_{6}} \right] - 7\Delta_{7}\bar{a}_{x}\overline{18-y_{6}} + \frac{7.8}{12}\Delta^{2}{}_{7}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &- 5\left[{}_{8}\bar{a}_{x}\overline{18-y_{6}} \right] - 8\Delta_{8}\bar{a}_{x}\overline{13-y_{6}} + \frac{9}{8}\bar{a}_{x}\overline{18-y_{6}} \right] \\ &+ \bar{a}_{xy_{10}}\overline{18-y_{10}} + \bar{a}_{xy_{11}}\overline{18-y_{11}} \right] \\ &+ 8\frac{3}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 5\Delta_{5}\bar{a}_{\overline{18-y_{6}}} + \frac{5.6}{12}\Delta^{2}{}_{5}\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 15\left[{}_{8}\bar{a}_{\overline{18-y_{6}}} \right] - 6\Delta_{6}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 5\Delta_{5}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 6\Delta_{6}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 6\Delta_{6}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 5\Delta_{5}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 5\Delta_{6}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_{5}\bar{a}_{\overline{18-y_{6}}} \right] - 5\Delta_{6}\bar{a}_{\overline{18-y_{7}}} + 7\bar{a}_{\overline{18-y_{7}}} \right] \\ &+ 3\frac{1}{3} \left[{}_$$

1. The death of at least six of the nine youngest children, during the lifetime and continued widowhood of the wife of the deceased, before the tenth child attains age eighteen.

2. The death of at least three of the nine youngest children, and the remarriage of the widow, before the tenth child attains age eighteen.

3. The death of the widow and at least five of the nine youngest children, before the tenth child attains age eighteen.

Although it is not feasible to include in this paper an investigation as to the extent of the error which will result from disregarding Δ^3 and higher orders of differences in the formula shown in "Table B" and "Table C," such an investigation is of considerable practical importance. Taking these higher differences into account, the formula of "Table B" calls for the calculation of 51 temporary annuities where the beneficiaries are a widow and nine children; while if we may disregard these higher differences, only 39 annuities need be calculated. Only 31 temporary annuities need be computed if we are justified in employing "Table C." It is of interest to repeat that according to the usual method of computing temporary annuities to run during the continuance of at least r out of n stati, it would be necessary to calculate 894 values (see "Table A," and context).

Where combinations of beneficiaries other than a widow and several children are entitled to compensation under the New York Law, the present value of their benefits may be computed in the great majority of instances by an adaptation of the formula exhibited in "Table C," or by elementary methods similar to those suggested in the opening pages of this paper.

The author is indebted to Mr. Edward Olifiers, A. I. A., A. A. S., for several suggestions which were helpful in the preparation of this paper.

REVIEWS OF STATISTICAL PUBLICATIONS.

The Austrian Accident Compensation Law. HAROLD G. VILLARD, Workmen's Compensation Publicity Bureau, 80 Maiden Lane, New York City. December, 1914. 15 pages.

The Austrian system of compensation for work accidents, effective in 1889, has been administered from its inception upon the theory that premiums charged for compensation insurance are to be sufficient to cover the "capitalized value" of all losses incurred during the period to which such premiums pertain. The first schedule of premiums employed in Austria was based in large measure upon the accident experience of Germany. In spite of revisions upon the basis of Austrian experience at intervals of five years, the premiums charged have until recently been insufficient in the aggregate and apparently inequitable with respect to individual industries. Beginning with the second year of the Austrian scheme, the deficit of the several insurance institutions increased annually until 1908, when it amounted to some \$16,000,000. The years 1909 to 1912 showed a steady reduction in this deficit to \$12,000,000, approximately, in the latter year.

Mr. Villard attributes the difficulties attendant upon the system of compensation premiums in Austria to the use of statistics gathered in another country; to an unforeseen increase in the ratio of compensatable accidents to full time workers; to "extraordinary variations in the risk rates . . . in some of the occupations insured"; to the infrequent intervals (five years) at which rates were revised; to the fact that in Austria the maximum amount chargeable as the premium for compensation insurance is fixed by law; and to an unforeseen depreciation in the market values of the securities in which the reserves were invested.

The reductions which are at present being effected yearly in the deficits of the Austrian insurance institutions are attributed to the fact that "lately the actual and relative number of accidents compensated have remained at about the same figure"; to a statute, effective in 1909, compelling a more correct reporting of payrolls on the part of employers; and to the adoption of the policy of awarding pensions on basis of an actual loss in earning capacity instead of, as formerly, upon basis of the physical result of the injury.

On the whole, Mr. Villard's account of the Austrian compensation system is not only most concise and enlightening, but interesting. The conclusions which he draws from the experience of Austria cannot be said, however, to hold out much hope that the history of American compensation insurance will so profit by the experience of Austria as to register a greater success of the "capital reserve" system of defraying the cost of compensation for work accidents. Mr. Villard points out that "a country initiating this form of legislation has to rely on the experience of other nations"-that is, for statistics upon which to base its system of compensation premiums at the outset. But, as he says, "accident statistics gathered elsewhere" are unsatisfactory because "even in different districts of the same country great variations in the degree of accident risk will appear." "Another factor which makes the calculation of correct premium rates difficult is the steady rise in the number of accident cases" (meaning accidents reported). "Again, a disturbing element arises through fluctuations in the degree of risk in different industries. The same proportion of accidents may occur for year after year in a given occupation and be followed all at once by some wholly unforeseen increase which will offset all previous calculations."

In conclusion, Mr. Villard calls attention to the "necessity of accumulating large reserves from the very start of all workmen's accident insurance systems" and to the fact that "it is a far sounder policy to overcharge at the outset and to allow rebates on premiums afterwards than to pursue the contrary policy, which usually results in a large part of losses remaining uncovered." He further recommends the revision of premium rates at intervals not greater than a year and expresses the belief that "in determining rates . . . the defraying of total requirements is the main object to be striven for."

All this is admirable as far as it goes, but it is surprising that the author makes no reference to the fact that in spite of the extremely rapid increase in the number of accidents reported in Austria, and of the less rapid but equally consistent increase in the number of accidents compensated, the number of fatal accidents per thousand full time workers has varied but little from the very outset of the Austrian scheme until the present time. This fact is at least suggestive of the probability that the "rising cost of compensation" in Austria has not been due so much to any change in the true accident rate as interpreted in the physical effects of work accidents, as to an increasing tendency on the part of workmen to avail themselves of the benefits of the compensation laws. If this is true, Mr. Villard would have done well to point out to students of American compensation insurance that the deficits accumulated by the Austrian insurance institutions (which American insurance organizations will never knowingly be permitted to incur) may in large measure be avoided by predicating premiums and reserves upon the physical effects of accidents rather than basing them blindly upon the more or less meaningless and altogether unsatisfactory estimates of financial losses incurred in the earlier years of American compensation insurance.

It is to be regretted that the pamphlet under review does not more specifically inform us as to what extent the Austrian institutions subdivided their loss experience for purposes of computing premium When we recall that, as Mr. Villard informs us, the aggrerates. gate payrolls insured by the eight Austrian insurance institutions amounted to only \$440,000,000 in 1911,-a payroll representing some 2,500,000 full time workers,-it will be readily understood that a subdivision of the Austrian experience into many small groups, each purporting to be sufficient in itself for purposes of calculating premiums, would inevitably lead to discouraging and disastrous results, especially as to equitable differentiation between the several industries. If, as we surmise, the Austrian institutions attempted to base premiums for industries where the payroll exposure was small upon the respective individual experiences of those several industries, it would have been well to duly emphasize this fact and correspondingly emphasize the obvious conclusion that American insurance organizations may avoid many of the difficulties experienced in Austria by combining the accident and loss experiences of industries of analagous hazard into as few groups as is rationally possible for purposes of rate making.

W. W. G.

Report of the Massachusetts Commission on Pensions. Boston, March 16, 1914. 345 pages.

This is the report of the second Commission, the first having made a report in 1910. The second Commission, however, was more especially created to investigate the pensioning of civil service employees, both regarding systems now in use and the most advisable system to adopt; it was to report also, however, upon the advisability of a general system of old age pensions, concerning which it advises adversely.

From returns which appear to be complete, the Commission found that on August 31, 1913, pensions were payable at aggregate annual rates as follows:

Paid by.	No. of Pensioners.	Amount Per Annum.
State of Massachusetts		\$1 20,516.46
9 counties	38	19,566.36
25 cities	1,208	566,826.81
15 towns	38	14,354.40
	1,501	\$721,264.03

Of this total Boston was paying at the rate of \$450,955.70 per annum.

The system recommended by the first Commission, viz., pensions provided by the contributions of the employees themselves, has, in the words of the Commission, "remained unaccepted by all cities and all towns of this Commonwealth."

"A non-contributing system of pensions for laborers of cities and towns," i. e., straight-out service pensions, was in 1912, the Commission says, "submitted to the voters of each city and town by referendum." More than two-thirds of these accepted it, viz., 23 out of 33 cities and 220 towns out of 320. A similar system had in 1911 been adopted by legislative act, for Boston.

The Commission, which reports in favor of pensions to be provided, half out of the accumulation of the employee's savings and half by the state, county, city or town, very naturally remarks concerning these results: "Permissive legislation has not only failed, therefore, to remedy the undesirable situation of the past," etc., etc., which, of course, is very true if non-contributory service pensions are in point of fact undesirable.

The system recommended by the Commission, however, is a decided advance from the position of the previous Commission (of which one of its members was also a member) and also from the previous, publicly-announced attitude of Mr. Herbert D. Brown, who was employed by the Commission to make its actuarial computations; for, as stated, the first Commission was for permissive contributory pensions while Mr. Brown was for a compulsory savings plan, the savings alone to provide the pensions. The second Commission now favors:

1. Compulsory deduction of 5 per cent. from all salaries and

wages of civil service employees of state, county, city or town, for 25 years or until the retirement age, to be accumulated at 4 per cent. interest and be applied (a) to the purchase of a pension commencing at age 65 (60 for policemen and firemen) if still in the service or (b) in event of earlier withdrawal to be returned with interest.

2. The addition of a like amount to the fund by the state, county, city or town to be applied to double the retirement pension.

In event of total and permanent disability, retirement is for such annuity as the employee's and the public accumulations will purchase—which in the early years would, of course, be very small, especially as the public contributions do not begin until after 10 years' service.

That feature of the plan is introduced in order to obviate, so far as possible, the objection to all joint-contributory plans that the public contributes to the fund in respect to thousands who enter the service and withdraw after a few months or years.

It will be interesting to observe whether in a state where no city or town accepted the contributory idea and more than two-thirds of them promptly adopted the non-contributory when given the opportunity, a change will now be made to half-and-half as to cost, with disability pensions greatly reduced and other changes, also to the disadvantage of those who are directly interested. In two respects, however, it would be a good thing to do, even when judged by advocates of straight-out service pensions, viz., it would displace the insolvent teachers' fund and it would introduce uniformity throughout the state and for different classes of employees.

Much the most interesting feature of the report is Mr. Brown's analyses and valuations, which are ingenious, though not always wholly convincing. He has, on the whole, however, made excellent use of the limited material supplied him and also excellent adaptations of other experiences; and his work is likely to interest actuaries greatly,—and several of his tables are likely to be widely used and possibly some of them widely useful.

They share certain marked defects with certain other tables which have previously appeared, such as, withdrawal rates by ages, instead of by years of service, which much more affects them; mortality among totally disabled by sickness, by years of age instead of duration of disability; mortality among disabled by accident on same basis as by disease, though after the first few months the former is lower than the average among persons not disabled; salary scales by ages, instead of years of service; etc. Some of these may be unavoidable.

The most peculiar and seemingly inexplicable departure, however, is the assumption that in the case of firemen, where the occupation hazard is great, "the rate adopted for disability other than that incurred in actual performance of duty is 95 per cent. of the total rates of leaving the service on pension to and including age 50."

If pensions were provided by setting aside a percentage of salaries and wages, as paid, Mr. Brown finds that the following percentage accumulated from admission to service would suffice to pay the pensions at the present liberal scales in the cases of policemen and firemen:

Age Act. Entry to Service.	Policemen.	Firemen.
23		7.30
24		7.81
25		8.25
26	5.25	8.70
27	5.45	9.26
28	5.67	9.85
29	5.92	10.44
30	6.19	11.08
31	6.48	
32	6.79	
33	7.10	

These do not seem excessive average additions to the pay of these important public servants, to cover (a) superannuation pensions, (b) total disability pensions and (c) pensions to widows in case of death incurred in the performance of duty.

The City of Boston is not providing it that way, to be sure, but it will cost no more dollars to pay these pensions if the funds are collected in one way or in another, though of course one way may be preferable over another.

He reports that, if provision is made for pensions as the money is required, the ultimate cost of the teachers' pensions would run at about 12.11 per cent. of the aggregate wages paid. In the cases of the policemen's and firemen's pensions, he gives no estimate of this but calculates that, in order to furnish the promised pensions for the present members of the force, and to the pensioners already on the roll is equivalent to an average addition to their future wages of 19.15 per cent. in the case of policemen and 24.40 per cent. in the case of firemen. This does not mean, however, of the entire payroll and also does not alter the fact, if fact it be, that the pensions are equivalent to percentage additions to wages as per the tables already given.

M. M. D.

Compensation for Accidents to Employees of the United States, 1908-1913. Report of operations under the Act of May 30, 1908. Prepared under the direction of ROYAL MEEKER, Commissioner of Labor Statistics (U. S. Bureau of Labor Statistics, Bulletin 155) Washington, 1914.

This is the second report issued by the federal government on the subject of compensation for industrial accidents to its own employees under the so-called Alexander Act of May 30, 1908. The first report, issued about a year and a half ago, covered the period 1908–1911, so that there has been a very commendable improvement as far as timeliness of issue is concerned. The Federal Employees Compensation Act is practically the first Compensation Act in the United States, which makes these reports especially valuable, since for no other does such a substantial volume of welldigested data exist.

The total number of accidents reported for the five periods was as follows:

1908 - 9*		4,887
1909-10		6,989
1910-11		9,381
1911-12†		7,997
191213		10,876
	Total	40,130

The rapid increase in the number during the second and third year is characteristic of all history of accident statistics, and is probably due as much to the improvement in the reporting accidents as to the extension in the knowledge of the provisions of the act.

As a matter of fact, excluding the Canal Zone because of the irregular character of its work, the number of reports for all other branches of service in 1909-10 was 3,765 and for 1910-11, 3,787,

*11 months only (Aug. 1, 1908-June 30, 1909).

[†]Short of minor cases in the Canal Zone for the 8 months, Nov. 1, 1911–June 30, 1912. With these included the number is estimated in the report as 10,157.

which would seem to indicate a certain stability after two or three years.

A careful examination of the tables indicates a few surprising increases for which unfortunately no explanation is offered. In the Bureau of Engraving and Printing, perhaps the largest establishment of its kind in the world, the number of accidents reported in 1910-11 was 86, in 1911-12, 95, and in 1912-13, 249. The Department of Agriculture reported 27 in 1910-11, 38 in 1911-12 and 123 in 1912-13.

If the Alexander Act had not been so glaringly deficient, as far as any measures of prevention are concerned, these figures should have called forth a searching investigation.

In a recent study of "Essentials of Workmen's Compensation Statistics" Dr. E. H. Downey indicates three purposes of such statistics: (1) accident prevention, (2) administration of laws, and (3) enactment of further legislation. Of course to workers in actuarial problems the fourth purpose will be obviously the establishment of insurance rates. A volume of some 330 pages containing a very detailed analysis of some 40,000 accidents will be very welcome therefore to a large variety of students.

The administrative and legislative aspect of the report is perhaps the most important one. While the Alexander Act has the proud distinction of priority, it is at present the stingiest, most inquitous and most inefficient of all the 25 or so compensation acts on the statute books of the American commonwealth. The pitiful amount of the compensation granted is amply disclosed by the summary tables in pages 68–77 and by the analytical tables III (giving the total and average cost for each government department, for each branch of service, and for each of the most important establishments) and table XI showing the distribution of cases according to the nature of the injury and according to amount of compensation. The material thus gathered and presented has therefore great value for purposes of amendment of the act. It is known that the American Association for Labor Legislation has been making very earnest efforts to accomplish such an amendment.

The "Kern bill" prepared by that Association is printed as an appendix. There is also contained in the report a short history, a careful legal analysis of the act, and the most important decisions made under it by the solicitor of the Department of Commerce and Labor, later by the solicitor of the independent Department of Labor, and in a few cases, of the attorney general.

The bulk of the report, however (comprising 240 pages of general tables, and some 25 pages of text tables) is devoted to statistical data. While the analysis of the effect of the provisions of the act has only a specialized administrative or political value, there are many tables dealing with accident statistics as such which possess a permanent value, especially in view of the paucity of such data in present American statistical literature.*

The accidents reported (including only accidents over one day duration, and practically coinciding with the recently accepted definition of a "tabulatable accident") are analyzed: (1) by departments, branches of service and some individual establishments, (2) by rate of pay of the injured person for each department, etc., (3) by cause and department, etc., (4) by cause and duration, for the entire service, except the Isthmian Canal Commission, for which an independent analysis is given, (5) by nature of injury and duration of disability, (6) by cause and nature of injury. The system of classification of cause of injury may not satisfy all the requirements of the modern safety engineer, but represents some improvement upon the customary European classifications, and has the great advantage of permitting comparisons with most European statistics. The classification of the nature of injury is vastly superior to that in use in almost all other American reports, although in view of absence of a dismemberment schedule in the Act of 1908, the analysis of dismemberment is not quite detailed enough for American actuarial purposes. Unfortunately the data as to partial permanent disability are very untrustworthy, because the act, incredible as it may seem, entirely fails to recognize this condition, and accident statistics can seldom rise above the nature of the compensation act, in virtue of which they are gathered. But the analysis of the duration of disability period is by weekly periods, as it should be, and proved to be useful to the reviewer in the construction of the "Standard Accident Table."

A very serious limitation upon the report is the absence of any basis for derivation of accident frequency, because all data as to exposure are lacking. The act suffers from the fault of many

* The reviewer, during his previous connection with the U. S. Bureau of Labor Statistics has largely contributed to the preparation of the report of the first year's operations, and the statistics of the accidents for the first year. But he does not feel that this circumstance necessarily disqualified him from reviewing the present report. American compensation acts, in that the limits of its applications are not definitely stated and depend upon legal or administrative construction. Nevertheless the statistics of accidents extend beyond these limits of the law and aim to cover the entire civil service of the federal government, and it would seem that at least for most branches of government service, such as the Isthmian Canal Commission, the navy yards, the arsenals, the large construction enterprises of the War Department, and the Reclamation Service, the postal establishment, with its three main divisions of rural mail delivery, city delivery, and railway mail service, the two large printing establishments in Washington, etc.; for all these definite and large branches of service some fairly reliable statistics of exposure should be available without any unsurmountable difficulties, and accurate accident frequency rates might have been computed.

In the mechanical presentation of the data there is room for criticism because of the failure to provide cumulative quinquennial tables, covering the entire period, for the more detailed analysis. For the presentation of the administrative data as to accidents, reported, compensated, etc., annual tables are obviously necessary. But when a detailed presentation of data of nature of injury according to cause, is undertaken, the annual volume of experience is too small, the results appear scattered; for many combinations there are no entries at all, or the entry "1" appears quite frequently. The actuarial value of such tables is not very great.

Table X for instance, entitled "Number of accidents reported which resulted from each specified cause by nature of injury," gives the data for each of the five fiscal years, ending June 30, 1913, and occupies 42 pages. A combined table for the five years would have saved some 32 pages and would have been very much easier to use. Nevertheless the difficulties created thereby are not such that patient figuring could not overcome them. On the whole the report is a very valuable addition to our literature on accident and compensation statistics, appearing at a very opportune time to set standards of careful analysis for the numerous accident boards and insurance departments.

I. M. R.

RECENT ARTICLES DEALING WITH CASUALTY INSUR-ANCE AND SOCIAL INSURANCE IN CURRENT PERIODICALS.

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Journal Institute Actuaries, Jan., 1914, Labor Gazette (London), Feb., 1914, Survey (The), Survey (The), Su	2.1.402011401113	0 410 1, 1011,	0'97
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66

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67

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(The Editor wishes to acknowledge the valuable assistance received from Mr. S. Levy in the compilation of this bibliography.)

Number 2

PROCEEDINGS

Casualty Actuarial and Statistical Society of America

February 19 and 20, 1915

PRESS OF The New Era Printing Company Lancaster, Pa

CONTENTS OF THE SECOND NUMBER

I	.°▲GE
OFFICERS, COUNCIL AND COMMITTEES OF THE SOCIETY	v
CONSTITUTION AND BY-LAWS	vii
RULES REGARDING EXAMINATIONS FOR ADMISSION TO THE SOCIETY	xi
MEETING OF FEBRUARY 19 AND 20, 1915.	
Address by I. M. Rubinow, President, "Our Problems"	77
Papers:	
Workmen's Compensation Claim Reserves. Miles M. Dawson.	90
Workmen's Compensation Reserves. Joseph H. Woodward	112
A Method Proposed for the Calculation of Liability and Work- men's Compensation Claim Reserves. B. D. Flynn	131
Discussion of Papers read at this Meeting, and at Previous Meeting	141
Minutes of this Meeting	171
THE ESSENTIAL FACTORS IN THE COMPUTATION OF THE COST OF WORK- MEN'S COMPENSATION. W. N. Magoun	173
REVIEWS OF PUBLICATIONS DEALING WITH WORKMEN'S COMPENSATION.	190
RECENT LITERATURE ON SOCIAL INSURANCE AND STATISTICS OF INDUS- TRIAL ACCIDENTS	198

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CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA.

CONSTITUTION.

Adopted February 19, 1915.

ARTICLE I.—Name. This organization shall be called THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA.

ARTICLE II.—Object. The object of the Society hall be the promotion of actuarial and statistical science as applied to the problems of casualty and social insurance by means of personal intercourse, the presentation and discussion of appropriate papers, the collection of a library and such other means as may be found desirable.

The Society shall take no partisan attitude, by resolution or otherwise, upon any question relating to casualty or social insurance.

ARTICLE III.—Membership. The membership of the Society shall be composed of two classes, Fellows and Associates. Fellows only shall be eligible to office or have the right to vote.

The Fellows of the Society shall be the present members and those who may be duly admitted to Fellowship as hereinafter provided. Any Associate of the Society may apply to the Council for admission to Fellowship. If his or her application shall be approved by the Council with not more than one negative vote he or she shall become a Fellow on passing such final examination as the Council may prescribe. Otherwise no one shall be admitted as a Fellow unless recommended by a duly called meeting of the Council with not more than one negative vote followed by a ballot of the Society with not more than four negative votes and not less than twenty affirmative votes.

Any person may, upon nomination to the Council by two Fellows of the Society and approval by the Council of such nomination with not more than one negative vote, become enrolled as an Associate of the Society provided that he shall pass such examination as the Council may prescribe. ARTICLE IV.—Officers and Council. The officers of the Society shall be a President, two Vice-Presidents, a Secretary-Treasurer, and an Editor-Librarian. The officers with ex-Presidents, ex-Vice-Presidents and four other Fellows shall constitute the Council.

ARTICLE V.—Election of Officers and Council. The officers shall be elected by a majority ballot at the annual meeting for the term of one year and two members of the Council shall, in a similar manner, be annually elected to serve for two years. The President and Vice-Presidents shall not be eligible for the same office for more than two consecutive years nor shall any retiring member of the Council be eligible for re-election at the same meeting.

ARTICLE VI.—Duties of Officers and Council. The duties of the officers shall be such as usually appertain to their respective offices or may be specified in the by-laws. The duties of the Council shall be to pass upon candidates for membership, to decide upon papers offered for reading at the meetings, to supervise the examination of candidates and prescribe fees therefor, to call meetings, and, in general, through the appointment of committees and otherwise, to manage the affairs of the Society.

ARTICLE VII.—Meetings. There shall be an annual meeting of the Society on such date in the month of October as may be fixed by the Council in each year, but other meetings may be called by the Council from time to time and shall be called by the President at any time upon the written request of ten Fellows. At least two weeks notice of all meetings shall be given by the Secretary.

ARTICLE VIII.—Quorum. A majority, or seven members, of the Council shall constitute a quorum. Twenty Fellows of the Society shall constitute a quorum.

ARTICLE IX.—Expulsion or Suspension of Members. Except for non-payment of dues no member of the Society shall be expelled or suspended save upon action by the Council with not more than one negative vote followed by a two-thirds ballot of the Fellows present and voting at a meeting of the Society.

ARTICLE X.—Amendments. This constitution may be amended by an affirmative vote of two-thirds of the Fellows present at any meeting held at least one month after notice of such proposed amendment shall have been sent to each Fellow by the Secretary.

BY-LAWS.

ARTICLE I.—Order of Business. At a meeting of the Society the following order of business shall be observed unless the Society votes otherwise for the time being:

- 1. Calling of the roll.
- 2. Address or remarks by the President.
- 3. Minutes of the last meeting.
- 4. Report by the Council on business transacted by it since the last meeting of the Society.
- 5. New membership.
- 6. Reports of officers and committees.
- 7. Election of officers and Council (at annual meetings only).
- 8. Unfinished business.
- 9. New business.
- 10. Reading of papers.
- 11. Discussion of papers.

ARTICLE II.—Council Meetings. Meetings of the Council shall be called whenever the President or three members of the Council so request, but not without sending notice to each member of the Council seven or more days before the time appointed. Such notice shall state the objects intended to be brought before the meeting, and should other matter be passed upon, any member of the Council shall have the right to re-open the question at the next meeting.

ARTICLE III.—Duties of Officers. The President, or, in his absence, one of the Vice-Presidents, shall preside at meetings of the Society and of the Council. At the Society meetings the presiding officer shall vote only in case of a tie, but at the Council meetings he may vote in all cases.

The Secretary-Treasurer shall keep a full and accurate record of the proceedings at the meetings of the Society and of the Council, send out calls for the said meetings, and, with the approval of the President and Council, carry on the correspondence of the Society. Subject to the direction of the Council, he shall have immediate charge of the office and archives of the Society.

The Secretary-Treasurer shall also send out calls for annual dues and acknowledge receipt of same; pay all bills approved by the President for expenditures authorized by the Council of the Society;

BY-LAWS.

keep a detailed account of all receipts and expenditures, and present an abstract of the same at the annual meetings, after it has been audited by a committee of the Council.

The Editor-Librarian shall, under the general supervision of the Council, have charge of all matters connected with editing and printing the Society's publications. The *Proceedings* shall contain only the proceedings of the meetings, original papers or reviews written by members, discussions on said papers and other matter expressly authorized by the Council.

The Editor-Librarian shall also, under the general supervision of the Council, have charge of the books, pamphlets, manuscripts and other literary or scientific material collected by the Society.

ARTICLE IV.—Dues. The dues shall be ten dollars for Fellows and five dollars for Associates payable upon entrance and at each annual meeting thereafter, except in the case of Fellows not residing in the United States, Canada, or Mexico, who shall pay five dollars at the times stated.

It shall be the duty of the Secretary-Treasurer to notify by mail any Fellow or Associate whose dues may be six months in arrears, and to accompany such notice by a copy of this article. If such Fellow or Associate shall fail to pay his dues within three months from the date of mailing such notice, his name shall be stricken from the rolls, and he shall thereupon cease to be a Fellow or Associate of the Society. He may, however, be reinstated by vote of the Council, and upon payment of arrears of dues.

ARTICLE V.—Amendments. These by-laws may be amended by an affirmative vote of two-thirds of the Fellows present at any meeting held at least one month after notice of the proposed amendment shall have been sent to each Fellow by the Secretary.

RULES REGARDING EXAMINATIONS FOR ADMISSION TO THE SOCIETY.

The Council adopted on March 29, 1915, the following rules providing for the examination system of the Society:

1. Examinations will be held on the first Wednesday and Thursday during the month of May in each year in such cities as will be convenient for three or more candidates.

2. Application for admission to examination should be made on the Society's blank form, which may be obtained from the Secretary-Treasurer. No applications will be considered unless received before the fifteenth day of March preceding the dates of examination.

3. A fee of \$5.00 will be charged for admission to examination. This fee is the same whether the candidate sits for one or two parts and is payable for each year in which the candidate presents himself. Examination fees are payable to the Secretary-Treasurer and must be in his hands before the fifteenth day of March preceding the dates of examination.

4. The examination for Associateship consists of four parts. Not more than two parts can be taken in the same year and no credit will be given for the passing of any part unless all previous parts have been passed during the same or previous years.

5. In the case of applicants not less than thirty years of age, who have had not less than five years' experience in actuarial or statistical work in insurance offices, the Council may, upon receipt of satisfactory evidence of general education, waive the passing of Parts I, II and III of the Associateship examination. Such applicants may thereupon become Associates by passing Part IV of the Associateship examination.

6. Admission to Fellowship examinations is granted only to those who are Associates of the Society. The examination for Fellowship is divided into two parts. No candidate will be permitted to present himself for Part II unless he has previously passed in Part I or takes Parts I and II in the same year. If a candidate takes both parts in the same year and passes in one and fails in the other, he will be given credit for the part passed. 7. As an alternative to the passing of Part II of the Fellowship examination, a candidate may elect to present an original thesis on an approved subject relating to casualty or social insurance. Candidates electing this alternative should communicate with the Secretary-Treasurer as to the approval of the subject chosen. All theses must be in the hands of the Secretary-Treasurer before the first Thursday in May of the year in which they are to be considered. Where Part I of the Fellowship examination is not taken during the same year, no examination fee will be required in connection with the presentation of a thesis. All theses submitted are, if accepted, to be the property of the Society and may, with the approval of the Council, be printed in the *Proceedings*.

8. In Part II of the Fellowship examination the papers will be so arranged that it will be necessary for the candidate to write on only three of the four prescribed topics in order to obtain full credit.

9. Special attention is called to the following important exceptions to the above rules effective as respects the years 1915 and 1916. The first examinations of the Society will be held on Wednesday, October 6, 1915. In the case of candidates for Associateship presenting themselves at that time the passing of Parts I, II and III will be waived and the candidates will be required to take Part IV only. Examinations will be regularly held in May, 1916, but in the case of candidates for Associateship presenting themselves at that time the passing of Parts I and II will be waived and the candidates will be required to take Parts III and IV only. Commencing with 1917, candidates for Associateship will be expected to pass in all four Parts of the Syllabus.

Syllabus of Examinations.

For Enrollment as Associate.

Part I:

- 1. Elementary algebra up to and including the binomial theorem.
- 2. Elementary plane trigonometry including the use of logarithms.
- 3. Elementary plane analytical geometry.
- 4. Double entry bookkeeping.

Part II:

- 1. Advanced algebra.
- 2. Elementary differential and integral calculus.
- 3. Elementary calculus of finite differences.
- 4. Theory of probability and least squares.

Part III:

- 1. Compound interest and annuities-certain.
- 2. Theory of statistics.
- 3. Elements of the theory of life annuities and assurances, including the calculation of premiums and reserves for the simpler forms of policy.
- 4. Elements of economics.

Part IV:

- 1. Practical problems in statistics.
- 2. Policy forms and underwriting practice in casualty insurance, viz.: Personal accident, health, liability, workmen's compensation, fidelity, surety, plate glass, steam boiler, burglary, fly wheel, automobile, workmen's collective, credit.
- 3. Practical problems in insurance accounting and statistics, including the preparation of annual statements.
- 4. Insurance law, including the more important statutes of the United States and Canada relating to casualty insurance.

For Admission as Fellow.

Part I:

- 1. Calculation of premiums and reserves for accident, sickness, workmen's compensation and other branches of casualty insurance.
- 2. Inspection of risks; adjustment and settlement of claims.
- 3. Investments of insurance companies.
- 4. Current problems in workmen's compensation and other branches of casualty insurance.

Part II:

- 1. Principles and history of social insurance.
- 2. Compilation and use of census or other government statistics relating to population, mortality, invalidity, sickness, unemployment, old age and allied matters.
- 3. Systems of invalidity, old age and unemployment insurance.
- 4. Calculation of premiums for and valuation of pension funds.

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NUMBER 2.

PROCEEDINGS

FEBRUARY 19 AND 20, 1915.

OUR PROBLEMS.

ADDRESS BY I. M. RUBINOW, PRESIDENT.

The Casualty Actuarial and Statistical Society of America has gone through the first three months of its existence. From most diverse quarters—from practical underwriters and university professors—there have come enthusiastic greetings. "The institution," says the Weekly Underwriter, "should have the sustaining hand of every man of strength in the casualty business for it will serve and profit all, without exception, in the results." "It is something that the business has needed for a long time,"—says the Western Underwriter, "there is no reason why this society should not be as valuable to the casualty business as the Actuarial Society of America has been to that of life insurance." When the fruitful work accomplished by the older society during the last quarter of a century is contemplated, the praise implied in these words cannot be overestimated.

This cordial reception is gratifying no doubt, but it also creates certain difficulties, for as a matter of fact, already impatient enquiries are heard, not only as to how our society is doing, but also as to what it has accomplished.

I am happy to be able to report that it has not wasted any time and has accomplished several things that are decidedly worth while. Its very organization has brought home to the casualty business the existence of many problems, the solution of which requires not business sagacity alone, but the possession of technical training and the application of scientific methods. There are so many problems and many of them are so urgent, that frequent meetings

OUR PROBLEMS.

will be necessary. It is the intention of the Council to stimulate scientific work along definite lines, by selecting specific topics for the preparation of papers, and their discussion at each meeting. At the same time we do not intend to interfere with, but on the contrary shall offer all possible encouragement to, independent efforts at investigation in all possible directions, by holding our Proceedings open to all valuable contributions on any topic connected with our lines of endeavor. We intend to make our Proceedings a good deal more than a dry record of events transpiring at our meetings. If our plans find the necessary support among the membership at large, the Proceedings will develop into one of the most important periodical publications in the domain of insurance science. The first issue, already distributed among you, may not come up to everybody's expectations. But it does, we hope, furnish sufficient evidence of earnest effort and thoughtful desire to be of help to all workers in this field.

The appointment of a committee on examinations to elaborate a careful program of the necessary fundamentals as a preparation to productive effort, before any examinations are announced, marks the beginning of a wide campaign to raise the educational level of the casualty insurance business. The next step will be the appointment of a committee on terms, because a satisfactory nomenclature is a necessary prerequisite of the development of any branch of science.

The interesting and important details of the work already accomplished, as well as that being laid out for the immediate future, will no doubt be outlined at greater length in the reports of your Secretary, your Editor and the various committees. But in addition to that I must ask your indulgence for a little while, for the purpose of dealing with broad underlying principles. I consider this both my great opportunity and my most important duty.

At the first meeting of our Society there were so many necessary things to be done, and the time within which to do them was so short, that it seemed wise to forego any extensive discussions of the general problems which must confront us. Moreover as a chairman of a self-constituted committee I felt that I did not possess the necessary authority to speak in the name of anyone else but myself. I need not waste your time to convey to you my deep appreciation of the honor which you have conferred upon me by electing me to the presidency of this organization. As I think of the epoch-making rôle it is destined to play in developing the new technical sciences, actuarial and statistical alike, of casualty and social insurance in this country, I am perhaps attaching a greater value to this distinction than many of you may have intended, for I feel that I have gained for myself a definite position in the history of American insurance, and my only hope is that by hard and conscientious work for the next decade, I shall acquire the right to think that I have earned what I have gained through your kindness.

It is quite evident that offices and officers, dues and thoroughly enjoyable dinners, even scientific papers and publications will not alone accomplish all that we hope for, unless all our work is influenced by a few underlying principles, by some general understanding as to the nature of the scientific problems which confront us, and by some agreement as to the methods which we must use.

The long and complicated name of our organization offers perhaps the best starting point of such a discussion. Experts seem to have agreed that no good definitions of the words "actuary" and "actuarial science" exist. The Germans have coined the terms "Versicherungsmathematik" and "Versicherungswissenschaft" (insurance mathematics and insurance science). My own preferences are in favor of the latter term as embracing the first as a component part.

Under this broad interpretation every problem in the theory and practice of insurance which permits of the application of the methods of scientific enquiry justly comes within the domain of actuarial science. Opinions also differ as to exact position of statistics in the hierarchy of human knowledge. It is an independent science according to some, and but a scientific method according to the others. I do not think that the abstract theory of statistics will properly come within the scope of our work, but the sum total of human experiences we are dealing with is especially adapted to fruitful study by means of the statistical method. Not only in popular usage but even within insurance circles, it was customary to limit the meaning of "actuarial science" to dealings with life insurance problems only. For definite practical reasons we have come here together for the study of one branch of insurance which is taken to include practically all forms of insurance excluding life. fire, and marine. In volume of business operations this is as yet the smallest, because the youngest of the three main divisions of insurance. But its importance in modern economic and social life cannot be properly measured by the premium income.

It is the general province of insurance to deal with the emergencies of human existence, with the dangers to life, health and property, and among these dangers those of normal death, and of loss through fire are by far not the greatest ones.

It is obvious that the Society owes its existence to needs of the business we are engaged in. Nevertheless, this should not, does not in the least deprive it of its true scientific character. The antagonism between pure and applied science is fortunately a thing of the past. It is a matter of historical record that the discoveries of the greatest practical and commercial value have come out of the laboratories and studies of most impractical, abstract scientific thinkers and workers; while on the other hand many deep scientific truths were discovered in the effort of the human mind to solve the practical problems which confronted it. Peace was concluded between pure and applied science, because it was being recognized that the guiding principle of both is one, that of service to human society.

It does not follow therefrom that the science of insurance and the business of insurance is the same. Over and above purely business considerations even dry-as-dust actuaries and statisticians must remember the social value of their service. The construction of scientific rates may be the business duty of actuaries and statisticians, but this business duty is of true social significance. since true rates mean an equitable distribution of the cost of insurance. Business considerations have created many acute problems, primarily in the field of insurance, of the relations of master and servant, and a wide divergence of opinions as to the proper relations between private business enterprise and government activity in this field has already developed in this country, It seems best for our organization as such to keep carefully out of this fight, especially since representatives of all forms of insurance have an equal standing in it. But whatever the outcome of the struggle may be, it is well to remember that neither the American Experience Table of Mortality nor the Standard Accident Table, nor the laws of compound interest or probability, nor even the rate of remarriage of the Dutch widows will be affected by the final outcome of the competition between casualty companies and the state funds.

The papers read during the first meeting, as well as those planned for to-day and to-morrow, deal almost exclusively with compensation. This is quite natural in view of the great complexity of

the problems created by the sudden change from employer's liability to workmen's compensation, problems which must be handled immediately whether or not we are quite prepared to furnish strictly scientific solutions of all of them. This predominance of compensation problems is likely to continue for some time to come. As was pointed out recently by one of our members, Dr. E. H. Downey, in a very interesting article in the Journal of Political Economy, there are three distinct objects which compensation statistics has to accomplish-prevention of accidents, proper administration of compensation acts, and calculation of compensation insurance rates. In all of these three objects, we as insurance men, have a direct interest and concern. As actuaries, we are perhaps thinking of rates first, but we are constantly reminded by our safety engineering and inspection department of the accident prevention necessities, and our friends in the various state insurance departments, and commissions, will see to it that we do not forget the administrative aspects of our work.

The general basis of actuarial work in connection with compensation rates has already been sufficiently outlined at our first meeting. It must not be presumed that the problem has been completely solved. In giving my brief account of the work of the actuarial committee, I was careful to state all the possible exceptions and doubtful points. In fact the paper called forth the biting criticism from a very experienced statistician that I seemed to have taken a great deal of pains to construct a fine structure. and then proceeded with equal pains to tear it down. But this impression is simply due to the frank recognition that while the plans for the building may have been satisfactory and mathematically correct, the material was staff, fit for a temporary structure only, and the structure to last must necessarily be rebuilt with perfectly good mortar and brick. Only through statistical work can this material be supplied. Undoubtedly everyone here has read and studied the comprehensive report of the plans of the Statistical Committee of the Workmen's Compensation Service Bureau, as presented by our Secretary in the Journal of Commerce. But after all this plan furnishes only the mechanical basis for successful Further development of methods of such accident statistics. statistics, the careful safeguarding of accuracy in the gathering of this valuable material, and the interpretation of the accumulated results, all this will require a great deal of statistical ingenuity,

just as the final perfections of compensation rates will tax the ability of the actuaries. Forgetting all differences between bureau and non-bureau companies, private and state insurance, we may safely assume that this work will be done by members of our society, or it will not be done at all. But instead of this being done in many different places, in many different ways, our organization will form a forum in which differences will be threshed out, and agreements reached.

For the open technical problems in connection with this work are many. There are many movements on foot at present for uniformity in accident statistics, and progress has not been any too rapid. The preparation of the necessary classifications, of causes of injuries, of nature of injuries, of occupations and industries, is much more than a mechanical problem. Its solution depends upon a deep study of manufacturing and industry, of economics, principles of safety engineering, and medicine and surgery, all conforming to the needs of actuarial science and the limited possibilities of statistical analysis. But vast as is the domain of problems connected with accident statistics, this alone does not exhaust the list of data necessary for compensation insurance. It may very likely be found that we shall need a more applicable mortality table, that we shall have to know more about the social statistics of wage workers, wage statistics, statistics as to marriage, divorce, widowhood, childbirth, size of the family, and last but not least we shall look forward to re-marriage statistics of our own widows, so to speak. To solve the vexed problem of the cost of medical service, some special investigations are necessary.

The enormous service that accident statistics can render to prevention is becoming rapidly recognized. But perhaps less attention has been paid to the allied problem of influencing the duration of disability, and stimulating speedy recovery by means of better statistics. That may seem far-fetched. It would seem that it would be equally reasonable to expect to reduce the temperature of the atmosphere by watching the thermometer in the window. Nevertheless, it is a fact that compensation must stimulate efforts towards more scientific treatment of accidental injuries, and already there is an appreciable demand from the more learned members of the medical profession for careful statistics as to the duration of certain injuries under different modes of treatments. The possibilities of statistical analysis are so extensive that one cannot fore-
tell them all. I should like to know, for instance, what effect, if any, the wage of the injured has upon the duration of injury, and whether it is true that a higher compensation scale by offering a greater incentive to malingering, increases the duration of disability, or whether the opposite may not be true by any manner of means, that by furnishing a greater measure of help and comfort, the higher compensation scale does lead to more rapid recovery. One or two states have failed to embody medical aid in their compensation acts. I should like to know whether that influences the duration of identical injuries. In short the problems both theoretical and practical, the problems both of business and science that may be solved by the aid of statistics are well nigh unlimited. Of course that is true not of compensation only.

Other branches of casualty insurance present problems of equal interest if not of the same magnitude. No matter how the present compensation rates may be criticized one thing at least has been accomplished; a good deal of light has been thrown upon the method of their construction and at least plausible reasons can be given for each one of them. A careful student can now, without great difficulty, find in print almost all the steps in their computation. There may be errors, but there is no mystery about them. Actuaries and statisticians will continue to gather material for their further refinement and adjustment. But let us hope that soon time will be found for similar careful study of other branches of insurance.

In the field of public liability our statistical material as yet is very scant. If in compensation and employer's liability we have witnessed an undesirable increase in a vast variety of classifications, public liability rates on the contrary offer a picture of monotonous uniformity, not only as between one industry and another, but also between state and state. The fact that experience on public liability insurance on the whole is favorable, may be a business justification, but not a scientific reason for neglecting to study its problems. It is true that with the absence of any definite scale of awards, the deduction of any generalisations becomes difficult; nevertheless, the problem statistically is not altogether an impossible one. It may be assumed that no matter how capricious individual juries may be there is some correlation between injury and verdict. Scientific rates in public liability will require extensive statistics of public accidents in relation to the nature of

work, as well as some statistics as to the comparative frequency of favorable and unfavorable verdicts, and the amounts of awards in various states. Variations as to accident frequency, which cause such heated discussions in connection with compensation insurance, must play an important part in public liability as well. Moreover, the general question remains how far is the payroll a proper measure of exposure in regard to public liability.

Especially numerous are the problems of special forms of public liability, namely, teams and automobiles insurance. Next to compensation, automobile insurance is the most rapidly developing branch of the casualty business, and yet it is still conducted on purely empirical lines. Speaking as an outsider, I may say that not a day passes but grave actuarial problems in respect to this branch of insurance confront me. Are we right in assuming a direct proportion between horse power and hazard? Do we give enough weight to the business of the assured? Are our rates for pleasure driving cars quite what they ought to be? Isn't it possible to devise some fairly accurate measure of exposure? Here are but a few purely theoretical questions which in the future may for all we know acquire practical importance.

Leaving the domain of compensation and liability, how much do we know in a scientific way about the personal accident and health business? Here is a business of enormous development, since the country already pays an annual price of over \$30,000,000, and is ready to pay vastly more. Socially it is of utmost importance, because it deals largely with non-industrial accidents, the number of which is perhaps equal to that of industrial accidents in this hazardous country of ours. But as far as we know, the scientific literature on the subject is nil. One may well think that some underwriters possess the necessary knowledge of facts, but it is a fact that the majority of companies underwriting personal accident insurance do so blindly, placing their faith in the wisdom of the stronger competitor. I beg to submit, however, that carefully guarded secrets do not constitute a body of scientific knowledge. How many of us would be willing to defend the classifications of occupations in present accident manuals? Are we right in almost disregarding age in its effect upon accident frequency and especially upon frequency of disease? These and many questions of similar nature wait for painstaking investigations by statisticians; and only on a foundation built by them may proper rates be constructed.

Again let us turn to the smaller branches of our business-such as burglary, or plate glass. There, too, the rates are purely empirical. So long as the loss ratio is favorable, the business of insurance can afford to disregard actuarial problems; nevertheless a good deal more than we know at present could be learned from a systematic study of large volumes of experience. What effect does the season of the year bear upon the burglaries? What the type of building or the occupation of the head of the family? What relation may there be between the general level of economic condition as measured by a variety of statistical indexes, and the frequency of crimes against property? Even in the small department of plate glass insurance, some effort to correlate the frequency of broken windows with the density of population, its enthnographic composition, or possibly the width of sidewalks, might bring forth exceedingly interesting results. Were my statistical department a university seminary, and my assistants students looking for topics of research I could mention dozens of most interesting subjects of enquiry, and so could every one present in this room.

It is true that not all of them appear to have an immediate practical value, and perhaps some of the problems I have enumerated tonight may never have any actuarial bearing upon rates. It is right here however that I want to make my strongest, my most eloquent plea if I can. I want to beg you to remember that this is an organisation of statisticians as well as actuaries, that it was conceived by persons, some of whom at least have no desire to claim the title of actuary, and that as statisticians we may be interested in problems entirely irrespective of their bearing upon rates. Because of the nature of our business we are dealing with many interesting and important aspects of human life—a large share of the mishaps and calamities to which the human race is subject, pass automatically before our eyes, if we but care to examine them closely.

As statisticians, we are derelict in our social duty, unless we make a concerted effort to tell society at large what it ought to know about the laws that govern the regularity of these periodic losses of property and life, unless we succeed in isolating the various factors responsible for them. Only in such a way can the work of prevention be stimulated. Indirectly, at least, such preventive effort will benefit the casualty business in a financial way, but whether it does or not, this preventive effect is one of the most vital arguments in favor of insurance as a productive economic

force. For we must not forget, that if insurance be considered simply as a financial mechanism for collection and distribution of funds, the criticism must appear fair, that in the final analysis insurance costs twice as much as the losses it endeavors to guard against, and therefore may on the whole result in additional economic waste. It is furthermore my deep conviction that the unwillingness to utilize this vast raw material for scientific purposes will sooner or later be brought forth as an additional argument against casualty insurance, and surely we statisticians cannot hope to retain our standing in the statistical profession unless we urge our insurance carriers to devote at least a small part of their returns to this work. As a matter of fact, the failure to do so must be charged at present not only against the commercial insurance carriers operating for profit, but against most state insurance departments, and even some industrial accident boards or commissions, the few brilliant exceptions notwithstanding. And yet precedents for such scientific work by insurance companies are not lacking,-one need only look at the enormous scientific output of the large and more progressive life insurance companies. While few of the casualty companies or compensation commissions may have the same unlimited resources yet some things could be done; and the important consideration is that the raw material which we obtain is vastly richer in variety and significance than the bare records of death which life insurance companies are dealing with.

We may then reasonably expect that the public mind will not fail to show a correspondingly greater interest in the scientific results of our investigations, with the result perhaps of enhancing the standing of our profession in the public eye. Finally, another word about the relation of our Society and its membership to the new science of social insurance and its problems. I am frank to admit that I was extremely gratified to read the new draft of our constitution in which the field was definitely enlarged to cover both casualty and social insurance. As some of you may know I came into the casualty insurance from a decade of study of social insurance problems. The three gentlemen of your "Committee on Constitution" who have prepared their report entirely independently of any suggestion of mine are or have been connected with private insurance, and their recognition of the importance of the study of social insurance is the more significant for this fact. τ shall not undertake at this time or place to draw any very definite line between casualty and social branches. For two urgent reasons

I shall not venture into a discussion of comparative merits of state and private insurance of workmen's compensation, first because as President of the organisation I do not intend to force my own views upon anyone, and second because my definite business connection would make any partisan opinion fairly worthless. But entirely irrespective of my sympathies and antipathies it is quite obvious that the United States, having made the first step, is bound to proceed with its ever broadening policy of social provision against the social ills. Throughout the country a powerful propaganda for sickness insurance, maternity insurance, old age pensions, unemployment insurance and mothers' pensions is rising.

I do not think it is at all necessary for me to quote here the entire text of Chapters 2 and 3 of my forgotten book to prove that social insurance in this country is both necessary and inevitable. Even an amateur, having been duly impressed with the gravity of the social problems of sickness or unemployment, can do a good deal in useful propaganda work. But if social legislation is to be successful it must be carefully thought out, and protected against To quote one illustration only, the National Insurance errors. Act of Great Britain in its conception is perhaps one of the greatest acts of legislation that the Anglo-Saxon world has witnessed. But the many severe criticisms of the act so frequently heard, may all be explained by some very serious technical actuarial errors committed in the planning of the system. It must be carefully thought out and guarded against errors. Only experts can do that. The frightful inefficiency of most of our earlier compensation acts is largely to be explained by the absence of any substantial and recognized body of experts in this country. If this organisation will be able to meet this situation in regard to the other branches of social insurance, if it will undertake the study of its technical aspects sufficiently early it will have accomplished a social service of large magnitude to the country, not to speak of the gain in the dignity of our profession which will necessarily accrue from such illustration of the application of our technical knowledge.

The problems then before us are varied and many. Insurance science is becoming an important branch not only of economics, but of applied sociology as well, and the profession of an actuary may be as often a form of social service as the beginning of a distinguished business career. The possibilities, therefore, of furthering not only our narrow professional interests, not only the impersonal development of statistical science, but also the welfare of the entire social organism, are very great. Under what conditions can these possibilities be realized,—can the various problems be solved? Our individual contributions to the body of science may depend upon many individual factors, or accidental circumstances. There is no uniformity in individual capacity to grapple with theoretical problems, nor in individual willingness to pay the necessary cost in sacrifice of leisure and the numerous joys of life.

But over and above these individual circumstances, there is one broad social factor upon which the collective success of our efforts must depend,-and that is total freedom of individual expression. Let us thoroughly agree upon these fundamental things: when we get together,-we meet not as representatives of business interests or of partisan political interests, but exclusively as citizens and scholars, working for that which is true, or at least appears to be true, and not afraid to tell the truth. It may well be that such complete freedom of expression will appear somewhat unusual and without precedent in the line of business we are engaged in. The more reason why this principle must be announced early and adhered to strictly, for without it there can be no hope for a sound development of our science and no respect and confidence from society. Let it be understood that when any voice is raised here, it is the voice of the unprejudiced expert and not of the paid attorney. Perhaps the majority of us will find that some effort will be necessary to overcome opposition and to achieve this ideal.

Having had extensive experience in both private and public employment, I know full well, that our friends in various state institutions have as many, if not more, limitations to contend with than we who are hirelings of soulless corporations. But what may have been too difficult for isolated individual effort to overcome should yield much more readily to the concerted influence of this organization. In addition to the freedom of individual expression, there must be some reasonable measure of publicity in regard to the accumulated experience of the insurance carriers. This demand may appear extravagant. It may be argued with a good deal of conviction that already the insurance carriers are suffering under an overgrowing burden of demands for enforced publicity. The English alphabet will soon be exhausted in response to the anxiety of Insurance Departments and Industrial Commissions to create new schedules. We have already reached Schedules W and Z, and one may reasonably expect that Schedules X and Y will not fail to appear presently.

OUR PROBLEMS.

But I am at present thinking of another, more productive form of publicity. The required schedules are governed by administrative considerations. The enforced expense upon insurance carriers must have ample justification. Simple scientific curiosity cannot serve as such justification. All schedule returns, therefore, must necessarily be of a somewhat mechanical character, they cannot exhaust the entire contents of the raw material at our disposal. Individual investigations by ingenious statisticians promise more valuable statistical results. After all, we may utilize arithmometers, comptometers, Hollerith and Powers outfits, until the din and racket of mechanical appliances wreck the statistician's sweet disposition, and make his employment so extra hazardous that even the New York Compensation Law will recognize him—nevertheless, punch cards and electric currents do not constitute statistics.

Over and above them there must be the spirit of scientific inquiry, of the striving for truth. Granted these, our statistical departments may become organizations for useful social service, provided we succed in impressing upon the management of insurance carriers that it is right and proper that the results of such individual investigations be given proper publicity, without which all exchange of knowledge is impossible.

WORKMEN'S COMPENSATION CLAIM RESERVES.

MILES M. DAWSON.

The claim or loss reserves, which should be held under workmen's compensation policies, fall under the following general heads:

I. Reserves to provide for the payment of sums to become due in future under awards already made.

II. Reserves to provide for the payment of sums to become due under claims already filed for which no award has yet been made.

III. Reserves to provide for the payment of sums to become due under claims which may be filed because of accidents that have already occurred, notice of which (a) has been received or (b) has not been received.

Unearned premium or reinsurance reserve is not here discussed, it being assumed that sufficient provision is made in that form to assure the payment of claims that will arise from accidents occurring during the unexpired portions of the terms of policies in force.

I. RESERVES TO PROVIDE FOR THE PAYMENT OF SUMS TO BECOME DUE IN FUTURE UNDER AWARDS ALREADY MADE.

It will be observed, of course, that under each of the three classes of claim or loss reserves, enumerated above, all kinds of claims will be included as, for instance, death claims, permanent total and temporary total disability, etc. These must, therefore, be carefully considered, which can best be done, first of all, under the first of the three enumerated general classifications, because all claims falling under it may be treated as fixed and definite by reason of which the distinctive characteristics of the kind of claims clearly appear, free from any involvement with contingencies or uncertainties regarding whether or not there will be a claim. It will be found, likewise, that, once these distinctive characteristics are well taken care of in computations free of such involvement, the effect of the contingencies and uncertainties in the two other enumerated classes can be dealt with, as a separate matter, quite simply and effectively.

Claims appear to fall by natural cleavage under the following heads, by kinds:

1. Death, leaving

- (a) No dependents.
- (b) Widow (or dependent widower):
 - (1) Without children, also claimants.
 - (2) With children, also claimants.
- (c) No widow (or dependent widower) but children, claimants.
- (d) Other dependents entitled to claim:
 - (1) Dependent parents or grandparents.
 - (2) Dependent grandchildren, brothers or sisters.
- 2. Dismemberment and mutilation.
- 3. Permanent total disability.
- 4. Permanent partial disability.
- 5. Temporary total disability.
- 6. Medical expenses.

Taking these up in turn, we have:

1. (a) Death, Leaving No Dependents.—Under this head, as regards awards already made, there is no reserve called for to provide for sums to fall due in future.

For the amount payable under workmen's compensation laws is in such cases, a lump sum, applicable to pay expense of funeral and burial, with remainder perhaps to apply on expenses of last sickness; accordingly it is due the moment award is made. If unpaid, it should be included in "Losses due and unpaid" in the statement and not in claim or loss reserves.

1. (b) (1) Death Leaving Widow, without Children, Also Claimants.—There are various forms for this compensation, the main sorts of which must be separately considered as follows:

I. If the widow's compensation is payable in one lump sum, no claim or loss reserve, because due at once upon being awarded and if not paid to be entered in "Losses due and unpaid" in the statement.

II. If the widow's compensation is payable for a fixed period as m years (as in Massachusetts) irrespective of death or survival, of which period n years* have elapsed, the reserve is for each dollar per annum payable

$a^{(12)}_{\overline{m-n}}$.

* Of course m and n may, each of them, be integral or fractional.

For convenience, it is, in my opinion, best to use continuous functions which are near enough correct, viz.:

 \bar{a}_{m-n} .

This brings up the question at once: At what rate of interest should this computation be made?

Several companies—perhaps most of them—have hitherto entered the gross amount, yet to be paid, without allowing for the interest the fund would earn until paid out.

Much could be said in these days in favor of assuming 4 per cent. or even a higher rate; but are not the following considerations decisive?

 $3\frac{1}{2}$ per cent. is the maximum rate used in valuing all future payments in life insurance.

The rate here adopted should be applicable to all such benefits, whether of long or short duration; if of long duration it would be unwise to assume a high rate and if of short, the inconvenience of investing and realizing would perhaps prevent a high rate being actually realized.

Several of the larger companies, supplying workmen's compensation insurance, are also life insurance companies and could not afford to assert that the security behind these annuities should be on a higher interest assumption than the security behind their other annuities; neither could the other companies afford to be less secure than these companies.

It certainly should not be the policy of a State Insurance Department to use a higher rate of interest in valuing annuities to be paid workmen and their families and thereby cause lower reserves to be held to secure the same than the legislature provides for in requiring reserves to secure other annuitants.*

Therefore, it seems clear that the present value should be computed upon the assumption that the funds will earn $3\frac{1}{2}$ per cent. per annum.

III. If the widow's compensation is payable for a limited period of m years but terminable in event of her prior death, n years having already elapsed, the reserve is for each dollar per annum payable (writing the same as if payable continuously):

$$\overline{a}_{+n\overline{m-n}}$$

* The New York Insurance Department has adopted 31 per cent.

The question now arises as to the mortality which should be assumed in computing this value.

Obviously it should not be the American Experience table, for that, it is well known, shows a higher death rate than is really experienced and so would bring out inadequate values for these annuities.

Obviously, also, it should not be McClintock's Annuitants' Table, because that, it is well known, shows a lower death rate than is experienced, except among persons who, thinking they will live long, purchase annuities; and so would bring out excessive values for these annuities.

The State Workmen's Compensation Commission of New York has adopted the Survivorship Annuitants' Table,* deduced from the experience of the Danish State Insurance Fund. This table is fairer, because it represents death rates among widows who are living on annuities, payments upon which commence after the deaths of their husbands.

This table, also, has been so constructed that the most complex combinations can be dealt with simply and easily and it also comprises safe mortality rates for valuing children's compensation.

A copy of my paper read before the Actuarial Society of America at its October, 1914, meeting, describing its usefulness for the purpose of valuing workmen's compensation, has been furnished each member of this Society.

IV. If the widow's compensation is payable for m years but to terminate upon prior remarriage or death, the reserve is for each dollar per annum payable:

$$\bar{a}_{x+n\,\overline{m-n}}^{\prime\prime}$$
,

in which the " signifies that both death and remarriage are involved.

The computation of these values will require the use of a remarriage, as well as a mortality, table. No remarriage table has hitherto been used in the United States.

The State Workmen's Compensation Commission of New York has adopted the remarriage table deduced from the experience of the Dutch State Insurance Fund* as regards the remarriage of widows in receipt of compensation.

As fully set forth in my paper, already referred to, this remar-

* Now also adopted by the New York Insurance Department.

riage table has been combined with the Survivorship Annuitants Mortality Table, in such a manner that these annuity values can be computed very readily.

V. If the widow's compensation is payable until death or remarriage, the reserve is for each dollar per annum payable:

 $\tilde{a}_{x+n}^{''}$

in which as before the chances of death and remarriage are both taken into account.

VI. If the widow's compensation is as in V but with two years' annuities paid in one sum upon remarriage, the reserve is for each dollar per annum payable:

$$\bar{a}_{x+n}''+2A_{x+n}',$$

in which A'_{x+n} is the value of \$1.00 payable upon remarriage.

1. (b) (2) Death Leaving Widow with Children, Also Claimants.—This case has already been discussed in Mr. Greene's paper read before this Society at its last meeting and also in my paper before the Actuarial Society of America, already mentioned; likewise, in my article "Mortality and Remarriage Tables for Valuing Compensation to Widows and Other Dependents" published in the Market World and Chronicle of November 21, 1914.

Formulas, annuities, commutation columns and other facilities for making these computations have been prepared, and will soon be ready for distribution.

1. (c) Death Leaving No Widow, but Children Claimants.— If there are no other claimants the reserve is for each such child, in case compensation of one dollar per annum is payable until age 18 is reached, n years having already elapsed.

$$\bar{a}_{w+n} \overline{18-(w+n)}$$
.

The most suitable table is the Survivorship Annuitants' Table, already referred to, which covers infantile ages, as well as adult, and is throughout so constructed as to enable complex problems to be solved quickly and conveniently.

If there are several children of ages w_1 , w_2 , w_3 , etc., the total reserve for compensation of one dollar per annum each, is:

$$\bar{a}_{w_1+n} \overline{18-(w_1+n)} + \bar{a}_{w_2+n} \overline{18-(w_2+n)} + \cdots$$

94

If for a limited term, say m years, n having elapsed, these become, respectively:

and

$$\bar{a}_{w+n} \overline{m-n}$$

$$\bar{a}_{w_1+n\,\overline{m-n}|}+\bar{a}_{w_2+n\,\overline{m-n}|}+\cdots$$

If limited both to a given age, say 18, and to a term, m years, the reserve for each must be selected according as m - n or 18 - (w + n) is the smaller.

But if the aggregate exceeds some limitation in the law, these values will be modified in a manner for which formulas have been prepared, as stated.

1. (d) (1) Death Leaving Other Dependents Entitled to Claim, viz., One or More Dependent Parents or Grandparents.—In such case, if not complicated by "limits," the reserve per dollar per annum if payable for life, n years having elapsed is:

 \bar{a}_{y+n} ,

or if there be more than one, aged y_1 , y_2 , y_3 , etc.:

$$\bar{a}_{y_1+n} + \bar{a}_{y_2+n} + \bar{a}_{y_3+n} + \cdots$$

If payable for m years, these become

$$\bar{a}_{y+n} \overline{m-n}$$

and

$$\bar{a}_{y_1+n\overline{m-n}}+\bar{a}_{y_2+n\overline{m-n}}+\cdots$$

How combinations with widow's or children's compensation or both and the complexities due to limits are dealt with, is shown in the formulas referred to.

The probability of dependence ceasing during life is so slight that it should be disregarded.

1. (d) (2) Death Leaving Other Dependents Entitled to Claim, viz., One or More Dependent Grandchildren, Brothers or Sisters.—If compensation is payable to age 18—or any other agethese reserves are computed precisely like those for children.

Likewise if payable for a limited term.

The probability of dependence ceasing before the age is reached or the term expires, is slight and should be disregarded.

The combinations with compensation payable to others and the

complexities due to limits are dealt with in the formulas referred to.

2. Permanent Total Disability.—This may have been provided for by compensation limited to *m* years; in such case the reserve for each dollar per annum is, *n* years having elapsed:

\bar{a}_{x+n} $\overline{m-n}$.

Or if the compensation is during the entire period of disability, if it has been adjudged permanent, the possibility of recovery had best be disregarded, as very remote, and the reserve for each dollar per annum be taken, after n years have elapsed, as:

\bar{a}_{x+n} ,

allowing for termination by death only, i. e., computing by a mortality table only and not taking account of possible recovery.

The question arises: What mortality table should be employed in such cases?

The Survivorship Annuitants' Table has, for this purpose, no particular claim, arising from its derivation which is (except as regards infantile ages) from experience of female survivorship annuitants.

If it should be used to compute reserves for permanent total disability, this can only be because it *chances* to be suitable. In such case, it ought to be used in order to avoid employing two mortality tables in these computations.

At first blush, it seems, of course, as if a table deduced from mortality experience among the totally disabled should be employed —such, for instance, as that which is printed on p. 51 of Vol. XII of the *Transactions* of the Actuarial Society.

But precisely such an assumption as that caused the Norwegian State Insurance Fund to underestimate its liabilities for several years and occasioned much embarrassment. It was found, instead, that the mortality among those receiving compensation for permanent disability on account of accident had been, after a preliminary period of a few months, actually lower than the population mortality rates in Norway at the same ages. It must be remembered that the population mortality in Norway is the lowest of all the countries of Europe, except Sweden and Denmark, and nearly the same as in those countries.

The Norwegian population table is so low as to indicate that it will not be unduly conservative to use the Survivorship Annuitants' Table for this purpose also after, say, six months have elapsed;* although it should, of course, be discarded for a more suitable table if there are reasons for doing so which outweigh the advantages of keeping to one table in computing compensation reserves.

During the first weeks or months, there may often be a much greater probability of death, for which some allowance should be made; but only in case reserve is also made for the contingency of a death claim, for these early deaths are nearly always due to the consequences of the accident.

III. Permanent Partial Disability.—As dismemberments and mutilations are usually separately provided for in American compensation laws, they are separately considered under the next head.

When permanent partial disability has once been established and an award made, one of three things will afterwards be true, regarding the amount, viz.:

The impairment of earning power will not change; therefore, the compensation also.

The impairment will increase, resulting in increase of compensation.

The impairment will improve, resulting in decrease of compensation.

Taken one case with another, it is safe and conservative to assume that on the average they will neither increase nor decrease. This is, however, to assume that decreases will balance increases, which will perhaps not be fully realized. Yet, with conservative interest and mortality assumptions, I consider that

\bar{a}_{x+n}

is a fair expression for a dollar per annum of such compensation if payable throughout disability and

\bar{a}_{x+n} $\overline{m-n}$

if payment is limited to m years.

IV. Dismemberment and Mutilation.—Under American compensation laws, these are always, unless classed as permanent total disability, compensated by instalments through a fixed or limited term.

* It has been adopted by the State Workmen's Compensation Commission and the New York Insurance Department for this purpose. If a fixed term of m years, the reserve, n years having elapsed, is for each dollar per annum:

 \overline{a}_{m-n} .

If for a limited term of m years:

 $\bar{a}_{x+n} \overline{m-n}$.

V. Temporary Total Disability.—Our president, Dr. Rubinow, reports in his table, "Standard Distribution of Accidents," that, out of 100,000 accidents reported, only 932 result in death, 2,323 in dismemberment, 110 in permanent total disability and 2,442 in permanent partial disability, in all only 5,808 cases, leaving no less than 94,192 of temporary disability.

Therefore, though the more difficult cases mathematically and also those involving the heaviest reserve per case have been provided for in the foregoing, much the greatest number yet remain.

The following is Dr. Rubinow's distribution of temporary disabilities according to duration:

TEMPORARY DISABILITY.

Not over 1	week	37,112
1-2 weeks		23,925
2-3 weeks		12,433
3-4 weeks		6,970
4-5 weeks		4,427
5-6 weeks		2,732
6-7 weeks		1,695
7-8 weeks		1,130
8-9 weeks	• • • • • • • • • • • • • • • • • • • •	942
9-10 weeks		565
10-11 weeks	• • • • • • • • • • • • • • • • • • • •	471
11-12 weeks		377
12-13 weeks		283
13-26 weeks	•••••••••	933
Over 26 week	8	197
		94,192

So far as disabilities of less than two weeks' duration go, the proportion given is large if compared with the number of notices of accident which result in claims. This is no doubt due to failure to give notice when the injuries are so trivial that it is plain that a disability extending into third week is not to be expected. But after the second week, these figures are pretty likely to prove reliable for reserve purposes.

98

WORKMEN'S COMPENSATION CLAIM RESERVES.

From Dr. Rubinow's table, I have deduced the following table of average further durations of disabilities just commencing, of disabilities one week old, etc.:

TABLE OF AVERAGE FURTHER DURATIONS OF TEMPORARY DISABILITIES.

(Deduced from Dr. Rubinow's Table of Standard Distribution.)

1	Period o	f D	is a bi	lity							Average	e Further	
	Alread	уE	laps	ed.						Pe	riod of	Disability.	
1	day	to	1	week .	 			• • •	 		2.07	weeks	
1	week	to	2	weeks	 			• •	 • •		2.42	weeks	
2	weeks	to	3	weeks	 	•••			 		3.16	weeks	
3	weeks	to	4	weeks	 	•••		• •	 		4.05	weeks	
4	weeks	to	5	weeks	 			• •	 	••	5.11	weeks	
5	weeks	to	6	weeks	 	•••		• •	 		6.53	weeks	
6	weeks	to	7	weeks	 	•••	••	••	 ••		8.24	weeks	
7	weeks	to	8	weeks	 	•••	• •		 •••	• •	10.09	weeks	
8	weeks	to	9	weeks	 	••	• •	••	 	••	12.11	weeks	
9	weeks	to	10	weeks	 		• •	•••	 • •	••	15.15	weeks	
10	weeks	to	11	weeks	 	•••		••	 	••	17.93	weeks	
11	weeks	to	12	weeks	 	•••		••	 		21.65	weeks	
12	weeks	to	13	weeks	 	•••	• •	••	 	••	26.43	weeks	
13	weeks	to	26	weeks	 	•••		• •	 ••		29.55	weeks	
Ov	er 26	wee	ks		 	•••			 	••	176 w	eeks less	the
											ter	m elapse	d.

The term beyond 26 weeks was interpolated by reference to British Government Friendly Societies' (Sutton's) Tables.

By listing the aggregate amounts of compensation awarded by weeks already disabled, multiplying those aggregate amounts by the average respective number of weeks further disabled and adding up the result, the required reserve for temporary disability compensation to become due in future under claims already awarded is found.

The ease and convenience of this method, as well as its theoretical soundness, should render it acceptable; the table can be modified later as experience may indicate.

Special Reserves for Suspended Death Claims.—This completes reserves for compensation to become due in future, except a special contingency reserve which should be maintained in order to cover the risk of death claims resulting from injuries under which disability claims are now awarded.

This is a risk which is at its greatest, perhaps, when the two

weeks' waiting period has expired and the disability claim begins to run, and which rather rapidly subsides.

Suppose it were considered that all the deaths have an antecedent period of disability.* This is not quite true because some are instantaneous, but some of the disabilities are also over almost immediately.

How many would result from the 110 cases of permanent total disability? I am not at the present moment aware of statistics bearing on this matter of how many of those who are adjudged totally and permanently disabled, die of their injuries nor of the respective years after the injury such deaths take place. Such statistics doubtless exist somewhere and the facts can be ascertained.

Pending obtaining this information, how would it do to assume that one-third of these 110 would die ultimately as the result of their injuries-say 37 of them-but that of those who die within three years, one-half die of their injuries.

On this basis, putting X for the amount of the death claim (present value), the special reserve to cover the contingency of a future death claim in a permanent total disability case would be, nyears having elapsed:

$X(1/3A_{x+n})$

in which A_x should (after six months) be computed by the Survivorship Annuitants' Table or (during such six months) by the American Experience Table.

If the law prescribes a period—say m years—after the expiration of which death will not be compensated, this might well be:

$X(1/2A_{(1/x+n)})$.

This would leave 932 less 37, that is 895 deaths which are assumed to follow temporary total disability of which there are 94,192 cases, i. e., about 95 per 10,000-practically 1 in 100.

The foregoing is suggested, to call out discussion.

VI. Medical Expense.—The reserve for this item, if limited in time or amount or both, should be provided for by ascertaining as nearly as possible the average cost of this service per case.

This would also apply to temporary disabilities, even though neither amount nor time limited; but in such case, if disability

* This may seem to violate the basis of Dr. Rubinow's Table; but it is not, I think, really 100,000 accidents but 100,000 cases, counting those which appear twice, a second time, etc.

is total and permanent, 10 per cent. ought perhaps to be added to the present value of the annuity, to cover such expenses if payable throughout disability.

II. RESERVES TO PROVIDE FOR THE PAYMENT OF SUMS TO BECOME DUE UNDER CLAIMS ALREADY FILED, FOR WHICH NO AWARD HAS YET BEEN MADE.

The claims having been filed, the company can compute from the data at hand, what the awards will probably be.

These are of the same nature as any other claims of which notice has been received; such should be charged up as liabilities at their probably maximum amount.

The course which should be taken if the company considers that there is no liability depends upon its degree of confidence; if it is reasonably likely that award will be made, the claim should be counted.

It would be wise, indeed, in my opinion, if all claims filed were valued and reserves charged for maximum possible awards, because thus this reserve is certainly ample and also because if a claim is disallowed, there is or may be liability in damages for negligence.

III. RESERVES TO PROVIDE FOR THE PAYMENT OF SUMS TO BECOME DUE UNDER CLAIMS WHICH MAY BE FILED BECAUSE OF ACCIDENTS THAT HAVE ALREADY OCCURRED.

These fall into two classes, (a) notice received and (b) no notice received. Apparently since notices contain some information concerning the character of the injury, these could be treated differently, i. e., the first by estimating up the claims and the second by making a percentage addition to these reserves to cover those for which no notice has been received. But this seems to me unwise because leaving too much room for individual discretion in estimating the reserves because the information available will be too scanty.

The number of such cases for which no notice has been received can be arrived at with reasonable accuracy, if the combined experience is studied with care. When this number is added to the number for which notices have been received, the resulting aggregate can be operated upon to obtain the total reserves for both.

In my opinion, the simplest and safest policy would be to utilize

101

102 WORKMEN'S COMPENSATION CLAIM RESERVES.

again Dr. Rubinow's Standard Table of Distribution, which is here reproduced:

STANDARD DISTRIBUTION OF ACCIDENTS AS COMPUTED IN A MEMORANDUM ATTACHED ON A BASIS OF 100,000 ACCIDENTS. FATAL CASES 932 DISMEMBERMENTS: 1. Loss of left arm 64 2. Loss of right arm 95 3. Loss of left hand 50 4. Loss of right hand 61 5. Loss of left thumb 29 6. Loss of right thumb 30 7. Loss of left index 59 8. Loss of right index 69 9. Loss of left middle finger 26 10. Loss of right middle finger 31 11. Loss of left ring finger 14 12. Loss of right ring finger 17 13. Loss of left little finger 32 14. Loss of right little finger 34 15. Loss of left thumb and one or more fingers left hand 14 16. Loss of thumb and one or more fingers right hand ... 17 17. Loss of two or more fingers left hand 63 18. Loss of two or more fingers right hand 66 19. Loss of one phalanx of finger of left thumb 55 20. Loss of one phalanx of finger of right thumb..... 62 21. Loss of phalanx of left index 83 22. Loss of phalanx of right index 93 23. Loss of phalanx of left middle finger 5224. Loss of phalanx of right middle finger 53 25. Loss of phalanx of ring finger left hand 25 26. Loss of phalanx of ring finger right hand 19 27. Loss of phalanx of left little finger 18 28. Loss of phalanx of right little finger 17 29. Loss of fingers accompanied by injuries of other fingers left hand 17230. Loss of fingers accompanied by injuries of other fingers right hand 173 31. Loss of one leg 129 32. Loss of both legs 3 33. Loss of toes 57 34. One eye 465 35. Loss of one eye with injury to the other 62 36. Loss of both eyes 24

Total

2,323

TO MALLE DI DOMINICATION COMINICALDERING. 10	WORKMEN'S	COMPENSATION	CLAIM	RESERVES.	1	0)	J
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Total permanent disability other than dismemberments	110	110
Partial permanent disability other than dismember-		
ments, leading to disability of	2,442	2,442
1-10 per cent 672		
11-20 per cent		
21-30 per cent		
31-40 per cent		
41-50 per cent 179		
51-60 per cent 92		
61-70 per cent 92		
71-80 per cent		
Total		2,442

Temporary Disability.

9–10 weeks	
10–11 weeks	
12–13 weeks	
13–26 weeks	
Over 26 weeks 197	

Since this table embraces *all* accidents, whether considerable or not, if it is found to be defective, it is likely chiefly to be in underestimating the proportion of the temporary disabilities, *of which notice* is given, which will become compensatable. The fact that compensation is not payable for the first two weeks will be found to make a material difference in the number of trivial accidents for which notice will be received.

The checking of the first three months' experience of the State Workmen's Compensation Commission with this table, the results of which Mr. Woodward, Actuary of the Commission, has kindly supplied me, is strongly confirmatory of the Rubinow distribution in all regards but this. It runs as follows:

	No. Cases (Rubinow),	No. Cases (Actual).
Fatal	16	16
Dismemberments	. 42	44
Total permanent-not dismemberments	. 2	1
Partial permanent-not dismemberments.	. 44	0
Temporary total-not compensatable	1,098	1,014
Temporary total-compensatable	. 598	725
	1,800	1,800

Should this prove, upon further test, to call for modifications of the Standard Table in this regard, of course Dr. Rubinow will introduce them; and, indeed, they should be made as early as practicable and if possible before the table comes into use. It will not in my opinion modify the average further durations beyond two weeks but only the proportion of the disabilities of which notice is received, which reach the third week.

The use to which this table can be put, I am confident, under the compensation law of a given state, is to estimate the average amount of claim per accident, irrespective of kind, for which notice is received.

The process would be as follows: Enter opposite "Fatal cases— 932," the aggregate claims thereunder, i. e., 932 times the average claim; opposite "Loss of left arm—64," the aggregate claims thereunder, i. e., 64 times the average claim; and so on. The sum of these aggregate claims would then be the cost per 100,000 accidents noticed under the law and, when divided by 100,000, the average cost per accident.

Then, for reserve purposes, this can be multiplied by the number of notices received, no claims filed, increased by the computed number for which no notice is received, which will yield the reserve to provide for the payment of awards because of such accidents.

Reserve for medical services should be computed according to actual experience and added to this total.

SPECIAL COMMENTS.

The foregoing, except as regards pensions to widows, children and other dependents, is not presented as definitive, though I am of the opinion that the method of using average further durations for reserves for temporary disabilities should be adopted without further delay than is unavoidable.

To the end that no insurance company by failing may bring discredit upon all, it is of the highest importance that claim reserves be ample. The British makeshifts in this regard will not answer; much less will the makeshifts which we have been compelled to use in employers' liability insurance for want of anything better.

American companies must not permit the insufficiency of their reserves to shake the confidence of the public; unlike in Great Britain, there is here a strong tendency to substitute public insurance.

That one who is, on principle, in favor of a public way of dealing with this matter, should give utterance to this warning, may seem singular; but no one desires, less than myself, a victory for public insurance by reason of claim-reserves being insufficient and thereby disabled workmen, widows, children and other dependents being deprived of support.

To avoid even a single instance of this should be the care of all the members of this Society, of managers of companies and of state insurance and compensation officials. It can only be avoided:

1. By making sure that the claim-reserves are ample and the method of computing them free from the exercise of discretion by the company or the valuer.

2. By obtaining legislation making this claim reserve fund a trust fund for the claimants and either separately invested or otherwise a first lien on all assets.

At the present time, under an opinion of the Attorney General, the *premium-reserve* is now held to have such a prior claim upon the assets and only the surplus of assets over such premium reserve can, in event of insolvency, be applied to pay these and other debts of the company. Certainly this must be reversed as regards workmen's compensation claims or a great scandal will one day come which will prejudice all the companies, sound as well as unsound, with the public, irredeemably.

THE NEW YORK STATE STANDARDS FOR 1915.*

Since the foregoing was written, the announcement by the New York Insurance Department of the standards for computing reserves as of December 31, 1914, has come to my notice.

* EDITOR'S NOTE: Mr. Dawson refers to the following circular of the New York State Insurance Department, issued under date of January 12, 1915.

"CIRCULAR TO

MUTUAL LIABILITY AND WORKMEN'S COMPENSATION INSURANCE CORPORATIONS

I. LOSS RESERVES

"The workmen's compensation loss reserves for mutual employers' liability and workmen's compensation insurance corporations are to be determined on the basis of an analysis of the accidents which have occurred up to and including December 31st, 1914. All references to the law refer to the Workmen's Compensation Act of New York State.

"All notices of accidents shall be classified as follows:

- 1. Death.—This requires no explanation.
- 2. Permanent Total Disability.—As per subdivision 1 of Section 15 of the law.
- 3. Permanent Partial Disability (Dismemberment).—As per subdivision 3 of Section 15 of the law.
- 4. Permanent Partial Disability (Not Dismemberment).--This covers cases where the injured has suffered a partial loss of earning power which probably will be permanent in character.
- 5. Temporary Total Disability.—Include in this class those accidents causing total disability lasting more than two weeks.
- 6. Temporary Partial Disability.--Include in this class accidents resulting in a temporary loss of earning power in accordance with subdivision 4 of Section 15 of the law.
- 7. Medical.—Eliminate cases arising under policies which do not provide medical aid. The remaining cases should be divided into two groups:
 - (a) cases entitled to compensation.
 - (b) cases not entitled to compensation.

"In arriving at the amounts of reserve to be held in respect to each of the foregoing classes of accidents, the following method is to be used:

"1. Death.—The present value of death cases is to be computed on the basis of the Danish Survivorship Annuitants Table of Mortality, the remarriage rate of the Dutch Royal Insurance Institution, and 3½ per cent. interest. In cases known not to involve dependency, a funeral benefit of \$100 is to be carried into the reserve unless the benefit has already been paid in cash. The department will furnish present values in death cases upon receipt of the necessary data as to each such case. This must include a statement of the name and wages of the deceased, together with the age and relationship of dependents.

"2. Permanent Total Disability.—Where the description of the injury indicates that total permanent disability will probably result, the amount to be set aside as reserve is the present value of a life annuity for the amount of annual compensation, computed according to the Danish Survivorship Table of Mortality with 3½ per cent. interest. The department will furnish present values upon receipt of information with reference to the name and wages of the injured employee and the age at date of injury.

"3. Permanent Partial Disability (Dismemberment).--These cases are to be valued in accordance with subdivision 3 of Section 15 of the law. "4. Permanent Partial Disability (Not Dismemberment).—Cases of this character are to be valued upon the same basis as permanent total disability cases, and in accordance with the last paragraph of subdivision 3 of Section 15 of the law.

"5. Temporary Total Disability.—All cases of this nature which have occurred, regardless of whether anything has been paid thereon, are to be valued at \$75.00 each. From the total deduct compensation actually paid up to December 31, 1914. The remainder is the reserve for this class.

"6. Temporary Partial Disability.—All cases of this nature which have occurred, regardless of whether anything has been paid thereon, are to be valued at \$25.00 each. From the total deduct compensation actually paid up to December 31, 1914. The remainder is the reserve for this class.

"7. Medical.

(a) Cases Entitled to Compensation.—Multiply each case in this class by \$30.00. From the total deduct payments actually made up to December 31, 1914. The remainder is the reserve for this class.

(b) Cases Not Entitled to Compensation.—Multiply each case in this class, where any or all of the medical cost has not been paid prior to December 31, 1914, by \$5.00. This total is the reserve.

"II. SPECIAL RESERVE.

"Companies which have not made provision for reinsurance of the catastrophe hazard are required to maintain a special reserve, equal to 10 per cent. of their earned premiums.

"III. UNEARNED PREMIUM RESERVES.

"The unearned premium is to be calculated in accordance with section 86 of the Insurance Law, which contemplates an actual pro rata computation based upon actual time during which the policies have been in force on December 31, 1914. The department will accept, however, a statement of the unearned premium reserve calculated upon the monthly pro rata basis. Any policies which may have been dated as of midnight, June 30th, 1914, to cover the employer's liability for workmen's compensation, are to be treated as if such policies had been dated July 1st.

"IV. PUBLIC LIABILITY.

"The loss reserves on public liability policies shall be computed in accordance with the provisions of Section 86 of the Insurance Law.

"V. AUTOMOBILE AND TEAMS PROPERTY DAMAGE AND COLLISION.

"The loss reserves on these classes of business shall be based on specific estimates of the individual outstanding claims."

The foregoing instructions were amended as follows, January 19, 1915.

"Paragraph 5 is changed to read:

"5. Temporary Total Disability. Include in this class those accidents which have already caused, or which probably will cause, total disability lasting more than two weeks. "Insert after Paragraph 7 a new paragraph as follows:

"8. All Other Notices. This group should include those notices which do not properly fall into any one of the foregoing groups. These cases will be trivial in character and will not involve payment of medical or compensation benefits, hence there will be no reserve charged against this group.

"Rule 7 (b) is changed to read:

"7. Medical.

(b) Cases Not Entitled to Compensation. Multiply each case in this class where any or all of the medical cost has not been paid up to December 31, 1914, by \$5.00. From the total deduct medical cost actually paid up to December 31, 1914, on such cases. The remainder is the reserve for this class."

As regards claim reserves in all cases where awards have been made, the announcement is exactly in accord with the foregoing, as regards reserves on account of claims arising under the New York law because of death, permanent total disability, permanent partial disability other than dismemberment, and dismemberment.

For the temporary total disability, \$75 is charged for each case yet in progress and the aggregate sum already paid upon all these case is deducted from the aggregate thus charged.

For temporary partial disability, \$25 is charged for each case and the aggregate paid deducted from the aggregate charged.

In view of the fact that the law has been but six months in operation, it is perhaps impracticable to put the more accurate and scientific method for computing these reserves, which has been recommended in this paper, into practice as regards "all notices of accidents," i. e., "of the accidents which have occurred up to and including December 31, 1914." It will be recalled that earlier in this paper, a distinction has been made by me between (a) awards, (b) notices of claims, not yet ripened into awards and (c) notices of accidents, notices of claims not yet due or received; and that the method of determining reserves by classes seemed applicable only to the first and (with the precaution of treating the amount claimed, unless clearly mistaken, as the probable award) to the second and not at all to the third,

It may be that \$75 per notice will cover the entire liability (other than medical) under notices of accident; but if so (eliminating cases of instant death or dismemberment), it must also provide for death-claims and permanent disability claims, both total and partial, that may follow temporary disability. The charge per case, ignoring classes, is really not at all justified when awards, determining the weekly compensation, have been made; nor indeed when notices of claim, specifying amounts, have been filed; but for cases of notices of accident, only, it is the reasonable method, except that the determination of the proper amount should be arrived at, by computing the cost of an average claim of every kind that can arise under a notice.

The change to such a system from that which has been adopted, can easily be made next year and will be made, of course, if the present rule is treated as tentative and temporary.

The department deserves credit for taking the matter up so promptly and dealing with it, upon the whole, so successfully.* But why is it implied in the language of the circular that this method is to be used only in valuing claims arising under the New York law? It is true that in other states death-claims are payable only for fixed or limited terms; but the same principles apply precisely as they always do to term and limited annuities alike. Then why not use the same standards? Does not uniformity of reserve standards in general call for this? Will it be assumed that present values to secure annuities to California widows will earn higher interest or that they will die or, if that be involved, remarry at a higher or lower rate than New York widows? Is not the sole difference the term limited to a given number of years?

In other words, alteration in formulas is of course requisite; but the methods and standards are, mutatis mutandis, applicable to claims under the laws of every state.

* The chief want of success may be found, very likely, in the round amount per case charged for reserve for temporary disabilities and yet more in the method. The following is the rule as laid down by the Insurance Department:

"Temporary Total Disability.—All cases of this nature which have occurred, regardless of whether anything has been paid thereon, are to be valued at \$75 each. From the total deduct compensation actually paid up to December 31, 1914. The remainder is the reserve for this class."

Making use of Dr. Rubinow's Table of Standard Distribution of Accidents and of the Table of Average Further Durations of Temporary Disabilities which I have deduced therefrom and given in this paper, I have made the following computations to show the average liability per continuing notice or claim (for I assume that the words "which have occurred," in the Department rule, can have no reference to disabilities that are at an end, but only to those in progress) on the basis that the average claim is for \$10 per week, probably a somewhat high average:

COMPUTATION OF AVERAGE RESERVE.

Temporary Disability.

(Assume 94,192 notices of temporary disability at the beginning of each week.)

Average

Lia	hility
At outset 94,192 notices to produce 33,155 claims of \$31,60 each	11.12
End of 1 week also 57.080 disabilities yet in progress, i. e., 151.272 to	
produce 66.310 of \$31.60 each	13.85
End of 2 weeks also 33.155 claims for same amount, i. e., 184.427	
producing 99.465 of \$31.60 each	17.04
End of 3 weeks also 20.722 claims for $$40.50 = 205.149$ in all for	
\$3 982 235 in all	19 42
End of 4 weeks also 13752 elaims for $$5110 = 218901$ in all for	40.10
\$4 684 962 in all	21 40
End of 5 weeks also 9 325 claims for \$65 30 - 228 226 in all for	
\$5 293 885 in all	23 20
End of 6 weeks also 6593 claims for $\$82.40 - 234.819$ in all for	
\$5 837 148 in all	24 88
End of 7 weeks also 4.898 claims for $$100.90 - 239.717$ in all for	B1.00
46 331 356 in all	26 41
End of 8 weeks also 3.768 claims for $$121.10 - 243.485$ in all for	00, 11
\$6 787 661 in all	27.88
End of 9 weeks also 2 826 claims for \$151 50 - 246 311 in all for	
47 915 800 in all	20 2 <u>0</u>
End of 10 weeks also 2261 elsims for \$170.30 - 248.572 in all for	20.00
47 691 107 in all	20 6 8
Find of 11 weaks also 1700 alsims for $$21650 - 250362$ in all for	00.00
\$8 0.08 739 in all	31 00
Find of 19 masks also 1.413 aloing for $6964.30 - 951.775$ in all for	01.00
49 399 399 in all	22.00
Find of 12 meaks also 1 120 alsing for \$205.50 252.005 in all for	00.23
49 716 303 in all	31 14
$f_{0,110,000}$ III all	J4.40
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	00,40

That is, after being 26 weeks in operation, the average liability upon each continuing disability would in such case be, under the New York law, \$35.46 instead of \$75.00, the amount named by the Department.

But (which is most important) it would not be a diminishing sum but up to that point a constantly increasing sum and beyond that period a level sum, if an equal number of notices of claim were received each week.

That, if properly computed, the average sum charged should not be reduced by crediting payments is indicated by the following transformation of the Table of Average Further Durations of Temporary Disabilities into a table of "average further costs of compensation at \$10.00 weekly per case," making suitable changes because no compensation is paid for the first two weeks:

	Time Elapsed.	Averag	e Further Cost.
D	ay of accident		11.12
1	week		13.85
2	weeks		31.60
3	weeks		40.50
4	weeks		51.10
5	weeks		65.30
6	weeks		82.40
7	weeks		100.90
8	weeks		121.10
9	weeks		151.50
10	weeks		179.30
11	weeks		216.50
12	weeks		264.30
13	weeks		295,50
26	weeks		1,500.00

That is, each disability *averages* to involve a larger, not a smaller, outlay in future, the longer it has continued already, subject to these limits. Probably all claims of more than 26 weeks duration should be valued as life or term annuities as set forth in this paper.

If the amount charged per disability were truly applied to "all cases of this nature that have occurred," including all which have already terminated, the rule would yet be applicable only as a temporary expedient. It could apply as a permanent rule only in case the amount charged were precisely correct for otherwise it would carry forward from cases entirely off the books an accumulated surplus in the reserve if the amount were too large or an accumulated deficiency if it were too small.

The amount charged per case, \$75.00, is not likely, as a temporary expedient, to prove much too large if any, especially as it is reduced by payments already made and as no other provision is made for suspended mortality among the disabled, which will result from the injuries received and for which the insurer will be liable to pay compensation.

WORKMEN'S COMPENSATION RESERVES.

JOSEPH H. WOODWARD.

The subject of the reserves necessary to establish workmen's compensation insurance in the United States upon a solvent basis is one which will doubtless occupy a large share of the attention of this Society during the immediate future. No satisfactory precedents or established methods of computing such reserves are as yet available and numerous contributions to the subject, from varying points of view, will be necessary before it can be treated as disposed of. No solution of the problem finally satisfactory from an actuarial standpoint will be possible until the analyzed statistics of some years' experience with workmen's compensation in the United States are available. Meanwhile the practical question is to find a method of computing reserves which will be workable as an insurance department requirement and uniformly applicable, so far as may be, to companies operating in many states and under varying workmen's compensation laws.

The two principal kinds of reserves to be considered in connection with any branch of insurance are (1) the loss reserve and (2)the premium reserve. The loss reserve may be defined as that sum which, with incidental accretions from interest, is sufficient to mature every outstanding obligation, known or unknown, on account of all accidents or other events which may lead to an insurance loss which have happened prior to the date as of which the reserve is being computed. In distinction therefrom, the premium reserve has for its primary function the liquidation of all losses which may be payable on account of accidents that may happen or events leading to an insurance loss that may occur subsequent to the date as of which the reserve is being computed but prior to the expiration of the policy period for which the premium has been charged or paid. Further reference to the premium reserve will not be made in this paper, since in the case of compensation insurance it does not differ in any respect from that for other branches of casualty insurance or for fire insurance. It may be remarked, however, that the premium reserve for workmen's compensation insurance should be required on the basis of the unexpired term of the policy calculated by months instead of by years as at present prescribed in the annual statement blank. The difference in results between the two methods of computation is in many cases sufficiently great to seriously impair the value of statistics based upon the less accurate method.

The two fundamental attributes to be sought in a loss reserve are: (1) it must be adequate; (2) it must not be excessive. As to the importance of adequacy, it would seem superfluous to argue, except for the acknowledged failure of existing liability loss reserve statutes to satisfy this most elementary of tests. In most affairs of life to be forewarned is to be forearmed, but in this particular matter the sources of error are so subtle and reveal themselves only after so careful a search beneath the surface that there is an ever-present danger that the unhappy history of liability loss reserves may be repeated. Under some compensation laws obligations are being assumed which will involve payments to injured employees or their dependents for periods extending over the entire lifetime of certain individuals. The annuity funds thus brought into being are in nowise less affected with the element of trusteeship than are the funds of a life insurance company. Indeed, in the case of compensation benefits, the element of trusteeship is more marked, since the income thus provided more often constitutes the sole means of support of the annuitant or beneficiary. These annuity funds, however, are not preferred liabilities of the insurance carrier and they must consequently suffer in their proportion from weakness at any point in the balance sheet. We should not, therefore, confine our conservatism to the computation of the present values of these annuities, but should extend it to the other portions of the loss reserve and, indeed, to the valuation of the assets and liabilities in general. But the duty of determining a method of computing a loss reserve which will be adequate remains to an especial degree a responsible one.

While this reserve, then, must first of all be adequate, it is also true that it should not be excessive. In the interest of conservatism it is always better to give the benefit of a reasonable doubt to a method which produces the higher reserve, but it is nevertheless important that the reserve should reflect with considerable fidelity the true probability of loss payments. Redundancy should not exceed a reasonable limit. If it does, the apparent cost of workmen's compensation will be exaggerated, the true profit or loss upon the business will be obscured, and mutual companies, state funds and the newer stock companies may be unfairly handicapped in their competition with old and well-established stock companies possessing an ample surplus from which they can temporarily borrow to set up reserves. To summarize, therefore, these introductory observations: The loss reserve should be (1) adequate; and (2) not excessive.

Before discussing in detail methods of valuing the various classes of compensation benefits it will be necessary to consider the practicability of making an analysis or grouping of every individual notice or claim received, including those relating to accidents occurring during a relatively short period prior to the valuation date. I have come to the conclusion that such a procedure will be found practically impossible where a large volume of transactions is involved. In the case of temporary disabilities, for example, to ascertain promptly whether or not the disability had ceased or was continuing on the valuation date, the wages in each case, whether or not an award had been or would be granted, etc., would involve an amount of labor and expense incommensurate with the value of the results obtained. With respect to the more serious cases, such as deaths, dismemberments, or permanent total disabilities, it would undoubtedly be possible to do more, but even here it is generally some little time after the accident before sufficient information for valuation, such as the number and ages of dependents, etc., is available. Further, bills for medical services incurred would in large measure not yet have been presented. In general, claim records are not conveniently accessible for actuarial purposes until some little time after the dute of the accident. Now, it is very important that an insurance company should be in a position to promptly close its annual statement at the end of a calendar year. This would be impossible if any system of reserves were demanded which actually or virtually required an individual analysis of all the more recent notices and claims. I think that we are driven, whether willingly or not, to the adoption of some method of valuation under which the minor cases will have been finally disposed of and the more serious ones will have had an opportunity to develop their true character before being subjected to individual analysis. As respects recent business, then, the loss reserve must, in default of other methods, be predicated upon the

familiar assumption that the pure premium as computed in advance was mathematically equivalent to the hazard and that, in consequence, the incurred losses on recently issued business are equivalent to the pure premiums earned for the corresponding period. I am not unmindful of the objections which may be urged against this method, particularly at a time when premium rates themselves are not being suffered to stand unchallenged. The obvious criticism is that it starts out by assuming, as it were, that which is to be proved. I am not sure, however, that this objection is so serious as it looks. Even though the reserve were based upon an actual analysis of every accident, it would still have to be calculated upon tables of experience which might or might not correspond with the facts in the cases to be valued. In either alternative, the reserve is based upon assumptions. It cannot in the nature of things be based upon anything else. Only completed experience can disclose the real facts. Has either method, then, greatly superior theoretical claims over the other? Not, I think, when applied to recent business. When applied to business so old, however, that the minor cases have been settled and the more serious ones have tended to develop their true character, there is no doubt that a valuation of each individual claim upon properly chosen standards is requisite. Otherwise the results will be vitiated by the accumulative effect of any redundancy or deficiency which might exist in the pure premiums.

The general conclusion is, therefore, that for recent business we should base the loss reserve upon pure premiums and for other business upon an actuarial valuation of each claim. Mr. A. W. Whitney has called my attention to the analogy beween these two methods and the so-called "retrospective" and "prospective" methods of computing the reserves upon life insurance policies, and throughout the remainder of this paper I shall therefore refer to the method based upon pure premiums as the "retrospective" method; while the method of individual valuation of each claim I shall refer to as the "prospective" method.

There is special justification for the use of the retrospective method in all cases where under the provisions of law the premium rates are subject to supervision and approval on the basis of being adequate to carry the risk. Theoretically, where rates are not approved as to their adequacy there is objection to their being used as a basis for reserve computations, but it seems in general impracticable to require that business should be specially rerated for purposes of valuation alone; and where the loss reserve is on the retrospective basis as respects recent business only, it does not seem that this objection is of great consequence.

Another objection which might, of course, be urged against the adoption of the retrospective method for any part of the reserve is that if a small company should have the misfortune to experience a catastrophe involving a large number of fatalities, the effect thereof on the company's financial condition would not, in the absence of some special provision for catastrophes, be immediately reflected in the returns. This objection, however, if considered serious, could be overcome by a provision that in the event of the aggregate present value of the death claims incurred by the company during the retrospective period being in excess of a specified percentage, say, thirty-three and one-third, of the earned pure premiums, such excess should be added to the reserve.

The next question for consideration is: over how long a period should the retrospective method apply and should it be made applicable to policy years or to calendar years? Taking up the second part of this question first, it may be noted that there appears to be a pretty general agreement of opinion that a policy year method of accounting is the preferable one. By a policy year method I mean one under which the business is grouped by policies issued during a given calendar year as distinguished from a strictly calendar year method under which the losses incurred during a given calendar year are set off against the earned premium or earned payroll for the calendar year regardless of the date of issue of the policies. Since policies of workmen's compensation insurance are rarely, if ever, issued for a term exceeding one year, I think that what is really meant by a grouping of policies by "years of issue" is a grouping by "policy years or periods commencing in a given calendar year." Where we have to do strictly with completed policy years or periods, the method seems properly described as a policy year method. Now, for the purposes of a loss reserve statute it does not seem of vital importance which of these two methods is adopted. Indeed, the calendar year method has much to recommend it in that its results are more readily comparable with the figures in the company's balance sheet and income and disbursement accounts. On the other hand, if the details of the loss payments and reserve are required to be stated

from year to year according to years of issue, we shall eventually obtain an experience which, after proper allowance has been made for the effect of interest, which is important, will readily disclose the true relation of the premiums and reserves to the actual losses. The business can be traced section by section to its termination and the ultimate cost of the commitments of a given calendar year ascertained. Finally, it is advisable that the system of grouping business for reserve purposes should agree with the system adopted as a basis for the compilation of experience statistics, and for this purpose the claims of the policy year method are undoubtedly superior.

As to the period for which the retrospective method is to apply, it is my opinion that a full calendar year should be permitted to elapse after the date of accident before the claim is valued by the prospective method. Assuming this to be desirable, it follows that the business of the two calendar years preceding the date of the statement should be valued by the retrospective method. Under this arrangement the most recent accident to which the retrospective method applies will be one year from the date of the statement and the most remote accident will be two years from the date of the statement. The average time elapsed between the date of accident and the date on which a prospective valuation commences will be eighteen months, and the total number of cases to be considered individually will be less than five per cent. of the total number reported.

On policies issued or renewed, then, during the two calendar years immediately preceding the date as of which the loss reserve is being computed I suggest that not less than $66\frac{2}{3}$ per cent. of the earned premiums on such policies or renewals, less payments actually made thereunder for losses, be required to be set aside as the loss reserve. The suggested percentage of $66\frac{2}{3}$ is arrived at from the consideration that the premiums approved by the Superintendent of Insurance of the State of New York as minimum adequate premiums for workmen's compensation insurance are based upon the assumption that $66\frac{2}{3}$ per cent. thereof is applicable to losses and $33\frac{1}{3}$ per cent. to expenses. Any insurance carrier which conducts its business on an expense ratio of less than $33\frac{1}{3}$ per cent. should be permitted at its option to charge a correspondingly higher reserve.

Before passing to the detailed consideration of the prospective

section of the reserve the following outline of the various subdivisions of the proposed loss reserve is presented:

SUBDIVISIONS OF LOSS RESERVE.

A. Retrospective section (based upon pure premiums).



Death Claims: Actual Mortality.

This item is intended to include all those cases where the death of the employee has actually occurred on or before the date as of which the valuation is made as distinguished from those cases where death adjudged to be the result of the work-injury occurs some time after the injury and subsequent to the valuation date. With reference to these cases three standards of valuation must be decided upon, viz.: (1) a table of mortality; (2) a table of remarriage; (3) a rate of interest. These standards being chosen, the remainder of the work falls strictly within the province of actuarial mathematics. Thus, under the New York law, assuming a widow aged x at the death of the husband and two children aged y and z respectively, the expression for the reserve on December 31 of the *n*th year following the year of death of the employee, will, for each \$100 annual earnings of the deceased, be as follows:

$$30\bar{a}'_{x+n+\frac{1}{2}} + 60\bar{E}''_{x+n+\frac{1}{2}}$$
(1) $+ 15(\bar{a}_{y+n+\frac{1}{2}:18-(y+n+\frac{1}{2})} + \bar{a}_{z+n+\frac{1}{2}:18-(z+n+\frac{1}{2})})$
 $- 5(\bar{a}_{x+n+\frac{1}{2}:y+n+\frac{1}{2}:18-(y+n+\frac{1}{2})} + \bar{a}_{x+n+\frac{1}{2}:z+n+\frac{1}{2}:18-(z+n+\frac{1}{2})}),$

where \overline{a}'_x denotes a continuous annuity terminable either at the death or remarriage of (x), \overline{E}''_x denotes the value of 1 payable at the moment of the remarriage of (x), and the other symbols have their usual significance. Further illustrations of this nature are

118
not given, since it is not the purpose of this paper to discuss the mathematical complications involved in the valuation of workmen's compensation death benefits. A paper by Mr. W. W. Greene, read at the last meeting of this Society, covers this subject in considerable detail. Some suggestions, however, as to the standards of mortality, remarriage and interest to be assumed may be appropriate.

It is proposed to use the Danish Survivorship-Annuitants' Table of Mortality, an account of which is given on pages 253-274 of Volume X of the Transactions of the Actuarial Society of Amer-This table reflects the mortality experienced by the Danish ica. State Insurance Institution among the lives of female beneficiaries of voluntary reversionary annuity contracts, a class of lives free from the influence of either medical selection or self selection. The experience included over four thousand deaths and covered the period 1842-1900. This table has the great practical advantages that it shows the rate of mortality from age 0 to the limiting age, that it is graduated by the Makeham formula for all ages without a change of constants, and that it is consequently available for valuing joint-life annuities involving the lives of children. For purposes of comparison the annuity values at 34 per cent. according to this and various other mortality tables are given below:

Age (x).	American Experience.	McClintock's FemaleAnnuitants.	French Annuitants.	Danish Survivor- ship Annuitants.
10	21,225	23.139	22.124	22.533
30	18.605	20.242	19.175	19.950
50	13,535	15.111	14.046	14.997
70	6.482	8.142	7.135	7.753

ANNUITY VALUES—31 PER CENT. (a_x) .

The use of the Survivorship Annuitants' Table for valuing compensation death benefits was first suggested by Mr. M. M. Dawson, consulting actuary to the New York State Workmen's Compensation Commission, and the table has been adopted by the Commission as a basis for the computation of present values of compensation and the reserves of the State Insurance Fund.

As respects remarriage, it is proposed that the Remarriage Table of the Dutch Royal Insurance Institution, based upon the remarriage experience of that institution covering a period of ten years, be adopted. This table, as well as the Survivorship Annuitants'

Table, is discussed by Mr. Dawson in his recent paper on Mortality and Remarriage Tables appearing in Vol. XV of the Transactions of the Actuarial Society of America, page 306. The Dutch Remarriage Table would appear to have a special fitness for the use to which it is proposed that it should be put by reason of the fact that under the provisions of the Dutch compensation law, the awards and payments under which are made by the Royal Insurance Institution, the proportion of the wages paid to the widow and the lump-sum settlement on remarriage are the same as those of the New York law, thus insuring that the underlying economic motives affecting the rate of remarriage are in this important respect similar. Whether or not the remarriage experience in the State of New York will coincide with that in Holland is, of course, a question which the events of the future are alone capable of determining. The table in question, however, is the only experience of this kind which appears in the least degree applicable to compensation conditions in the United States, and it has consequently been adopted by the New York State Workmen's Compensation Commission as a basis for the computation of present values.

For purposes of comparison the rates of remarriage among widows according to several experiences are given below:

Age of Widow.	United Kingdom 1896–1906.	British Patriotic Fund 1854-1900.	Dutch Insurance Institution.
20	.1136	.1395	.1270
30	.1112	.1026	.0665
40	.0413	.0434	.0300
50	.0118	.0103	.0060
60	.0029	.0016	.0015

RATES OF REMARRIAGE.

The desirability, in this connection, of the compilation and analysis of the mortality and remarriage experience under workmen's compensation benefits in the United States, just as soon as a sufficient volume of data has accumulated, is obvious.

The rate of interest assumed should be sufficiently low to take care of investment expenses, possible losses on investments, possible reduction in the rate of interest on the reinvestment of maturing securities and to offset the uncertainties necessarily attendant upon the adoption of a remarriage table based upon foreign experience. The New York Workmen's Compensation Commission has adopted $3\frac{1}{2}$ per cent., which is the highest rate which life insurance companies are in general permitted to use in valuing currently issued business, and it is suggested that this rate will be found suitable for general adoption.

To summarize: the standards proposed for the valuation of claims where the death of the employee has actually occurred are the Survivorship Annuitants' Table of Mortality, the Dutch Remarriage Table and $3\frac{1}{2}$ per cent. interest.

Death Claims: Suspended Mortality.

Where, as in New York, the death benefit is relatively costly as compared with the other benefits provided in the law the question of suspended mortality is of considerable moment and neglect to make proper provision therefor may have a serious effect upon the adequacy of the reserve. In using the term "suspended mortality" I refer to those cases where death adjudged to be the result of the work-injury occurs some time after the injury and subsequent to the date as of which the reserve is being computed. Cases appearing on their face to be permanent or temporary disabilities prove, every so often, to be cases where compensation for death following the disability is payable. Now, from a priori considerations, it seems a fair assumption that the probability that deaths occurring among the disabled will be adjudged to arise from the work accident causing the disability will diminish as the period elapsed since the accident increases, and that it will eventually become so small as to be negligible. How many years it will require for this suspended mortality to wear off is a question which, so far as I am informed, there are no statistics to answer. After considering certain data published by the German National Insurance Office, I venture to propose the arbitrary assumptions, however, that suspended mortality wears off at the end of twenty years and that its effect diminishes at the rate of one-half of one per cent. per annum. Under these assumptions the reserve for suspended mortality may be calculated by multiplying the computed reserves for actual mortality by percentages depending upon the number of years elapsed since the year of issue of the policies to which the actual deaths relate as follows:

Years Elapsed Since Year of Issue.	Percentage for Suspended Mortality.	Years Elapsed Since Year of Issue.	Percentage for Suspended Mortality.
2	9.00	12	4.00
3	8.50	13	3.50
4	8.00	14	3.00
5	7.50	15	2.50
6	7.00	16	2.00
7	6.50	17	1.50
8	6.00	18	1.00
9	5.50	19	0.50
10	5.00	20	0.00
11	4.50		

The foregoing is suggested merely as a working rule which might be adopted until statistics which will enable this problem to be analyzed with accuracy become available.

It is possible to investigate mathematical expressions for suspended mortality in the shape of single premiums for an insurance upon a life disabled by a work accident payable in the event of death adjudged to be the result of the work accident for an amount equivalent to the present value of the compensation payable to the dependents existing at the time of death. But while, save for a short period immediately following the accident, the probability of death from all causes increases with the time elapsed since the accident, the probability of the death being adjudged to be due to the accident decreases, and the present value of compensation for death also decreases by reason of the increasing ages and the diminishing numbers of the dependents. In view of all these complications and of the utter lack of any statistical data upon which to proceed, it does not seem to me worth while to attempt at this time to practically apply a mathematical expression for suspended mortality.

The principal objection to the tentative and confessedly arbitrary rule which I have suggested is that it is not fairly applicable to very small or recently organized companies with an exposure insufficient to produce a stable death rate. A company unfortunate enough to have an abnormally large number of deaths would suffer the further aggravation of being heavily charged for suspended mortality, while if a company experienced no deaths at all it would have no reserve for suspended mortality. This objection would not, however, I think, be found in practice to operate frequently. Theoretically there seems no doubt that the reserve for suspended mortality should be based upon a consideration of the disability cases, since it is these cases which constitute the source of the concealed liability. Where, therefore, the proposed arbitrary rule is used in estimating the suspended mortality, the extra reserve for this purpose should, where a company's business is to be analyzed in small groups, be reapportioned among the groups in proportion to the reserves for disability instead of in proportion to the reserves for actual mortality.

Permanent Total Disability.

Cases of permanent total disability should be valued according to the accepted methods for valuing annuity obligations. Thus, where the compensation law provides for the payment of compensation during the entire period of the continuance of disability, the reserve on December 31 of the *n*th year following the year of accident is, for each unit of annual compensation,

 $\bar{a}_{x+n+\frac{1}{2}}$,

where x is the age of the employee at the date of accident.

Where the compensation law limits the period during which compensation is payable either directly or through the specification of the maximum amount payable, the corresponding expression becomes

$$\bar{a}_{x+n+\frac{1}{2}}; \overline{t-n-\frac{1}{2}}|,$$

where t is the maximum period in years for which compensation may be paid.

It is proposed that the same standards of mortality and interest be employed in valuing permanent total disability benefits as are used for the valuation of death benefits. Aside from its obvious convenience, there are what appear to me to be sound reasons for such procedure. Most of the existing tables showing mortality among lives totally and permanently disabled deal with a group of persons disabled by reason of sickness as well as accidental injury. It seems hardly safe, however, to make any other assumption than that the extra mortality arising from disability due to accidental injury alone will wear off during a brief period after the accident. Although maimed and incapacitated for work at their trade, these lives, after recovery from the shock of the accident, will not ordinarily be suffering from any organic disorder. Experience has amply demonstrated the stimulus to longevity which the assurance of a small income for life confers upon annuitants, and while an annuity value on a life totally and permanently disabled through an accident is doubtless much lower, if computed as of the date of accident, than the value of a corresponding annuity on a healthy life, I think that there is as yet no evidence to prove that after the initial period of heavy mortality has worn off there is any great difference in the annuity values.

A practical matter of great importance is that the cases of permanent total disability should be determined by a careful consideration of the actual nature of the injury and that, in addition to dismemberment cases and those where the disability has been otherwise adjudged total and permanent, there should be grouped among the total permanent cases all those where there is little or no likelihood that the employee will regain his earning capacity. In the event that one or more of these cases should prove to be temporary, the extra reserve thus created would probably have served as an offset to other cases classed as temporary and which turned out to be permanent. It is difficult to see how this matter could be handled without requiring the exercise of some discretion at this point. It will have to be constantly borne in mind that cases of temporary disability of long standing are apt to be cases of permanent disability in disguise, since a seriously injured employee is kept along in the temporary class by a renewal of the award from time to time until the expiration of the maximum period for which temporary disability may be paid, after which he is adjudged to be permanently disabled.

Temporary Total Disability.

The number of cases of temporary total disability which will have to be individually considered under the reserve system proposed in this paper is very small in relation to the total number of such cases. A rational and conservative treatment of these cases, however, will, on account of the great seriousness of each case, be found of the utmost consequence in securing an adequate reserve. In referring to transactions under the (British) Workmen's Compensation Act, 1906, Mr. William Penman, Jr., of the Atlas Assurance Company, states (J. I. A., XLV, 116):

"Now it seems evident that when compensation has been paid for at least two years, there is very little prospect of recovery or of settlement by arrangement, and that the injured workman has probably in most cases recovered from the shock of his accident and settled down in his altered circumstances. I cannot think, therefore, that there is any very considerable difference between the reserve required for a claim of five years' standing and that for a claim of two years' standing."

There can be no question that an injured employee whose disability has continued for eighteen months from the date of accident will be subject to an enormously smaller rate of recovery than the average employee whose disability has continued for a few weeks. Among the temporary disabilities of long standing there are doubtless many cases where the disability is in fact permanent. It would appear to be a fundamental principle that the present value of a temporary disability approaches nearer and nearer to the present value of a permanent disability as the time elapsed since the accident increases. Available tables of the average durations of temporary disability are of little or no help in this connection, since they cease to give detailed information beyond a certain limited period, usually 26 weeks. In the absence, therefore, of any statistical basis upon which to proceed, I suggest resort to the following hypothesis: If (x) has been disabled for ten years since the accident he is permanently disabled: If (x) has been disabled for eighteen months he will remain disabled for a period which will produce an annuity value equal to 55 per cent. of the present value of a permanent disability benefit. Then on December 31 of the nth year following the year in which the accident occurred, the reserve per unit of annual compensation will be

$$\frac{100 - 5(10 - n)}{100} \bar{a}_{x+n+\frac{1}{2}} \qquad [n \ge 10].$$

Where the term or total amount of compensation payable is so fixed in the law that in no event can compensation be paid for more than t years from the date of the accident the formula becomes

$$\frac{100-5(10-n)}{100}\bar{a}_{x+n+\frac{1}{2}}=[n \ge 10].$$

In either of the above forms this formula is so simple as to be very easily applied in practice.

The reserve for temporary disabilities thus ascertained should prove sufficient to carry to their maturity cases of this class and also to provide against those cases of permanent partial disability, not dismemberment, which may emerge from the cases of temporary total disability of long standing. Among the more serious cases of temporary disability it is especially likely to happen that an employee who, on returning to work, finds that he is unable to secure the same wages as he received before the accident, will receive an award for permanent partial disability based on the adjudged diminution in his earning power.

Partial Disability.

Detailed discussion of the treatment of partial disability cases is unnecessary for the reason that the general principles involved are the same as in cases of total disability, the only additional assumption necessary being that future possible increases in the degree of impairment will be offset by future decreases. So far as we have any information, there seems to be no sufficient reason why this assumption should not be made. Partial permanent disabilities due to dismemberment will, of course, where compensation is provided for a limited term as in the New York law, require a reserve per unit of annual compensation on December 31 of the *n*th year following the year of accident as follows:

$\bar{a}_{x+n+\frac{1}{2}}$; $\bar{t-n-\frac{1}{2}}$,

where t may be either integral or fractional and is the number of years in the specified term during which compensation is payable.

Medical.

Under the scheme suggested in this paper few, if any, medical or hospital bills will have to be considered, since the most recent accident the consequences of which are to be given individual consideration will have occurred at least one year prior to the statement date. If there are any such, however, they may be easily provided for by specific estimates.

Deferred Claim Expenses.

Compensation benefits are payable at very frequent intervals, usually weekly or bi-weekly, and this service involves a large amount of clerical and other labor—much larger, for example, than is usually necessary in the case of annuity contracts issued by life

126

insurance companies, under which the payments are less frequent. There will therefore be a large proportion of the claim expense which will not properly be chargeable against current premiums, but must be provided for by an item of liabilities supplementary to the loss reserve proper, which item should not, however, be merged in the loss reserve itself, since we should be in a position to distinguish clearly between the pure losses incurred and the claim expenses incurred. It is difficult to estimate the probable cost of administering these annuity funds, but it would appear that a sum not less than $2\frac{1}{2}$ per cent. of the reserve for losses should be required to be set aside as a reserve for loss expenses.

Liability Loss Reserves.

This paper refers solely to losses under workmen's compensation policies-not to losses under policies covering common law liability or where the question of negligence may be involved. It is assumed in this discussion that the present liability loss reserve statutes will either be revised in the light of existing conditions or will at least be so amended as to provide that they shall not apply to workmen's compensation losses. Where a policy is primarily a workmen's compensation policy but incidentally covers common law liability, it is suggested that it should be treated as a compensation policy and that the liability losses thereunder should be assumed to be covered, on business issued during the two calendar years preceding the date of the statement, by the earned pure premiums reserved, to be followed by a reserve for each individual claim to be not less than what would be charged for the same injury if covered under the compensation law.

Compensation Claims should be Preferred Claims.

The question of making claims for workmen's compensation just as secure, financially, as it is possible to make them is one to which careful thought should be given. It is suggested that it should be provided by statute (1) that in the event of insolvency or liquidation of any insurance carrier workmen's compensation claims are to be treated as preferred over other loss claims and (2) that claims for insurance losses in general, including workmen's compensation losses, are to be treated as preferred over claims against the unearned premium fund. Such action would prove more effective in giving special protection to beneficiaries under workmen's compensation policies than would the requirement of a special deposit and it would be free from discriminatory results of an objectionable character.

Necessity for Uniformity.

A point to be borne in mind in connection with reserves for compensation benefits is the great complexity of these benefits as compared with those provided in the insurance or annuity contracts ordinarily issued by life insurance companies. This means that the work of developing the necessary valuation formulae is difficult and that the necessary derived tables based upon the assumed rates of mortality, remarriage and interest are extensive. It suggests the great importance of uniformity between states in establishing standards of valuation, since the work involved in employing several different mortality or remarriage tables would be extremely burdensome. Hence it is important that careful consideration should be given to the standards adopted, with the idea that these standards shall continue to be employed uniformly until such time as the experience in the United States permits the compilation of tables showing the rates of mortality, remarriage and the continuance of disability among the beneficiaries of workmen's compensation policies.

Lump Sum Settlements.

While not strictly pertinent in a discussion of reserves, some comment as to procedure where lump sum settlements are required may be of interest. It should be pointed out that standards adopted as bases for the determination of reserves are not necessarily suitable as standards for the computation of the surrender values of benefits under a compensation law. This is particularly true as to present values based upon a rate of remarriage. The rate of remarriage being largely subject to the volitional control of the individual, it is extremely doubtful to what extent these values are admissible for purposes of commutations of compensation on the application of the widow. Even though we could obtain satisfactory evidence not merely that the widow was in good health but that there was no present intent of remarriage, there would still be doubt as to the applicability of present values to particular cases. For example, it would seem from a priori considerations that the rate of remarriage among widows with a large

number of minor children will be lower than the rate among widows of the same age with no children, by reason of the indisposition of the ordinary prospective husband to assume heavy economic responsibilities not of his own creating. But to attempt to take account of this fact in the calculations would be at present impossible, owing to lack of data, and even if the data were available the additional actuarial complications introduced would be insurmountable. In general, the element of self-selection makes the use of reserve values for purposes of commutation a dubious procedure.

Increasing Cost of Compensation.

In connection with loss reserves one further point may be mentioned. It is occasionally intimated that these reserves should be made very high to provide for the demonstrated increase in the cost of workmen's compensation insurance following what Mr. F. Spencer Baldwin has aptly characterized as the "psychological response" of the workmen to the law. This fact, however, has no logical connection with the fixing of the loss reserve. That reserve is to take care of accidents which have already occurred, and the fact that these same accidents would cost more if they happened two or three years later, or that more accidents would be reported if the same law had been in effect for several years longer, has nothing to do with the case. It simply means that if rates remain unchanged and loss reserves are accurately computed, the insurance carrier will experience a decreasing underwriting profit as the time since the enactment of the law increases. Any company which wishes to guard against this by setting aside, out of current profits, something to offset the diminished profits of future years should do this by creating a special reserve for that purpose, not by arbitrarily increasing the loss reserve. However, the increasing cost of compensation may indirectly affect the loss reserve, inasmuch as statistics and experience collected during the early years of the operation of an act, if used as a basis for reserve calculations in later years, may prove misleading. It is well to bear this fact in mind in considering standards for valuation.

CONCLUSION.

Briefly stated, the salient features of the method of computing workmen's compensation loss reserves proposed in this paper are: (1) the basing of the reserve upon pure premiums during an initial period sufficiently extended to make unnecessary the detailed consideration of that vast majority of claims which are for trivial or minor injuries; (2) the individual valuation of other claims upon the basis of suitable standards of mortality, remarriage and interest; (3) the valuation of the more serious cases of temporary disability upon the assumption that these cases merge into cases of permanent disability after a certain number of years from the date of the accident and that they meanwhile tend to approach permanent disability cases in value as their duration increases; (4) the charging of a reserve for suspended mortality proportionate to the reserve for actual mortality but decreasing as the time elapsed since the year of issue increases; (5) the charging of a supplementary reserve for deferred claim expenses calculated as a percentage addition to the sum of the foregoing items.

Such a plan has no great claim to originality, but I venture to submit that, pending the accumulation of suitable and extensive statistics relating to workmen's compensation in the United States, it will be found labor-saving and practically convenient and may be made to produce reserves which will measure with a reasonable degree of accuracy the probability of loss payments.

A METHOD PROPOSED FOR THE CALCULATION OF LIA-BILITY AND WORKMEN'S COMPENSATION CLAIM RESERVES.

B. D. FLYNN.

The various methods used or proposed in the past for the calculation of Liability and Workmen's Compensation Claim Reserves have fallen under one of the two general headings mentioned below or have been a combination of these two methods: (1) An estimate of the probable cost of outstanding claims—either by means of average claim costs based upon previous experience or by individual estimate. (2) A reserve of that part of the expected loss payments which has not been paid out up to date of valuation; that is, the excess of a certain percentage of earned premiums over losses and loss expenses paid prior to date of valuation.

As a basis for determining the most desirable method of reserve valuation let us study the good and bad points of each of these general plans.

The first method bases the claim reserve of a company directly upon the record of outstanding claims and, for this reason, it would appear to be the logical solution of the problem. This method is weak, however, when we attempt to apply it to the great number of immature cases arising from the policies issued in the two years preceding date of valuation-particularly those of Workmen's Compensation contracts. To attempt an individual estimate of these undeveloped claims is a practical impossibility. It is also unreliable even to attempt to throw these cases into certain broad groups by nature of disablement. Even if we grant that such a division could be made upon a reliable basis, we are then confronted with the fact that it would be unsafe in the present changing conditions of experience to attempt to fix upon average costs to be used against these broad divisions of outstanding claims by nature of disablement. The weakness of this method as applied to immature cases under Liability policies was shown under the old "notice and suit" method of valuation, first because of in-

132 LIABILITY AND COMPENSATION CLAIM RESERVES.

ability to obtain a reliable record of the number of notices of accidents received and, second, in the fact that the average notice costs did not follow closely the increased cost resulting from changing conditions. A safe conclusion to make with regard to the first method of valuation outlined above is that it is reliable only when outstanding claims are valued which are of sufficiently long standing to have reached a definite fixed basis. If what might be called immature cases are to be considered, some other method of valuation must be utilized.

The principal advantage of the second method is that it can be applied with results more accurate than under the first method in obtaining the reserve for the immature claims arising from business issued within a few years prior to date of valuation. The value of this method, however, depends first upon a reliable estimate of the proper percentage of earned premiums to be used as the expected loss ratio and, second, upon the assumption that the gross premium basis upon which the business is written by all companies is practically the same. In regard to the first of these two points it should be stated that the plan of using a percentage of premiums based upon the loss ratio under business written from five to ten years previous to date of valuation gives unreliable results. Some percentage which will be a reasonable estimate of the probable ultimate loss ratio for the business under observation should be fixed. In regard to the second point,--that the business of some companies may possibly be written at rates far below the general rate level of other companies,-the method of supervision of rates at present followed in New York and Massachusetts seems to offer a solution so far as Workmen's Compensation business is concerned. In these states the possibility of some companies writing business at cut rates is practically removed. As the policy of state supervision of Workmen's Compensation rates grows-which will probably be the case-the situation with regard to this feature of the second method outlined above should be gradually improved.

be expended for losses and loss expense under the business in the particular industrial classification. This method, considered from a theoretical standpoint, is ideal, but, from a practical standpoint, there are several important objections to giving it serious consideration. Briefly, the objections can be outlined as follows: First, it would be an enormous and expensive task to value all of the payroll exposed by industrial classification and by state upon a basis of pure premiums; and, second, there are not sufficient data available as yet to warrant the issuance of a set of pure premiums by industrial classification for all states-particularly a set which an Insurance Department would want to approve as an adequate basis for reserve valuation. There is a further point in this connection that it would be particularly difficult to obtain a set of pure premiums for Liability Insurance in view of the rapidly changing conditions in this line of business. In view of these practical difficulties in applying the pure premium method and, further, in view of the fact that the rate situation is constantly improving as states take up the supervision of rates, a proposal to base the percentage upon the earned gross premiums seems to be the most practical for the valuation of the claims arising from the business written in the years just preceding date of valuation.

The present Liability Claim Reserve Law of New York, which was drawn up by insurance men qualified for the work after careful study of all plans, utilizes the first method outlined above for the valuation of mature claims, and the second method for the valuation of immature claims resulting from business written in the years just preceding date of valuation. In the method proposed below the general plan of the present law will be adopted with minor changes in detail. In the following outline no attempt has been made to put the proposed plan in legal phraseology.

All outstanding Liability and Workmen's Compensation claims under policies issued prior to January 1, 1913, shall be valued by the method outlined in the present law of New York State—except that the individual estimates of outstanding Workmen's Compensation claims shall be made upon the basis mentioned hereafter.

The claim reserve for Liability policies issued after January 1, 1913, shall be calculated separately from that for Workmen's Compensation contracts issued after that date.

The claim reserve for Liability policies issued after January 1, 1913, shall be calculated as follows:

134 LIABILITY AND COMPENSATION CLAIM RESERVES.

For policies issued in the eleventh and earlier years of business preceding date of valuation the reserve shall be the number of outstanding suits valued at \$1,000 per suit.

For policies issued in the fourth to tenth years (inclusive) preceding date of valuation the reserve shall be the number of outstanding suits valued at \$750 per suit.

For policies issued in the third year preceding date of valuation the reserve shall be 60 per cent. of earned premiums, less losses and loss expense paid, with a check on outstanding suits at \$750 each.

For policies issued in the second year preceding date of valuation the reserve shall be 60 per cent. of earned premiums, less losses and loss expense paid, with a check on outstanding suits at an average cost per suit derived from the experience of all companies—as outlined hereafter.

For policies issued in the first year preceding date of valuation the reserve shall be 60 per cent. of earned premiums, less losses and loss expense paid, with no suit check.

The claim reserve for Workmen's Compensation policies issued after January 1, 1913, shall be as follows:

For policies issued in the fourth and earlier years preceding date of valuation the reserve shall be the total of the individual estimates of the cost of outstanding claims calculated upon the basis mentioned hereafter.

For policies issued in the third year preceding date of valuation the reserve shall be 65 per cent. of earned premiums, less losses and loss expense paid, with a check by individual estimates of outstanding claims calculated upon the basis mentioned hereafter.

For policies issued in the second year preceding date of valuation the reserve shall be 65 per cent. of earned premiums, less losses and loss expense paid, with no check by individual estimate of outstanding claims.

For policies issued in the first year preceding date of valuation the reserve shall be 65 per cent. of earned premiums, less losses and loss expense paid, with no check by individual estimate of outstanding claims.

Except that the percentages of earned premiums to be used for policies issued in the calendar years 1913, 1914 and 1915, while these years are in the three year period just preceding date of valuation, shall be 55%, 60% and $62\frac{1}{2}\%$ respectively.

Below is given a schedule which shows the valuation method just outlined if it were put into effect at the end of 1915.

1905 and earlier	
1906]	
1907	
1908 Present legal metho	d (combined Liab. and Work. Comp.)
1909 } except Compens	ation claims outstanding shall be
1910 valued on new b	asis of individual estimates.
1911	
1912	
1913 Liab 60 per cent. + snit	Work. Comp 55 per cent. + in-
check at \$750.	dividual est. check.
1914 Liab 60 per cent. + suit	Work. Comp60 per centno
check at Ave. Cost.	check by indiv. est.
1915 Liab. — 60 per cent. — no	Work. Comp 62.5 per cent
suit check.	no check by indiv. est.

The following schedule shows the valuation method as it would appear at the end of 1917:

1006)	
1900	
1907	
1908 Present legal m	ethod (comb. Liab. and Work. Comp.)
1909 - except Comp	ensation claims outstanding shall be
1910 valued on new	basis of individual estimates.
1911	
1912	
1913 Liab. — suits at \$750.	Work. Comp Indiv. est. outs.
	claims.
1914 Liab. — suits at \$750.	Work. Comp Indiv. est. outs.
	claims.
1915 Liab 60 per cent with	h Work. Comp. — 62.5 per cent. —
suit check at \$750.	with indiv. est. check.
1916 Liab 60 per cent with	h Work. Comp. — 65 per cent. — no
suit check at Ave. Cost.	indiv. est. check.
1917 Liab 60 per cent n	o Work. Comp. — 65 per cent. — no
suit check.	indiv. est. check.

The method of apportioning unassigned loss expense paid in a particular calendar year to the various years of business under the policies of which the expense was incurred shall be for Liability business-that required in the present law of New York. For Workmen's Compensation business the method of apportionment should take into consideration the relatively shorter period during which this expense is incurred. A distribution is proposed of 40 per cent. to the year of business corresponding to the calendar year of payment, 50 per cent. to the year just preceding and 10 per cent. to the second year preceding.

The average suit costs to be used against the number of outstanding Liability suits based upon policies issued in the second year preceding date of valuation shall be the cost which the combined experience of all companies indicates as necessary for the future settlement of suits of that age. That is, the suit cost to be applied against these cases shall be that which the combined experience of all companies for say five years shows necessary for the liquidation of these cases after date of valuation.

The above reserve method is proposed for the valuation of the liabilities of stock insurance companies. If the same general method is to be applied to the valuation of the outstanding claims of mutual companies, the percentage of earned premium if fixed by law should be based upon a gross premium similar to that charged by stock companies or else a different percentage which will reflect the expected loss ratio under the business of mutual companies should be fixed upon.

The principal changes involved in the method proposed with the reasons for suggesting them are given below:

1. The proposed method provides for the valuation of all business-both Liability and Workmen's Compensation-written prior to January 1, 1913, upon the present legal basis. The reason for fixing this date for applying the new method is, first, that the Annual Statement blank shows the division of premiums and losses between Liability and Workmen's Compensation business beginning at this date, so that the figures for use as the basis for the valuation are easily obtainable; and, second, in order that a company will not be obliged to hold an unnecessarily high percentage of Workmen's Compensation earned premiums under the policies issued in the calendar years 1913 and 1914 until these years are in the sixth year preceding date of valuation. That is, it is proposed to use the method of individual estimate to obtain the reserve for these years of business-after three years have elapsed from year of issue-rather than to require a company to maintain an unnecessarily high percentage of earned premiums (less losses and loss expense) for five years after issuance of contract.

2. In order that the lower loss ratios under Workmen's Compensation business written in 1913, 1914 and 1915-which have undoubtedly been experienced by the companies—shall be recognized in the reserve a lower set of percentages to be used for these years is suggested—55 per cent. for 1913, 60 per cent. for 1914 and $62\frac{1}{2}$ per cent. for 1915. It is thought that these percentages, although they may overestimate the loss ratios on the business for these years somewhat, if taken with the Liability percentage (60 per cent.), will give a more reliable basis of valuation for the combined business of the companies than the present method which, in the case of some companies, will be but 54 per cent. in the reserve valuation made at the end of 1915.

3. The proposed method as applied to the valuation of the claim reserve under Liability policies issued after January 1, 1913, calls for a percentage of earned premiums for only the three years preceding date of valuation-instead of five years under the present method and also under the method recently proposed by the Committee on Reserves Other than Life of the Insurance Commis-The idea in mind in suggesting this change is that the sioners. outstanding Liability suits provide a reliable basis for claim reserve under the policies issued in the fourth and fifth years preceding If several years from now the Automobile date of valuation. Liability and other Public lines produce a loss ratio below 60 per cent., there is no necessity for holding this percentage of earned premiums for the five years following issuance of the policies. The number of outstanding suits calculated at \$750 per suit should provide a reliable claim reserve for the business issued in the fourth and fifth years preceding date of valuation.

4. The proposed method as applied to the valuation of claim reserves under Liability policies issued after January 1, 1913, calls for a fixed percentage (60 per cent.) of earned premiums instead of using the percentage indicated by the experience of the earlier business of the company—or, in the case of companies which have not been in business ten years at date of valuation, an arbitrary percentage of 54 per cent. or 55 per cent. The unreliability of an average loss ratio based upon experience of business written from five to ten years preceding date of valuation is so generally acknowledged that no argument seems to be necessary upon this point. Conditions and forms of coverage have changed so completely in the Liability field—mainly due to the decrease in the amount of Employers' Liability business exposed—that any reserve based upon a percentage derived from an average loss ratio on old Liability business is entirely misleading. In view of this fact the provision for losses and loss expense in the Liability gross premium, 60 per cent., is proposed as the proper percentage of earned premiums to be used.

5. The proposed method as applied to the valuation of claim reserves under Liability policies issued after January 1, 1913, calls for a suit check at a cost which the combined experience of all companies indicates as the expected cost of disposing of cases of similar duration against the outstanding suits of the policies issued in the second year just preceding date of valuation. The recommendation of the Committee on Reserves Other than Life is the application of a suit check of \$500 per suit against these cases. It would seem best, however, not to adopt a fixed amount of \$500 for these suits but to obtain a more accurate figure based upon the experience of all companies—having in mind the probable increase of the number of suits outstanding—by cases yet to be brought—and the consequent necessity for an adequate estimate of the average cost of these outstanding suits.

6. The proposed method as applied to the calculation of claim reserves under Workmen's Compensation contracts issued after January 1, 1913, provides that the percentage of earned premiums, less losses and loss expense, shall be held for the three years preceding date of valuation only. This proposal is in agreement with that of the Committee on Reserves Other than Life. A reserve by individual estimate for the claims arising from the business issued in the fourth and earlier years preceding date of valuation should be reliable—particularly if these estimates are made in a careful and scientific manner. (The method of calculation of individual estimates will be taken up later.)

7. The proposed method as applied to the calculation of claim reserves under Workmen's Compensation contracts issued after January 1, 1913, requires a check by individual estimate to be applied only to the claims arising from policies issued in the third year preceding date of valuation. The method proposed by the Committee on Reserves Other than Life applies a check upon the claims arising from policies issued in both the second and third years preceding date of valuation. It is submitted, however, that because of the undeveloped character of claims arising from policies issued in the second year preceding date of valuation a check by individual estimate of the cost of these claims will be practically worthless. It will be seen that the last policy issued in the second calendar year preceding date of valuation will have expired only at date of valuation, so that during the six to nine months previous there will have arisen a great number of claims which will not have developed sufficiently at date of valuation to permit a reliable estimate. To make up a check upon that year's business will be a most difficult and expensive task for a company to undertake and one which will in no way be justified by the value of the result obtained. For the same reason an exhibit of the number of cases outstanding and the estimated cost, developing from policies issued in the year of statement is of even less value. No exhibit of the number and estimated cost of outstanding claims resulting from the two years of business just preceding date of valuation should be called for from the companies.

The following method is proposed for the valuation of outstanding Workmen' Compensation claims resulting from the business written in the third and earlier years. All claims payable in annuities which do not involve a life contingency; that is, those which are payable for a term certain, shall be valued upon an interest basis only. All claims which do involve a life contingency; that is, those which will terminate upon the death of the person to whom the compensation is being paid,-but which contain no remarriage contingency-shall be valued upon the basis of mortality and interest. All compensation claims payable in annuities which involve a life contingency together with a remarriage contingency shall be valued upon the basis of mortality, rate of remarriage, and interest. No mortality or remarriage tables or rate of interest have been recommended as a basis for the valuation of these claims as, in the opinion of the writer, this question of the proper basis of valuation of outstanding claims for reserve purposes should be given separate and thorough study. The method of individual estimate of outstanding claims is now proposed. The basis of these estimates can be determined later after more thorough study can be given to the subject.

The valuation of Workmen's Compensation claims of the character just mentioned should be a careful calculation, possibly upon sheets provided for that purpose which will call for the work in detail. Compensation annuities could be grouped by calendar year of expiration and what is known as a mean reserve calculation made. That is, if the valuation were at the end of 1915, all

140 LIABILITY AND COMPENSATION CLAIM RESERVES.

annuities expiring in 1916 could be grouped and the total amount of such weekly payments shown; all annuities expiring in 1917 grouped, etc., and then a factor for the present value of weekly compensation payments for six months, one year and a half, etc., applied to such groups of annuities. For instance, if at the valuation at the end of 1915 the total amount of weekly compensation payments under annuities not involving life contingencies expiring in 1917 were obtained, a factor upon an interest basis, which would be the present value of a weekly payment of \$1.00 for one year and a half, should be applied to the amount just mentioned and the total present value obtained. In the case of annuities involving life contingencies or life and remarriage contingencies a more detailed valuation must be made as the age of the annuitant must be taken into consideration.

A detailed calculation of this kind might seem to be an unnecessarily complicated and expensive task. In the writer's opinion, however, the great desirability of placing this large item of Liabilities upon a reliable basis would justify the expense and trouble involved in such a calculation. Some parts of the work would not be particularly difficult as, for instance, the valuation of annuities of certain classes by groups. In other parts of the work, however, it may be necessary to obtain actuarial advice but here, again, the importance of a careful and reliable estimate would seem to justify that step. It should be noted in this connection that the Insurance Law of Great Britain calls for the preparation of the reserve for long standing cases by an actuary or someone qualified for such work. In other words, it recognizes the importance of placing the reserve for long term serious cases upon a reliable and scientific basis.

ORAL DISCUSSION, FEBRUARY 20, 1915.

WORKMEN'S COMPENSATION AND EMPLOYER'S LIABILITY CLAIM RESERVES.

PRESIDENT RUBINOW IN THE CHAIR.

THE CHAIRMAN: The members present are at some disadvantage because they have not received the galleys of the three papers a sufficient time in advance to enable them to come prepared for the discussion. We hope in the future to have that situation corrected, and if all the papers will be sent sufficiently early to give us an opportunity to have them printed and sent out to the members a week or two before the meeting, we will undoubtedly be able to discuss things a little more intelligently than we may be able to do today.

I also want to say in this connection that since the first number of our *Proceedings* did not appear until this morning, the discussion of the papers read at the last meeting, and the discussion of the papers read today, will be continued at our next meeting, so that you need not feel if you are not in a position to discuss them today that you won't be able to express your opinion at some future date. We shall be glad to receive written discussions as well, especially of the subject discussed today, which may come up before the legislature some time this year, when the voice of the Casualty Actuarial and Statistical Society should be heard with regard to this problem of loss reserves.

Recognizing all these difficulties, I still hope that we will have an intelligent discussion of the various papers read this morning. We should particularly like to hear from the gentlemen who read the papers, every one of the three, as to the papers of the other two, because, so far as I can see, they are not altogether in agreement with each other.

MR. DAWSON: Mr. Chairman, or Mr. President, if that is meant for a call for myself, I don't think the papers generally are very much in disagreement, notwithstanding that they appear to be so.

If you will place them in reverse order, consider Mr. Flynn's paper first, you will find, which is very natural, that approaching the matter from the standpoint of the actuary of the company—the largest company in this country and, I am not sure, but the largest in the world at this time, although the Ocean at one time claimed that—in the liability business—that the transition from liability reserves over to compensation reserves, a process which is only beginning, naturally took up a large part of his attention, with the result that the problems which I have personally dealt with were put at the latter part of the paper, in which there was little if any disagreement with the views which you will find in the first of my paper.

In a similar manner, Mr. Woodward, representing the State Fund, and

also thoroughly familiar with the requirements of the liability conditions, has followed a somewhat similar course, but giving more attention to the newer problems.

I said in presenting my paper that it seems entirely clear that the problems that are immediately before you are those of a transition stage. Any course which seems, all things considered, to be the wise one to follow during this transition stage, is justified by the necessity of the case. This, I was not attempting in the least to deal with. My paper was written from the standpoint of adequate loss or claim reserves for workmen's compensation insurance, considered entirely by itself.

Now, in practice, even in New York, the companies do not write workmen's compensation policies entirely by themselves. They write accident policies which cover any liability that the employer may have under the employer's liability act, or the common law. And consequently you find the situation, as regards at least the companies engaged in the general liability as well as workmen's compensation business, that they are not considering the matter from the standpoint of the ultimate computation of these claim reserves standing by themselves.

As a temporary expedient for dealing with the matter, it seemed to me that the instructions of the New York department were preferable to passing over by carrying the so-called pure premium or percentage of gross premium method into workmen's compensation reserves.

I pointed out in the notes connected with my paper some defects in the instructions of the New York department in this regard, but in the main they seemed to me to be very wisely provided.

I think there are some perils in attempting to pass over by means of the other system. Two of those perils occur to me at this time. Suppose you apply the rule that on December 31, of the year of issue, December 31 of the next subsequent year, and December 31, of the second subsequent year, which is. I think, the idea, 65 per cent. of your premiums-I assume it means the earned gross premium,-will be treated as the losses, there being deducted from those amounts the sums which have actually been paid. Now, in the case of a company which does not have that loss experience, you have either overestimated the claim reserve, or you have underestimated it. There have been rather wide fluctuations in experience even where it was a matter of employer's liability. I think your experience so far in workmen's compensation indicates that not less wide but even wider variations in individual company experience are to be anticipated. I also think, and I am speaking now of the differences between the experiences of individual companies, that your experience in sickness insurance, and in similar lines has indicated the same thing.

Now, if that is true, may you not run into the condition that some company will have been certified to have been entirely solvent as regards its outstanding claims, while actual experience will show that that certificate is entirely wrong?

Now, the second objection seems to me to be almost equally serious. Under the system of the fixing of rates by state authorities, you have been

and you will be to a still greater degree, confronted by critical analyses of your returns, and as you have found in Massachusetts, that critical analysis will not be postponed for three years, but it will be undertaken very shortly after you have completed your first year, in many cases.

Now, if it should happen, as I think it is happening, that up to the present time that 65 per cent. or even the $62\frac{1}{2}$ per cent. suggested for 1915 is a rather high estimate of the average experience, would this not be likely to be the attitude taken by the investigators: that in practice the reserve method had worked out in such a manner, and was working out in such a manner, as not to disclose the facts concerning the experience, but to conceel them?

Now, might that not be a rather serious objection? Those two objections occurred to me against that method as a tentative and transition method.

As regards a permanent method, I am very confident that the skill and resourcefulness of the men connected with these companies of which you are a representative body largely, will overcome the difficulties as to classification of claims, and in the course of a very few years you will be able to deal with workmen's compensation claims in a manner which will make it far more certain that, as regards each individual company, you have neither materially overstated, except in a reasonably conservative way and to an extent that you fairly thoroughly know and understand, its liability for claims, and on the other hand that you have not understated them. I don't think, as a permanent method of dealing with it, I am confident, that the proposal to carry over into workmen's compensation a modification of the system which, purely because you could not find a better, you adopted in connection with liability insurance, is likely to prove the solution of your problems.

As regards the temporary expedient, I am not so confident, but I think there are some particularly serious objections to it, and suggest that the method which the New York department has given instructions for be given very serious attention in that connection. It looks to me that with very slight modifications, it might be found to be not only a good transition method but fundamentally, a good method for permanent use. In making that statement I may say that I knew nothing of the New York Insurance Department's method until after the instructions were made and published in the insurance papers.

MR. WOODWARD: Mr. Chairman, there are one or two points connected with Mr. Dawson's paper that, it seems to me, should be made perfectly clear. Otherwise there may be considerable misconception with respect to what Mr. Dawson has described as the New York Insurance Department's method of computing these reserves.

Mr. Dawson did not, I think, mention the fact that these requirements only apply to mutual companies, and that the stock companies will necessarily be governed by the provisions of the regular liability loss reserve law. This circular which was sent out by the New York Insurance Department has, therefore, an extremely limited application. Furthermore, it seems to

me that it should appear in the record that in adopting this method, the New York Insurance Department had no responsibility placed upon it, since the law relating to mutual insurance companies required the Department to adopt for the Reserves of such companies whatever system might be adopted by the State Workmen's Compensation Commission for the reserves of the State Insurance Fund. The Department was not a free agent in adopting this method.

With further reference to that method, I might say that it was one that was adopted by the State Insurance Fund last October for the purpose of getting up an estimate of the result of the Fund's operations during the first three months. At that time, owing to the extremely immature character of all the claims, it was necessary to adopt something which, in the light of theory, must appear crude. The \$75.00 average referred to was, notwithstanding Mr. Dawson's assumption to the contrary, really applied to every temporary case believed to be compensatable, including disabilities which might be at an end. The method was never intended to be anything more than a temporary expedient.

There was one statement that struck me particularly in Mr. Dawson's paper, from which I am reluctantly compelled to dissent. That statement is, referring to his proposed method of valuing temporary disability claims, "The ease and convenience of this method, as well as its theoretical soundness, should render it acceptable." I have no quarrel with Mr. Dawson's theory and I believe it will prove extremely useful within a limited range of application. But my feeling is that the method will prove difficult and inconvenient to apply in general practice. I believe that that will be the experience of everybody who has actually to do the work of getting the data together on which the compensation loss reserve must be based, and I doubt very much whether the time will ever come when it will be possible, practically, to make a classification or individual analysis of all the more recent accidents. Especially in the case of the larger companies, whose business is scattered all over the country, and who are operating in many states under many varying laws, I don't believe they can get that information together. If it were attempted on a large scale the delay and expense involved would, in my judgment, be disproportionate to the value of the results.

A further point occurs to me in connection with the proposal to adopt Dr. Rubinow's table as a basis for the valuation of temporary disability cases. It seems to me that that method or a similar method, is bound to prove extremely useful for limited purposes, where it is impossible or inadvisable to resort to a pure premium method. But I seriously doubt whether the adoption of this particular table would give safe reserves, because my impression is that the average durations of disability derived from Dr. Rubinow's table are even shorter than those derived from the statistics of the Massachusetts Industrial Accident Board. The treatment of the cases of over 26 weeks duration is a matter of very great importance. There are only a few of those cases, but I think it will be found that all of them or a large part of them are of great seriousness, and that in order to get a

proper average duration of disability, it will be necessary to assume a very long duration for the cases over 26 weeks, and also to provide for the permanent partial disabilities which may follow temporary total disabilities. I doubt whether Dr. Rubinow had in mind the utilization of his Standard Distribution of Accidents for reserve purposes when he compiled these statistics. Whether he did or not, it remains true that the exercise of personal judgment is required at many points in computing a table of reserves from Dr. Rubinow's data.

MR. FLYNN: I would like to add my voice to that of Mr. Woodward in emphasizing the practical difficulties to be met in attempting to estimate immature claims. I talked recently with our chief claim adjuster in regard to the preparation of estimates of certain outstanding claims. He stated that at least five months should elapse from the date of receipt of the last notice of accident, before estimates of any value could be made of the future cost of the claims. Injuries develop so rapidly and the changes in their nature are so important during the six months following date of accident that it is practically impossible to make a reliable division of cases by nature of injury until claims have matured somewhat. To one who sees the thousands of cases which are reported to a company with their rapidly changing condition the hopelessness of the proposition of assigning to character of injury all notices received prior to December 31 within a couple of weeks following that date as a basis for a reserve calculation, is apparent.

Mr. Dawson raises the point that any method which uses a fixed percentage of earned premiums may do an injustice to a company which is going to have a lower loss ratio on its business or may produce an inadequate reserve for the company which is going to have a higher loss ratio. I would submit that no injustice is done in this case by a fixed percentage method of reserve valuation for the reason that no company can tell whether its business will produce a low or a high loss ratio until a couple of years from date of issuance of the policies. The fixed percentage method requires that a reserve be carried upon a reasonable estimate of the expected loss ratio until two or three years have elapsed—sufficient time for the experience to indicate whether the loss ratio is going to be high or low. When the experience has become two or three years old the method of individual estimate is applied and the resulting reserve indicates the ultimate experience results.

Another point which Mr. Dawson brings up is the fact that workmen's compensation experience results of the companies have differed widely in some of the state returns—and consequently that a fixed loss ratio provision may apply more severely to one company than to another. In the experience returns for certain states this variance in results has been true to some extent. The probability is, however, that when the experience of the companies of all states is under observation the results will be close together. The practice of handling the business with uniform rates and business practices, such as the companies doing this business now employ, should tend toward a similarity in loss ratio results.

I would say with reference to Mr. Dawson's paper that it provides a scientific basis for the method of individual estimate of the future cost of outstanding claims. Although I agree with the method proposed for making individual estimates, I must disagree decidedly with Mr. Dawson's ideas of the wisdom and practicability of applying this method to immature claims.

With regard to Mr. Woodward's paper, I would say that it is most interesting and that it has covered the subject thoroughly. Bearing upon the subject of suspended mortality, which is brought up by Mr. Woodward, I would point out that a reserve method which utilizes a fixed percentage of earned premiums in determining the liability for the business written in the two or three years preceding date of valuation takes care of any adverse development of claims. In the method of individual estimate, however, the factor of suspended mortality must be taken into consideration. So far as I know there is but little information bearing upon this subject.

The question of a separate reserve for deferred loss expenses should be given consideration if the percentage of the earned premiums to be used in a fixed percentage method does not contain an allowance for such expense. The present liability claim reserve law provides a reserve for deferred loss expenses in that the percentage of earned premiums used is partly made up of the provision for adjusting expenses. It would be consistent with the other casualty claim reserves to make provision in the liability and workmen's compensation method for a reserve for future loss expenses.

MR. DAWSON: I think I ought to say, Mr. President, that I did not know that the circular sent out by the New York Department applied only to mutual companies. I saw it in the *Spectator*, and if I am not mistaken it did not mention that, and it may possibly be that some of the things which I have stated here in argument, or in my note, will require being modified. I may also say that the remark that I made that I had nothing to do with that applies also to the State Workmen's Compensation Fund. I did not know anything about it until I saw the circular.

THE CHAIRMAN: If nobody else is anxious to take up the discussion just at this point, perhaps the Chairman will be excused for taking the floor with the understanding that the discussion is not closed with that.

The subject is of great importance, we all understand; it is also one in which conditions change very rapidly. At the time when this subject was selected I had a paper on it in one of the drawers of my desk for about a year. But in looking it up I saw how hopelessly out of date it was, because I had spent most of my argument in proving how unsatisfactory the present loss reserve law is, and now that seems to be taken for granted.

Nevertheless, it is perhaps worth while in view of the fact that some of the suggestions embody the methods used at the present time with only minor modifications, to point out why the present law is thoroughly unsuccessful.

While my memory does not carry me very far back into the history of liability insurance, yet I understand that the main purpose was not to make

accurate reserves but to make *adcquate* reserves, and I think there is some difference between those two points of view. The situation as existing at that time was largely one of danger to several companies because of the inadequacy of reserves, and any method was desirable which would produce an increase in the reserves. While this may have been the necessary thing to do at the time, yet actuaries or statisticians cannot take the point of view that any liability loss reserve law is good just because it increases the loss reserve.

Some time ago I made a somewhat careful analysis of the loss reserves of the ten largest companies as disclosed by comparing two consecutive financial statements, and even with that inadequate material I could see that in the majority of cases the law did not even accomplish what it intended to do. That is, taken by themselves, without considering the hidden asset in the premium reserves, the loss reserves were still insufficient.

The law is unsatisfactory in every one of its details, is wrong in every one of its assumptions. There is one assumption that the companies naturally preserve a fairly uniform loss ratio. Of course, we all know that that is not true. As you look down the column of percentages of Schedule P you find them subject to violent fluctuations. Moreover, these fluctuations are not necessarily all in the same direction in all companies. There are companies with a very materially increasing loss ratio and there are other companies with a very material decrease in the loss ratio. For companies which did not possess an experience of ten years, the assumption is that there is a certain uniformity of loss ratios between the companies, and of course, that is absolutely incorrect.

For older cases, which, under liability, always matured into suits, the assumption was of a uniform average cost of suits for all companies which was accepted at \$750. The figures seem to indicate that there is no such thing as a uniform cost for suits for companies, and insofar as there is an average cost it is above \$750.

Thus every one of the assumptions upon which the present loss reserve law is built is wrong. And that is a rather important fact to remember, because we are still working under that law.

The liability and the compensation reserves which are being discussed today should be handled differently. In regard to compensation, it is agreed that so far as the older cases are concerned they should be handled by individual estimates—by actuarial computations, I should have said. The details of those computations have been discussed today, and, I need not go into that.

The question at issue is just when should we stop making these individual valuations of cases: whether for the last year of issue, or for the last two, or for the last three years of issue. In trying to form an opinion on that subject, it is necessary to remember two facts: first, that for a good many years to come, and especially for newer companies, the reserves necessary for the issues of the last two or three years will constitute the bulk of all the loss reserves, while the reserves for the older years will be a small, though an increasing proportion of the total.

Of course, if we had life long compensation benefits for many more cases than we have, if we did not have the dismemberment schedule, if we did not have the limitation of period of compensation for even fatal accidents, then it is possible that after a long period of years the accumulated liability on the older cases would represent a substantial or even major part of that loss reserve. In time, a safe and proper actuarial valuation of all the older cases would in itself offer a sufficient basis of security, because the recent cases would proportionately represent only a small part of that loss reserve. But I think that situation will not come, for a good many years, and it may not come for even a longer period of years, if the smaller companies, the mutuals and others, should undertake to purchase annuities for the more difficult cases.

I don't know whether the problem of compulsory purchase of such annuities in the state of New York has been solved one way or the other, but if I were running a mutual I would probably want to do that myself whether compelled to or not.

Thus the cases for the last two or three years will constitute the bulk of the reserves, and in the treatment of such cases there will be the criterion of solvency, or the criterion of everything else for which loss reserves stand. It is really an important matter that we arrive at some proper method of reserving for recent cases.

It is not only the adequacy of loss reserves that both accountants and actuaries should strive for. Excessively high loss reserves may inconvenience even a company which is thoroughly sound. I understand there have been cases where for some peculiarities of the loss ratio of ten years earlier it was necessary for companies to issue stock and build up their surplus, although any one who would examine the statement carefully could readily see that that company did not need that additional capital or surplus. But in addition to that the situation develops that the underwriting statement has become absolutely worthless, and one cannot get the slightest idea of the underwriting results of any company not your own by examining the underwriting exhibit, page 8. I believe some companies cannot tell their own results by looking at that particular page unless they have been very careful to keep a different set of records, and I don't doubt that the larger companies do, as ours does.

Now, I think that is not a situation that as actuaries we should countenance, a condition of affairs under which no one knows what the financial results of compensation or liability insurance are. And secondly, I don't think that it is quite the thing to be desired to have a situation under which rates cannot be checked up by the underwriting results,—and at present they cannot be.

But we are required to furnish statements of underwriting results in compensation in various states, and if all the states had required that, an addition of those underwriting statements would produce an entirely different result than the underwriting page in the financial statement, the difference being largely due to the improper loss reserve law.

Is there really no way out of it? Is there really no middle ground

between preserving the principle of the old law, even with a change from 54 per cent. to 62 or 65, and between a very complicated method such as has been outlined here and which may take an enormous amount of labor and a long time before you will know where you stand? The cost of making the actuarial computation as intended by Mr. Dawson would be very substantial and the loss of time is more important. We would have to change the law in Massachusetts, which requires us to put the statement in their hands on January 15, and in most other states February 1, or March 1, is the latest date, and without an increase in clerical force, it would be quite a difficult matter to make all these computations on time,—I doubt whether just at this time it is desirable to load an additional underwriting expense upon the business, when the tendency is toward cutting down the entire loading for underwriting expenses. Moreover, that method, as Mr. Dawson very properly indicated, will not help us at all in regard to liability loss reserves, which problem he has not at all undertaken to settle for us.

As a matter of fact we do value all our claims individually, and so does every large company. I am sure that no large company is satisfied to stand on the legal loss reserve. But the valuation of those claims is not done with the actuarial care, such as has been outlined today, and on liability cases could not be done with that actuarial care, because the basis for such actuarial computations is lacking.

Now, that actuarial care should be applied to the older cases, but on the more recent cases a rough and ready method only need be used. The persons in charge of claim departments, and even the average claim examiners succeed in accumulating a goodly amount of practical experience. They get what you might call a "hunch" as to what the case is going to cost, and so long as there is no definite tendency within the company itself to deceive any body else on the inside,--which sometimes happens, that "hunch," if applied to a sufficient number of cases, produces remarkably accurate results. It is not a very difficult matter to follow up throughout the year a test as to whether the original "hunch" proved to be more or less accurate, and so far as our own experience goes we have had years in which the final cost of liability claims did not fluctuate over one or two or three per cent. from the original estimate put on them during the month of December. And I don't think that as statisticians we should be at all surprised at that, because there is such a thing as elimination of error through large numbers.

If you can take 1,500 or 2,000 claims on which there is a reserve anywhere from a million to a million and a half, and then after four or five or ten years have elapsed and practically all of the cases have been closed you find that the actual cost has not been over five per cent., or sometimes not over two per cent. over or under the original estimate you cannot help coming to the conclusion, as I have, that this affords a very substantial basis for getting at some method of valuing liability reserves anyway, and possibly recent compensation reserves as well.

Two difficulties, however, remain: first, the cases which have not been valued at all and which are of three kinds. There are the cases so recent

that you did not get a chance to find out what they are, or whether they amount to anything at all,—because they have been reported, possibly, during the last two weeks in December. Then there is the second group of cases which were not reported until January, or later, but had occurred before the end of the year. And there is the third group of cases which you thought were closed but have had to be reopened. Under liability conditions that was quite an important factor, and I am not prepared to say how important a factor it is going to be under compensation conditions, but we are getting such cases in compensation even now.

These three groups of cases present one problem. And the second problem is how to guarantee honest and efficient estimating. Conditions may arise under which some companies might want to misrepresent their liability, either because of threatening insolvency, or because of a desire to put forth their data as a claim for higher premiums.

Well, I think that both of these questions do not represent any great difficulties. They can be handled on the basis of actual experience, because after all we are not dealing with a business that is starting today. In regard to the three groups of cases for which the data is incomplete or absent there is what we might call the hidden liability, and I have for the last two or three years kept a very careful record of that hidden liability and I don't doubt at all that some other companies have. We know exactly at the end of 1914 how much we had to pay during 1914 on cases for which we had no reserve before 1914 began, and we have some idea as to what our estimates are on such cases, and since all of those cases are over a year old you can again see that those are all cases to which all the old principles discussed today in regard to old cases apply. In other words, after a year has passed, and you know what that developed hidden liability was, data of that kind could be readily obtained by the Insurance Department, and that simply represents a question of the proper loading upon your actual estimate as derived from past experience. In our case, for two years in succession, that hidden liability did not fluctuate over, I think, one per cent. It was, perhaps, just an amazing coincidence. But in any case, the question of hidden liability can be very readily handled by the method of a loading based upon a percentage of the estimated liability on account of actual cases.

Finally, the question of wilful misrepresentation of estimates remains. Now, I think that that again can be handled, and a suggestion for a method of handling that was the essential point of my paper which I still hope to be able to whip into shape, and with the indulgence of the Society print in a future number of the Proceedings. The suggestion was, briefly, that companies be required in addition to the various statements, to give a statement as to how their liability reserves have worked out. As a matter of fact, Schedule O calls for that information for all the miscellaneous departments, some of which are of very little importance to most companies, even down to plate glass. The liability and compensation departments are omitted.

I think it would not be at all difficult to call for that information, and

each company could stand then rightly on its own merits as to whether the tendency of that company was for underestimating of claims or overestimating of claims, and the ratio of overestimating or underestimating for the previous two years could be applied to the present estimate as a penalty. This would be a very important factor to keep the claim estimates in proper shape because a company would know that when they are underestimating these reserves for one year, that condition would be disclosed quite readily in the next year, it would be charged that ten per cent. additional, because it had underestimated its reserves ten per cent. the year before.

I think that with these two suggestions with a loading of credits derived from the experience of reserves of the previous two years, and with the necessary loading for hidden liabilities some method could be devised to handle the cases of the last year or two years which would not be as difficult as Mr. Dawson's method and yet much more accurate than the method of an assumed loss ratio.

There are just one or two points I want to make which have not anything to do with my general plan that I outlined; Mr. Woodward has raised some question about my table of duration of disability. I think I can readily explain the apparently small number of cases over 26 weeks. I know I am taking too much time for my discussion, but since we haven't so many papers, perhaps I may be excused. If you will look at the little table indicating a check of my table by the figures of the New York Compensation Commission as furnished by Mr. Woodward, I think you will find a most amazing condition of affairs. So far as the very serious cases are concerned, the fatalities and dismemberments and even total permanent cases, the similarity of figures is amazing. I know it is a good deal more than I ever hoped for my table. But when you get down from these rather serious cases which on the theory of probability there would be more fluctuations than on other cases, when you get down to the very next line to the partial permanent, not dismemberment, you find a very much different condition of affairs. There should have been forty-four cases, but there was not a single one. Now, of course, no one for a moment, would believe that out of 1,800 cases where the disability extends over one day's duration there is not a single case that came under the description of "Partial Permanent Disability." But on the other hand, I expected that, inasmuch as there could not have been any recorded, because 26 weeks have not yet clapsed. And even now, after some months have elapsed, those forty-four cases are still put in the fifth line of "Temporary Total," and they will still be in that class of cases over 26 weeks. That is where they are. The large number of cases over 26 weeks that you find in your experience is explained by the very fact that you have no cases of permanent partial. There will be cases of permanent partial. In any case that lasted over 26 weeks for temporary disability the strong presumption in my mind is that it is a permanent case, and unless you be as liberal in New York as in Austria and charge it as a case of permanent total the chances are nine against one that it will be a case of permanent partial.

I have gone through hundreds or thousands of accident records, and I

find many cases of permanent partial disability, although I admit that in most instances those cases are not handled as such yet,—a shortening of legs; a paralysis of muscles; a fracture without union; a stiffened dislocation, and many other cases of that kind. They last over twenty-six weeks, and they will last for years and years, and they probably will last as long as compensation is payable.

As to suspended mortality, that, no doubt, is an important factor. I am a little doubtful whether Mr. Woodward's assumption that it will go on for twenty years would hold. If I remember the German figures aright there was a very material suspended mortality for the four or five years, which is not at all uniform, but very rapidly declines. It is doubtful, I think, whether any cases of death after five years could be traced back to the original accident. I think that for practical actuarial purposes any suspended mortality after five years might be disregarded, and I think for the first five years it would be considerably more than one half per cent. per annum.

I want to make just one more remark in regard to the inadequacy of the method of premium loss ratio for some companies at least. The premium loss reserve method is based upon the assumption that the premiums are fairly adequate, or fairly, properly and thoroughly accurately computed. I am not here to say that our premiums are wrong, but no one would say that every premium on every classification is right, and we have a peculiar situation, with mutuals especially, which write business of very restricted kind. It may be that on the whole the premiums will approximate the necessary loss ratio as indicated by the Massachusetts Schedule "Z," and nevertheless as between two mutuals, one writing only the very non-hazardous business of clothing and the other writing the very hazardous business of lumber, one error in the pure premium on clothing, or one in the pure premium on lumber, might make any loss reserve based on percentage of premiums for that particular mutual absolutely inadequate and either break the mutual and jeopardize the interests of the people to whom compensation is due, or make that mutual an argument for unnecessarily increasing the premium.

MR. MOWBRAY: I want to say at the start that I am somewhat unfortunately placed in discussing these papers, because though Mr. Flynn let me have a copy of his paper last night, I have not seen the others until this morning. Further I am not situated so that I can fully appreciate the argument that the labor required by Mr. Dawson's and similar methods is prohibitive because I am connected with a company that does nothing but compensation business and is limited to one state. What Dr. Rubinow said just before we adjourned met my view to a considerable degree. The company I am connected with works under a ruling of the Attorney General as to what law applies to us, and we do actually make our estimates on the basis of the claims themselves, and have periodically re-checked those estimates.

I have been thinking of the whole plan of reserve for some time, but I

have not begun to work out in detail the plan that Mr. Dawson suggests. It has occurred to me that in connection with computing the differentials for the different states the cost per accident, according to the standard table we have now, has probably been computed for each state, and that if we were to take the same table and consider what the cost per accident would be according to that table, one year after the occurrence of the accident, or perhaps some other period, we could very easily obtain average factors. We could then take our accidents reported by state and by study of our delayed reports make a percentage correction to cover the delayed reports, and then, knowing the total claims outstanding from a given state, after making this correction, apply that average factor and at least get a check upon an individual estimate of reserves.

Further, I have this in mind, that at least in Massachusetts we are required to make up individual estimates for our outstanding in Schedule Z. Take our last Schedule Z. It covers the issues of 1913 up to September 30, and it had to be reported on as of September 30, 1914, and we had three months in which to get it up. Now, for that purpose for the state of Massachusetts, no matter what the work of the company was, the individual estimate had to be made. It seems to me if we were able to get some method of checking general compensation loss reserves by application of the standard table we could get a line on our estimates in Schedule Z.

Turning to the proposed pure premium method of making reserves, or of making reserves based upon gross premiums, as a percentage it seems to me that we are making a mistake in dealing with the general public in this regard if we adopt this method. If it be the general practice to make reserves upon the basis of individual estimate, the public will come to know this, at least those of the public who consult the companies' statements. Whoever then has occasion to examine the companies' statements will examine them with that known to him and will view the reserves in that light. If on the other hand, we make our reserves based upon a pure premium in a way which the people believe is a scientific method, the reserves built up in a way that will be accepted pretty generally as a scientific reserve, when as a matter of fact that reserve rests upon a pure premium, which involves direct estimates of outstanding claims, and is perhaps then further adjusted by individual judgment. That, it seems to me, is following things around somewhat in a circle and depriving whoever is examining the statement of whatever warning there would be in the knowledge that the reserves were straight out estimates.

Considering the matter from the standpoint of the mutual companies, the discussion has been entirely on the basis of uniform premiums, or the assumption that mutual companies, by reason of lower expenses or otherwise, will charge lower premiums than the stock companies. But, in life insurance, at least, the mutual companies generally charge more than the non-participating companies. And the mill mutual fire companies charge much higher initial premiums than the stock fire companies. The scale of initial rates of my company is higher than that of the stock companies in Massachusetts. I think Mr. Flynn tried to cover that to a certain extent

by stating that instead of the percentages he named, the mutual companies might have a reserve computed by the percentage of premiums but based upon an expected loss ratio of their own. But the whole compensation problem—the whole compensation business—is new. The term of the companies' experience with compensation is very short and when you come to determine loss ratios upon such scanty material coupled with shifting rate scales, and changing compensation acts for the purpose of modifying a reserve law in that way, it seems to me you are piling another hypothesis on.

My judgment would be that we would get better results if we took individual estimates and then by some method of approximation checked those individual estimates by comparison with the results according to a standard table. If those two methods brought results which did not check out with reasonable closeness, a satisfactory explanation should be required to account for the difference.

A reasonable discretion might be left with the insurance commissioners to demand such explanation and make public the conclusions.

MR. GOODWIN: The papers which have been presented show it to be the consensus of opinion that outstanding workmen's compensation losses should be valued individually or by analogous groups in all cases where such procedure will produce the most reliable basis of reserve calcuation. The point which cannot be disregarded is that, athough such a method is well fitted for use in connection with losses payable for injuries where a sufficient period of time has elapsed for the case to have developed to a point where the nature and extent of the injury is definitely established, it will not apply equally well in valuing losses incurred in any period just prior to the date of valuation.

In this connection a brief resume of what has been experienced in the liability field during the past five or ten years should be of interest. The first liability loss reserve method extensively applied was that which called for a reserve figure based upon the sum of the products of the number of notices of accident reported during the eighteen months immediately prior to the date of valuation times the theoretical average cost of such notices and the number of suits outstanding arising under notices of accident more than eighteen months prior to the date of valuation times the theoretical cost of such suits, less all payments actually made on account of such injuries. In theory this method was excellent as the amount of reserve produced fluctuated in accordance with any increase or decrease in the volume of outstanding losses. Although it fulfilled the requirements of the situation at the time it was made operative it soon became apparent that it furnished a reliable basis of reserve only so long as the current average costs of notices and suits coincided with the average costs which prevailed during the earlier period from which the averages applied were derived. With the removal of certain common law defences in various states came rapidly increasing average costs which necessarily were not promptly reflected in the averages used with the result that before long reserves compiled upon that basis produced for many companies little or no reserve for the purpose of offsetting large amounts of outstanding losses.
In the workmen's compensation field similar conditions are being experienced at the present time. Average loss costs are changing rapidly by reason of increasing familiarity with the benefits provided by the various acts, by reason of the enlargement by amendment of benefits under existing acts and through new acts of varying degrees of liberality becoming operative in states where compensation laws have not previously been in effect. Consequently, it is not possible at this early date to secure averages based upon actual American experience which can be applied in the making of individual valuations of recently incurred outstanding losses. This being the case, if individual valuations are made they must be made upon some such basis as that adopted by the Differential Committee of the Workmen's Compensation Service Bureau for rate making purposes. It would therefore seem that the most practical method of compiling a reserve under the more recently issued policies would be to apply the principles of the loss ratio method which is now the legal standard in New York and other states to such business. In other words the earned premiums under such business would be multiplied by a percentage representing the provision for losses in the premium dollar and from the resulting amount would be deducted the losses already paid. Under this method of procedure a reserve would be obtained which would represent the amount which the most experienced men in this line of business after examining existing foreign and American statistics have concluded to be necessary to liquidate such losses. The resulting figure would contain a provision for delinquent notices, adverse developments in the nature of injuries suffered, interest savings and similar factors, many of which are at this time necessarily matters which must be determined upon the basis of individual judgment.

The point at which individual estimates should be introduced into the reserve calculation as against the loss ratio method would seem to be in connection with business under policies dated during the third year prior to date of valuation. The last policy issued in that year would have expired one year prior to the date of valuation, all delinquent notices should have been received and the injuries would have had time to have developed to a point where further adverse developments should not have as great an effect upon ultimate costs as would be the case were notices of shorter duration included. The result would be a reserve giving proper weight to cases which had developed to a definite basis and as respects undeveloped cases equal to the amount which experienced underwriters and actuaries have agreed upon as representing the best possible approximation of the cost of that more recent portion of the business.

In addition to the fact that the application of the loss ratio method to the last two years of business should produce as reliable a reserve figure as can be obtained, it is also a fact that such a reserve could be compiled at a considerably less cost than could one which involved an attempt to value individually a large number of cases respecting which sufficient data could not be obtained.

In addition, the policyholders, the injured workmen and their dependents would have the benefit of a reserve based upon rates which are indicated by

experience already at hand to have been made upon a scientific basis. Should there be any question as to the adequacy of such a reserve it follows of course that the recipients of compensation from stock insurance companies have the benefit of the protection afforded by the capital stock and surplus of such companies, which corresponds in a way to the funds which may be raised by a mutual company through the assessment of its policyholders.

MR. GREENE: Mr. Chairman, when you spoke this morning about the tendency of the German experience in regard to suspended mortality, I was wondering if a study of the figures appearing in the official report of the German Imperial Insurance Office, to which you referred, would not indicate, or at least fail to contradict, the probability that a considerable number of deaths attributable to the injury occur more than five years after the injury.

These figures include a table purporting to be a classification of a certain number of injuries, according to the result of the injury, at dates approximately a year and a half, two years and a half, three years and a half, four years and a half after the accident. The column of this table headed "Death" shows a yearly increase for the entire period. Although this increase was largest during the first year of experience, as exhibited in the table, the most natural inference is that if the figures in this column mean deaths attributed to the injury, as far as the table goes it is more an indication that deaths attributed to the accident will continue to occur after the close of the first five years than that such deaths will not occur and be so attributed. Of course, it is possible that the figures in the column headed "Death" may mean something else, although I might point out that it is quite obvious that these figures cannot pertain to all the deaths among the injured, as anyone may find out for himself by applying any mortality table to the numbers of disabled exposed to risk.

THE CHAIRMAN: It occurred to me that if we are to determine upon a definite loss ratio percentage, right now we have a situation where the premiums have changed so much that what might be fair under the experience in 1914, would not at all be adequate in 1915 or 1916, and the loss ratio method of computing losses would obscure that very situation. That is, we have introduced two distinct methods, the schedule rating and experience rating, and no one as yet knows definitely what effect these are going to have upon that pure premium or upon your loss ratio, and naturally a loss ratio determines upon full premiums without your schedule rating, as has been done in Massachusetts Schedule "Z." If applied after Schedule rating, and experience rating, it might produce an entirely different loss ratio and 65 per cent. even for all we know might prove to be inadequate, and yet, under this method we won't have it disclosed for about three years, especially since the loss payments with loss expense are going to be deducted, although as a matter of fact, under the New York rating the loss expense is not supposed to be included in that sixty-six and two thirds.

MR. MOWBRAY: There are two points which it occurs to me we might get into the record so that students of the problem studying our discussion may not overlook them.

One is a matter I was thinking of, suggested in part by what Mr. Goodwin said about the amendments of the laws. We have allowed, and I presume we will expect in making differentials in the different states, when there is a material change in the compensation act, to allow for that in preparing our rates, but recently, or I think it was at the session of 1913, the Massachusetts Compensation Act was amended so as to provide that the loss of use of a member should be equivalent to the actual dismemberment. That was a very slight change. I dare say that none of us would attempt to estimate how much difference it would make in our actual cost. In our Schedule Z experience, it is all merged, because it was not considered a sufficiently definite change in the act to call for a different treatment in experience, yet it certainly must, to a measure at least, have increased our costs.

Again, by a decision of the Supreme Court there, the Act which has been construed in operation as covering only accidents, was interpreted to cover industrial diseases. Our experience covers a period when we treated it partly as limited to industrial accidents and partly when it covered industrial diseases. It is my personal judgment that we have not yet felt the full pressure of that industrial disease feature. It seems to me that is a factor which tends to operate against a satisfactory reserve based upon premiums.

There was another thing which Mr. Dawson has suggested to me and which is confirmed by some material which I have seen.

Our earned premiums, at any time computed on the pro rata basis, whether on an average of the year or by monthly periods, are based upon estimated payrolls. Sometimes, we are fortunate enough to have those under estimated, so that we get something more when we come to adjustment, but right now we are passing through an extreme period of industrial depression, and we don't know but that our earned premium estimates may be too high, that our payrolls when we come to audit them will be short, and that our losses, as they are coming in, and we think are giving us a low loss ratio, when we come to adjust on adjusted payrolls, may be otherwise.

It seems to me that when we depart from the actual losses by either direct computation or by some other approximately direct method such as computation by a standard table of reference, we involve all those elements in the fundamental proposition of our loss reserves, which of itself should involve none of them.

MR. FLYNN: I think payrolls as a whole are underestimated. It is an underwriting practice for a company to accept an estimate of payroll for the coming year slightly under expended payroll for the previous year. This may be due in part to the fact that, when the basis of renewal of the risk is reviewed by the underwriter, the audit showing the payroll expenditure of the preceding year has not been completed. I doubt if there has

been in any company a year's experience which has shown upon the total business an excess of rebates over additionals. In every year of experience of the Travelers, even during the industrial depression of 1908, there has been a net additional to estimated payrolls.

MR. SCATTERGOOD: Mr. President, I wish we might invoke some little discussion with regard to whether or not loss expenses should be included with losses paid to the workman directly, and in order to start such a discussion, I would like to state that I have always considered under the employer's liability forms of contracts that where we agree to pay the expenses of any award made against the employer, and also to defend any suit brought against the employer, that we stand in the shoes of the employer both with regard to the payment of the award by the jury or by the board, and with regard to the defense of the suit for him, and that therefore under the liability contracts, as we sell the protection against a jury's award and also against the losses. But with regard to the compensation situation, I think it is just merely a matter of how you look at it.

The companies certainly stand in the shoes of the employer, since they agree to take all of this work from his hands with regard to the payment for losses occurring to his workmen, to administer this for him. Instead of the employer keeping a force of men to pay the claims to his workmen as they may fall due, the company does it for him. Up to this point it would seem that the analogy is perfect between the old liability situation and the compensation situation, and looking at it in this light the loss expenses should be included with the losses. But you can look at it from the other standpoint too, that we are selling a service to the employer who insures with us, and to look at the losses paid the workman from the standpoint of losses, and loss expenses from the standpoint of service. I would just like to indicate that distinction and see what the opinion of the meeting is concerning it.

MR. WOODWARD: Mr. President, if I may say just a word on this: It seems to me that with respect to workmen's compensation insurance the companies will probably have to make up their minds that the losses are not going to include claim expenses, because I am pretty confident that that will prove to be the attitude of insurance departments and industrial commissions. What they want to know is, what these injured workmen and their dependents are receiving, exactly, and they don't want to have that amount obscured by putting in other sums of money which the company has been spending, or alleges that it has been spending, for services in connection with the settlement of those claims. There is a sharp distinction between compensation and liability conditions with respect to that question, because under the old liability policies the losses were really what was spent on behalf of the employer. They represented what he would have been compelled to spend if he had not been insured. It is, of course, possible to reason from that fact, just as Mr. Scattergood appears to have done, that compensation claim expenses stand on the same footing. It does not

seem to me however, that in practice that this view will have considerable support, except, possibly among the companies themselves. I think the wiser thing to do will be to keep those two quantities, claim experience and pure losses, absolutely separate and to include in the loss reserve for workmen's compensation only the reserve that is going to be necessary to actually pay the pure losses, and to put up an entirely separate reserve to cover the outstanding expenses that will be involved in administering the annuity funds which will gradually accumulate, and to include in a separate item of disbursements a statement of the adjustment and claim expenses on compensation business.

MR. SCATTERGOOD: Mr. President, for the purpose of determining the solvency of a company so far as its reserves are concerned, seeing that the expenses form part of the premium and we must take according to some of the methods described, a percentage of the earned premiums, do we not make the distinction in the reserve by stating the losses paid to workmen and the expenses incurred separately, but both to be included as a deduction from the percentage of earned premium?

MR. WOODWARD: It depends on what you take as the percentage of earned premium. If you assume that that pure premium includes the loss expense, you make an assumption, inconsistent with the separation of claim expenses from the pure losses. In New York State, under the formula adopted by the Insurance Department, the pure premium does not include the loss expense, and therefore if you follow the Insurance Department's theory, you would require a separate reserve for claim expenses. It is wholly a matter of what you assume is included in the pure premium.

MR. DAWSON: I concur in what Mr. Woodward has just said, and I think it would be very perilous for companies to attempt to pursue the policy hereafter that they have been pursuing under liability. The service in workmen's compensation is not to the employer; it is to the community, and particularly to the injured employees and their families. The whole theory of workmen's compensation is that the state has made a provision, in the case of our own state wiping out every solitary provision of the constitution that might have prevented its doing it, for injured workmen and their families, and the thing which the state and these people are interested in is, how is this money getting to these families.

Now, under employer's liability the theory was a different one. I am not saying that even under employer's liability it would have been desirable for reports to have been made the other way. You followed the British precedent in that matter. But as regards employer's liability, you are dealing with an entirely different situation. The employer might or might not be liable in a given case. First of all that had to be determined. In workmen's compensation, if the man is injured in the course of his employment, the employer is liable; and if the employer is not liable, then the insurance company is, directly, under the laws of the state of New York. And you don't have that same situation, you are not performing the double service at all, you are merely performing the one service of paying compen-

sation, and it is the compensation paid which will have to be reported. And there isn't the slightest doubt, if the other system of reporting were continued, you would have great and continuing trouble with superintendents of insurance, or with commissions. From another standpoint, it would be highly unwise, in the contest which is going on both as to whether there should be a public system of dealing with this matter exclusively and as to whether if there is competition there shall be competition with state funds. It is going to be absolutely essential that whatever the actual facts are shall appear in those reports.

If you have them in any other form, the only result will be that when people are convinced that they are in the other form, they will put an estimate upon the amount of expense that is hidden in the loss ratio—that would doubtless be charged whatever the fact—and it will do very great harm, do the companies very great harm.

For instance, it has been suggested that two and a half per cent. be added to the claim reserve for expense. Now, there isn't even the slightest possibility that if the facts were all hidden anybody would ever dream it was only two and one half per cent. you have there, and the statement would be that it was ten percent. or twenty per cent., or some other large estimate, so from every standpoint you cannot afford to do it.

MR. SENIOR: Supplementing the admirable discussion which has been brought out on the floor, I might perhaps make a distinction in the two contracts, the contract for employer's liability and the contract for compensation. The former one under the old practice was strictly a contract of indemnity and the relation was purely the relationship of the company with the employer. There was no third party to the contract at all heretofore. Under compensation insurance you have a differnt form of contract. You have a contract between the employer and the company made for the benefit of the third party. It is largely, I believe, for that reason that the New York Department, with which I had the honor to be connected at one time, has ruled that the term "losses" under workmen's compensation shall be losses paid to workmen and their dependents, and nothing else. In other words, it was intended that the loss expense should not enter at all into the subject of loss payments, and should not be confused with loss payments, that the experience should be an experience indicating purely payments made under the compensation law for the benefit of the workmen and their dependents. I think the decision of the Department was a wise one, and I believe that in practice it will be found that that decision will be followed in all other states, namely, that the loss expense shall be maintained separately and entirely distinct from all other expenses of the company.

Workmen's compensation is not subject to a great deal of litigation. You probably won't have one tenth the amount of litigation that you had in England. A great many of the points will be settled in the early days, and the few cases which will be brought will be simply for the purpose of clearing up some obscure phraseology. And there is no justice and no reason, I think, for including the cost of litigation and the cost of investigation together with the loss payments which are made to workmen under the compensation act.

MR. MOORE: Mr. President, we use the term "payment to the injured," but it is a grave question what constitutes "payment to the injured." The cost of medical service in the various states is causing more and more attention. Does anyone know how much of the medical service paid is a direct benefit to the injured under the workmen's compensation act?

THE CHAIRMAN: It depends upon the doctor. (Laughter.)

MR. MOORE: It is often necessary to send a doctor to find the condition of the injured. The doctor might prescribe, or might not. However, he charges a fee. A portion of this fee might be a payment to the injured under the medical aid portion of the act, and a portion might properly be charged to adjusting expense.

The very fact that we are paying out money as a benefit to the injured costs money to pay it. Then too, there is a certain amount of malingering under the act, which has to be watched, making an added expense, and whether the company be a mutual company, a stock company, or a state fund, this item will have to be reckoned with.

I am inclined to think that adjusting expense under any workmen's compensation act for this medical service alone is going to be a considerable item. In fact, in some states already the increase in this expense is arousing attention, and the same might be said of non-statutory medical aid. Is non-statutory medical aid to be considered an expense, or as medical benefit under the act? How are we to set up in our liability loss reserves an amount to cover this so called "adjusting expense." There is no provision in the present annual statement blank for such an item, and in the consideration of any liability loss reserve, this point should be thoroughly discussed.

MR. PHELPS: Whether we like it or whether we don't, the insurance community is up against a cumulative, steadily-increasing combat between state and private insurance in all lines, casualty, life, and fire. As I see it, the all-essential top-notch ratio which is going to figure in this fight, probably at an increasing rate, is going to be the ratio of payments to beneficiaries, in other words, of loss payments, whether fire, life, casualty or workmen's compensation.

Private insurance corporations may consider that, taking all factors into account, they are benefiting if they can bring about the inclusion of expenses incident to the adjustment of workmen's compensation losses under the heading of losses. Isn't it entirely possible, however, that in the long run it may prove a boomerang which will come back and hurt? If the public and the various legislative committees, and the yellow journal reformers should sooner or later discover that of the so many millions of dollars or such a ratio supposedly paid to the beneficiaries under workmen's compensation at least some part of that amount and that ratio did not actually go to the beneficiaries, would not they then have a chance with the

magnificent public ignorance of the technical complexities of the subject of playing this up very hard and making serious trouble for the stock insurance companies making such returns, might they not intimate, however unfairly, that this debatable item was a very considerable factor of the alleged total of direct payments to the beneficiaries and thus frame up a pretty strong additional argument for state insurance?

It seems to me that this is really a larger problem than it seems offhand.

MR. SCATTERGOOD: Mr. President, perhaps I did not make myself exactly clear. My statement in regard to the inclusion of loss expenses here was not brought out in connection with the determination of the cost of workmen's compensation as a whole. It was merely brought out with regard to determining the solvency of a company from the standpoint of its resources. It seems to me the two things are distinct. I would not consider for one moment, and would agree with Mr. Phelps, that we should not include the expenses of administering the payment of those losses and charge it up to losses themselves and say that that was our expense in workmen's compensation, but for the purposes of determining the solvency of the company, so far as it may be ascertained from its reserve where the premium theoretically is supposed to cover the expense of the company including the adjustment of claims, it does seem to me that the loss expenses, stated separately should be included with the losses paid to the workmen, and that used as a deduction figure from the percentage of your earned premium.

But from the other standpoint of cost of compensation in order to have the different systems comparable, state, mutual or stock company insurance, the terms should be similar, the losses should be losses paid workmen and the expenses should be stated. Similarly, the expense of administering the state fund or mutual should be in a class by itself so that we might compare the expenses with the expenses of stock companies.

I simply wanted to bring out an apparent misunderstanding of my question with regard to the cost of compensation and the determination of the solvency of the company through its reserves.

MR. GOODWIN: There are two ways of looking at this matter: one is in its relation to the reserve exhibit and the other to an underwriting exhibit. The present reserve law relating to compensation business is an outgrowth of the liability law and clearly calls for the inclusion of loss expense in the reserve computation. In order to produce a proper reserve it is consequently only necessary to include in the ratio applied to the earned premiums the proper provision for loss expense. On pages two and four of the annual statement appears a classified outline of disbursements and outstanding liabilities in connection with this class of business. So far as determining the solvency of a company is concerned, it makes no difference whether the provision for outstanding loss expense is contained in the loss reserve or appears in the form of a separate obligation.

In Schedule "W," which is submitted to New York and certain other states, the various items such as losses divided to death, dismemberment, disability and statutory aid are shown separately as are also the costs of investigation and adjustment. In fact, that statement goes even further and shows such costs as taxes, inspection and accident prevention service, etc. It follows that as respects the compensation business in any such state, no matter how the general reserve is compiled, the cost of the adjustment of losses will appear as a distinct item.

Non-statutory medical aid which was mentioned by Mr. Moore can best be placed by reference to that portion of our loss expense which was known as surgical examinations, in connection with liability business. This was distinguished from first aid because the examination was made for the purpose of determining the seriousness of the injury for the purposes of the adjuster and not for the purpose of securing medical treatment proper. This charge in connection with liability business was treated as adjusting expense and it follows that any similar payments in connection with compensation business should be treated likewise, charging to statutory medical aid, however, all items accruing by reason of treatment and accommodations furnished the injured workmen.

Returning to the original question of the treatment of adjusting expense, it may be stated that from the standpoint of an insurer the direct service which it renders to the injured man consists: first, in financing the payment of statutory medical aid; second, in financing the payment of indemnity; and, third, in maintaining the equipment necessary for transmitting the money to its proper source, including any slight expense incidental to determining the nature and extent of his injuries. Under workmen's compensation coverage, at least, the later items of expense mentioned are all necessary expenditures for the benefit of the injured man and are in the nature of a service to him. As a matter of fact, the inspection service, which is accident prevention work, is a direct benefit to both the employer and the employe as its real purpose is to reduce accident hazards and incidentally premium rates. The only interest which we have in regard to the manner in which these payments shall be stated is that they shall be clearly shown so that anyone making a comparison of how much or what part of the premium charge is paid to the injured man or expended for his benefit shall not misrepresent the real situation. It is a fact that statutory aid payments, claim payments, costs of adjustment and accident prevention charges are all expended for the benefit of the injured workmen and as they are necessary expenses they should be included in any display made for the purpose of showing the beneficent purposes to which premium receipts are applied. It follows that under workmen's compensation practices the part of an insurer's expense ratio which represents the payment of taxes and all other expenses not just mentioned is the only part which is an indirect rather than a direct benefit to the public and, for that reason, it is only proper that comparisons made should class as direct benefits the various items which are such and as indirect benefits the remaining charge which represents expenses necessary to the systematic conduct of the business. It would seem to be well to endeavor to have information of this nature appear in an orderly way in the future as a better understanding of the true situation will make evident the real value of the equipment which is necessary for the administration of workmen's compensation benefit funds.

MR. WOODWARD: Mr. President, from an accounting standpoint if the statement of liabilities is to be consistent with the statement of disbursements, you have got to treat expenses and losses in the same way in both of those places. It would be quite illogical to argue from the standpoint of solvency and say that we will include the outstanding expenses combined with the outstanding losses in the liabilities and then in disbursements to separate the losses from the expenses, because the incurred losses, after all, are nothing but the paid losses plus the increase in the outstanding losses, and if you wanted to get your incurred pure losses under such a system of accounting, you could not get them from a consideration of your disbursements and the liability items, at the end and beginning of the year respectively. From an accounting standpoint there would be serious inconsistency in treating this question in one way in the reserves and in another way in the disbursements.

MR. MOWBRAY: Mr. President, it occurs to me it might be worth while observing here that this confusion which does arise when you handle this proposed percentage by the pure premium method of reserving, does not arise by Mr. Dawson's method or an approximation to it.

MR. DAWSON: The point Mr. Woodward mentioned, I think deserves a little more elaboration. Suppose you had adopted the plan of making a provision for two and one half per cent. of your estimated claim reserve for a claim expense, for instance. That is a very small percentage, but it is obvious, just as Mr. Woodward has said, you would in attempting to arrive at the actual losses of the year, first take the claim disbursements and then correct that by the increase or decrease in claims reserve, and that increase or decrease would in turn be met out of the actual claim reserve by this two and one half per cent., so that the two things would not correctly fit each other. I think also it would be objectionable from other standpoints. I have this impression as the result of all this discussion of these papers, which to me has been extremely interesting, that in the stages of passing over from the employer's liability to workman's compensation, it is very probable that some system such as has been brought out by the other two papers, is certain to be used, and very likely ought to be used, as a departure from it so wide as I have suggested, at least, would be a violent revolution. I have quite the feeling that in the long run, companies like the Aetna and Travelers, for instance, which are accustomed in their departments such as personal accident and life insurance departments, accurately to discover what their liabilities are, would not be satisfied any more than the general public would be with any system of claim reserve that was not actually based upon the claims experience instead of really upon the premiums of the year.

I am quite confident that by the time our Society celebrates its third birthday, and certainly its fifth, we will have found some greatly improved basis compared with anything I have had heretofore to suggest to you, and some basis by means of which your claim reserve will actually be computed from the claims, so that the company which has the more favorable experience will have the smaller claim reserve, and particularly—and that is the most important of all—the company which had a bad experience will have a large claim reserve.

MR. FLYNN: To go back to the discussion of expenses again it seems to me that there is another way we can look at the problem; namely, that the question as to whether the loss expense should or should not be included in the loss ratio provision depends entirely upon what percentage of earned premiums is to be used as the total provision. There is no good reason for following the liability practice with regard to this question. If adjusting expenses are to be taken out of the loss ratio provision, however, a further subdivision of the premium dollar is advisable rather than simply a division to losses and management expense. It is important that the various percentages which appear in Schedule ''W'' and in the underwriting exhibit show a proper division of the premium dollar. I would suggest the following division:

- (1) The part expended for losses.
- (2) For service,
- (3) For taxes.
- (4) For management expenses.

(1) would contain simply loss payments, including statutory medical; (2) adjusting expense, inspection expense and payroll audit expense; (3) taxes, departmental fees, etc.; (4) administration expense and acquisition expense. If some division such as this were to be shown in the insurance publications it would be clearer to the lay reader what part of the premiums received by an insurance company had been returned to the employer and his employes in losses and in service. The taxes and expenses involved in the preparation of statements, department fees, etc., which make up a surprisingly large figure, would also be shown.

MR. MOORE: Mr. Chairman, with regard to the reserve for the investigation and adjustment of claims, the reserve for this amount could very easily be taken care of in the annual statement blank on page 4, liabilities, under the heading, "estimated expense of investigation and adjustment of claims," provided a subdivision be made for workmen's compensation. That I believe is the proper place for it to go.

WRITTEN DISCUSSION.

▲ METHOD PROPOSED FOR THE CALCULATION OF LIABILITY AND WORKMEN'S COMPENSATION CLAIM RESERVES.----B. D. FLYNN.

MR. RYAN;

From the standpoint of a stock company with a large volume of business, Mr. Flynn's method of calculating liability and compensation loss reserves is a practical and suitable one. It consists of a modification of the present

New York liability loss reserve law and also of the basis proposed by the Commissioners' Committee on Reserves other than Life, at its meeting held in New York during December, 1914.

From the theoretical standpoint, much might be said in favor of the pure premium method of valuation, but in view of the present unstable condition of both lines of insurance—liability and compensation—due to rapidly changing conditions affecting the cost of benefits, this is hardly the time for the establishment of a method like the pure premium method which depends for its accuracy upon the extent to which the pure premium is a true indication of the actual insurance cost.

The proposal to apply a percentage of the premium for three years onlyinstead of five years as at present-is a good one for reasons which Mr. Flynn sets forth. In changing to 60 per cent. for liability losses and 65 per cent. for compensation losses, it is proposed to make a temporary modification for business issued during 1913, 1914 and 1915 to avoid the shock of putting aside a large amount of surplus to be held in reserve against business upon which the loss ratio will undoubtedly be less than the indicated percentages. The separation of liability and compensation business, commencing with January 1, 1913, is a reasonable concession. The insurance commissioners' annual statement blank made no provision for a separation of liability and compensation premiums or losses until that time, consequently the insurance companies were unprepared for any such separation until the statement blank was furnished by the commissioners toward the close of 1913. Further, workmen's compensation constituted a relatively small proportion of the business transacted prior to 1913, so that the separation between liability and compensation would have no particular value if made as of some earlier date. At the same time, it would involve considerable labor and expense to go over the old records of 1911 and 1912 to ascertain the volume of compensation premiums written in those years, while the value of the results would not seem to justify the trouble.

In speaking of the pure premium method, Mr. Flynn says on page 3 of his paper that the pure premiums could not be depended upon as adequate for reserve purposes. There is a possibility of misunderstanding in this statement, as the question might be raised "How could an Insurance Department approve rates as adequate for conducting the business of compensation insurance, and yet not be able to apply such rates for reserve purposes"? The answer, of course, is that the approval of rates for undertaking the insurance obligations are subject to speedy correction in the discretion of the supervising official, while any rule of law which might govern the calculation of reserves would be subject to the more slowly moving processes of legislative enactment.

It is noted that throughout the paper, Mr. Flynn assumes that 65 per cent. of the compensation premium shall be for losses and loss expense. This deserves serious consideration. Much might be written on the subject of insurance expense under a form of insurance which like workmen's compensation is of the nature of a social service. Is it not reasonable to suppose that the future tendency of workmen's compensation rates will be to recognize the social character of the business by the development of a new theory of expense limitation? The California law in effect recognizes this point since a loss ratio of 75 per cent. is provided for and the loss expense is regarded as a part of the loss payment. It may be asked, therefore, whether the assumption of 65 per cent. loss ratio should not eliminate from consideration the inclusion of loss expenses—in other words, is it unreasonable to expect that 65 cents out of every premium dollar shall eventually be returned to the injured workman or his dependents? If so, the percentage to be used for reserve purposes should be increased to cover the additional item of loss expense.

Perhaps the greatest difficulty in applying the method proposed by Mr. Flynn will arise in connection with mutual companies. In the first place, the mutuals take the position that for two principal reasons they are able to furnish insurance of the workmen's compensation obligation at lower cost than the stock companies. The first reason is stated to be the fact that they write only preferred risks, frequently confined to a given trade or business, and the second, that they do not have the same heavy acquisition expense as do the stock companies. It may be argued that these advantages do not necessarily follow from the plan of mutual organization, but since it is theoretically possible, we must assume for purposes of discussion that practice follows theory. Now under state supervision of rates, the mutual, under ordinary circumstances, will charge the same gross premium as the stock company, and will depend for its competitive advantage largely upon the ability to pay dividends within a reasonable time from the date of the policy undertaking. Having assumed that the stock rates must be charged by mutual companies, and that their losses and expenses will be considerably less, it must follow that a reserve method which requires a company to hold in reserve a high, fixed percentage of the premium for as long a period as three years is bound to work to the disadvantage of the mutual companies. To meet this difficulty, it may be suggested that the percentage test be eliminated in respect of the third year preceding date of statement, and that actual estimates of outstanding cases be applied at this point. This will not involve additional labor for the stock companies, since the proposed method already requires individual estimates as a test of the percentage reserve. At the same time, the suggested change affords reasonable relief to successful mutual companies by permitting them to base their dividends to policyholders upon actual experience as disclosed by the estimates of outstanding cases on the business written during the third and earlier years preceding the date of statement.

It might be argued that the mutual companies are not obliged to charge the same rates as the stock companies, but in establishing minimum rates through governmental supervision, it seems desirable for the good of the business as a whole that the minimum rate for one company should become the minimum rate for all companies. Indeed, the economic laws of competition will ordinarily have the effect of forcing all rates to a common minimum level. Still, if the reserve requirements for mutual companies are based upon premiums, and are placed so high that the mutual companies are likely to suffer on that account, the curious though possible effect may be that the supervising official, in order to afford proper relief to the mutual companies, may be obliged to approve a level of rates for their use which is below the level for stock companies' rates.

The effect of the progressive change of state laws from employers' liability to workmen's compensation must soon begin to be reflected in the average cost of claims and suits under the remaining form of liability insurance, viz.: public liability. Statistics which heretofore have furnished the basis of such averages have included both forms of coverage. This suggests that in obtaining suit tests to apply against future liability business, it might be advisable to ascertain separately the cost of employers' liability suits and those brought by the public. It is not unlikely that the public liability suits will show a decidedly different trend from those brought by employes, largely for the reason that employers' liability suits are now settled with greater rapidity than formerly and hence cost less on the average.

The suggestions for the valuation of compensation annuities are all appropriate, and can be endorsed by everyone who understands the nature of these outstanding obligations.

SCIENTIFIC METHODS OF COMPUTING COMPENSATION RATES, VOLUME 1, NUM-BER 1, PAGE 10.—I. M. RUBINOW.

MR. ORR:

Inasmuch as the rates for workmen's compensation insurance for the different states are likely to be compared by the various supervising officials, it would now seem to be an opportune time to investigate the matter of the expense factor.

It is now customary to load the net (pure) premium with a percentage. A little consideration shows that this is not only unscientific but is very unfair to those states having a high compensation rate. At the best we should use a percentage only for that part of the expenses which are in the nature of a percent. of the premium, such as commission, taxes, and possibly some adjustment expenses. The balance of the expense part of a premium cannot be considered as a percentage for the reason that such expense in a state having a high net premium rate is no more than the expense in a state having a low net premium rate.

There is absolutely no reason why a differential cannot be easily applied to a net premium in such a way as to adjust the loading fairly between the various states.

If the commission element should be eliminated, it is readily seen that the percentage factor immediately becomes very small.

Take the differential formula: basic premium times law differential times

loading for expenses; I would suggest the following modification so as to produce a constant derived from the basic premium to cover level expenses and a percentage to cover percentage expenses.

Taking $\pi = \text{basic premium}$

and $l = \text{loading for basic state } (A) = .663\pi$.

Then
$$\pi/.60 =$$
Gross premium for (A).

As now applied, the gross premium for the basic state (A) is multiplied by the law differential (d) to get the gross premium for any other state (B). This is unfair when the differential is greater or less than 1—in fact it may even become dangerous if the differential should be materially less than 1, assuming, of course, that the loading in the basic state is no more than adequate.

The differential formula as now applied would be $\pi d/.60$. The loading should be divided, however, in such a way as to give a level loading for those expenses which are equal in the different states and a percentage loading for those expenses which vary with the amount of the premium. Accordingly, if one half of the expenses in the basic state are level and one half are in the nature of a percentage, we would have the following:

$$\frac{(\pi d + \pi.33\frac{1}{3})}{.80}$$

It is interesting to consider the result that would be obtained under the method now in use if the basic rate should happen to be higher than the derived rate or, in other words, if the differential should be less than 1. In such case, it can easily be seen that if the expense factor was no more than adequate in the basic state then the derived rate would be inadequate and a company operating solely in the state having this derived rate would ultimately become insolvent.

Theoretically this formula should be applied to adjust the expenses between the various classifications and also between the different payrolls. It can hardly be claimed, however, that such an application of this formula at this time would be practical. In this connection it is interesting to note the attitude of certain large employers who would be benefited by such an application.

This adjustment as between payrolls was submitted to certain large employers of labor and they were emphatic in stating that the plan would not work out in practice.

There is, however, no reason why the formula should not be used as between the various states. It certainly will be difficult for anyone to explain why the expense loading should be increased proportionately with the net cost of compensation.

It is interesting to study the application of this principle to the payrolls under individual policies. Theoretically, at least, it costs no more in office expense to handle a policy covering a small payroll than it does one covering a large payroll, and as a matter of fact, it is frequently the more difficult to handle the small payroll on account of poor bookkeeping of the insured. This being true, it must follow that either the small business (outside of minimum premiums) is being carried at a loss or else there is an enormous profit in the large business.

Carrying the study a little further, let us ask what would become of a company carrying small business entirely—say from \$12.00 to \$20.00 premiums? Would such a company be able to continue its existence indefinitely under present rates? Even so, it cannot be contended that the profits would amount to much, if anything.

This leads us to the consideration of the so-called policy-fee which is in much disfavor with certain supervising officials. It takes no discussion to prove that the policy-fee would, if scientifically adjusted and properly used, make a more equitable adjustment of the premium. However, at the present time, the practicability of the policy-fee plan for workmen's compensation insurance is to be seriously questioned.

The principle of a combined constant and percentage loading is well recognized in life insurance premium calculations, as between ages and policy plans, although it can hardly be claimed that present-day tendencies are towards an absolutely scientific adjustment of the loading.

After all has been said, we must come back to the question of practicability. We must not take up an attractive theory simply because it is attractive. It would seem, however, that there should be a persistent effort on the part of all actuaries to bring about the use of those plans which will put the casualty business on a more scientific basis; a basis which is more just and which will obviate the danger of criticism.

MINUTES

CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA MEETING OF FEBRUARY 19, 1915

The second regular meeting of the Casualty Actuarial and Statistical Society was held in the library of the Metropolitan Life Insurance Company at 8 P.M., February 19, 1915. President Rubinow presided.

The following Fellows were present:

A. H. MOWBRAY
. R. MULLANEY
E. B. Phelps
. G. REITER
. M. Rubinow
. E. SCATTERGOOD
. Scheitlin
. H. WOODWARD

The reading of the minutes of the first meeting was dispensed with, as these minutes appeared in the first number of the Proceedings, already in the hands of the members present.

The minutes of the meetings of the Council since the previous meeting of the Society were read by the Secretary and approved by the Society.

The President delivered an address entitled "Our Problems." The Council presented its recommendations with regard to admission to membership in the Society and the following were elected to Fellowship:

F. H. Burns, Vice-President, Maryland Casualty Co., Baltimore, Md.

Gordon Case, New York State Insurance Department, 165 Broadway, New York City.

Henry Collins, Assistant United States Manager, Ocean Accident and Guarantee Corporation, Ltd., 59 John street, New York City.

MINUTES.

- C. W. Fellows, Manager, State Compensation Insurance Fund, San Francisco, Cal.
- James E. Flanigan, Connecticut General Life Insurance Co., Hartford, Conn.
- Richard Fondiller, Chief Clerk, Actuarial Department, State Workmen's Compensation Commission, 1 Madison avenue, New York City.
- F. S. Garrison, Manager, Burglary and Plate Glass Department, Travelers Indemnity Co., Hartford, Conn.
- John M. Laird, Assistant Actuary, Connecticut General Life Insurance Co., Hartford, Conn.
- Abb Landis, Consulting Actuary, Nashville, Tenn.

Harry Lubin, Actuarial Department, State Workmen's Compensation Commission, 1 Madison avenue, New York City.

W. R. Maddrill, Travelers Insurance Co., Hartford, Conn.

Franklin B. Mead, Secretary and Actuary, Lincoln National Life Insurance Co., Fort Wayne, Ind.

William J. Montgomery, State Actuary, Boston, Mass.

- Mrs. Dorothy Rolph, Acting Insurance Commissioner, Denver, Col.
- George Lambert Smith, Comptroller, New England Casualty Co., Boston, Mass.
- John T. Stone, President, Maryland Casualty Co., Baltimore, Md.

Twelve applicants for membership were admitted to participation in the examinations for Associateship.

The reports of the Treasurer and of the Librarian-Editor were read by them and accepted by the Society.

Mr. Woodward, Chairman of the Committee on the Revision of the Constitution and By-Laws, read the report of this committee. The constitution and by-laws, as revised by the committee, were adopted by the Society.

On motion of Mr. Flynn, the matter of appointing a committee to prepare classifications of industries, causes of injury and nature of injury, with relation to the statistics of work accidents, was referred to the Council.

The Society voted its thanks to the Metropolitan Life Insurance Company for the use of its rooms for the meeting of the Society.

Upon motion, the meeting adjourned.

THE ESSENTIAL FACTORS IN THE COMPUTATION OF THE COST OF WORKMEN'S COMPENSATION.*

W. N. MAGOUN.

Had the originator of the saying, "Comparisons are odious," ever heard of the subject of workmen's compensation, he would have been more likely to have said, "Comparisons are essential."

"The function of statistics in social studies is to afford a definite quantitative measure of forces and tendencies concerning which there are conflicting opinions because of the wide fluctuations occurring in the narrow field of the individual observer's experience or knowledge." This definition which I quoted is from the report of the Commission on Compensation for Industrial Accidents of Massachusetts, which Commission drafted our Compensation Statute and carried out the investigations and preliminary work in connection therewith.

With the extraordinary demand which now exists all over this country for accurate and dependable information in respect to workmen's compensation on the one hand, and the meager contribution which any one state is able to make on the other, the necessity for uniformity in the keeping of statistical data so that it may be interchangeable, stands out clearly.

Owing to the differences in the laws in the various states, it will be natural for each state to find it necessary to keep certain data peculiar to itself. This, however, should not operate to prevent the general handling of the subject on a uniform basis.

I will admit at the outset that if we are to become uniform in our methods it will involve two concessions on the part of many of us.

First, we shall have to keep a certain amount of data over and above that which we believe we need for our own use.

Second, we shall have to change to a greater or less extent some of the tables which we are at present using.

As an illustration of the first point, I may mention that in Massachusetts a widow is paid for 500 weeks, and consequently her age is

* Read before the National Association of Industrial Accident Boards and Commissions, Chicago, January 12, 1915. of no great importance under our statute. I believe we should tabulate such information however for the benefit of others, on the principle of give and take, and if, in the future, it should be proposed to amend our law to cover payments to a widow for life, we should be very glad that we had our statistics, so that accurate information as to what such a change would cost would be available.

In regard to the second point, I realize that a change in tabular presentations is a serious mattler, as one year's experience cannot be compared with another year's unless the basis is the same. We may, for the time being, to some extent conflict with our own older statistical records, but if we are ever to accomplish uniformity, the sooner it is brought about the better, and that is the chief reason for this discussion.

The principal idea which I wish to present to you, and which I believe is reasonable and practicable, is this.

The National Association of Industrial Accident Boards and Commissions in conjunction with others who are closely identified with workmen's compensation could, I believe, advantageously consider the advisability of adopting and publishing a standard text-book on the subject of the fundamentals of workmen's compensation and industrial accident statistics. A committee might be appointed with full authority to prepare such a book which would have such a standing that it would be recognized as the one authority of the country on the subject of the preparation of industrial accident data.

While no time should be lost if the idea is to be carried out, sufficient thought should be given to the matter to insure a careful and accurate analysis of the essential factors necessary, and if need be expert actuarial advice should be secured.

There are four main divisions into which the subject falls, namely:

1. Uniform Tables for the Establishment of Compensation Costs.

2. The Uniform Classification of Industries.

3. The Uniform Classification of Causes of Injuries.

4. The Uniform Classification of Nature of Injuries.

None of these present a new field, and considerable work has been and is being accomplished in respect to each of them.

Dr. Royal Meeker, the United States Commissioner of Labor Statistics, is deeply interested in the subject, and through his efforts committees are at work on the problems.* These committees are not only friendly with this organization, but there is an actual interrelationship. Cooperation in this direction may therefore be confidently expected.

That any intelligent effort toward uniformity in accident statistics will receive the endorsement of public organizations like the National Civic Federation I believe goes without saying. Mr. Cyrus W. Phillips, Chairman of the Joint Commission to Study Operation State Laws, representing the Department of Compensation for Industrial Accidents and Their Prevention, National Civic Federation, will have something to say at this conference along this line. There is a universal demand for uniform statistics, but as yet the foundation is not laid, on the substantial basis, and with the official endorsement necessary for complete success.

The Workmen's Compensation Service Bureau of New York has, through its statistical committee, issued a report on the compilation of workmen's compensation statistics including the necessary codes for the convenient handling of statistical data in connection with the punch card system. This report was the result of a considerable amount of careful study and investigation, and I see no reason why its principal divisions as to age periods and the like could not be utilized by this organization. If there are certain points wherein a difference of opinion arises, as there may be for example in the classification of causes of accidents, the sooner an adjustment and agreement is reached the better, for we must if possible all get together for the good of the cause.

As a representative of the Workmen's Compensation Service Bureau is on the committees appointed by Dr. Meeker, that Bureau will have an opportunity to be heard and also to learn the point of view of those committees which, as I have just outlined, are representative of the Federal Government, state departments, insurance interests and safety councils.

* On the committees appointed by Dr. Meeker there are representatives of the United States Bureau of the Census, Interstate Commerce Commission, Bureau of Mines,—State Industrial Accident Commissions, Insurance Departments, and Labor Departments,—insurance companies,—the Workmen's Compensation Service Bureau,—and the National Council for Industrial Safety.

COMPUTATION OF THE COST

THE UNIFORM CLASSIFICATION OF INDUSTRIES.

(See Exhibit A.)

Of the four divisions to which I have referred, probably the most important is the Classification of Industries, as to this all the others relate. That is to say, we want to know the cost of compensation and the details of accident frequency by each industrial classification, and we also want to know the causes and the nature of injuries by industrial classifications.

The fundamental basis therefore is a clear, logical arrangement of all the varied industries of the United States into groups in accordance with the nature of the business and the degree of risk of injury.

The committee appointed by Dr. Meeker to consider this subject has tentatively adopted the following eight primary groups:

- 1. Agriculture.
- 2. Extraction of Minerals.
- 3. Manufactures.
- 4. Construction.
- 5. Transportation and Public Utilities.
- 6. Trade.
- 7. Service.
- 8. Miscellaneous.

These have been subdivided into fifty secondary groups.

There is a manual of workmen's compensation rates and classifications issued by the Workmen's Compensation Service Bureau of New York, and known as the Basis Manual, with which you are all familiar. Upwards of 1,500 classifications appear in this manual which is intended to cover every conceivable line of industrial endeavor in this country.

It goes without saying that such a refinement in classifications is impossible for statistical purposes in general. The United States Census Bureau or the state industrial accident boards do not want their tables of accident data separated into 1,500 items. We must recognize, however, that for better or for worse from the insurance standpoint this minute refinement has been universally adopted in this country, and seems likely for the present at least to continue as the accepted method of classifying industries for rate making purposes.

The practical question it seems to me, therefore, is whether these

classifications as they stand to-day can be so combined or grouped under a reasonable number of headings (say for example 300) as to be conveniently handled.

Starting therefore with the eight primary headings, divided into 50 secondary headings, we are confronted with the somewhat laborious but by no means impossible task of establishing a series of tertiary headings which will in turn cover all the manual classifications, each tertiary heading covering a group of classifications which are of analogous nature and hazard so far as present experience shows. As time goes on, corrections and additions will of necessity be made.

Just to illustrate one "series group," let us take the following:

If an agreement can be reached on the tertiary headings so that these are acceptable to the various organizations interested, I feel that a long step will have been taken in the direction of uniformity. This is essentially work for a competent committee, and the results obtained should find a place in such a standard text-book as I have already mentioned, and be given the widest publicity possible.

One other thought in connection with this question of classifications. Every classification should have a code number which should be utilized to the fullest extent. I believe that such number should appear on every workmen's compensation insurance policy issued, and this would be even more valuable if more than one classification is used in the same policy as frequently happens. This code number would assist the various departments of an insurance company, such as the auditing department, claim department and the statistical department, and tend to prevent errors and possible misunderstandings between them.

The standard accident blank should provide a place for the code number, and in all states where the insurance company is required to report accidents to the industrial accident commission, such number should appear, and any dispute which might arise in the matter of classifying could be straightened out before it was too late. In other words, the insurance companies and industrial accident commissions would thus be assured of classifying each accident in identically the same manner.

THE UNIFORM CLASSIFICATION OF CAUSES OF INJURIES.

(See Exhibit B.)

The uniform classification of causes of injuries I will not touch upon other than to say that if an agreement can be reached whereby a standard list of causes is adopted, it will serve as an important link in the chain of uniformity. This feature should have a very direct bearing on the most important phase of workmen's compensation, namely, the prevention of accidents. If through uniform statistics it is shown, for example, that in California there are only half as many accidents per unit of exposure from a specified cause as in Ohio, then Ohio can investigate the reason and learn from California just what measures have been adopted in that state, affecting such causes of accidents. No doubt reciprocity would be in order, and where a given cause shows an exceedingly low rate of accidents in Ohio, that state can give others the benefit of its experience in that particular line. No such result will be possible, however, unless the classification of causes is uniform, and consequently the data comparable between the various states.

The development of systems of merit discounts based on the physical conditions of plants, will be greatly assisted as regards the accurate measurement of the relative allowances by uniform tables setting forth in detail the cause of the accidents which occur.

THE UNIFORM CLASSIFICATION OF NATURE OF INJURIES.

The uniform classification of nature of injuries means merely an agreement to tabulate the data in respect thereto according to an accepted list. Where the punch card system of tabulation is used, and the different details coded, a large variety of "natures of injury" can easily be recorded. In states which do not care for this detail for their own use, no great additional labor is involved in keeping the records, and by combining various items, the total list may be materially reduced if desired.

UNIFORM TABLES FOR THE ESTABLISHMENT OF WORKMEN'S COMPENSATION COSTS.

(See Exhibit C.)

The analysis of workmen's compensation experience falls naturally into two divisions:

- (a) The work of obtaining the net loss cost or pure premium for each industrial classification.
- (b) The detailed analysis of claim statistics.

These two divisions are separate and distinct, the starting point being the same however in that the losses are distributed under the same general headings as to what may be termed "Class of Benefit," namely:

- (a) Death.
- (b) Specified Injuries.
- (c) Permanent Total Disability.
- (d) Permanent Partial Disability.
- (e) Temporary Disability
- (f) Medical and Hospital Services.

The purpose in compiling the statistics in the first division is to ascertain the net loss cost of accidents which *have occurred* in the numerous classifications in order to determine the basis for the establishment of a proper compensation rate. Special Massachusetts Schedule Z fulfills this purpose.

The Massachusetts Insurance Department has just now received the third series of Schedules Z. Massachusetts was the first state to establish a schedule of this nature, and while many of you are familiar with it, I will briefly describe it for the benefit of any who may not know just what its purpose is.

Each insurance company authorized to transact workmen's compensation business in the state is required to report its experience to the Massachusetts Insurance Department on Schedule Z. The columns of this schedule are as follows:

1. The classification of industries following exactly the manual classifications of the insurance companies.

2. The audited payrolls upon which premiums are based.

3. The audited earned premiums.

4. The incurred losses subdivided to show the losses paid and outstanding in respect to the various classes of benefit. 5. The pure premium or net loss cost which is obtained by dividing the losses incurred by the audited earned payrolls and multiplying by 100. That is, you arrive at the cost per \$100 of payroll for paying for the losses classification by classification.

The returns relate only to terminated policies so that the experience is divided by policy years, and the payroll is the actual payroll for the period as shown upon audit. The calendar years are of little significance to insurance companies. The policy year, or year of account, is the basis of their data, and this should be recognized as of vital importance in calling upon insurance companies for statistical data of all kinds. An attempt to observe claim statistics by calendar years in which the accidents occur regardless of the dates of issue of the insurance policies loses the advantage of a possible comparison of claim information with payroll exposures.

Owing to the fact, however, that necessarily it will take many years to definitely establish a pure premium in the smaller classifications in each individual state, there will always be a demand for "outside" experience for comparative purposes.

The idea of comparing accident statistics gathered in different parts of the world or even of this country suggests at once the necessity of adjustments to offset the difference in conditions, so that the comparison may be a true one.

Two factors enter into such a calculation.

- (a) The difference in the laws of the two states which is reflected in the cost of the individual accident.
- (b) The effect of the variation in industrial conditions on the frequency of accidents.

If the pure premium for *Bakers* in Massachusetts is 35 cents, and in Wisconsin 52 cents, the comparison is misleading unless we adjust the two pure premiums by suitable allowance for these two factors, viz., the difference in the benefit provisions of the two laws, and the actual though admittedly somewhat intangible variation in the physical and moral conditions in the industries of the two states. Such factors as the rigidity of factory laws, the attitude of employers toward safeguarding, etc., may be cited as an illustration. (The introduction of merit rating for physical and moral conditions will tend to discount these differences.)

Statistics of accident frequency should undoubtedly be computed on the basis of the number of "man-hours" worked as the standard unit. Such data not being at present obtainable, the best substitute seems to be the earned payroll basis, which reflects the hours of work, but contains the element of variation in wages. For example, the payroll for 100,000 hours work in a machine shop in Wisconsin would probably not be identical with the payroll for 100,000 hours work in a machine shop in Massachusetts, and to the extent that it varies, the accident frequency table is inaccurate, if based upon payroll.

It is furthermore probable that if experience shows that accidents occur in general, more frequently in state "A" than in state "B," some individual industries within those states will show just the opposite result. Too much importance therefore in my opinion must not be given to the present available statistics of accident frequency. It is probably wise to accumulate such data, however, against the future, when a sufficient amount of data is available to be reliable. We are at the present time obliged to rely largely upon foreign experience in respect to accident frequency, and for this experience we are certainly grateful, but as "home" experience develops, and in New York especially it will develop very rapidly, we shall accumulate data of our own, based purely upon American conditions.

The aim of workmen's compensation statisticians should, I believe, be to so tabulate their experience data that the least possible adjustment must be made in comparing one another's figures.

The excellent and impartial work done by the "Differential Committee" of the Workmen's Compensation Service Bureau along the line of state differentials is very valuable and useful. After we have sufficient American data, however, so that it can be used to the exclusion of foreign data, the work of this committee might be revised and a purely American basis used, *provided* that American data is so kept that its value is not lost through errors consequent upon too much readjustment.

Much that may be said in regard to the need of proper statistics for comparative purposes is pertinent to the question of changes in each individual state law. It is imperative that the workmen's compensation statistics of any given state be available in such form that the cost of changes in the law may be closely estimated therefrom. If the waiting period is cut down or the maximum weekly indemnity raised, or any other change made, the correct determination of the added cost of such change depends upon the availability and reliability of the accident statistics. I have little doubt but that industrial accident boards and others who are in a position to contribute data of the greatest value would willingly present that data in accordance with any reasonable demand therefor. At present, however, I have never seen what may be called the "A, B, C of Compensation Statistics," that is a clear, concise statement of what is really needed by those most interested.

Isn't this the answer to Dr. I. M. Rubinow, who maintained in an address before the first meeting of the Casualty Actuarial and Statistical Society of America (*Proceedings Casualty Actuarial and Statistical Society of America*, Vol. I, No. 1) that a careful analysis of the reports of the industrial accident boards of various states failed to disclose the statistical data so much desired in the casualty business?

Dr. Rubinow says: "Each of these reports is interesting and to some extent valuable, but an effort to bring them together produces a maze of dis-similar data, absolutely barren of any tangible actuarial results."

Isn't the first step towards securing uniformity of results a proper setting forth of precisely what is wanted backed by the endorsement of such bodies as this and by leading actuarial organizations?

No one person, it seems to me, should assume that he is alone competent to promulgate such a series of workmen's compensation tables. The combined ideas of many who have had practical experience in handling workmen's compensation data should be utilized to develop standard tables, and here again comes in the text-book idea, once such tables are adopted so that they may be freely distributed.

I have always found, however, that when a certain matter is under discussion, that better progress is made when something tangible is actually in hand, as a basis for argument. This is my feeling in presenting these tables for your consideration. They are not offered as the embodiment of all that ought to be adopted, but as a basis for building something better, and if the time should come when a uniform system of statistics is actually adopted, any small contribution to that end may be modestly regarded as a service in a good cause, the success of which depends absolutely on the cordial and earnest cooperation of all those to whom the privilege and duty has been entrusted.

EXHIBIT A.

SAMPLE PAGE

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TENTATIVE UNIFORM TABLE OF CLASSIFICATION OF INDUSTRIES. Manufactures (2000).

3200 Chemicals and Allied Products.

3210 Acids and Chemicals: **Basis Manual** Number. Symbol. 3211Acid Mfg. (n.o.c.) 4510 LC 3212 Analytical Chemists, including shop work and work performed away from shop .. 4511 \mathbf{LC} 3213 Sulphur Mfg. 4512 \mathbf{LC} 3214 Vitriol Mfg. 4513 LC 3221Alcohol and Acetic Acid Mfg. 4520 ĸw 3222 Ammonia Mfg. 4521 KW Arsenic Mfg. 4531 3223 ĸw 3224 Tartaric Acid Mfg. 4522 KW 3225 Disinfectant Mfg. 4523 KW 3226 Chemical Mfg. (n.o.c.) 4524 KW Saltpetre Mfg. 4525 3227 KP 3228 Wood Preservative Mfg. 4526 KP 3229 Bleaching Powder Mfg. 4527 KP 3230 Creosote Mfg. 4528 KP Borax Mfg. 4529 3231 KP Camphor Mfg. 4530 · 3241 CA **32**50 Baking Powder and Yeast: 3251 Baking Powder Mfg. 4500 BL 3252 Yeast Mfg. 4501 BL 3253 Soda Bicarbonate Mfg. 4502 BL

EXHIBIT B.

SAMPLE PAGE

OF

TENTATIVE UNIFORM TABLE OF CAUSES OF INJURY.

II. Explosives, Electricity, Fires, Heat and Corrosive Substances.

		C. Expl	osives — Gas.	
Industry.	Death.	Permanent Total Disability.	Permanent Partial Disability.	Temporary.
2000 Manufactures 3200 Chemicals and Allied Pro- ducts 3210 Acids and Chemicals 3250 Baking Powder and Yeast. 3260 Paints, Colors and Dyes 3270 Drugs and Medicines 3280 Soap and Tallow 3290 Starch				

EXHIBIT C.

TENTATIVE UNIFORM TABLES FOR THE ESTABLISHMENT OF WORKMEN'S COMPENSATION COSTS.

Table I. Class of Benefit.

The number of accidents by character and extent of injury.

Accidents Resulting in :	Number of Accidents.
(a) Death	
With dependents.	
No dependents.	
(b) Specified injuries (dismemberments)	
(c) Permanent total disability	
(d) Permanent partial disability	
(e) Temporary disability	
(f) Medical and hospital services only	
(a) Total number of tabulatable accidents	
(h) Minor accidents reported not tabulatable	

(a) Fatal.	Amount of Wages.	(b) Non Fatal.
	Under \$4	
	\$4 and under 5	
	5 and under 6	
	6 and under 7	
	7 and under 8	
	8 and under 9	
	9 and under 10	
	10 and under 11	
	11 and under 12	
	12 and under 13	
	13 and under 14	
	14 and under 15	
	15 and under 16	
	16 and under 17	
	17 and under 18	
	18 and under 19	
	19 and under 20	
	20 and over	

Table II. Wages of Injured Employees.

Table III. Dependents in Fatal Cases.

	Number	of Cases.
Extent of Dependency.	Native.	Alien.
Surviving wife		
Dependent husband		
Surviving wife and 1 minor child	ĺ	
Surviving wife and 2 minor children		
Surviving wife and 3 minor children.		
Surviving wife and 4 minor children	1	
Surviving wife and over 4 minor children		
Dependent husband and 1 minor child		
Dependent husband and 2 minor children		
Dependent husband and 3 minor children		
Dependent husband and 4 minor children	!	
Dependent husband and over 4 minor children	i	
1 minor child		
9 minor children	ĺ	
2 minor children		
a minor children	1	
Quan A minon children	ł	
Over 4 minor children	•	
	1	
Partial dependents		
To the extent of 10%		
11 to 20%		
21 to 30%	Ì	
31 to 40%		
41 to 50%	į	
51 to 60%	-	
61 to 70%		
71 to 80%		
81 to 90%		
91 and over		
No dependents	I.	

		Native.			Alien.	
Age.	Widow.	Husband.	Other.	Widow.	Husband.	Other.
Under 19						
20 to 24	1					
25 to 29	1					
30 to 34)		
35 to 39	l	1			1 1	
40 to 44	ļ					
45 to 49	1					
50 to 54	1	1)	1	
55 to 59	1				1	
60 to 64		1				
65 and over	1			1	1 -1	

Table IV. Age of Dependents in Fatal Cases.

Table V. Age of Minor Child in Fatal Cases.

Age.	Native.	Alien.
Under 5 5 to 9 10 to 12 13 to 15 16 to 18 19 to 21		

Table VI. Period of Incapacity.

]	Duration	ı.			Temp.Total Disability Preceding Permanent Partial Disability.	Temp.Total Disability Preceding Death.	Other Temporary Total Disability.	Partial Disability.
1	day	and	under	4	days.					
4	days	and	under	7	days.					
7	days	and	under	10	days.					
10	days	and	under	14	days.			1		}
14	days	\mathbf{and}	under	21	days.					
21	days	and	under	28	days.					
- 4	weeks	and	under	5	weeks					
5	weeks	and	under	6	weeks			Ì		
6	weeks	and	under	- 7	weeks			ļ	1	
7	weeks	and	under	8	weeks					
Š	weeka	and	under	_9	weeks					1
_9	weeks	and	under	10	weeks					
10	weeks	and	under	11	weeks					
11	weeks	and	under	12	weeks			Į]	
12	weeks	and	under	13	weeks	• • • •	1			
10	weeks	and	under	20	weeks	• • • •			1	
20	weeks	and	under	100	weeks	• • • •	ł	ł	Ì	}
100	weeks	and	under	150	weeks	••••				}
150	weeks	and	under	200	weeks		}			
200	weeks	and	under	250	wooba		1		1	
250	weeks	and	under	300	weeks	••••			1	-
300	weeks	and	under	350	weeks	• • • •	1	1	1	1
350	weeks	and	under	400	weeks					
400	weeks	and	under	450	weeks					
450	weeks	and	under	500	weeks	· · · ·			1	l

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Age.	Death.	Permanent Total Disability.	Permanent Partial Disability.	All Other.
Under 14 male				
14 and under 19 male				
20 and under 24 male female				
25 and under 29 male female		1]
30 and under 34 male				
35 and under 39 male female				1
40 and under 44 male female		Ē.		l
45 and under 49 male female				
50 and under 54 male female				
55 and under 59 male female				
60 and under 64 male female				
65 and over		1		

Table VII. Age and Sex of Injured Employees.

Table VIII. Permanent Partial Disability or Impairment in Wages.

Ашо	unt of Impairment.	No. of Cases.
Less than	\$1	
1 and under	2	
2 and under	3	
3 and under	4	
4 and under	5	
5 and under	6	
6 and under	7	
7 and under	8	
8 and under	9	
9 and under	10	
0 and over.		

Per Cent. of Disability to Total Disability.	No. of Cases.
Up to 10% Disability. 1% to 20% Disability. 1% to 30% Disability. 1% to 30% Disability. 1% to 50% Disability. 1% to 60% Disability. 1% to 70% Disability. 1% to 80% Disability. 1% to 80% Disability. 1% to 80% Disability. 1% to 90% Disability. 1% to 90% Disability.	

Table IX. Per cent. of Disability.

Table X. Specific Injury or Dismemberment Cases.

This represents a summary table according to the needs of the individual state, and may be made up from the detailed classification of Nature of Injuries.

Nature.	No. of Cases.
Loss of both arms	
Loss of both hands	
Loss of both legs	
Loss of both feet	
Loss of one arm and one leg.	
Loss of one hand and one foot.	
Loss of major hand	
Loss of minor hand	
Loss of either foot	
Loss of both eves	
Loss of either eve	
Loss of two or more fingers	
Loss of two or more toes.	
Loss of phalange	
Cases of disfigurement	

Table XI. Cost of Medical and Hospital Services.

	Death.	Specified Injuries,	Permanent Total Disability.	Permanent Partial Disability.	Temp. Dis- ability.	Medical Hospital Services Only.
Medical services Hospital services Nurses						

REVIEWS OF PUBLICATIONS DEALING WITH WORKMEN'S COMPENSATION.

Report of the Industrial Accident Commission of the State of California. San Francisco, 1914. 81 pp.

The report of the California Industrial Accident Commission, which has just appeared, covers the operation of that Commission during the six months January-June, 1914, and also the operations of the Industrial Accident Board, of which the Commission is the successor, for the calendar year 1913. The report is of great interest and supplies abundant evidence of the energy and ability with which the new California Act has been administered. The Commission has not spared criticism where it believed that criticism was due, but the general impression left by the report is that all the interests affected by the Act—those of the employees, of the employers and of the insurance carriers—have been dealt with in a broadminded and judicial spirit.

Among those portions of the report of special interest to actuaries and statisticians is the description of the Commission's "permanent disability rating department." As is well known, the California Compensation Law provides in a unique manner for the determination of the amount of compensation payable in cases of dismemberment. Under the California Act there is no schedule of dismemberment benefits such as one is accustomed to look for, but in its place is a provision, the purpose of which is to base the compensation upon the actual economic loss to the injured employee through taking into account three quantities: (1) the occupation, (2) the age, and (3) the nature of the injury or disfigurement. By means of an extensive field investigation of industrial injuries and their effect a schedule has been constructed for the purpose of thus rating permanent disabilities. This feature of California compensation is of such importance that it seems well to quote the report of the Commission as to the success of this system in actual operation:

"Today, when a permanent injury is sustained, it is possible to obtain a rating by consulting the schedule after determining three items: (1) the exact nature of the physical injury or disfigurement, (2) the occupation,
and (3) the age of the worker at the time of the injury. The schedule is easy to apply and has solved the problem of making settlements without the formality of hearings for the adjustment of claims before the Industrial Accident Commission. It is equitable, and has met with the most general appreciation and approval. For a scientific work it has found a wonderful popularity among the parties interested. There are not more than two pages of explanation, and it has been found possible to instruct almost any person in its use in a few moments. Considering the fact that the schedule will answer 1,080,000,000 questions, the simplicity of its operation is remarkable. The schedule better meets the needs of the problem than the ordinary permanent disability schedule which takes into consideration the one item of physical loss and omits all others from the discussion. Instead of placing a fixed dollars-and-cents valuation on the different members of the body, the schedule actually considers the effect of the loss on the earning capacity of the individual by including in the method of determination a discussion of all of the vital factors which are capable of measurement, namely, the items of physical loss, occupation and age. The schedule fits the ins and outs of the problem where others only hit the high places."

The first report of the State Compensation Insurance Fund, covering the six months ended June 30, 1914, is of great interest. The past history of state insurance, wherever it has been tried in competition with private enterprise, has been the history of a languishing institution unable to make a healthy and satisfactory growth. The statement before us of the California Fund. however, would appear to indicate that where we have to do with a compulsory or virtually compulsory form of social insurance, as distinguished from voluntary individual insurance, conditions are so different that we may not safely assume that the past history of competitive state insurance is destined to repeat itself. During the six months the Fund wrote 4,417 policies and its cash receipts for premiums were over \$370,000; losses paid amounted to \$21,600 and expenses to \$27,000. The loss reserve is \$45,500. No explanation is given of the method of computing this loss reserve except a statement that if the statutory loss reserve-72 per cent. of the earned premiums-had been set aside the reserve would have been increased to \$104,000. In view of the wide difference between these figures a detailed statement of the basis actually adopted would be of interest. Assuming, however, the sufficiency of the reserve, the loss ratio of the Fund was 36 per cent., which even for the first six months of the operation of an act under rates which may possibly prove somewhat high, nevertheless would indicate a careful selection of business on the part of the management of the Fund. The expense ratio of the Fund is 15 per cent., which compares very favorably with the expense ratio of private carriers as a class.

It will be recalled that in California the State Fund adopted at the outset the same rates as those followed by the private insurance companies. Concerning this the report says:

"But as the law provides that the State Compensation Insurance Fund shall be ultimately no more or less than self-supporting, and that the rates shall be only sufficient to carry out the specific purposes stated in the act, the policy form issued by the 'Fund' provides for return to policy-holders of any excess premium collected. This makes of the 'Fund' a purely mutual insurance institution for employers, which, through competition, is expected finally to force compensation insurance rates charged by all insurance carriers to a minimum."

The report praises in high terms the technical rate making work conducted by the private companies as well as the disposition on their part to court publicity, but, referring to expense, it uses such expressions as "the present excessive expense load upon rates" and "several items of wasteful expense common to the companies."

Of technical interest is the criticism of the Commission of the provision in the rates for the cost of medical aid through the addition of a uniform percentage to the pure premium for compensa-The report points out the well-known and somewhat tion proper. obvious fact that the charge for medical would be theoretically more equitable if based upon accident frequency, since the cost of treating a worker earning, say, \$5.00 a week is not greatly different from the cost of furnishing medical aid to a worker earning \$20.00 a week. It might have made a further excursion into theory and pointed out that a constant addition for medical is also inequitable in classifications where the number of fatal accidents is high as compared to the total number of accidents. In this connection, however, the Commission was apparently not able to supply any statistics or suggest any practical means of more equitably distrib-uting the provision for medical aid.

The statistical section of the report is naturally of much interest to compensation statisticians. It bears evidence of enthusiastic and painstaking investigation into the data in the possession of the Commission. Like too many other reports of this character, however, the statistics, while interesting, are not of great practical value in solving compensation problems. Data regarding accident rates, causes and natures of injuries, character and duration of disability, etc., are of extremely limited value in the absence of any information as to the payrolls or numbers of employces exposed to the hazards of the various employments. The value of statistics lies mainly in the useful ratios that can be deduced therefrom. A ratio presupposes two comparable quantities, a numerator and a denominator. In this and other similar reports we have a multiplicity of numerators accompanied by an almost complete absence of denominators. It thus appears that for really valuable data on the cost of compensation we must still revert to the statistics published by the Massachusetts Insurance Department.

A further unavoidable defect in the statistics is the fact that a large number of the cases of disability considered were still "open cases" at the date of the report. Referring to the many accidents that were thought at first to be temporary injuries which resulted in permanent incapacity, and the many that were determined as permanent which will result in death, the Commission says:

"With such changes in the status of many of the cases it is apparent that the only safe figures are those that have been gathered for a period of five or ten years and which include only cases where a satisfactory determination of disability and cost has been obtained."

Having made this conservative and wholly admirable observation, the Commission then proceeds to utilize the figures in a manner which by its own statement must be condemned as unsafe and which will be extremely likely to mislead inexperienced or hasty readers.

The report contains a number of statistical diagrams, some of which are helpful in tending to increase the vividness of the impression made by the tables. Several of these diagrams, however, while they add nothing of value for the technical reader, are likely to prove positively misleading to the general public. For example, in figure 2 on page 38, illustrating the proportional amount which is payable for medical attendance, for non-fatal accidents and for fatal accidents, there is no clear explanation of the fact that the diagram has been constructed on the basis of actual cash payments, while the real value of the compensation incurred during the period under these heads is, though widely different, not shown. Again, in those sections of the report dealing with the total wage loss to injured employees as compared with the compensation provided by law, the operation of compound interest appears to be a matter which has been wholly left out of consideration.

A striking feature of the statistics is the high average wage of employees coming under the California Act, amounting to about \$18.00 per week.

J. H. W.

Three Years under the New Jersey Workmen's Compensation Law. Report of an Investigation by the American Association for Labor Legislation, New York. 1915. 71 pages.

This report covers the settlements made under the Compensation Law of New Jersey during the three years following July 4, 1911, when the act became effective. Under this statute, election is presumed, unless either the employer or employee serves notice that damages will be claimed under the common law. About 95 per cent. of compensatable cases are settled under compensation. It should be noted, however, that although the judicial system of New Jersey is administered under the common law procedure, this law specifically abrogates the defences of fellow servant and assumption of risk. The question of willful contributory negligence in the employee is left to the jury to determine. The alternative remedies of elective compensation and legal action were provided because it was believed that a compulsory compensation act would be declared unconstitutional.

Administration.—Notices of accidents resulting in death or two weeks' disability must be sent by employers to the Department of Labor. Casualty companies must report to the same department payments made on every case. Less than one half of all accidents are reported, because no compensation is due in case of a majority of the accidents. The Employers' Liability Commission collates the data filed with the Labor Department and annually publishes a report, which is inadequate, by reason of a small appropriation. The clerks of the county courts transmit to the Commission a summary of compensation cases adjudicated by the courts.

The investigators have carefully examined the settlements and court records filed with the Commission and supplemented this task by personal interviews with the injured employees or their dependents. They found that many claims had been improperly settled or not settled at all, and encountered many glaring in-

194

equalities in administration, due to the lack of an industrial board to rule with uniformity upon disputed cases.

The tardiness of court procedure is shown by the fact that in fatal cases over six months elapse on the average between the accident and the award; while eight months elapse on the average in non-fatal cases. The investigators point out that the heavy legal and medical bills incident to court cases have a tendency to decrease the number of such cases; the law thus becomes effective only with regard to the more serious injuries. About 6 per cent. of compensatable cases come before the courts either for trial or to approve commutation. The lump-sum awards, many irregular settlements and errors in calculation may be attributed to the present system, under which 21 county courts have concurrent jurisdiction.

Security for Payment of Compensation.—The law does not make insurance compulsory on the part of the employer; hence the employee's claim for compensation is protected only by the solvency of his employer, when the latter is uninsured. Numerous cases detailed in the report bear out the conclusion therein drawn, that insurance must be compulsory in order to afford to the employee security for his compensation. It appears that the old liability policy form providing for indemnity to the employer, and not compensation to the employee, is still issued in New Jersey.

Scale of Compensation.—An excellent study of the scale of compensation is contained in the report, which urges the adoption of a more liberal schedule. This view is shared by the Employers' Liability Commission, which suggested to the legislature a material increase in the scale of compensation.

The law allows medical treatment for a period of two weeks, with a maximum of \$50, which is shown to be too small in the light of cases outlined in the report. The investigators have done signal service in their demonstration that the up-keep of the social unit demands an increased scale of indemnity for total disability. Even a small family cannot be kept from want with a compensation ranging from \$5 to \$10 a week. This conclusion is even more apparent with regard to compensation for death, where the law provides for a maximum benefit of 300 weeks at \$10 per week.

Other recommendations are that the waiting period be reduced from two weeks to one, that the money value of board and lodging be added to the cash wage, and that injuries due to occupational discase be placed on a par with work injuries. The act does not allow any payments to alien beneficiaries, a discrimination which, it is urged, should be removed.

The principal conclusions of the report are substantiated by the facts therein disclosed. The report is well worth study and is a creditable addition to social insurance literature.

It is to be regretted, however, that the legal and the actuarial aspects of the law's operation have not been more thoroughly reviewed. As an instance of some important data not covered by the investigation, we may refer to the Supreme Court reports, as follows. In 86 A 435 the court allowed a benefit for temporary total and permanent partial disability in excess of that provided for permanent total; in 89 A 979 the court refused to notice judicially the age, character of work or expectation of life of the injured employee, although it is patent that these are important considerations in effecting a lump sum settlement.

The report is manifestly a brief for the creation of an industrial board to administer the compensation law, for the courts are scored at every point for their inefficiency. This is in the face of the majority report of the Employers' Liability Commission, which opposed the creation of an industrial board.

Neither the report nor the Commission suggests that the interests of beneficiaries in fatal cases require that commutation should be based upon tables of mortality and remarriage as well as upon compound interest, in order to be actuarially sound.

The report of the New Jersey Insurance Department for the year ending December 31, 1913, shows a loss ratio for compensation insurance of 31 per cent. on a total premium income of \$1,-646,663.78. The adoption of the recommendations of the report would increase the benefits in the following respects: (1) Increase of all schedules from 50 per cent. to 663 per cent. basis; (2) increase of minimum and maximum weekly payments; (3) increase of duration of death benefits from 300 weeks to "until death or remarriage of widow"; (4) increase of duration of total permanent disability benefits to "for life" instead of 400 weeks; (5) reduction of waiting period from two weeks to one week; (6) extending benefits to alien dependents; (7) increase in cost due to the fact that every case will receive full compensation from an industrial board.

The apparent cost of workmen's compensation is increasing rapidly; permanent total disabilities emerge out of cases originally classed as temporary total, and deaths often follow an amputation caused by a minor injury. Furthermore, even *if the loss ratio of 31 per cent. is not an underestimate*, the increases in benefits enumerated above make it evident that the statement in the report "The reductions in rates that have already been made by the casualty companies in New Jersey mean that the scale of compensation can be materially increased without raising the premiums paid by the employer in the past" would be more appropriate had it been substantiated by statistical proof. In this connection, we should not overlook the fact that premium rates were decreased by 15 per cent. late in 1914.

The Legislature has just adjourned without taking action upon any of the bills introduced by the Employers' Liability Commission providing for compulsory insurance, creation of a state fund and increase of all schedules.

R. F.

RECENT LITERATURE ON SOCIAL INSURANCE AND STATISTICS OF INDUSTRIAL ACCIDENTS.

PREPARED BY S. LEON LEVY.

CLASSIFICATION BY SUBJECTS AND AUTHORS.

ACCIDENTS.

Causes.

1. Nettleship, E.

Accidents from defective sight. 1913. Pp. 54.

 New Jersey—Employers' Liability Commission. Tabulation of the causes of accidents. Trenton, '14, p. 30.

Industrial.

3. New York—Labor Department.

Statistics of industrial accidents in 1912 and 1913. (New York Labor Bulletin. Whole No. 68. Series of industrial accidents and diseases No. 1. Albany, December, 1914, p. 175.)

4. Zolla, D.

Les accidents du travail et les intérêts agricoles en France et à l'étranger. 1913. (*Revue des sciences politiques*, tome 30, pp. 48-66; tome 31, pp. 62-79.)

Mines.

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SUBSCRIPTIONS TO THE PROCEEDINGS

The PROCEEDINGS will be mailed to persons who are not members of the Society at the following rates: per year, \$3.00; per number, \$1.00.

The Society contemplates publishing at least three numbers of the PROCEEDINGS each year.

Communications regarding the PROCEEDINGS should be addressed to "W. W. Greene, Editor, Casualty Actuarial and Statistical Society of America, 345 Metropolitan Tower, New York City."

CONTENTS OF THE SECOND NUMBER

P	AGE
OFFICERS, COUNCIL AND COMMITTEES OF THE SOCIETY	v
CONSTITUTION AND BY-LAWS	₩ü
RULES REGARDING EXAMINATIONS FOR ADMISSION TO THE SOCIETY	×i
MEFTING OF FEBRUARY 19 AND 20, 1915.	
Address by I. M. Rubinow, President, "Our Problems"	77
Papers:	
Workmen's Compensation Claim Reserves. Miles M. Dawson.	90
Workmen's Compensation Reserves. Joseph H. Woodward	112
A Method Proposed for the Calculation of Liability and Work- men's Compensation Claim Reserves, B. D. Flynn	131
Discussion of Papert read at this Meeting, and at Previous Meeting	141
Minutes of this Meeting	171
THE ESSENTIAL FACTORS IN THE COMPUTATION OF THE COST OF WORK- MEN'S COMPENSATION. W. N. Magoun	173
REVIEWS OF PUBLICATIONS DEALING WITH WORKMEN'S COMPENSATION.	190
RECENT LITERATURE ON SOCIAL INSURANCE AND STATISTICS OF INDUS- TRIAL ACCIDENTS	198

NUMBER 3

PROCEEDINGS

Casualty Actuarial and Statistical Society of America

May 19, 1915

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VOLUME I, PART III

Number 3

PROCEEDINGS

Casualty Actuarial and Statistical Society of America

May 19, 1915

PRESS OF The New Era Printing Company Lancaster, Pa.

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CONTENTS OF THE THIRD NUMBER

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ADDRESS OF THE PRESIDENT, Dr. I. M. Rubinow, "Schedule Rating in	AGE
PAPERS:	201
I. Development, Application and Effect of Schedule Rating in Liability and Compensation Insurance. Carl M.	
Hansen II. The Effect of Schedule and Experience Bating on Work-	217
men's Compensation Risks in New York. Leon S. Senior	227
III. Schedule Rating Considered from an Actuarial Point of View. Albert H. Mowbray	241
IV. Notes on the Theory of Schedulo Rating. Albert W. Whitney	250
V. Schedule Rating of Permanent Injuries. G. F. Michel-	
bacher	257
VII. Liability Loss Reserves. I. M. Rubinow	279
DISCUSSION OF PAPERS	295 314
THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA:	
Officers, Council and Committees	i
Minutes of Meeting May 19, 1915	ii iv
Examination Requirements	viii
List of Members, May 19, 1915	xi

VOLUME I, PART III.

NUMBER 3.

PROCEEDINGS

MAY 16, 1915.

Address of the President, Dr I. M. Rubinow, Schedule Rating in Compensation Insurance.

Schedule rating is not a detail in the methods of insurance, it is one of its underlying principles. Its history in the field of casualty insurance is so brief, that as yet no definite judgment from experience is possible. When we turn to the older branches of insurance for precedents, we are confronted with the fact that life insurance has practically had no schedule rating, while in fire insurance it has been the dominating thought for many years. Under the circumstances, I feel that I may be justified in asking your indulgence to consider for a moment the first principles of insurance before touching lupon the practical aspects which develop in every day office work in connection with merit rating. Collectively, "Insurance is a method of loss distribution." In the definition of the Encyclopedia Britannica, it is "A provision made by a group of persons, each singly in danger of some loss, the incidence of which cannot be foreseen, that when such loss shall occur to any of them, it shall be distributed over the whole group."

There is on the other hand, an individual aspect to the insurance contract—a transfer of the risk from the assured to the insurer irrespective of the further process of loss distribution.

Collectively, the proportionate share of the loss is the pure premium. Together with all the necessary loadings it constitutes a scientific premium. Individually however, premium rates may be, and have been, determined in an entirely different way; the transfer of the risk through contract takes place at a price which the assured is willing to pay and at which the insurer is willing to assume the risk. Viewed from the collective point of view the distribution of the loss should be in proportion to the factors causing the loss. Viewed individually the price at which the insurer is willing to assume a certain risk must necessarily be governed by the existing hazard or recognized probably of loss.

Theoretically every difference in hazard should reflect itself through a corresponding difference in rate. Practically, finer differences are extremely difficult to measure. Moreover, an adjustment that is ideally fine and accurate to the third place beyond the decimal point, would have little profit to the insurer. It is the natural tendency of a private insurer to endeavor to collect an extra premium for excessive hazard, without necessarily spending sleepless nights in corresponding reductions of rate for supernormal conditions. But competition between insurers may be depended upon to create the necessary stimulus for adjustment of rates downwards as well as upwards.

As a matter of fact, in a crude way merit rating was practised even in the earlier days of liability insurance, when the underwriter was at liberty to bargain and quote a rate over the telephone, because his judgment was often based upon results of inspection and a study of the experience of the risk. Where the underwriter was competent, his attitude in the bargaining was an effort to adjust the rate to the particular hazard. But the drawbacks of such primitive merit rating are quite evident. In absence of an objective certain standard, even the most experienced underwriter was liable to commit gross errors. Moreover, the pressure of competitive bidding represented a strong influence towards the lowering of the rates, while it was practically impossible to rate a risk upwards unless the risk was so bad, and bad for so long a time that nowhere a complacent underwriter could be found who would be willing to experiment with the risk at the standard rate. It is guite certain that as a business proposition under conditions of private insurance which is not monopolistic, impartial merit rating is absolutely necessary, if destructive competition is to be avoided.

It appears therefore that merit rating, being an effort to accomplish a finer adjustment of premium and hazard, may do substantial justice both to the assured and to the insurance carrier. It is a result of the same effort, which has produced and is now producing a rapid multiplication of classifications, to which so many objections are raised by statisticians of supervising state authorities. Not that these objections are altogether unwarranted. But under conditions of private competitive insurance these efforts for a close appraisal of the comparative hazard are inevitable. Under compulsory state insurance, on the other hand, such an adjustment may be equally desirable, but it is not so necessary. For then the insurance rate is levied by a government authority as is a tax, and a tax may be adjusted to a great many conditions besides those of physical hazard.

In dealing with a problem of such magnitude, it is only proper to examine its broadest aspects. Entirely irrespectively of the interests of the business of insurance, what are the social effects of merit rating? One such effect I have already referred to that is, a fairer distribution of the insurance charge, not in a mechanical arithmetical sort of way, but in true proportion to existing hazard. within certain limits of possibility. Substantial justice is done to: various business enterprises. It is a trite observation that justice is, always to be preferred to injustice. Yet this formal justice, to my. mind, is a very minor consideration. The charges of insurance are. shifted so many times, are in the final analysis distributed so widely. that even an unjust rate will usually do very little specific injury. The greatest argument in favor of merit rating is not static justice, but its dynamic effect upon prevention of losses. It is true that such an effect is very difficult to prove statistically, and therefore. the door remains open to scepticism. It may be pointed out that the fire loss in this country is enormous notwithstanding the many years of rigorous practice of merit rating in fire insurance, and that as yet this loss does not show any strong disposition to abate. And, yet such criticism is very unscientific. There are so many potent, factors influencing fire loss, that it is extremely difficult to isolate the effects of any one factor. But that millions of dollars were spent in the work of fire prevention under the influence of merit, rating, cannot be disputed. In other words, the fire insurance schedules cause that to be done, which can be done, to reduce the losses from fire. A wise schedule in the field of accident insurance. cannot fail to have the same effect. It has already forced many employers to pay close consideration to the problems of accident. prevention and will continue to do so at an accelerated speed. Here we have an important force for social progress for which a great many sins will be forgiven to private insurance on judgment day. ١

210 SCHEDULE RATING IN COMPENSATION INSURANCE.

In making these general observations, I have no one particular schedule of merit rating in mind, or rather I am thinking of the true, ideally correct schedule. Where any one definite schedule is proposed, discussions and differences of opinion as to its accuracy are inevitable. But in trying to appraise the value of such a schedule, it is well to keep in mind this consideration:

As far as the most important effect of prevention is concerned, the question of absolute accuracy is of very little moment. Just as the taxing power of the state is exercised for preventing certain harmful activities, so a merit rating schedule may very properly emphasize the preventable causes of accidents by charges or credits which are manifestly excessive if measured from the standpoint of comparative hazard.

Granted this, it is still true that the business of insurance has not the taxing power of the state. Besides, one cannot escape the faint suspicion that besides trying to do justice to the assured, or to accomplish useful social results, the business of insurance looks forward to the earning of moderate profits. But even disregarding this, the demands of proper accounting are stringent. Schedule rating must not interfere with the solvency of insurance institutions.

The direct effect of schedule rating is to redistribute the charges differently than through uniform rates. The indirect effects is, or should be, to reduce the total volume of loss. But this indirect effect must not be overestimated. The strength of the forces which cause industrial accidents must not be minimized. History has demonstrated that even the most energetic efforts for industrial safety are slow in showing substantial results. No revolution in the methods of American industry may be expected over night. If the basic premium rates have been properly computed then the application of the schedule should leave the volume of premiums practically unchanged.

Of the many efforts to produce schedules for merit rating, the one elaborated by our fellow member Mr. C. M. Hansen, and known as the Universal Analytic Schedule remains practically the only one in extensive use. Mr. Hansen was asked and kindly consented to present here a careful explanation of the engineering and statistical basis for his work. To actuaries and accident statisticians this must be a fascinating problem, for the ideally accurate schedule , would be the result of a statistical analysis of the causes of accidents on such large dimensions as no country has as yet under-

I feel rather safe in assuming that Mr. Hansen will admit taken. the provisional character of his work and will not claim absolute accuracy and finality for it. But any criticism on such grounds would seem to me to be quite barren. Mr. Hansen may well fall back upon that old motto-"Feci quod potui, faciant meliora potentes "---"I have done what I could. Let those who can do better." Much more productive at the present moment is such criticism as is based upon the study of the results of the schedule. And at this early stage, the only results about which we may speak with any certainty are the effects upon the rates. Since New York has the largest volume of business under stringent schedule rating. I have asked Mr. Senior, Manager of the Compensation Inspection Rating Board, to present to us the results of his and the board's experience. Mr. Senior has kindly consented to have data compiled which will indicate the effect of the schedule on the rates, the average reduction or increase, the differences in the effect upon different classifications and industrics, the range of variations in the increases and decreases, and so forth. It is unnecessary for me to tell you how interesting and important such material must be to the actuaries.

The schedule was prepared by safety engineers. It was adopted by managers who shape the business policies of insurance carriers. It is being applied by inspectors, rating experts, underwriters, and last but not least, by agents. But the final judgment upon the schedule will have to be passed mainly by actuaries.

I shall not undertake here to anticipate Mr. Senior, and disclose the facts which his investigations have brought out. In a general way, however, the effect of the present schedule is known to the insurance world. The fact that on the whole the effect of the schedule was not to preserve and redistribute the premium volume, but to reduce it by a substantial percentage, has caused considerable alarm and called forth a good deal of criticism.

Were the original standard rates true average rates, then such reduction in the total volume through schedule rating would be very difficult to defend. But the insufficient volume of experience available for the computation of basic rates made many selected pure premiums or estimates necessary, and through these a certain loading of the premiums was effected. In the light of later data, the general loading for catastrophes and underestimates of outstanding losses also appears to have been more than ample. It

212 SCHEDULE RATING IN COMPENSATION INSURANCE.

thus appears barely possible that the dangerous effect of a reduction of rates through schedule ratings has been nullified. Yet it must not be forgotten that there is constant pressure for correction of excessive rates based upon excessive pure premiums and that as the volume of completed experience grows, and as the basic pure premiums are revised in the light of this wider experience, that unconscious loading, due to selected pure premiums, will altogether vanish. And in so far as the basic rates will approach the actual average cost plus the necessary loading, a slashing of the rates through schedule rating may become a very dangerous matter.

Whatever the general effect, in regard to certain classifications this must already be true. The importance of the analysis which Mr. Senior has so kindly consented to undertake, lies just in this: there are undoubtedly certain charges, and especially credits, in the schedule which do not indicate exceptional conditions, but in application to certain industries represent standard conditions of work. If, then, every risk in that classification is entitled to a certain reduction for the absence of conditions which are altogether foreign to that classification, then we are dealing with a condition which more properly should be reflected in the pure premium and average rate.

I have already stated that a faulty merit rating schedule is better than no schedule at all. It is, therefore, no criticism of the present system to say that it was outlined, as in the very nature of things it had to be, without sufficient actuarial data, since its experimental character was thoroughly understood. But for this very reason the actuary has a right to insist that the results of schedule rating upon rates be subjected to very careful study.

Not only must the combined influence of the entire schedule upon the premium income of every classification be ascertained, but also the reaction upon losses, as between such risks which have received the benefits of material reduction and others which did not prove to be up to the standard. With a sufficient volume of experience, we may look forward to a time when each and every credit and charge will have a solid statistical basis to stand upon.

As at present administered, merit rating has deviated from a purely physical control of plant conditions, through the introduction of so-called experience rating. This will be readily recognized as a modification of the underwriting practice of the liability epoch. Here, too, commendable effort was made to turn from the shaky basis of individual judgment to an objective impartial appraisement of facts. Nevertheless, a good many criticisms of this plan are brought forth by underwriters, and even casualty statisticians.

Frankly, the actuarial argument for experience rating is very much weaker than in case of physical rating. Insurance deals with chance; it undertakes to reimburse for the loss which is unexpected. Merit rating undertakes to adjust rates to the true probability of loss; but given a large number of risks with the same probability, in the nature of things, the loss will occur only in a few of the risks. Shall the bare fact of the occurrence of the loss be penalized? In accordance with the theory of probability, the very fact that the loss has occurred in a certain risk is a potent argument against expecting the repetition of it.

Of course scientifically speaking there is no such thing as chance, and there is cause for every occurrence under the sun. We speak of chance, and accidents, simply because we have not been able to ascertain the cause. But though we may not know its nature, we may suspect that it still persists, and perhaps we ought to adjust the premiums to it. The practical underwriters know of many plants which are persistently good, and others which are persistently bad in their accident experience—the condition which is known under the somewhat illogical designation of "moral hazard." But recognizing the presence of this factor, which may influence accident frequency irrespective of conditions disclosed by physical rating, is experience the best method of ascertaining its existence or presence?

The consideration of past experience was useful in liability conditions, especially in the case of very large risks, many of which in this country have a sufficient exposure to give a fairly dependable average. The smaller the risk, the larger the fluctuations from year The present plan of experience rating endeavors to meet this to vear. difficulty by placing a minimum limit upon exposure required, and incidentally raises the charge of discrimination against the smaller employer. Whatever the legal aspects of the charge, economically its force is not great. The purchaser of large quantities always has some competitive advantage over the petty dealer, and it does not appear clear, why a similar slight advantage in the purchase of insurance is against public policy or sound economics. Rather the criticism may be made that the minimum limit is too small, especially since the same minimum applies to all classifications. This is evidently unscientific. Take a clothing risk, with a premium of

213

214 SCHEDULE RATING IN COMPENSATION INSURANCE.

some 30 cents. A fatal accident with a cost of \$6,000 would have to be spread over an exposure of some \$3,000,000; in a contractor's risk, with a rate of \$9.00 the necessary exposure is only \$100,000, or 30 times less.

Of course, for its effect upon accident prevention, as a reward for extreme care, resulting in favorable experience, experience rating may have its useful purpose. It is possible, however, to overpay for this, and there is danger that the present experience rating plan accomplishes just this result. It is safeguarded in many ways and by many complex regulations. So complex are these regulations that few are fortunate enough to understand them, and perhaps for this reason, comparatively few ask for its benefit. But for the same reason, and also because its application is optional, only the lucky risks are likely to be rated for their experience, and a very material reduction in average premium is likely to take place, without perhaps influencing the general accident frequency. When the plan was formulated the best known large risks, good or bad, were probably thought of. But a very large proportion of the business consists of smaller and average risks, and of these the majority have no losses at all, throughout the year. Otherwise insurance would have been impossible. We cannot undertake to rebate on the premium of every automobile that passes a year without an accident, or to make the illustration still more extreme, on the premium of each building that does not burn.

The answer often suggested is that experience rating is to be applied upwards as well as downwards. To realize this, experience rating would have to be compulsory, which at present according to my understanding, it is not. Secondly, in the case of a risk with even one serious accident, the indicated rate (in absence of a maximum limit) becomes so high, that it ceases to be insurance; and there is no earthly chance to get it, and finally even if it were possible to collect a premium, 10 times above the manual in the case of the exceptionally bad risk, this does not balance a 10 or 20 per cent. reduction on a hundred other risks with a good experience.

To sum up,—a slight moral advantage and preventive effect of uncertain value may be admitted for experience rating, as a differential between good and other risks, but the threatened reduction in the average rate, in case of universal application, is very grave, and this should be provided for in the average rate.

A somewhat superficial test with a few hundred risks made in our office seems to indicate an average reduction of 12 per cent. for experience rating, as indiscriminately applied to good and bad risks alike, and probably as much as 15 per cent. if the excess rates in the worst risks should prove non-collectible. Here again the actuary and statistician can do a valuable service by ascertaining the actual facts for the guidance of the underwriters. There are other problems which arise in connection with the present plan of experience rating. To make it effective, experience under liability is being utilized, and this explains the somewhat indirect way of arriving at the experience—by counting the accidents rather than ascertaining the loss. The incomplete character of the accident reports under liability policies is responsible for putting all accidents other than fatal and dismemberments together, and ascribing an average value to each such accident. There is, however, such a vast difference in the gravity and cost of accidents (even outside of dismemberments and fatals),-one tabulatable may mean 1 day's disability and another 3 years of disability,-that the appraisal of all of them by an average value produces purely accidental results. As far as my personal experience goes, this is also a factor for underestimating losses and reducing premiums. There are so many more light than severe accidents that the average value is low, and as a result even if the risk had two or three severe and expensive accidents (provided they were not dismemberments) the experience rating plan fails to bring that out. There are other technical difficulties in the way of ascertaining the average wages, etc., and it would seem on the whole that if experience rating is to remain, the sooner it would be adjusted to the ascertainment of actual losses under compensation, the better. Personally, I am ready to express my opinion that it should be limited to large risks only, and as far as the charge of discrimination is concerned, I think the shoe is on the other foot, and that the present plan discriminates in favor of small risks, most of which have a clear slate for many years in succession because of their smallness, until the crash comes.

The details of both forms of merit rating should receive a thorough consideration to-day, both in the papers and in the disscussion which will follow. Undoubtedly healthy differences of opinion will appear. But besides sheer commendation or destructive criticism, what is really needed at this time is a constructive plan for testing

216 SCHEDULE RATING IN COMPENSATION INSURANCE.

merit rating statistically, smoothing out its wrinkles, so that merit rating should be definitely established, not only as a measure of justice between one individual and another, but also as a potent factor for the furthering of the safetly movement, without however bringing about a situation under which insurance is being sold below cost.

DEVELOPMENT, APPLICATION AND EFFECT OF SCHEDULE RATING IN LIABILITY AND COMPENSATION INSURANCE.

BΥ

CARL M. HANSEN.

That all risks within a given classification do not present identically the same hazards has been recognized by underwriters of liability insurance for years and the need of a more refined or detailed system for measuring the hazards in the individual plants has been Special rating based solely on the individual experience apparent. of a risk was too susceptible of misuse to attain universal adoption and was in many respects contrary to the accepted practices of underwriting based on the law of average. It was a serious question also whether past financial results of risk especially in a manufacturing establishment subject to changes was dependable as an indication of probable risks in the future. There was at least an honest difference of opinion among underwriters on that score, one school arguing solely for the retrospective, or experience basis for rate determination; the other for the introspective basis, or an attempt to measure the hazard of the plant under consideration by a detailed physical examination, thereby establishing the probable or anticipatory financial result of risk before underwriting, gauged on an analysis of the presence or absence of known causes of accidents and on the presence or absence of other than pure or inherent hazards of the industry in the plant under consideration, and as is usual when extremes meet, a compromise was the final result.

As in the case of all fundamental changes in procedure in a given line of endeavor, the problem was attacked simultaneously from several different angles and quarters. Experiments were conducted at the same time by the Aetna Life Insurance Company of Hartford, Connecticut, and by Professor Albert W. Whitney, at that time consulting expert to the Industrial Commission of California, in conjunction with the author. As the result of our labor, a plan for applying schedule rating to workmen's compensation insurance, with a tentative draft of a schedule for rating machine shops, was published by the California Commission and sent broadcast for criticism. This plan, whereas theoretically sound, proved impractical in application. It was based on the assumption that the exposure to any given hazard or accident cause would be a definite known quantity. A standard rating was given each defect in relation to total hazard presented in the plant based on an assumed exposure to each. It was found, however, that no statistics were in existence which would form a basis for the measuring of the exposure; in other words, the actual number of men or payroll in the average plant exposed to each individual hazard, such as belts. gears, lathes, planers, etc., were not available.

The Workmen's Compensation Service Bureau at the same time became actively interested in the question. A department for the purpose was established and instructions were given to proceed with development of a system which would meet the requirements presented, namely, that it be thoroughly practical, that it be easily applicable by the underwriter at the desk, that it appeal and do justice to the plant owner whose establishment was to be rated in accordance with it, that it produce a rate commensurate with the hazard in the individual plant, and that at the same time it would not disturb the present basic or average manual but that it could be applied to that manual. These were the essentials necessary to have schedule rating universally adopted and an effort was made from the beginning to meet them all.

No easy task to be sure, because of the acknowledged lack of data on the subject.

As already stated, no statistics were available from which could be deduced any facts in relation to exposure to different hazards. The next question naturally was "Can we establish the relative accident frequency and severity from known causes?" An investigation was undertaken of all the official accident statistics of the various states. It was found, however, that their classification of causes was not uniform, that the statistics were lamentably incomplete and they were therefore discarded as a basis. The next source of information were the records of the liability companies. As far as could be determined, only one liability company had kept statistics on causes of accidents in such a manner that they were readily available for study and comparison. This company submitted for our investigation some 60,000 compensatory accidents; that is, accidents for which money had been paid under liability. They were

218

carefully classified by industries, by cause and extent or severity of injury.

Next, we turned to European accident statistics, primarily Germany and Austria. We obtained records of approximately 125,000 accidents from these sources. They were studied in relation to the statistics submitted by the one liability company here and the similarity, both of causes of accidents and severity of accidents from identical causes, were striking. In fact, a review of the data from the two sources established this thesis as fundamental: That the effect on the human body of an accident from a given cause under similar conditions is the same whether it occurs in Europe or in the United States, a fact which should dispel in the minds of some gentlemen the idea that European statistics applied to American conditions are necessarily dangerous. If properly used, these foreign records which are known to be authentic and scientifically compiled would undoubtedly prove of great value in the solution of our problems as to accident frequency by causes, were it not for our apparent hesitancy in availing ourselves of them.

The next step was that of determining the comparative importance of the established causes of accidents in order to determine their relative rate value. That was the hardest problem to solve with any degree of accuracy for the reason, again, that no statistics were available giving exposure to causes. It was comparatively easy, however, to establish the relative importance of each to the total from a frequency and severity standpoint and underwriting judgment combined with engineering knowledge and the facts before us were used in assigning respective values. For instance, it was found from the records before us that the accident frequency from protruding set screws was comparatively low in relation to other causes but that the accidents were unusually severe resulting most often either fatally, in total permanent disability, or partial permanent disability. A rate value in comparison to these facts was assigned. A similar analysis was made of all the other causes taken into account and their comparative values established on the same basis.

We now came to the actual construction of the schedule and the basis upon which the rate values were to be applied.

There are three distinct methods through which schedule rating can be successfully used.

First, we may construct a hypothetical perfect plant, establish
standards for safety and sanitation in that plant and charge in the insurance rate a certain fixed amount for any deviation from these prescribed standards, such amount to be either on a flat dollar and cent basis added to the rate or on a percentage of manual rate basis.

Second, we may, on the other hand, establish a hypothetically very poor plant with no guards at all, use the same standards of safety promulgated for the hypothetical perfect plant and credit for each item of the standards complied with on the same basis as outlined above.

Thirdly, we may take what we term an average plant, establish sub and super standards and charge or credit for each item respectively as to whether it be below or above the average adopted.

The ultimate result of the three methods must of necessity be the same if correctly applied and provided the necessary data to establish true basis rates for each method is available. If the first method is adopted, the basis manual must be minimum rates; that is, rates predicated on conditions in the classification which permit of no hazards outside of the pure or inherent hazards actually necessary and incident to the operation of the industry. If the second method is used, on the other hand, the basis manual must be maximum rates predicated on the presence of or on the hazards often found in an industry but not necessary for the successful conduct of that industry. Whereas, if the third plan is adopted, the basis manual must be compiled on average experience per unit of rating adopted, to reflect the total value of the total hazard in a given district in a given classification.

As one of the prerequisites for the adoption of schedule rating was that the present system of compiling manuals be disturbed as little as possible and as such manuals are determined on average experience and therefore are average rates, the third method as here outlined was the one decided upon. It was a case of expediency, however, rather than scientific determination. The first plan mentioned is, in the author's opinion at least, the most nearly scientifically correct one, provided competition in rates is entirely eliminated and provided further that the data available for the construction of a minimum basis manual is available and he has no hesitancy in stating at this time that sconer or later that plan must be adopted.

Having established the relative values of the accident causes

which were to enter into the schedule and having also determined upon the plan of application, the deciding of how the different values were to be used, how they were to apply to the manual rate was the next question. In the plan proposed under the auspices of the Industrial Commission of California, a percentage basis was used entirely predicated however on the assumption that the relative importance of causes of accidents by actual exposure was a definite known quantity which later was found to be an erroneous assumption. In the plan used by the Aetna Life Insurance Company, an opposite procedure was adopted, namely, that of a flat charge or credit on the rate.

A careful analysis was again made of all causes of accidents as to their relative effect on the employees in a given establishment and it was determined that there are in the average manufacturing establishment three distinct classes of hazards or accident causes, namely:

First, catastrophe hazards, such as those due to the burning of buildings, collapse of buildings, boiler and other explosions. The charges and credits applicable under this head affect necessarily the entire payroll in the building and therefore were to be applied on a basis which would affect the rate on the entire exposure, it must be borne in mind here that compensation is based on earnings of injured or killed employees and has no relation whatsoever to rate for insurance and as the wages on an average are as high in low rated classifications as they are in high rated classifications, a charge or credit for the presence or absence of such catastrophe hazards if on a percentage basis would necessarily establish discrimination as between the low rated and high rated classifications, a discrimination not at all justified because in case of a catastrophe the actual amount in compensation to be paid the low rated classification would be as high as it would be in the high rated classification, assuming the same number of employees killed in either. Still if the charges were made on a percentage basis, we would have received a much higher premium for identically the same hazard in the high rated classification than we would in the other. The rate charge or credit imposed for these hazards, therefore, had to be the same for both classifications and applied by adding or deducting the same amount to or from the base rate for all classifications.

Second, we have the hazards incident to or inherent in the particular industry and affecting all employees. This hazard, sometimes referred to as pure hazard, is constant as long as the present methods of conducting a certain industry are used. Any increase or decrease in that hazard, however introduced, by new methods of operation of the industry or otherwise, must have a corresponding effect upon the basis rate computed to cover the hazard in the classi-Therefore, charges and credits under that heading were fication. made on the percentage of manual rate basis. The hazards to which this applies are, particularly, the working machine hazards, some of the power transmission equipment hazards and such conditions as affect the plant as a whole in relation to management, nature of employees and general moral conditions. In this category comes. naturally, also the amount of the machine payroll in relation to total payroll exposure, it having been definitely established under liability conditions that the accident frequency in a given establishment bears a close relation to machine payroll. For instance, a furniture factory with an 80 per cent. machine payroll exposure as against one with a 20 per cent. machine payroll exposure present quite a different underwriting risk and as that machine hazard is part of the inherent hazard in the classification, the difference is reflected in increase or decrease of manual on a percentage basis.

Third, we have the hazards incident to, but not necessarily inherent in or necessary for the successful conduct of the industry, hazards, however, to which only a limited number of employees are ever exposed at any one time. It would manifestly be unjust to charge the entire payroll for these hazards because in a large plant it would be a physical impossibility to expose all employees to either one of them simultaneously. Let us take for instance, a stairway. After careful investigation of several thousand manufacturing plants, this fact was established: that due to the location of the stairway only a limited number of employees could ever, in the daily routine of their work, use that stair; and that the limit on the average was approximately fifty men. The same was true with numerous other hazards of a similar character. Therefore, fifty men, or \$25,000 payroll, was assumed as the average exposure to any one of the so-called adjusted to payroll charges and credits.

It may not be amiss to submit a few explanatory comments in relation to these charges and credits, in view especially of certain criticisms having been presented from various quarters on the correctness of the principle involved. It is held that in applying the schedule this part imposes disproportionate charges on small payrolls-such is not the case-whereas the percentage in relation to basis rate is greater in the small plant; in other words, the rate charge is greater in a small puant than it is in a large plant, the premium charge is the same in both, the reason being that the cost of improvement or removal of the hazard must be taken into consideration as well as the accident probabilities and it obviously costs as much to remove a protruding set screw or cover a set of gears or a belt in a plant with ten employees as it would cost to remove the same hazards in a plant with one thousand employees. Therefore, from an economic standpoint, the principle is correct. From an exposure standpoint it is equally sound because, whereas in a plant of one thousand, fifty men are assumedly exposed to that hazard some time or other during the working hours, in the plant of ten men with a greater proximity of these men to the hazard, the exposure per man becomes greater in the same proportion.

It will undoubtedly be argued on this point that an insurance company as an underwriting medium is not concerned fundamentally with improvement of risk; in fact, some have already argued that if the companies do concern themselves on that point, it is certain to result in financial disaster. By what line of reasoning this thesis can be sustained is admitted to be beyond the author's comprehension. He holds it fundamental to the correct establishing of the rate values in a schedule that the cost of removing the hazards must be considered. He further holds that the very position the insurer of industrial accidents holds, automatically compels him to pursue a line of endeavor which an organization established solely for the purpose of accident prevention would follow.

As the schedule now stood it constituted a combination of the ideas brought out under the auspices of the California Industrial Commission and the ideas brought out in the experiments of the Aetna Life Insurance Company.

Certain phases of the schedule as a whole met with strenuous objections from prominent underwriters, particularly the so called discretionary credits. It was realized in the study of the subject that there were numerous hazards incident to industrial establishments upon which it would be impossible to affix specific values unless other conditions having bearing on the hazard were studied conjointly. For instance, a faulty foundation of a building, a tank on top of the building, the elusive term of "general order, light and sanitation," maintenance, etc., nature of employees, and so forth. To successfully value, say for instance, a defective foundation, the extent of the defect had to be known and it was impossible to establish degrees of defects of that nature. That had to be brought out on inspection; it had to be studied in relation to the exposure as well. A faulty foundation in a building containing only one man would naturally not present the same horror to an underwriter from a catastrophe standpoint as it would if, say a hundred employees were present. The same is equally true of overhead tank exposures. The objecting underwriters were convinced on that point, that it was necessary these values remain discretionary, but when it came to nature of employees, the effectiveness of management, general order, light and sanitation, etc., it was held that facts in relation to these so-called moral conditions could be established only after an intimate knowledge of the risk based on past experience. Instead of these items being discretionary as respects the underwriting, therefore, they were put on the basis of experi-In other words, individual experience was added to the ence. schedule as part of it, dividing it into two distinct parts with a limit of reduction permissible under physical improvements and a limit of reduction allowable under individual experience. After eighteen months, therefore, the two extreme views, that of the introspective school and that of the retrospective school had resulted, as stated, in a compromise. It has been argued that this compromise is equivalent 'to an attempt to mix oil and water; that the thesis that both can be successfully applied to the same risk is fundamentally wrong. Results so far obtained have not demonstrated the verity of this contention, but it is too early yet to speak of any definite result in this respect. Time only will bring it out.

Successful application of schedule rating is dependent upon two fundamental operations. First, a detailed analysis of the hazards in the risk under consideration by personal investigation. Second, a correct application by the underwriter and rater of the facts thereby brought out. The facts to be brought out on inspection, however, must be determined on a common basis; that is, the hazards in the different plants within the same classification must be measured by the same standard. As no uniform standards of safety were in existence, it became necessary before the schedule could be applied to establish such uniformity to enable the different inspectors, irrespective of the human equation, to arrive at practically the same result in the same plant. Necessity, again, was the compelling factor and a series of standards, known as "Universal Safety Standards" were adopted covering all the accident causes considered under the schedule.

In conclusion as to the effect of schedule rating objections are frequent that it has shown a tendency to reduce manual rates. The author will say to these objections that if it did not reduce manual rates on the average, it would not be worth the time or money spent in its development. Reduction of average rate must be a natural sequence of all forms of schedule rating.

Assuming a given classification with a basis rate on average experience on the entire classification say of 100, the hazards within the industry of that classification are analyzed and valued as to frequency and severity by causes. Upon inspection of all the risks, it is found that 50 per cent. of them carried an increase in manual due to sub-standard conditions, the other 50 per cent. carried a decrease due to super-standard conditions; that is, in both instances conditions, varying from the average, produced as a whole the net gross premium which would have been obtained if manual rate was applied to the whole.

Is it to be assumed that the employers paying the higher premium are not going to find out why they are paying more than their competitors for insurance of the same line of operation? And is it to be assumed that competition among insurance carriers is not going to result in their being made conversant with how they may reduce their rates? Surely not! And that is exactly the condition or the result schedule rating should bring about. The insurance carriers are sending their experts through the plants to locate and advise the establishment owner of where and how by actual improvements he can reduce his rate, and by these improvements the hazard of the classification as a whole is naturally reduced in direct proportion. And if the average rate originally computed was a correct one, that rate must necessarily, with the plants bettered through the removal of these hazards, be reduced in direct ratio.

The president of the society requested the author not to make the paper a defensive one as respects the "Universal Analytic Schedule." An effort has been exercised in the preparation to comply with his wishes. However, as no other schedule but this one is in universal application and as the author has professional and personal interest in it, it has been hard entirely to comply with the request. Let it be noted, however, that it has been frankly admitted that many factors in the compilation of the schedule were assumed without any definite data to substantiate same. This, however, is not to be charged against the author of the schedule, but rather is an indictment of the lack of foresight displayed by the actuarial and statistical departments of the federal and different state bureaus as well as by these departments of the liability insurance companies. Referring especially to the latter, and in the words of Mr. C. E. Scattergood, "it should not be counted enough for the statistical departments to simply compile figures as to how much the insurance companies have been paying out for accidents; they should be able to show with equal conclusiveness why it had been paid out and why and how accidents happen." Until such data are available any proposed changes in the schedule as now applied will be but a pitting of expert opinion against other expert opinion and any radical changes in the present system, until authoritative data is available would be to say the least ill advised.

THE EFFECT OF SCHEDULE AND EXPERIENCE RATING ON WORKMEN'S COMPENSATION RISKS IN NEW YORK.

ВΫ

LEON S. SENIOR.

The actuaries and underwriters who have prepared the present classifications and rates in the New York Compensation Manual have failed to take into account a very important factor essential to an accurate formula which may be used as a basis for rate calculation. I am referring to the factor which represents the influence of schedule rating on the ultimate premiums to be collected by the companies from their assured. The New York Compensation Manual has now become the basic manual for a number of states where compensation laws have been adopted. This fact enhances the importance of the consideration which should be given to each element of the rate formula. The factor representing schedule rating has been ignored for various reasons enumerated below.

First: The actuaries were engaged in the task of preparing average rates. The schedule rating system under discussion provides debits for imperfect and credits for perfect conditions. It was alleged that the volume of increased premiums above manual rates would be equal to the volume of decreased premiums below manual rates. That was the theory upon which a schedule was established and the underwriters were justified apparently to act upon that theory and to establish rates which did not take into account the probable increase or the probable decrease in premiums resulting from schedule rating. The theory that schedule rating will produce a volume of premiums above manual sufficiently large to offset the volume of premiums below manual has been entirely shattered in practice, as may be seen from the tables exhibited in this paper.

Second: The men engaged in preparing the manual were widely divided in their opinions on the main factors of the rate formula; on the values to be attached to the various types of injuries in the accident frequency columns; on the value of the incompleted experience for outstanding claims and on the value of the law differential for the greater benefits provided by the New York statute over

228 EFFECT OF SCHEDULE AND EXPERIENCE RATING

that of Massachusetts. The probabilities of error in any one of the items stated were so great, and the values finally determined, by the process of analogy and judgment rather than by the exact and scientific process of mathematical calculation, so speculative in character that the omission of an important but doubtful factor was not considered in the discussion as endangering the final result.

Third: The paucity of available material in the form of statistical data and the absence of reliable judgment due to the youth of the schedule rating system in this country, made it practically impossible to determine a correct or nearly correct factor.

Fourth: From the viewpoint of the safety engineer it is not necessary to modify the formula by providing a factor for schedule rating. The argument presented is to the effect that the schedule rating system produces individual rates which reflect the true hazard of the risk and that, therefore, an increase or decrease in the average manual rates for the given classification is decidedly improper. When you point out to this ardent advocate of schedule rating the fact that the system has reduced the average rates to the extent of 12 per cent., you will probably meet with the reply that we have either started out with a manual of rates for risks of an inferior and not average type, or else that employers in this state have been so stimulated by the prospect of reduced premiums as to equip their establishments in the brief period since the introduction of schedule rating system with standards of safety, so as to reduce the accident hazard in true proportion to the resultant premium reductions.

Rate-making for compensation insurance is now under the close supervision of several important states. Things which were ignored in the past will be required to be accounted for in the future. Ratemaking bodies will be put on their defence to justify their rates by data in the shape of statistics, sound judgment and analogies of hazard. With the accumulation of experience, statistical data will be required to a greater degree than heretofore. Judgment rates, found in abundance in the present manual, will be gradually superseded by rates founded on statistical information. All the component elements which enter into rate-making and all the important factors which influence final premium results, will have to be carefully considered and analyzed and brought into the formula required by insurance companies and state departments for the construction of adequate rates for compensation insurance.

ON WORKMEN'S COMPENSATION RISKS IN NEW YORK. 229

Results in New York.—A schedule rating system has been adopted in this state and put into effect in July, 1914. The system has been applied through a central organization known as the Compensation Inspection Rating Board. This organization, which is a voluntary association of forty insurance carriers, has inspected and rated 20,776 risks up to April 1, 1915.

The general results of such inspections and ratings are shown in the following table.

Number of risks	20,776
Estimated premium manual rates	\$ 5,437,632.63
Total premium increase	93,468.92
Total premium decrease	768,116.06
Net premium decrease	674,647.14
Per cent. of decrease	12.41
Payroll amounts to	\$453,829.871.00

Statistical information has been tabulated by the board from units representing individual risks, and assembled in groups according to classifications. We are thus enabled to analyze the effect of inspection and rating for each classification. The value of the information is enhanced by the fact that the system was applied by an impartial body under uniform rules and methods. Analysis of results in important classifications is reproduced in the following table:

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Classifications.	Estimated Payroll.	Manual Rate.	Premium at Manual.	Premium at Schedule.	Reduction.	Increase.	Per Cent.
Aluminum smelting works	\$ 1,116,000	2.66	29.685.60	25,066.60	4.619.00		15.52
Artificial feather and flower mfrs	1.055.167	.36	3,333,43	2.884.09	449.34		13.47
Automobile mfr	7,323,170	1.10	80,560.30	59,335.94	21.224.36		26.34
Bakers	3.878.209	1.72	66,705.04	66.569.97	135.07	1	12.92
Bookbinders	1,151,184	.49	5.640.88	4.748.82	892.06		15.81
Boot and shoe mfr	7,830,596	.39	30.539.34	25.044.11	5.495.23		14.71
Box mfr.—solid paper boxes, etc/	954,575	2.49	23.769.54	21,256.32	2.513.22]	10.57
Brass goods mfr.	1.484,167	1.36	20.193.22	18,153.89	2.039.33		10.09
Candy mfrs	602,627	1.46	8,797.96	7.622.62	1,175.34		13.83
Canneriesno can mfg	1,560,471	1.78	27,687.60	26,707.38	980.22		3.54
Cigar mfr.	1,022,300	.39	3,986.97	2.903.93	1,083.04	1	27.16
Cigarette—cigar mfr.—machine made	676,749	.49	3.315.83	2.764.45	551.38		16.62
Clothing mfr	38,114,656	.36	137,212.92	119,578.75	17,634.17	t i	12.12
Collar and cuff mfr	1,126,052	.31	3,491.53	3,131.21	360.32		10.31
Copper refiners-no ore reduction	1,146,492	2.66	30,504.84	32,509.28		2,004.44	6.57
Corset mfr	1,136,756	.36	4,095.00	3,390.03	704.97		17.21
Dressmakers	1,428,642	.36	5,142.96	5,242.05		99.09	1.92
Electrical apparatus mfr	941,918	1.13	10,643.47	8,955.46	1,688.01		15.85
Elevator mirs	753,300	1.94	14,604.02	12,045.31	2,558.71		17.52
Fur goods mfr.—no preparing of skins	1,087,022	.36	3,913.20	3,088.92	824.28		21.06
Furniture mfg	1,607,892	1.46	23,475.34	20,353.41	3,121.93		13.37
Jewelry mfr.	928,449	.65	6,045.54	5,112.22	933.32		15.43
Knitting mills	2,498,631	.75	18,739.50	16,542.04	2,197.46		11.72
Knitting mills from cop yarn-no yarn mfg	2,180,735	.65	14,041.74	12,950.01	1,091.73		7.77
Laundry—N.O.C.	2,295,563	2.92	67,031.52	60,232.97	6,798.55		10.01
Leather wearing apparel and novelties	952,547	.65	6,191.25	5,274.66	916.59		14.80
Machine shop—no foundry	4,108,076	1.36	55,870.16	50,198.58	5,671.58		10.15
Machine shop—foundry	976,958	2.07	20,223.90	17,664.64	2,559.26		12.85
Millinery mfr.	1,320,382	.36	4,753.44	4,633.34	120.10		2.52
Necktie mfr	\$36,326	.36	3,011.03	2,627.09	383.94		12.75

Classifications.	Estimated Payroll.	Manual Rate.	Premium at Manual.	Premiu.n at Schedule.	Reduction.	Increase.	Per Cent.
Newspaper publishers. Perfumery and flavoring essence mfr Plano mfrs. Planing and moulding mill. Printers. Pump mfr. Shirt mfr. Spinners.	\$ 3,094,761 234,175 994,150 872,522 6,900,435 865,700 1,325,784 1,086,800	$\begin{array}{r} .65\\ .81\\ .68\\ 3.43\\ .97\\ 2.07\\ .31\\ .78\end{array}$	$\begin{array}{c} 20,089.43\\ 1,897.02\\ 6,756.85\\ 30,126.75\\ 66,933.88\\ 17,925.03\\ 4,109.98\\ 8,487.04 \end{array}$	$\begin{array}{r} 15,670.11\\ 1,665.17\\ 5,810.18\\ 28,695.02\\ 55,254.30\\ 14,375.86\\ 4,390.94\\ 6,957.67\end{array}$	4,419.32 231.85 946.67 1,431.73 11,679.58 3,549.17 1,529.37	280.96	$\begin{array}{c} 21.99\\ 12.22\\ 14.01\\ 4.75\\ 17.44\\ 23.16\\ 6.86\\ 18.02 \end{array}$
Woolen spinners and weavers	2,388,758	.78	18,633.02	15,996.56	2,636.46		14.15
Total	109,858,697		908,166.07	795,403.90	115,146.66	2,384.49	12.42

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232

Prominent classifications with an analysis of risks that have received net credits of from 5 per cent. to 30 per cent., segregrated in six groups, in accordance with the extent of credit allowed are shown in the following table:

		No. of Risks Receiving Deductions.						
Classification.	Rate.	05 %.	5-10≸.	10 - 15 ⊄ .	15–20 ≸.	20-25 \$.	25-30 %.	Total.
Art. feather and								
flower mfr.	.36	2	4	10	9	20	6	51
Bakers	1.72	31	94	71	24	7	$\tilde{2}$	220
Bookbinders	49	2	4	2	12	34	5	50
Boot and shoe mfr	30	ĩ	2	2	10	22	7	46
Bottlers—under pres-	.00	-	Ű	U	10	20		40
sure	4.05	17	18	14	4	2	ļ	55
Box mfr.—solid paper					1			
boxes	2.49	16	15	21	5	7		64
Canneries—no can			_		-		1	
mfg	1.78	9	11	13	4	3	2	42
Carpenter-shoponly	2.01	6	16	$\overline{20}$	8	6	Ī	57
Carriage and wagon		Ŭ		-0			1 -	
mfr	1.10	4	17	14	9	13	1	58
Cloak mfr	.36	2	4	6	12	32	5	61
Clothing mfr	36	76	118	125	184	566	143	1,212
Dressmakers	.36	1	5	5	5	26	10	52
Fur goods mfr	.36	2	3	11	17	53	15	101
Furniture mfr	1.46	9	19	20	13	11	3	75
Glove mfrleather	.39	1		6	7	18	<u>ğ</u>	41
levelry mfr.	.65	2	7	17	11	28	5	70
Knitting mill-no			•				ľ	
yarn	65 .	6	3	11	14	18	5 7	59
Laundry-N.O.C	2.92	27	32	45	17	8	2	131
Leather wearing ap-	1	İ					•	
parel and novelties	.65	2	6	10	7	24	4	53
Machine shop—no	t I				[1		
foundry	1.36	30	35	51	36	30	8	190
Millinery mfr	.36	3	4	3	2	30	3	45
Necktie mfr.	.36	1	$\bar{3}$	4	1	21	9	39
Newspaper publishers	.65	$\overline{2}$	Ĭ	5	$\overline{2}$	24	l ĕ	40
Planing and mould-		-	-	Ŭ	-		۲ I	10
ing mill	3.43	5	13	11	8	4	1	41
Printors	97	30	47	68	101	110	25	201
					101			
Fotal		287	482	566	522	1 1 1 7	978	3 959
Per cent of total risks		89%	14 7 %	17 4 %	16%	34 60%	8 4 0%	0,202
L CI COHO, OI DOVAI HISKS		0.070	/0	-11/0	10 /0	01.0%	0.170	

TABLE (3.
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Prominent classifications where the inspections have resulted in increased rates arranged in six groups, according to the size of debits, ranging from 5 per cent. to 30 per cent., are shown in the following table:

Classification.		Number of Risks Paying Excess Rate of						
		0-5≰.	5-10 %.	10–15 ≸.	15–20 ≉.	20–25 ≸.	25-30 %	Total,
Bakers . Bottlers—under pressure . Canneries—no can mfg. Carriage and wagon mfr. Clothing mfr. Dressmakers . Hat. mfr.—not straw . Ice cream mfr. Knitting mill—no yarn . Laundry—N.O.C. Machine shop—no foundry. Planing and moulding mill . Printers	$1.72 \\ 4.05 \\ 1.78 \\ 1.10 \\ .36 \\ .39 \\ 1.72 \\ .65 \\ 2.92 \\ 1.36 \\ 3.43 \\ .97 \\ 1.97$	$9 \\ 3 \\ 5 \\ 50 \\ 3 \\ 4 \\ 2 \\ 12 \\ 11 \\ 6 \\ 16 \\ 16 \\ 16 \\ 16 \\$	$ \begin{array}{r} 6\\2\\3\\4\\61\\2\\3\\2\\1\\6\\9\\8\\17\end{array} $	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	4 2 37 3 1 1 3 4 4	$2 \\ 2 \\ 18 \\ 1 \\ 3 \\ 2 \\ 1 \\ 3 \\ 4 \\ 3 \\ 4 \\ 3 \\ 3 \\ 4 \\ 3 \\ 1 \\ 3 \\ 4 \\ 3 \\ 1 \\ 3 \\ 4 \\ 3 \\ 1 \\ 3 \\ 1 \\ 3 \\ 1 \\ 3 \\ 1 \\ 1 \\ 3 \\ 1 \\ 1$	4 2 3 8 100 3 4 9 7 19 4 7	$\begin{array}{c} 25\\ 11\\ 15\\ 22\\ 295\\ 11\\ 16\\ 15\\ 16\\ 34\\ 54\\ 29\\ 51\\ \end{array}$
Saw mill Shirt mfr	5.99 .31	5	11 1	6 1	$\frac{2}{1}$	$\frac{4}{3}$	7 5	35 11
Total Per cent. of total risks		129 21	$\begin{array}{c} 136\\ 21.3\end{array}$	77 12	66 10.3	46 7.2	186 29.2	640

TABLE D.

You will observe that the results of the application of the system show quite conclusively that the advances above manual are comparatively unimportant, while the reductions below manual are substantial and will have a marked effect upon the net volume of premiums to be collected from the companies by the assured.

Furthermore, account must be taken of the fact that the education of employers as to methods for reducing premiums is growing apace and that there is a tremendous pressure exerted by companies and their agents to enhance the credits, so as to make the insurance more attractive to the employer. These facts and tendencies will undoubtedly result in still greater premium reductions on future ratings.

An Ideal Basis for a Schedule Rating System.—Practice and observation leads me to the conclusion that the distribution of credits and debits in the present rating system are not ideal and that it is possible to so modify the system as to provide a more equitable distribution which will be better from a theoretic as well as from a practical standpoint.

Three systems of applying debits and credits are possible. First, a system based upon an inferior plant; that would provide all credits. Second, a system based upon a superior plant and pro-

233

234 EFFECT OF SCHEDULE AND EXPERIENCE RATING

viding all debits. Third, the present system based upon an average plant and providing both debits and credits. The first plan possesses a disadvantage in the fact that the starting point is a high manual rate, difficult to inaugurate after the employer has been educated to the point of accepting a lower basis. Furthermore, under a plan of that kind, an employer will frequently receive quite undeservedly credits to which he is not entitled. The second plan is probably the most scientific of the three enumerated but has been so far regarded as impractical from the viewpoint of the underwriter and the agent, who are obliged to justify definite increases in rates to the assured. A solution is suggested here which may be effected by a combination of the good points involved in the first and the second plans and adhering at the same time to the principle of a schedule founded upon a superior plant.

The plan proposed is as follows: The present schedule rating system is divided into two parts. First, physical hazard for which charges and credits are specific. Second, moral hazard for which charges and credits are discretionary. I believe that a clear distinction may be drawn between those two divisions and the application made as follows:

Begin at a point which is equal to 80 per cent. of the manual rate, that represents a plant physically perfect. Under our present practice we allow 20 per cent. from manual rate for physically perfect plants; therefore, a rate representing 80 per cent. of the manual stands for a physically perfect plant. Build a system of charges upon that foundation subject to no limitation of any kind. This will enable the employer to get on his rating form a clear conception of the debits for physical conditions and will place him in a position where it is possible to correct his plant in a manner to enable the rating body to remove charges for the defects as shown in the inspection report. If a plant is physically perfect, no charges are imposed and the 80 per cent. represents automatically the rate for physical conditions. This will remove all possibility of the argument which has heretofore been presented, that once an employer receives a credit of 20 per cent. under the present condition, all incentives for correcting conditions are removed, no further credit being possible. It will also remove the charge that an employer receives credits undeservedly for items which do not represent any real hazard. For the element of moral hazard embodied in the discretionary features of the schedule and for experience submitted in support of the moral hazard, the system of debits and credits may be retained to good advantage.

An amendment of our schedule rating practice on the lines suggested here, may be brought about without any serious disturbances and without any violent fluctuation of conditions as they exist. The ideas suggested here are not revolutionary and may be applied without any serious friction. It is possible that the application of this method of rating will bring about a greater number of risks subject to rates above manual.

Much has been urged against advanced rates as unwieldy and unpopular. I would not suggest, however, that the rating practice should be so amended as to wipe out advanced rates. It is quite true that they are unpopular, but at the same time they offer the strongest possible incentive for correcting existing defective conditions. The companies, agents and assured are thoroughly awake to conditions only when an advanced rate is promulgated. If the reasons for the advanced rate are sufficiently clear, it is then possible to induce the employer to use all the powers at his command to correct the conditions which have produced the charges. The system proposed herein will so clearly show all charges for physical conditions that the employer will have at his command a detailed rating form indicating a charge for every defective item.

Experience Rating.—There is a division of opinion among underwriters and actuaries as to the wisdom of applying individual experience in the rating of compensation risks. The subject is growing in importance and bids fair to take a prominent place in the schedule rating of compensation risks. As applied in the office of the rating board, individual experience is used as follows:

Risks subject to inspection include the extensive group of manufacturing classifications. The experience application submitted by the company gives an analysis of accidents divided according to nature of injury. A schedule of valuation has been adopted for each type of accident. The valuation produces a theoretic pure premium for the risk, which is converted into terms of a loss ratio by comparison with manual rates. A chart has been adopted (shown in illustration 1) providing debits and credits applicable in accordance with the loss ratio produced by a valuation of the experience.

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Risks that have been rated on basis of inspection and experience show following results:

TABLE E.

Number of risks	550
Estimated premium manual rates	\$577,461.45
Total premium increase	2,136.28
Total premium decrease	111,002.03
Net premium decrease	108,865.75
Per cent. of decrease	18.85
Payroll amounts to	\$33,594,738.00

The formula for application of experience on inspection risks is as follows:

To the manual rate add result of physiscal rating and one-half the algebraic sum of discretionary and experience ratings, viz., $M.R. + P.R. + \frac{1}{2}$ (D.R. + E.R.) = Schedule Rate.

It is to be noted that on inspection risks experience is used only as a guide in determining the extent of the discretionary charges or credits to be applied under the heading of Safety and Welfare and General Order.

Risks not subject to inspection include largely the group of contracting risks for which an inspection schedule does not appear to be practical. Experience is used as a sole method for departure from manual. The method for determining the extent of departure is the same as used for inspection risks, subject, however, to different limits, as shown in illustration 2.

236



The following table shows the results of rating on basis of experience:

TABLE	F.
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Number of risks	230
Estimated premium manual rates	\$321,068.98
Total premium increase	473.91
Total premium decrease	78,191.70
Net premium decrease	77,717.79
Per cent. of decrease	24.21
Payroll amounts to	\$10,146,025.00

The general tendency is to make experience applicable only to such risks as show a favorable record. That seems to be the weakness of the system. The idea which was advanced previously in connection with the schedule rating practice, may be applied with equal logic to the experience rating system, viz., beginning at a point which is equal to 80 per cent. of the manual rate, apply the accident experience as a system of debits under certain limitations (see illustration 3).

With the development of experience under compensation insurance, many of the valid objections now urged against the experi238



ence method will be eliminated per se. Accident frequency and loss payment records on individual risks of a reliable character will become available to the rating office and should prove an important guide in the determination of the proper rate.



The probabilities are very strong that the companies will in the future resort with increasing frequency to experience as the true standard for measuring the hazard and fixing the rates for manufacturing as well as contracting risks.

ON WORKMEN'S COMPENSATION RISKS IN NEW YORK. 239

Accident Prevention.-Aside from the effect which schedule rating has produced upon premium rates for compensation insurance, the important question, from a humanitarian point of view, is whether the system has contributed to any degree in reducing the number and severity of accidents in industrial establishments. The vindication of the system will be complete if it can be demonstrated by facts and figures that accidents, preventable by the installation of standard equipment, have been avoided through the adoption of measures for the protection of the workers. While figures demonstrating the beneficence of the system are not available as yet, in these early days of compensation, information received from all parts of the state indicates that the employers are taking a lively interest in schedule rating, that they are eager to learn and to put into effect methods which will guard the operation of dangerous equipment and result in the prevention of unnecessary accidents.

Evidence is not wanting that the system has given a tremendous impulse to the propaganda of safety ideas, to the organization of safety committees and to the exercise of greater care and caution in the operation of dangerous equipment.

Safety engineering as a profession has become of real importance with the adoption of compensation laws and schedule rating systems. Employers, faced with the problem of high rates, welcome the opportunity to secure reductions through compliance with reasonable requirements for protection of employees.

To the close observers of conditions there is no doubt left that employers are interested and recognize the possibilities that may develop as a result of a perfected system of schedule rating. If in addition to convincing the practical employers and business men of this state as to the inherent virtues of the plan, it can be successfully demonstrated to the members of this society that the application of the plan will eventually reduce the number of accidents and the extent of losses under compensation, the triumph of the idea will be complete.

As soon as the reports of the experience for the first compensation year have been tabulated, sufficient facts may be marshalled to indicate the effect of schedule rating, not only on premiums, but what is more important, on the accidents and losses sustained in the manufacturing plants subjected to schedule rating.

It will be gratifying to the writer if the discussion that may follow the reading of this paper will develop opinions and ideas to-

240 WORKMEN'S COMPENSATION RISKS IN NEW YORK.

wards the solution of the questions presented: (1) as to the need of modifying the future rate formula, (2) as to the value of experience as a factor in schedule rating, (3) as to the manner of conducting research to establish the influence of schedule rating on accident frequency and (4) as to the best plan leading towards an ideal schedule.

Schedule Rating Considered from an Actuarial Point of View.

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ALBERT H. MOWBRAY.

NATURE OF PROBLEM.

It is generally considered that schedule rating for compensation risks serves two purposes:

1. It promotes greater equity in the assessment of insurance cost than is possible where all risks in the same classification must take the same rate.

2. It promotes effective accident prevention work by offering rewards for better than average conditions and charging penalties for worse than average conditions.

Since it is the actuary's function to adjust rates as equitably as possible in the light of experience and to continually study and compile statistics to that end, the problem of schedule rating comes within the purview of his duties. But the burden is not upon his shoulders alone. It is shared by the safety engineer.

In the work of fixing the values of the different items entering into a schedule the actuary can take but a very small part, for the statistical data with which he works are lacking. This, however, does not relieve the profession of its share in the solution of the problem. Not only must the individual items be carefully determined, but the general relations between them must conform to sound principles. Leaving, for the present, the fixing of values for separate items to the engineers we can and should study these principles and endeavor to determine the relations which must subsist between such values in order that rates may be as equitable as possible.

An analytic study of principles and relations will serve the further purpose of pointing out the statistical studies which should be undertaken for the purpose of correcting and improving the schedule both in the accuracy of values given individual items and in the relations between such values. ANALYSIS TO DETERMINE PRINCIPLES AND RELATIONS.

The present paper is an attempt at a first analysis along these lines.

Starting from the generally accepted formula for pure premiums,

$$\pi = L/P \tag{1}$$

we may analyze the losses by causes and write

$$\pi = \frac{l_1 + l_2 + l_3 + \dots}{P} = \frac{l_1}{P} + \frac{l_2}{P} + \dots + \frac{l_n}{P}.$$

If we multiply both numerator and denominator of each of these fractions by the same quantity its value is unchanged, and we may further write

$$\pi = \frac{l_1}{a_1} \times \frac{a_1}{P} + \frac{l_2}{a_2} \times \frac{a_2}{P} + \dots + \frac{l_n}{a_n} \times \frac{a_n}{P}$$

and interpret a_k as the number of accidents due to cause k. Continuing in the same way

$$\pi = \frac{l_1}{a_1} \times \frac{a_1}{P_1} \times \frac{P_1}{P} + \frac{l_2}{a_2} \times \frac{a_2}{P_2} \times \frac{P_2}{P} + \dots + \frac{l_n}{a_n} \times \frac{a_n}{P_n} \times \frac{P_n}{P}.$$
 (2)

SCHEDULE RATING.

We may interpret the several factors as rates as follows:

 l_k/a_k = rate of cost per accident according to cause,

 $a_k/P_k =$ accident frequency per unit of exposure according to cause,

 P_k/P == rate of exposure, i. e., proportionate distribution of payroll according to exposure to cause.

For brevity, we may write $l_k/a_k = \lambda_k$, $a_k/P_k = \rho_k$, $P_k/P = \phi_k$ Using this notation (2) may be written

$$\pi = \sum_{k=1}^{\infty} \lambda_k \rho_k \phi_k, \qquad (3)$$

where the upper limit is taken as infinity to imply that the analysis as to cause should be exhaustive. Of course, for some causes λ or ρ or ϕ may any or all be zero so that the term representing that cause drops out.

If π be the average or classification rate then π' the true rate for an individual risk will be derived in the same way, AN ACTUARIAL POINT OF VIEW.

$$\pi' = \sum_{k=1}^{\infty} \lambda'_k \rho'_k \phi'_k = \pi + \Delta \pi, \qquad (3a)$$

in which

 $\lambda'_{k} = \lambda_{k} \pm \Delta \lambda_{k}; \quad \rho'_{k} = \rho_{k} \pm \Delta \rho_{k} \quad \text{and} \quad \phi'_{k} = \phi_{k} \pm \Delta \phi_{k},$

where $\Delta\lambda$, $\Delta\rho$ and $\Delta\phi$ are variable quantities dependent upon local conditions.

Then the charge or credit for departure from average conditions will be

$$\Delta \pi = \pi' - \pi = \sum_{k=1}^{\infty} (\lambda'_k \rho'_k \phi'_k - \lambda_k \rho_k \phi_k), \qquad (4)$$

from which equation it appears that the charge or credit for departure from the average is to be found by considering each accident cause separately, fixing for it the charge or credit (having due regard to the three factors of proportional exposure, frequency and seriousness) for local conditions and taking the sum of such items.

In a general schedule for use with several classifications, rarely, if at all, should the charge or credit for a given change of conditions affecting the cost due to a particular hazard be a percentage of the base rate.

For this to be so for cause k we must have

$$\lambda'_k \rho'_k \phi'_k - \lambda_k \rho_k \phi_k = c\pi = c \sum_{k=1}^{\infty} \lambda_k \rho_k \phi_k,$$

where on the left-hand side $\lambda'_k \rho'_k \phi'_k$ and $\lambda_{k\rho_k} \phi_k$ take all possible variations within the classification limits, and on the right the range of variation is even wider.

It may be that some one condition will alter one or more factors of the combination $\lambda_{\rho\phi}$ for every cause in an approximately uniform degree. For example, we may have $\lambda'_k = (1 \pm a) \lambda'_k$ where λ'' varies according to the cause of the accident and is determined without reference to the constant condition.

Then

$$\pi' = \sum_{k=1}^{\infty} (1 \pm a) \lambda_k'' \rho_k' \phi_k' = (1 \pm a) \sum_{k=1}^{\infty} \lambda_k'' \rho_k' \phi_k' = (1 \pm a) \pi''.$$
(5)

If there be any such condition, the rate should be found by the schedule method according to formula (3a) and the effect of this condition then estimated and combined with the first result by multiplication as indicated by (5).

243

NATURE OF FACTORS TO BE CONSIDERED.

Before proceeding to consider the basis of determining the values of λ , ρ and ϕ and the relation of changes in their value to charges and credits under a schedule rating plan, it will perhaps be well to take up a few illustrations of conditions within classification limits which severally alter the value of these factors.

A part of the pure premium on "planing and moulding mills" is due to the cost of operating buzz planers or jointers. The experience available to us probably contains observations of mills in which both the old square jointer head is used and mills in which the safety cylindrical head is used. The difference between these conditions, alone, does not affect the proportion of payroll exposed (ϕ) to jointer accidents nor the frequency of such accidents corresponding to a unit of exposure (ρ). The cost per accident is very different where the cylindrical head has replaced the old type. For this cause then λ in the basis pure premium has an average value and λ' is greater or less than λ depending upon the proportion of jointers equipped with cylindrical heads.

The use of safety foot ladders is becoming more common and our pure premiums on many classifications contain an item due to the cost of ladder accidents which is based upon an average use of ladders so equipped and not so equipped. The use of such ladders does not primarily reduce the cost per accident of ladder falls, etc., (λ) nor the proportion of employers called upon to use ladders (ϕ) but does reduce the frequency of such accidents per unit of exposure (ρ) . For this cause then ρ in the basis pure premium of any classification has an average value and ρ' is greater or less than ρ depending upon the proportion of ladders used which are equipped with safety feet.

The placing of a covering over a set of gears does not affect the cost per accident of gear accidents (λ) nor the frequency of gear accidents when the cover is removed (ρ) but each such cover placed where employees must pass does reduce the exposure to gear accidents (ϕ) . As in the other two cases the value of ϕ in the basis pure premiums is an average value and in any individual case ϕ' is greater or less than ϕ depending upon the proportion of exposed gears. This is the factor most commonly affected by safety work.

Independent of the cause of accident prompt and efficient medical care tends to reduce the cost per accident fairly uniformly. So also malingering tends to increase it. Intelligence and safety spirit among employees tend to reduce the exposure to all causes of accident. It is the general view that those intangible elements usually grouped under moral hazard are of this nature.

BASIS OF DETERMINATION. STATISTICS TO BE ACCUMULATED.

As was said at the outset, statistical data do not exist for the solution of the problem by actuarial methods, but we may consider what should be compiled for such a solution and the advisability of attempting its compilation.

The different things to be considered and compared are indicated in equation (2) and most companies now provide for punching their cards to show the cause of the accident as well as cost. The determination of λ and variations in λ for different causes and conditions therefore does not call for any change in our statistical methods.

The determination of both ρ and ϕ depends upon our knowing the proportion of payroll exposed to each cause. The writer has heard of no attempt to get at this. We might do so by planning to punch exposure card from our inspection reports, but designing the cards would be a difficult task and preparing and tabulating them both difficult and expensive. When it was done it is doubtful whether at the present time the expense would be justified, for conditions are so rapidly changing. Perhaps as the work of laboratory testing is carried on the value of ρ for varying conditions may be found in that way. We may then, I think, undertake special studies looking to the determination of ϕ .

THE INTANGIBLE ELEMENTS. MORAL HAZARD.

It is the tradition of underwriting practice, coming from the days when analytic rating was considered so impossible that scientific studies looking to that end were considered useless, that this element is to be determined by observing the experience of the individual risk. In our endeavor "to substitute fact for appearance, and demonstration for impression" we may well consider whether this method may properly be combined with a system of analytic rating.

Where an attempt is made to measure the moral hazard by observing the experience with the individual risk it is usual to take its value as a percentage of the difference between the actual loss ratio and an assumed standard ratio. Expressing this in accordance with the symbols used in (5), taking π' to be the actual experience pure premium, and π to be the manual pure premium we have

$$a = c(\pi' - \pi)/\pi. \tag{6}$$

Let us assume that the pay roll observed in the individual risk has been sufficient to eliminate accidental variation^{*} and that our schedule has correctly valued the physical hazard. Then we have from (5) for comparison with this

$$a = \frac{\pi' - \pi''}{\pi''}.$$
 (7)

In the original New York plan of applying a rating schedule the physical items were estimated and the intangible items by the above method and the results combined by addition, the formula corresponding to (5) being

$$\pi' = \pi'' + a\pi = \pi'' + c(\pi' - \pi).$$

 $a\pi'' = c(\pi' - \pi)$

This will only give the same result as (5) when

or

$$c = \frac{a\pi''}{\pi' - \pi}.$$
 (8)

Since c depends upon variable quantities it will not in general be a constant. Hence this method will not in general produce the true pure premium even when the statistical data are ample.

One reason why this is an unsatisfactory method of estimating the moral hazard is shown by an inspection of the numerators of the fractions on the right of (6) and (7) remembering that $\pi'' = \pi \pm \Delta \pi$ as determined by the schedule for physical conditions. In the usual method of determining this value by comparison of loss ratios the effect of physical conditions already separately allowed for is again allowed to influence this value.

There are other reasons which cannot be demonstrated by formula, but are nevertheless cogent. Some of the more important ones are the following:

* This will be an exceedingly rare occurrence. For a discussion of the extent of pay roll necessary to give a dependable pure premium see *Proceedings*, No. 1, p. 24.

1. By reason of too small payroll exposure to furnish a dependable pure premium luck is as much, if not more, of a factor than merit in the showing over a limited term of any moderate sized plant. At a rate of \$1 per \$100 (which is more than the average rate in Massachusetts) it would take the entire premium on a \$400,-000 payroll plant to pay for one maximum value death loss. What shall be said of New York when it has been estimated that one death case may cost two or three times the Massachusetts limit? In the plant of one corporation given highest praise by all for its splendid interest in safety and welfare work such an accident did occur not long ago. It may be said that such cases are to be considered extraordinary and specially allowed for in making up the experience as they are not an indication of bad moral hazard. To say the least this would be a dangerous precedent, and where are we to draw the line? If we take this view should we not similarly modify the statistically recorded experience of risks where we believe the moral hazard bad? We can hardly justify such a course to the insured.

Indeed, looked at from this point of view, the introduction of the experience of an individual risk as an element in determining its rate seems to be an anomaly, a breaking down of the principle of distribution on which all insurance rests.

2. The experience considered must always relate to the past and the rate to the future. Human progress goes by waves. After a period of effort and advancement we relax, grow careless, slip backward, till some strong stimulus again rouses us to action. A run of bad accidents, sometimes but one, will rouse many an employer to the need of accident prevention work. When things have apparently been running smoothly for some time, look out for the crash! The use of experience to measure moral hazard not only ignores this natural law, but runs counter to it.

3. Where the employer knows that the experience with his plant affects his rate, he is tempted to suppress the reporting of minor and sometimes serious accidents and by coercion obtains an acquiescence of his employees in this policy. (See cases cited in Report on New Jersey conditions by American Association for Labor Legislation.)

At the outset of our work in this field and until we can find a better measure of the moral hazard, it might be a wise discretion to differentiate only for the physical hazard while we diligently seek a suitable means of including these other elements. After all, is not the moral hazard to a very large degree reflected by physical conditions?

PRACTICAL SCHEDULE RATING ACCORDING TO AN ENGINEER'S SCHEDULE.

If, as it appears from the above analysis, it is impossible to test the details of a proposed schedule by compiled statistics, it may be, indeed it has been, assumed that schedule rating should not be undertaken at all. With this view I cannot agree. Absolute equity in any human affair is unknown and probably unknowable. From this point of view it is quite likely that committees of engineers, testing each item for conformity to the above principles, will from time to time construct schedules which will be entirely satisfactory so far as equity between individual risks in the same class is concerned. Doubtless such schedules will far surpass an actuarial schedule in promoting safety work.

The difficulty with such a schedule is apt to be that the result of applying it to a given body of risks will be a distortion of the average experience premium. So far as this distortion is due to changes in safety conditions since the time for which the experience was compiled, this is as it should be. Further disturbance of the basis pure premiums is a defect in the schedule and may lead to serious inequity between classifications, or may even, if the result is an unexpected general and considerable reduction, result in the insolvency of some companies.

One practical solution which has been adopted is limitation of the aggregate charges or credits. This tends to diminish the value of the schedule from the accident prevention point of view as the insured will be left to seek the easiest and cheapest way of securing the maximum reduction. Would it not be better to test the schedule in actual application to a considerable number of risks in various classifications? From these tests an approximate measure of the effect of the schedule can be obtained and this may be allowed for in the loadings added to the pure premiums to find the gross. In this way the companies would be assured fair incomes without excessive charges to the insured.

In the above discussion pure premiums only have been considered. As long as gross premiums are made by adding a uniform percentage loading this percentage of loading may be added to each of the items to be added to or subtracted from the base rate and if this is done the final rate will have the same percentage loading. Of course, if a sum of items containing uniform percentage loading is multiplied by any quantity the product will contain the same loading. Therefore, any factor by which the built up rate is multiplied needs no loading.

NOTES ON THE THEORY OF SCHEDULE RATING.

BY

ALBERT W. WHITNEY.

Mathematics is too often thought of, by the unmathematical at least, as concerned merely with numbers. In reality there are extensive demesnes in the field of mathematics in which number is of no concern. But even in those parts of mathematics which involve number the numerical result is usually of secondary importance; the fundamental interest is with the general form from which the numerical result springs as a special case. Mathematics is essentially the study of form and structure, and not only that but it is the study par excellence of form and structure.

The present paper deals with the mathematics of schedule-rating in the sense that it is a consideration of the form which a schedule should take. A schedule in the sense here used is the expression of an insurance premium-rate as a function of the elements contributory thereto. As a rate can be figured both prospectively and retrospectively it is pertinent to say that it is the prospective method which is referred to here. The rate is the premium divided by the payroll, the insurance in force or whatever the basis may be upon which the policy is written. The premium is an expectation, made up in general of the sum of other more elementary expectations. A simple expectation is the product of a contingent amount and the probability of the contingency in question.

While probabilities themselves cannot be added unless the corresponding events are mutually exclusive, this restriction does not apply to the case of expectations. This may be shown as follows: Suppose two events a and b not mutually exclusive. In terms of symbolic logic we have:

$$a - b = a\bar{b} - \bar{a}b - ab. \tag{1}$$

Logical addition is here distinguished from numerical addition by a heavy symbol; logical addition is interpretable as "or"; logical multiplication is interpretable as "and"; \bar{x} means not x. The righthand side consists of mutually exclusive terms and to it can therefore be applied the principle that the probability of a logical sum is equal to the numerical sum of the probabilities. Denoting the probability of the event x by |x| we have therefore:

$$|a + b| = |a\bar{b}| + |\bar{a}b| + |ab|.$$
⁽²⁾

Suppose that the amount payable in case the event a alone happens is α , in case the event b alone happens is β and in case they both happen is $\alpha + \beta$ and assuming that we may apply the law of addition of expectations to mutually exclusive probabilities we have: Expectation in connection with the happening of the event a - b

$$= |a\overline{b}|\alpha + |\overline{a}b|\beta + |ab|(\alpha + \beta), \qquad (3)$$

which reduces evidently to $|a|\alpha + |b|\beta$. The law is therefore independent of whether or not the events *a* and *b* are mutually exclusive; this can of course be extended to any number of terms.

This law is strictly true for expectations of events not mutually exclusive and approximately true for the probabilities themselves provided they are small, as they usually are in the case of insurance, and provided the events are independent or approximately independent.

The form of the function expressing the hazard differs for different kinds of insurance. In fire insurance the process of damage production whose expectation is to be measured can readily be recognized as separable into three independent events or processes, viz.: ignition, combustion and damage production proper; the first two are probabilities, the last an expectation. These are related to each other dependently: unless they all concur there is no loss. There may be no ignition; there may be ignition but no combustion; there may be ignition and combustion but no damage produced. The probabilities are therefore related multiplicatively; that is, the probability of ignition is to be multiplied by the probability, if there is ignition, of combustion, and this is to be multiplied by the expectation of damage, if there are ignition and combustion. Each of these factors is expressible as a sum in view of the laws referred to above and in view of the fact that ignition, combustion and damage-production can all take place in various ways. If this analysis*

* This subject was more thoroughly discussed by the writer in Vol. 12, p. 28, of the Transactions of the Actuarial Society of America, and Vol. 85, p. 306, of the Weekly Underwriter.

were made in fire insurance schedules I am satisfied the results would be more satisfactory than under the present schedules which are found to have a very restricted region of applicability. The case of fire insurance is introduced here only as an example of the fact that each kind of insurance demands a separate analysis.

So far as I know all present rating schedules are based upon the principle of building the rate up additively item by item from a given basis rate. This can be given an interesting mathematical expression. It is an application of Taylor's theorem for several variables:

$$f(a + h, b + k, \dots, \text{etc.}) = f(a, b, \dots, \text{etc.}) + h \frac{\partial f}{\partial a} + k \frac{\partial f}{\partial b} + \dots, \text{etc.}$$
(4)

The expression on the left represents the rate in question; a, b, \ldots , etc., are the values of the parameters which describe the standard condition for which the basis rate is $f(a, b, \ldots, \text{etc.})$. h, k, \ldots , etc., express the deviations from standard of the particular risk. The higher powers are omitted. Those who made the rating schedules doubtless did not have this formula in mind and the schedules would come far from checking up in detail and yet the formula is unquestionably the rigorous expression of the general idea which they followed.

Two general lines of procedure have been adopted with regard to the coefficients $\frac{\partial f}{\partial a}$, $\frac{\partial f}{\partial b}$, ..., etc.

In the Moore fire schedule these are for the most part assumed to be constants, that is the rate is assumed to change uniformly as the conditions change. In the Dean fire schedule, on the other hand, for the most part the coefficients are taken as proportional to the basis rate, that is the more hazardous the risk the greater the effect of a change in conditions. This latter procedure is equivalent to making the rate an exponential function of the parameters.

One very significant fact stands out at once. The Taylor expansion, particularly if the higher powers are dropped off, is limited in its application to conditions not far different from those upon which the basis rate are predicated. The schedule will break down if it is stretched to cover too wide a field. The regular fire schedules for instance cannot be applied to sprinklered risks. In fact the fire companies have found it necessary to have as many as a score of schedules adequately to cover the field.

In what follows I shall now confine myself to a discussion of rating for Workmen's Compensation insurance. It is evident that the compensation premium is susceptible of a very considerable In the first place it is a summation of the expectation of analysis. loss for each of the employees separately. In the second place for each employee it is a summation of expectations with regard to all possible injuries; for example, the compensation for loss of arm multiplied by the probability of loss of arm plus the compensation for loss of eye multiplied by the probability of loss of eye, etc., through the whole list of possible injuries. Thirdly the expectation of each employee may be analyzed on the basis of cause or hazard. There seem to be three general types of hazard, first the catastrophe hazard, second the general hazard of the industry and third the peculiar hazards to which particular employees are exposed. Very likely still further differentiations might with advantage be made.

At this point it is well to point out what is already quite evident to anyone who has given this matter any considerable attention, namely that the subject is an exceedingly difficult one and that, while it is well to have an ideal in mind as a guide, one must be prepared at almost every point to make simplifying assumptions, oftentimes violent, in order to prevent the problem from being unmanageable because of its complexity.

The catastrophe hazard is fairly simple. Certain features of the risk affect the rate only through their influence in bringing about a catastrophe. This influence in the case of standard conditions is measured by a certain part of the basic rate. In the given risk however let us suppose that there are certain sub-standard conditions. The corresponding increase in the catastrophe hazard should be independent of the basis rate. For example, a weak floor is just as great a hazard in an otherwise safe industry as in a dangerous one. This means that the coefficients in the expression for the catastrophe hazard should be constants.

The hazard of the industry however is different. There the presence of sub-standard features will be more dangerous the more dangerous the occupation. This must be taken by and large; the truth of the principle as a whole however is clear. Insufficient light where there are dangerous machines or other hazardous conditions is far more serious than where the conditions are less hazardous. It seems reasonable to assume that the coefficient expressing this shall be taken proportional to such hazard; that is in an industry where the hazard of the industry is twice that of another the charge for insufficient light should be doubled. This in effect is to say that the charge for sub-standard conditions should be a percentage of the hazard of the industry, or that the coefficients in the expression for the hazard of the industry should be proportional to that part of the rate which describes the basic hazard of the industry. As a practical matter however the hazard of the industry is not separately given in the basis rate and we shall not seriously err if we make the charge proportional to the basis rate as a whole, especially since the hazard of the industry is doubtless in general the largest part of the hazard.

The third element consists of the special hazards. If it is assumed that there are certain special hazards, exposing a limited number of employees however many the whole number of persons employed, then the premium for this part of the hazard should be the expectation for this exact number of employees and should therefore be an absolute constant independent of the payroll as a whole. Such a condition as this might arise in for instance the case of a flight of stairs which would not in the nature of things be used by more than a limited number of employees. Since in this case the premium must be an absolute constant it follows that the rate must be a constant divided by the payroll.

The coefficients then in the expression for the catastrophe hazard will be of the form l, a constant; in the expression for the hazard of the industry they will be of the form mR, where m is a constant and R is the basis rate; in the expression for the special hazards they will be of the form $\frac{n}{P}$ where n is a constant and P is the payroll on which the premium is computed. In any particular case the constants l, m, n will depend upon the particular hazards under discussion.

The general expression for the rate will therefore be: R' (the rate for sub-standard conditions) = R (the basis rate) + the sum of terms of the form lh_1 + the sum of terms of the form mRh_2 + the sum of terms of the form $\frac{nh_3}{P}$, where h_1 , h_2 , h_3 are the values of the departures of the parameters from the standard. Indicating the results of the summations by large letters we have:

$$R' = R + L + MR + \frac{N}{P}.$$
(5)

255

This investigation of the subject of schedule rating from a mathematical or at least quasi-mathematical point of view was undertaken without any idea of where it would lead. It is gratifying to me that it should have come out in harmony with the principles underlying the Universal Analytic Schedule. It seems to give some added weight to the schedule to have had the same results reached independently along two somewhat different lines of approach.

It should be clearly understood that the mathematical basis for schedule rating is brought forward not at all with the idea of forcing the schedule into this exact form but as a guide. Schedule rating is an art, with a scientific basis to be sure, but there must be a liberal admixture of judgment and tolerance for a considerable amount of empiricism. I should not want to insist for instance that the parameters, h, k, etc., must in practice enter into the schedule linearly; in fact in the case of height of buildings for instance I know that they should not.

Several observations may be made regarding equation (5). For one thing, when this is thrown into the form:

$$\frac{R'-R}{R} = \frac{L}{R} + M + \frac{N}{PR},\tag{6}$$

it affords an explanation of the fact, shown in Mr. Senior's paper, that the greatest percentage reduction in rate is in connection with the low-rated risks. Secondly it suggests the possibility of determining the constants L, M and N. It would be a simple matter to determine these from the data which Mr. Senior has made use of. This determination would show how the different elements of the schedule work out in practice. To check this it would be necessary to determine them also by accident experience. This could be done by the use of a body of experience classified both as to nature of injury and cause; the nature of injury would serve to determine the cost or weight and the cause would determine in each case whether the accident were to be thrown to the determination of L, M or N.
256 NOTES ON THE THEORY OF SCHEDULE RATING.

One serious difficulty suggests itself however. L, M and N are increments. The constants determined by the causes describe the whole hazard and not merely the increments. To determine L, M and N it would be necessary therefore to make some further assumption.

I believe however that this would be in general a very fruitful line of research. In fact I believe it is practically the only way to apply statistics to a schedule. It would be out of the question to attempt to determine each of the items of a schedule separately. If we can satisfy ourselves that it is right in its larger features we must expect to put in the finer shadings by judgment.

SCHEDULE RATING OF PERMANENT INJURIES.

BΥ

. G. F. MICHELBACHER.

A proper method for rating permanent disabilities adds much to the efficiency of a workmen's compensation act, for while the number of permanent disabilities is comparatively small, the effect of accidents of this character upon the working population is most important.

The permanent disability accident is responsible for the creation of a class of permanently maimed and crippled workers, who suffer a decrease in earning power by reason of the loss of a function or a part of the body. The proper treatment of these accidents to insure an adequate amount of compensation which will prevent the worker from becoming a public charge, and at the same time leave a just share of the burden to be borne by the worker himself, is the problem of the workmen's compensation expert.

The permanent disability schedules which have been used in connection with many compensation laws in the United States, which were enacted before the passage of the Workmen's Compensation, Insurance and Safety Act in California, have taken care of this problem of rating permanent disabilities in a more or less haphazard manner. It may be said of these schedules that they do not fit the ins and outs of the problem, and that the amounts of compensation awarded do not adequately compensate, in a great many cases, for the injury rated. Most of these schedules are based upon physical loss only, and award varying amounts for the various injuries enumerated as causing permanent disability. These amounts are paid to all employees who sustain the same kind of injury, irrespective of the employee's age and his occupation, and other factors which we have found in California to be of the utmost importance.

It is a matter of common knowledge that the laborer who, for example, loses one eye, while he may suffer no loss in earning capacity by reason of the physical impairment, he does suffer a loss in competing power, which is an important factor in determining the effect of this accident upon his future earning capacity. The worker who has lost an eye must compete for the rest of his life with healthy two-eyed workers, and even though he be physically able to perform the work equally as well as before the accident, he will still have difficulty in obtaining a chance to perform work in competition with other workers who are physically perfect.

The old idea of rating permanent disabilities with reference to physical loss only, cannot, with any degree of accuracy, be expected to do full justice to the problem. A method must be determined which adequately compensates employees by taking into consideration every factor which in any way contributes to the permanent loss in earning capacity and which is capable of arbitrary measurement. We may briefly state the factors which affect the worker's earning capacity as follows:

(A) In the first place, he must have a certain amount of skill or experience. The worker in any craft, whether the craft requires skill or not, must have served a brief apprenticeship. Even the laborer who digs sewer ditches for a living must know what he is to do and how he is to do it before accepting work. The amount of skill or experience required is a function, first, of the occupation, varying from no skill at all to the highest type of efficiency which requires an elaborate training and years of experience; and second, of the age, varying as the worker passes from apprenticeship to the status of the skilled mechanic or the efficient worker in any line of employment.

(B) In the second place, the worker must have a sound body and be in perfect working condition, in order that he may put his skill and experience into practice. Here again we find the occupational factor a most important one. The degree of skill required to perform the work of a given occupation has a direct bearing on the requirements imposed upon the various parts of the worker's body.

One occupation may require a great amount of physical use of a particular part of the body or of some particular function; another may require no physical use of this same part of the body or this same function, and still another occupation may be found where the degree of physical use compared with the physical use required by the first occupation is greatly modified. There are all grades and degrees of physical requirement as far as the work incidental to an occupation requires greater or less use of the various parts of the worker's body.

Thus it may be pointed out that the leg of a structural steel rigger is much more important in the performance of the work incidental to structural steel rigging than the leg of a cobbler in the performance of the work incidental to shoe repairing. The body with its functions is used to interpret the worker's skill and experience. An ornamental modeler may have a wonderful conception of ornamental art. Still, this conception of itself would be of little use without two unimpaired eyes and hands with which to express it. A musician may have a wonderful faculty for playing his instrument in company with other musicians; still this faculty of itself would be useless without good hearing. A schedule which rates all employees alike, and is based upon the fact of physical loss only, without reference to the varying degrees of use the employee makes of the various parts of his body in performing his routine work, cannot do full justice to the problem of adequately compensating permanently disabled workers.

(C) In the third place, the worker must be able to compete with other workers in his class in the open market. The worker must be able to secure employment wherein he can use his body to display his skill and experience. A disfigurement which hideously distorts the face of a laborer may not interfere seriously with his power to compete with fellow laborers in securing employment, for the reason that laborers are chosen with reference to physical fitness rather than with reference to good looks. The disfigured laborer may have a powerful physique and, by reason of this fact, secure employment in competition with other laborers who are less fortunate in their physical make-up; but this same disfigurement would absolutely bar the worker from certain classes of employment in which the personal appearance of the worker counts for more than the evidence of physical strength. Again, the occupational factor is most important: the power to compete varies with the nature of the work, the skill and experience required, the supply of labor available, the general condition of business-all of which items create the occupational factor which affects the worker in his competition with his fellow workers for a chance to perform work

We may refer to the factor defined under "Section A" as the

259

worker's occupational ability. The factor defined under "Section B" may be termed the worker's functional ability, and the factor defined under "Section C" may be termed the worker's competing ability. If any one of these factors is damaged the worker's earning power is damaged, and if the damage is permanent, the method of rating permanent disability should allow an adequate amount of compensation to enable the worker to again assume his position in the open labor market with as little disadvantage as possible.

The principal factors to be considered in rating permanent disability then are the following:

- 1. The nature of the physical injury or disfigurement.
- 2. The occupation, and
- 3. The age.

There are other important items which should be taken into consideration, as for example, general education, inherent adaptability, general health, and so on. But while these items are important, it is impossible to measure them arbitrarily and, therefore, impractical to attempt to incorporate them into any scheme for rating permanent disability. We must remember that compensation gives the injured worker average justice. Compensation should, therefore, be based upon an average man of average education, average inherent adaptability, average health, and for this average man the three items enumerated above constitute the vital factors as far as permanent impairment of earning capacity is concerned.

To turn to the California law and the supplemental schedule which is used in that state for rating permanent disabilities, let us first refer to the Workmen's Compensation, Insurance and Safety Act and review the sections which refer particularly to compensation indemnity for permanent disablement:

Section 15 (b) (9) defines total permanent disability as follows:

"The following permanent disabilities shall be conclusively presumed to be total in character: Loss of both eyes or the sight thereof; loss of both hands or the use thereof; an injury resulting in a practically total paralysis; an injury to the brain resulting in incurable imbecility or insanity. In all other cases, permanent total disability shall be determined in accordance with the fact."

Section 15 (b) (5) (6) (7) defines the method of rating permanent partial disability, stating that the percentage of disability to total disability must be determined in all cases, taking into account the following three items: (1) Nature of physical injury or disfigurement, (2) the occupation of the injured employee, and (3) his age at the time of the injury.

The compensation schedule for permanent disability, therefore, depends upon ratings which are based upon permanent total disability taken as 100 per cent. In all other cases the rating is fixed at such percentage as the case may require compared with 100 per cent. total impairment, taking into consideration the items of injury, occupation and age. Thus, under this method, we will have ratings from 10 per cent. to 100 per cent. The compensation indemnity payments for these various ratings are computed in accordance with the following rules:

For disabilities under 70 per cent., 65 per cent. of the employee's average weekly earnings at the time of the accident is paid at the rate of 4 weeks for each 1 per cent. of disability. Thus, the duration of compensation payments for a 40 per cent. disability is 160 weeks. For disabilities rated 70 per cent. and over, compensation is payable in two items: The first item represents a payment each week of 65 per cent. of the employee's average weekly earnings at the time of the accident, for a period of 240 weeks; the second item represents the payment of a pension which becomes effective after the compensation under item one has been paid, and continues until the worker's death. The amount of this pension varies with the percentage of permanent impairment. The following rule may be given for determining the percentage of wages allowed as a pension: Subtract from the rating 60 per cent. The difference will represent the percentage upon which the pension payment is based. Thus, for an 80 per cent. permanent impairment, compensation is first paid for 240 weeks, the weekly payment being an amount equal to 65 per cent. of the employee's average weekly earnings; and second, for life, following the last of these 240 weekly payments, the amount of each weekly payment being equivalent to 20 per cent. of the employee's average weekly earnings.

From a statement of the method of treating permanent disability in the Workmen's Compensation, Insurance and Safety Act it is evident that some way of determining percentages of physical impairment arbitrarily must be devised in order to enable the Industrial Accident Commission to properly administer the Act in connection with permanent disability cases. Without an arbitrary schedule, each case of permanent disability would form the basis for a formal hearing before the Commission, at which hearing the percentage of permanent disability would be determined by the Commission in the manner suggested in the provisions above referred to.

It has been found possible to devise a method which rates permanent disabilities justly and fairly, though arbitrarily, and allows the Commission to fix the amount of compensation to be paid.

The theory of the method used to apply these sections of the Act was evolved by Professor A. W. Whitney.

This method, stated briefly, involves the creation first of a rating for a standard age and occupation for each injury, and second, tables whereby other ages and occupations may be rated with reference to this standard. The basic idea of the plan is the idea of schedule rating, the schedule being different only as far as subject matter is concerned, from the schedule used in rating fire risks in connection with fire insurance. The standard rating is the rating for an unskilled worker of age 39. This occupation was chosen for the reason that the worker employed therein performs no particular work requiring specialization of any part of his body. Because of this fact, the problem of determining the effect of injuries upon this worker's body is reduced to its simplest terms. Age 39 was taken because it is the average age of workers who are injured in California.

"Table I" of the schedule for the rating of permanent disabilities presents some 306 injuries, each of which was carefully considered in its effect on the earning capacity of this standard individual. Certain injuries enumerated were in accordance with the provisions of the Act arbitrarily assumed to represent 100 per cent. disability, all other injuries were rated with reference to these 100 per cent. injuries and the degree of physical impairment determined. For example, it was decided that having regard to the 100 per cent. injuries, the loss of the major arm at the shoulder should not be rated as creating more than 60 per cent. permanent impairment for the standard worker. Consequently, 60 per cent. represents the standard rating for the loss of the major arm at the shoulder. The loss of an eye was considered as creating a 30 per cent. permanent impairment for the standard worker; consequently, 30 per cent. is the standard rating for the loss of an eye.

All ratings in "Table I" represent the degree of physical im-

pairment suffered by reason of the 306 injuries enumerated where the occupation is that of the standard, unskilled worker, and the age 39.

In considering the effect of occupation, five investigators were employed. Each investigator was given a particular industry group, and was required to make himself an expert in the work performed in the industry in general and in particular by the occupations which the industry represented. One investigator was assigned to the industry, "Wood and its Products"; another, to the industry, "Leather and its Products"; a third, to the industry, "Paper and its Products"; a third, to the industry, "Paper and Steel and their Products"; a fifth, to the industry, "Construction."

As soon as an investigator had completed his work in one field, he was assigned to a new field. These investigators made it their business to become expert in the work incidental to the occupation in the industry to which they were assigned. By reason of the authority given by the Act and the co-operation of manufacturers and other employers, it was possible to send the investigator into several different plants where work incidental to a certain occupation the investigator was studying was being performed. The investigator, in inspecting these plants, paid particular attention to the general method employed in manufacturing the product, and incidentally, to the work the worker in each occupation performed in this general scheme. It was his business to know what the worker in each occupation had to do.

In this way he studied the physical requirement imposed upon each part of the worker's body by the work incidental to his occupation. Several different plants were investigated in this manner in each occupation, in order to be certain that conditions of employment and physical requirement were the same everywhere.

During his study of the occupations, the investigator was constantly required to keep two things in mind. In the first place, he was required to compare the physical requirement imposed upon the parts of the worker's body with the physical requirement imposed upon the similar parts of the standard man's body. In this way, all occupations were referred to the standard occupation, in order that any difference in the relative use of a part of the body, or a function in a particular occupation, might be properly weighted. In the second place, the investigator was continually required to keep in mind that occupations would be classified according to the physical requirement, in order that the many occupations investigated might be reduced to as few classifications as possible.

In addition to becoming expert in his knowledge of the industry to which he was assigned, the investigator was required to interview employers and employees in order to gain a clear perception of what the worker himself and his employer considered the requirements imposed upon the various parts of the worker's body in the occupation under consideration. This information was used to supplement the investigator's own estimate of the physical requirements imposed upon the parts of the worker's body. Many thousands of employers were interviewed, and because of the great interest taken by the labor unions in the subject, it was possible to meet committees from almost all crafts represented. Usually five members of the union were appointed and were invited to discuss the question with one or more representatives of the Rating De-In addition to meeting representatives of the unions, partment. it was found possible to secure the co-operation of manufacturers' associations and employers' organizations, so that much valuable information was obtained from these sources.

In discussing the effect of occupation upon the question of rating permanent disability, employers and employees were never informed of the exact rating which had been assigned to the injuries for the standard man. The theory of schedule rating was used, and the investigator merely referred occupations to the standard occupation, rating them above or below standard for various injuries, according as the occupation required more or less use of parts of the body than the standard occupation.

Thus, employers were asked whether they thought that the work incidental to a particular occupation placed a greater or less physical requirement upon the lower extremities of the worker engaged in that occupation than the work incidental to the standard occupation. If the employer answered that the work incidental to the occupation considered certainly did impose a greater requirement than the work incidental to the standard occupation, an attempt would be made to have the employer name some percentage which he considered reasonable. Several estimates were obtained from employers and several from employees, and these estimates were carefully considered in rating occupations above or below standard for various injuries.

No information could have been obtained had the employer and employee been requested to give opinions of the degree of physical loss resulting from the amputation of various parts of the body. As an experiment, this method was followed on one or two occasions. Invariably the employer gave a ridiculously low percentage of permanent impairment, while the employee showed a tendency to rate the injury under consideration as high as he possibly could and still maintain a sort of rough relativity between the various degrees of physical impairment. It might be stated that the result of conferences with employers and employees merely served to form a reasonable estimate in the mind of the investigator. In a great many instances the information received could not be used because of an evident bias which entered into the discussion.

After carefully investigating some 1,300 occupations, it was found possible to create 52 different forms or classifications. In other words, while it was possible to send investigators into the field to find two or three different names for occupations, it was found in carefully considering the problem that there were really no more than 52 different occupations as far as the question of physical requirement was concerned. For the purpose of this classification by occupation in accordance with physical requirement, we were not interested, for example, in a distinction between an acid man, a furnace man, and a concentrating room man in connection with the manufacture of acids, for all of these occupations, while they have different names, are really one as far as the physical requirements imposed upon the various parts of the worker's body are concerned.

It was a rather difficult matter to establish these 52 forms for classification. The actual process involved many conferences, in which all of the investigators took part. At these conferences the investigator used his knowledge of the work incidental to the occupation under consideration to suggest classifications, and to classify occupations after a list of classifications had been created. The forms are numbered in the schedule from 1 to 52. In the work of classifying occupations these forms had particular designations by which they were known, some of which might be mentioned as follows:

One was called "Supervision over Process, plus." The work of

the occupation classified under this form involved the supervision of a process where the worker himself was required to perform labor incidental to the creation of the product. Another form was called "Supervision over Process, minus," where the worker performed no work incidental to the creation of the product. Both of these forms were then subdivided, making four forms in all, with reference to the question of carrying on the process on one or more floors. It was necessary to do this because of the fact that as the number of floors increased, the physical requirement imposed upon the lower extremities of the worker, and possibly upon his upper extremities, to some extent increased in like ratio. There were other forms for machine workers and people engaged in similar work.

For example, there was a class called "Stand on Feet, plus." The worker classified under this form was required to stand before a machine all day long and perform some special work with his feet, as tripping a machine, or operating a machine continuously with one foot or the other. Another classification was designated "Stand on Feet, minus." The worker here stood at the machine or at a bench all day long, never moving more than one or two steps from a certain place, but did not use his feet to perform any special part of his work. Then there was a classification "Plus on Feet, sit," where the worker was required to sit at a machine and use his feet, or to sit at a table and do some particular work with his feet. A further classification, "Minus on Feet, sit," where the worker merely performed certain work with his hands or eyes and never used his lower extremities in the performance of any particular part of his occupation.

It will be noted from the character of these classifications that 52 classifications of this sort are ample to cover the whole field of physical requirement in industries. All of the occupations investigated were readily classified under one of these 52 forms.

1

All of the occupations investigated are tabulated in numerical order in "Table II, Section 1" of the schedule. The proper occupational rating for injuries enumerated in "Table I" and occupations collected in forms is given for each injury and each form in "Table II, Section 2" of the schedule. The exact method of introducing the occupational factor into the discussion of establishing a permanent rating will be taken up later in connection with a discussion of the rating tables. "Table III" contains the rating tables, of which there are 17. The general scheme of taking into consideration injury, occupation and age, may be outlined somewhat as follows:

Table I takes into consideration the question of injury. Table II takes into consideration the question of occupation. Table III takes into consideration the question of age.

Of the 17 rating tables contained in "Table III," one table, "Table A" is the standard table; 8 tables are above standard, and 8 tables are below standard. The tables above standard are lettered, but may be termed Tables plus 5, plus 10, plus 15, and so on to plus 40. The tables below standard are lettered also, but may be termed tables minus 5, minus 10, and so on to minus 40. If, for example, it appeared that employers and employees were unanimous in stating that the work incidental to a given occupation involved a 25 per cent. greater physical requirement on the lower extremities of the employee in that occupation than the requirement imposed upon the lower extremities of the standard employee, the table plus 40, or "Table F," was assigned as the proper table to be consulted in rating injuries to the lower extremities for this occupation.

All of the occupations considered, grouped by forms, of course, were carefully rated by assigning tables above and below standard, according as the work incidental to the occupation required a greater or less use of the part of the body to be rated than the work incidental to the standard occupation. It will be found that structural steel riggers are rated for lower extremities in table plus 40, "Table I," that bookkeepers are rated for lower extremities in table minus 40, "Table Q." These two occupations represent the limits of physical requirement imposed upon the lower extremities. The lower extremities are extremely important in connection with structural steel rigging, and have little or no importance in connection with the actual work performed by the bookkeeper.

In taking into consideration the question of age in the standard table, it was necessary to use reasoning which was more or less abstract. An empirical formula was used to compute the ratings for age 39 and age 75. All other ratings were determined by simple interpolation between 39 and 75, and by simple extrapolation between 39 and 15. The underlying theory may be stated somewhat as follows:

268 SCHEDULE RATING OF PERMANENT INJURIES.

Age is an important factor in rating permanent disability, for the reason that as the age varies the power of accommodation varies also. Two limiting cases were taken. In "Table A" these limiting cases are represented by the unskilled worker of age 15 and the unskilled worker of age 75. The boy of age 15 is considered as having perfect power of accommodation, that is to say, if he receives an injury which bars him from following the occupation represented by this table, because of his youth, he has every chance to perform work in any one of a number of occupations where the loss he has sustained is either of no importance or of very much less importance than in the occupation represented by the table. The man of 75, on the other hand, is considered as having no power of accommodation at all. If he is injured, he is, because of his age, required to remain in the occupation in which he received the injury, which naturally causes him to fall to a lower earning groove. His power of accommodation we may represent by zero. The power of accommodation of a boy of age 15 we may represent by 1. It has been assumed that this power of accommodation is a simple function of age, and that it varies with the age, so that the power of accomodation of a man of age 45, midway between the ages of 15 and 75, may be represented by the figure $\frac{1}{2}$.

There are certain definite rules laid down for computing the relation between 15 and 75, which relations Professor Whitney used originally in determining the empirical formula which he used in comparing ratings for age 15 and age 75. These rules follow:

1. According to the law, a 100 per cent. disability is a 100 per cent. disability for every one, no matter what his age may be.

2. A 0 per cent. disability is, of course, a 0 per cent. disability for all ages.

These two rules determine certain factors from which the empirical formula may be derived. Enough points are not determined in this manner, however, to determine the locus of the conic section whose equation is the empirical formula we are looking for. It is necessary, therefore, to make one assumption, and, of course, the correctness of the schedule as far as age is concerned depends largely upon the correctness of this assumption.

Professor Whitney assumed that a 10 per cent. disability for a boy of age 15 should be considered a 20 per cent. disability for a man of age 75. In the actual construction of the schedule, Professor Whitney's theory was somewhat modified, so that as "Table A" stands, a 10 per cent. disability for a boy of age 15 is the equivalent of a $17\frac{1}{2}$ per cent. disability for a man of age 75. The formula as determined, which represents the relation between ages 39 and 75 in the standard table, is the following:

$$y=\frac{18x-5x^2}{13}.$$

Substituting for x, the values .01, or .05 or .10, or any other value, the value of y found from this formula will give the rating for age 75. Age 39 was used as the basis because it was desired to have the ratings under this age read 5:00, 6:00, 7:00, 8:00, 9:00 and so on.

As before stated other entries in "Table A" were obtained by simple interpolation and extrapolation. In this simple interpolation and extrapolation, the ratings were carried to $\frac{1}{4}$ of 1 per cent., the reason being that an attempt would be made to do this if the schedule had not been made thoroughly complete. The schedule might be criticized for carrying these ratings to such a degree of accuracy. However, one week's compensation is given for a quarter of one per cent. permanent disability, and it was found possible to formulate a rule whereby the rate of compensation could be easily determined if the ratings were written in the following manner: 20:1, 20:2, 20:3, 21:0. The numbers following the colon in each of these ratings represent quarters; thus, rating 20:1, represents $20\frac{1}{4}$ per cent.; the rating 20:2, $20\frac{1}{2}$ per cent., and so on. In each line of each table there are 31 entries, or ratings, for ages 15, 17, 19, 21, and so on, in order that Line numbers might be assigned to the injuries enumerated in "Table I." It will be remembered that the injuries in "Table I" are given a standard rating which represents the degree of physical impairment in each case where the occupation is that of the standard worker and the age 39. For all ratings up to 60 per cent., the Line number is 4 less than the percentage of disability for age 39. For example, a 20 per cent. disability for a man of age 39 requires the use of Line 16 in determining the ratings for other ages in "Table A." A 60 per cent. disability for a man of age 39 requires the use of Line 54 in determining the ratings for other ages in "Table A."

It is a very simple matter to translate the rating for the standard man to a Line number. As a matter of fact this has been done, and all of the ratings are given in "Table I" as Line numbers.

To return to the question of considering the occupational factor: The effect of occupation can be measured in our theoretical discussion only upon age 75, for the worker of this age has no power of accommodation. The boy of age 15, on the other extreme, being limited not to the occupation to be rated is able to turn to thousands of occupations in case of permanent injury. Consequently, ratings for age 75 are affected in the tables which follow "Table A." For example, "Table B," a plus 5 table, adds 5 per cent. to all ratings for age 75 in "Table A"; "Table I," a plus 40 table, adds 40 per cent. to all ratings for age 75 in "Table A"; "Table J," a minus 5 table, subtracts 5 per cent. from all ratings for age 75 in "Table A." The ratings for age 15 are never affected, for the reason that the boy of age 15 always has perfect power of accommodation, no matter in what occupation he may be working at the time of his injury. Ratings for age 75 in all of the tables are determined by adding or subtracting from the ratings for age 75 given in the standard "Table A." Other ratings in these tables are determined by simple interpolation, using values for age 15 found in "Table A," and the proper values for age 75 found in the table in which the values are to be inserted.

The limit of 100 per cent. was, of course, observed in adding to the ratings for age 75 in "Table A." Likewise, the limit zero was observed in subtracting from the ratings in "Table A." Consequently, it will be found that a great many Lines in some of the plus tables are exactly alike, and that the same is true for Lines in many of the minus tables. One peculiar fact which can, of course, be explained mathematically, will be noted in considering the rating tables:

Where the ratings for age 75 are not affected by the limit zero or 100 per cent., the ratings for age 39 increase in plus tables by 2 per cent. for each 5 per cent. increase on age 75. Thus, under Line 10 in "Table A," the rating is 14 per cent. for age 39, the corresponding rating in "Table B" being 16 per cent. In the minus tables, the ratings for age 39 decrease by 2 per cent. for each 5 per cent. decrease under the corresponding ratings for age 75 in "Table A." Thus, to use the example given above, the corresponding rating for age 39 for Line 10 in "Table J," which is the minus 5 table, is 12 per cent. To review the question of taking the occupational factor into consideration: Where it was the general consensus of opinion that the work incidental to a particular occupation imposed a 25 per cent. greater physical requirement upon the index finger of the worker engaged in that occupation than the physical requirement imposed upon the index finger of the standard man by the work incidental to his occupation, the table assigned to this injury was "F" plus 25, this 25 per cent. increase being measured on the man in the occupation who had no chance to get out of it, i. e., the man of age 75. In his case, an absolute 25 per cent. was added. In the case of the boy of age 15, nothing was added. For all other employees in the occupation to be rated between the ages of 15 and 75, a proportional amount was added; this amount, of course, varying with the age and in accordance with a fixed law of accommodation.

The following example illustrates the general method of rating permanent injuries under this schedule, and will perhaps explain certain parts of the foregoing discussion which are not absolutely clear:

Nature of physical injury or disfigurement: Loss of major arm at shoulder joint.

Occupation: Laborer.

Disability

Age: 38 years, 9 months.

Average weekly earnings: \$15.00.

The item of injury is taken first to consult "Table I" (a portion of which is given below), in order that the proper Line to be consulted in taking the item of age into consideration may be determined.

TABLE I.

TABLE FOR THE DETERMINATION OF THE PROPER LINE TO BE READ FOR EACH INJURY AND DISFIGUREMENT.

Number.	Li	ine.
VII- 1.	Irreducible fracture, or faulty union of collar bone, resulting	
	in decided limitation of motion of major arm	16
VII- 2.	Same as foregoing to minor arm	11
VII- 3.	Ankylosis (stiffness) of the major shoulder joint, not permit-	
	ting arm to be raised above a level with the shoulder	16
VII- 4.	Same as foregoing to minor shoulder	11
VII- 5.	Fixation of shoulder joint of major arm more severe than	
	above described	26
VII- 6.	Same, severe fixation of shoulder joint of minor arm	21
VII- 7.	Habitual dislocation of either shoulder as a result of indus-	
	trial injury	21

This Line, after it has been determined, remains fixed for each occupation. It does not matter what table the occupation determines as the proper one to be read, the line for each particular injury or disfigurement remains the same. From "Table I" the disability number is also determined, each injury being given a number in order that the schedule may be simplified later on by the... use of a number instead of a legend of some length. Upon consulting "Table I," it will be found that injuries are grouped according to the location of the injury. Each injury number is composed of two parts, a group number, which locates the portion of the body injured, and an injury number, which defines a certain degree of impairment or a certain injury to this part of the body. The group numbers are in Roman numerals and the injury numbers in Arabic numerals. In the particular case in question, we find that the group number is Roman VII, and the injury number, Arabic 8. The disability number, therefore, is VII-8, and the proper Line to be consulted for this is Line numbered 56. \mathbf{It} makes no difference what occupation is considered, Line 56 is always the Line to be consulted for this injury. The plus and minus tables in which this line may be read for various occupations, give various ratings for different ages. The exact reason for this has been carefully considered already. Having determined the proper Line to be read, the next item of importance is the determining of the proper table in which to read this Line.

Using the second item, the occupation of the injured person, we next consult "Table II," first division, from which the form number of this classification may be determined. Occupations in "Table II" (a portion of which is given below) are listed alphabetically, the form number being given opposite each occupation.

In the case in question, we find that laborers are all classified under Form 1. Having determined the form number for the occupation, we next consult "Table II," second division, from which can be determined the proper table in which to read Line 56 for the injury and the form. A portion of "Table II," second division, is given below.

.. :

TABLE II.-FIRST DIVISION.

TABLE FOR THE DETERMINATION OF THE PROPER TABLE TO BE READ FOR EACH OCCUPATION.

Occupation, L,	Industry.	Form No.
Labelers	.General	. 7
Laborers	.General	. 1
Lacquerers (Beds)	.Metal Working	. 4
Lacquerers (Fixtures, etc.)	.Metal Working	. 4
Lacing or Fly Leaf Machine Operators	.Paper and Products	. 8
Ladlemen (Steel)	.Metal Working	. 10
Ladlemen's Helpers (Steel)	.Metal Working	. 1
Lampblack Men (Gas and Electric)	.Heat, Light and Power	. 1
Landing Men (Logging)	.Wood and Products	. 1
Lard Can Crimpers (Packing)	.Provisions	. 2
Lard Fillers (Packing)	.Provisions	. 3
Lard Makers (Packing)	.Provisions	. 9
Lard Wipers (Packing)	.Provisions	. 3
Lasters (Hand) (Shoes)	.Leather and Products	. 3
Lasters (Machine) (Shoes)	.Leather and Products	. 2

TABLE II.-SECOND DIVISION.

TABLE FOR THE DETERMINATION OF THE PROPER TABLE TO BE READ FOR EACH OCCUPATION.

					Fo	rm 1	Jum	ber.				
Disability Number.	1	2	3	4	5	6	7	8	9	10	11	12
						Tai	ole.		_	_		
VII- 1. VII- 2. VII- 3. VII- 4. VII- 5. VII- 6. VII- 7. VII- 8	A A A A A A A A	K K K K K K K K K A	K K K K K K K K A	A A A A A A A A	A A A A A A A B	A A A A A A A B	K K K K K K K K K C	K K K K K K K K A		A A A A A A A		A A A A A A A A
VII- 8 VII- 9 VII-10 VII-11 VII-12	A A A A	A A A A	A A A A	A A A A	B B B A	B B B A		A A A A	A A A N	A A A A	A A A N	A A A A
VII-13	A	A	A	A	A		C	A	N	Â	N	A

It will be noted that injuries are designated in this table by the disability number. For each disability number and each form number there is a table letter, which represents the table in which the Line number which has already been determined is to be read in taking the item of age into consideration. In this case, we find that "Table A" is the proper table in which to read Line 56 for the given injury and occupation. We, therefore, turn to "Table III, A," which, by the way, is the standard table, and find upon consulting this table that the proper rating for Line 56 and age 39 is 60:0.

TABLE II	ц.	
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				A	ge.			
Line,	15	23	31	39	47	55	63	75
	Rating.							
51 52 53 54 55 56 57 58 59	$\begin{array}{r} 48:3\\49:3\\50:3\\51:3\\52:3\\53:3\\59:0\\64:3\\70:1\end{array}$	$50:3 \\ 51:3 \\ 52:3 \\ 53:3 \\ 54:3 \\ 55:3 \\ 61:0 \\ 66:2 \\ 71:3 \\ 1:0 \\ 1$	$53:0 \\ 54:0 \\ 55:0 \\ 56:0 \\ 57:0 \\ 58:0 \\ 63:0 \\ 68:1 \\ 73:2 \\ 73:2 \\ 73:2 \\ 75:2 \\ $	55:0 56:0 57:0 58:0 59:0 60:0 65:0 70:0 75:0	$57:0\\58:0\\59:0\\60:0\\61:0\\62:0\\67:0\\71:3\\76:2$	59:160:161:162:163:164:169:073:278:1	$\begin{array}{c} 61:1\\ 62:1\\ 63:1\\ 64:1\\ 65:1\\ 66:1\\ 71:0\\ 75:1\\ 79:3\\ 94:1\\ \end{array}$	$\begin{array}{c} 64:2\\ 65:2\\ 66:2\\ 67:2\\ 68:1\\ 69:1\\ 73:3\\ 78:0\\ 82:1\\ \end{array}$

RATING TABLES A to Q. TABLE A.

In this case, the employee is entitled to receive 65 per cent. of his average weekly earnings, \$9.75 per week, for a period of 240 weeks.

DIVISION OF PAYROLL.

E. C. DEKAY.

It has been held by many underwriters that classifications and rates for workmen's compensation insurance should apply only to industries as a whole, and that each risk should be written at a single rate, representing as accurately as possible, the average cost of carrying the insurance for that particular industry. This system, while making for simplification in both underwriting and statistics, would be most inequitable, as nearly every individual risk is bound to have conditions surrounding its operations, which are not found in others of a generally similar character.

The separate underwriting of each individual operation in a given industry, is equally undesirable, inasmuch as an unrestricted application of such a system would not only destroy the value of the statistics resulting from the experience of these industries, but would produce an infinite number of divisions, whose individual values should normally be considered as negligible. Such a method would not tend to establish statistics of real value, but would only result in unlimited abuses and greatly increase the cost of underwriting

In the old liability manual, arbitrary rules were made, and, where there were exceptions, these were treated separately. Something of this spirit still seems to prevail in the minds of those who were subjected to the old influences, and their considerations of classifications and rates are frequently colored by such memories.

We therefore have two extremes of opinion to bring into harmonious accord, if we are to create rules which will even partially insure accurate assignments of operations upon which the value of underwriting statistics must finally depend. Unless we can be reasonably sure as to what operations have been included in the experience reported under each manual classification, the compilation of loss ratios is bound to be more or less unsatisfactory.

The Massachusetts Commission to investigate practices and rates in insurance makes the following statement on p. 53 of their report dated April 22, 1915: "The great variety of the classifications of industries of the Commonwealth, together with the imperfect understanding of the rules and regulations as to payroll divisions, makes it possible for the unscrupulous or ignorant underwriter to completely destroy the all-important effects of uniformity," and on p. 50 the Commission states, "Since pure premiums are constructed from payrolls, it is very essential that the payroll audits disclose the actual facts as to the exposed payroll during the year. It is very essential, likewise, that employers be assigned to proper classifications, and that payrolls be not split as to occupations, in violation of manual rules."

The fundamental principle of payroll division was recognized in New York state by the adoption of a standard form of policy which authorized the use of fourteen divisions of payroll, enumerated in the declarations, and respectively designated by the letters A to O inclusive.* The difficulties, however, arose out of the necessity for a further distribution of operations under subdivision A, describing the "general business operations upon the employer's premises," and it is with this feature of the situation that the differences of opinion as to payroll division are chiefly concerned.

In endeavoring to formulate rules for the regulation of payroll division, it is necessary to combine the qualities of both strength

* These divisions were as follows:

A. General business operations upon the employer's premises, including all operative management and superintendence and all ordinary repairs and upkeep of machinery and ordinary repairs to buildings, not included in Divisions M and N.

B. Employees engaged in the erection, installation, repair or demonstration of the employer's product elsewhere than upon the employer's premises herein defined.

C. Executive officers of corporations.

D. Clerical force-exclusively engaged in office duties.

- E. Draughtsmen-office duties exclusively.
- F. Outside salesmen, collectors and messengers-wherever engaged.
- G. Drivers-wherever engaged.
- II. Helpers and others engaged in connection with vehicles.
- J. Chauffeurs-wherever engaged.
- K. Metal stamping-give number of hand-fed machines.
- L. Railroads-operation and maintenance.

M. Employees engaged in the repair, alteration and construction of buildings, structures or plants, except machinery.

N. Millwrights—erecting, repairing and removing machinery—not included in Division A above.

O. Blasting operations, including all employees connected therewith.

and flexibility. They must be rigid, and at the same time susceptible of such interpretation as will work justice to both the assured and the carrier.

The extremes which we must consider represent the classification by industries, on the one hand; and by individual occupations on the other. By using the industry as a base, and directing that any modification of its normal operations be subdivided under fixed rules, we should, in a great measure, eliminate the errors resulting from payroll divisions based on ignorance, or competitive expediency.

A very important criticism of various manual classifications has been made in regard to the inclusion within one classification of operations representing a combination of totally different hazards, such as "Brick Mfg.—including underground mining." Such classifications should be amended as speedily as possibly so as to provide for the underwriting of the unrelated hazards on a divided payroll basis.

In the first days of the operation of the New York Act, I thought that a restriction could be scientifically and equitably imposed, by limiting divisions of payroll, to subsidiary operations representing a fixed percentage of the total operating payroll, unless such subsidiary operation, even though it represented less than the minimum percentage, was in itself of sufficient volume to produce independent statistics.

To accomplish this object, the following rule was suggested:

"No division of payroll shall be allowed where the payroll of the subsidiary operation amounts to less than ten per cent. of the total payroll, exclusive of clerical; unless such subsidiary payroll amounts to \$2,500 or represents at least five employees."

Some of the underwriting experts, however, feel that this restriction would work a hardship to small employers, and that, where the conditions laid down in the proposed rules, are *all* existent, a division should be not only permitted, but *directed*.

To establish a uniform method of underwriting, the following rules are submitted, for consideration, with the belief that they represent a crystallization of the best ideas on this important question:

SUGGESTED RULES FOR PAYROLL DIVISION.

Definitions.

Not Available for Division of Payroll.—This term when used as a part of a manual classification, means that the classification so qualified shall not be used for writing business, unless such classification is in itself the governing classification.

Governing Classification.—The governing classification of a risk is defined as that classification which carries the largest amount of payroll, disregarding all items under subdivision B to O, inclusive, in the declarations.

Incidental Operations shall be taken to include all the operations which normally prevail in the business industry or employment represented by the governing classification, and are not separable under the rules for underwriting subsidiary operations.

Subsidiary Operations shall be taken to mean such operations of the assured as are properly described by existing manual classifications and which may or may not be incidental to the governing classification.

Separable.—In order that a subsidiary operation of an assured may be considered as separable, *all* of the following conditions shall obtain in connection therewith:

1. Separate payroll record.

2. Separate as to location, regardless of whether such separation of location be by buildings or portions thereof.

3. Separate as to exposure to operating hazards with no interchange of employment.

DIVISION OF PAYROLL REQUIRED.

1. Where the general business operations of the assured combine one or more subsidiary operations which conform to all three requirements of separability, such operations shall be underwritten on a divided payroll.

2. The manufacture of containers shall, wherever such operations are conducted in accordance with the above rules, be separately underwritten.

3. Stevedoring operations connected with the handling of the assured's materials or product, shall, under similar conditions, be separately underwritten.

NO DIVISION OF PAYROLL.

1. No division of payroll shall, under any circumstances, be allowed for a subsidiary operation whose payroll amounts to less than \$500 per annum, or represents less than one employee.

LIABILITY LOSS RESERVES.

I. M. RUBINOW

The unstable condition of liability insurance and the lack of experience and precedent in workmen's compensation insurance are quite naturally matters of deep concern, not only to those engaged in the branch of the insurance business, but also to the government officers entrusted with the duty of supervision. Side by side with efforts to keep the cost of insurance down, and thus prevent excessive waste, efforts must be made to keep the insurance organizations solvent, and thus protect the interests of the assured and the injured workmen. The new state organizations for supervision of insurance rates, are more frequently called upon to keep premiums up against the onslaught of ruinous competition, than to keep them down against the efforts of rate-making combinations.

The establishment of solvency of an insurance company, and especially of a casualty company is not a simple matter, with millions of advance receipts and millions of deferred obligations, many of which are altogether unknown, and others uncertain. The supreme test of solvency is in the reserves, and primarily the reserves for outstanding losses. Many different methods of ascertaining the loss reserves of casualty companies have been tried within the last decade. It is not necessary to go here into a description of these methods, for this has recently been done in the extremely interesting pamphlet* of Mr. Frank E. Law, Vice-President of the Fidelity & Casualty Company, who is particularly qualified to discuss this important problem because of his own activity in the shaping of the laws as they stand in the statute books of many states at present. The significant situation at present is the gradually growing feeling that the loss reserves as computed by the method established only a few years ago, and at present required in the majority of states, are often insufficient. This was officially announced a few years ago by Hon. W. T. Emmet, then the New York State Superintendent of Insurance, as follows:

"''A Review of Liability and Workmen's Compensation Loss Reserve Legislation.''

"There can be no question of the inadequacy of the reserves produced by the new liability loss reserve law, nor of the desirability of so amending it that it will produce reserves entirely adequate for the purposes intended."* In view of this statement, new legislation on the subject of liability and compensation loss reserves may reasonably be expected. The whole subject must, therefore, be considered anew in the light of recent experiences, and the time is propitious for suggestions as to a proper basis for the more exact computations of the loss reserve.

The first step in the inquiry is to ascertain how successful or unsuccessful is the present law in accomplishing its purpose. While this is not a simple matter, and one may not be absolutely sure of his results, certain conclusions the writer has arrived at seem to be fairly justified.

How are we to judge of the adequacy or inadequacy of the legal reserve? The law says: you are to make certain prescribed and complicated computations and to put away as a reserve the figure arrived at. How is anyone to know that that sum is sufficient for the purposes intended?

Evidently one method is to compare the figure so obtained with the sum of individual estimates on losses outstanding which are kept by nearly all large casualty companies for their own use, mainly as a check upon the work of the adjusters. In the cases of some companies such a comparison is made. The results of the comparison differ, however. The company may find that the sum. of its individual estimates is greater than the legal reserve demanded, and as a result it may put aside the difference as a voluntary reserve.

Another company may have an entirely different experience. Thus Mr. Law finishes his interesting study with the following statement:

"In the case of the Fidelity & Casualty Company the reserve by the method of loss ratios with suit test at December 31, 1912, was \$1,486,449.96 while by the method of individual estimate it was \$1,099,688, a difference of \$386,781.96. This is significant."

It is difficult, however, to appraise the real significance of this comparison until more is known of the accuracy of the individual

*Statement made before the National Convention of Insurance Commissioners at Spokane, Washington, July, 1912. (See Frank E. Law's pamphlet, p. 30.) estimates. Evidently, positive and definite information cannot be had until all the cases for which individual estimates had been made have been disposed of, which may take many years.

In discussing the necessity for revision of the loss reserve law, only the adequacy of the reserves is usually considered. As the loss reserve laws came primarily in response to a demand for a better guarantee of solvency, the efforts were directed only towards increasing the reserves. Thus, for instance, Mr. Law says: "The law has produced results of value. The companies in general are carrying higher reserves than before its passage, and by so much the policyholders are in a safe position." Nevertheless, it is obvious that excessively high reserves are equally undesirable. Reserves are used not only for purposes of determining solvency, but also for the computation of the underwriting results. The business being one of advance receipts and deferred liabilities, it is impossible to determine the underwriting result, or to be more explicit, the profit and loss, without reserves. An undervaluation of outstanding liabilities will show a fictitious underwriting profit, and cause perhaps an unjustifiable optimism, which in its effect upon dividends and rates may work untold harm to the business. But an overvaluation of the outstanding losses, by unduly reducing the underwriting profit, must also have its effects. If it should occur in all companies, it would have its effect upon the rates, for the companies must necessarily try to adjust premiums to the losses. and thus increase the cost of insurance.

The reserve law in force at present is known as the method of loss ratios with suit test. This reserve law is based upon the following assumptions:

1. That for each company there is a fairly definite loss ratio, based upon its methods of underwriting.

2. That while it may differ very much between one company and the other, for each other it remains fairly permanent.

This being so it is but necessary to determine for each company what its ultimate loss ratio is, and having ascertained that, reserve for each year's business as much as has not yet been paid out.

As it takes about seven years for all the liability losses of any one year's underwriting to mature, the loss ratio of the company must be determined from the experience of several years back. The law requires the experience of a five years' period five years back. Thus for the 1914 reserve the five year period, 1905-1909, must be taken as a basis. The loss ratio for that period having been ascertained, it is applied to each one of the five years following, namely, The probable loss is computed from the earned 1910-1914. premiums on each year's policies, by applying to it the theoretical loss ratio, and by subtracting from the probable loss the payments already made, the remainder is to be set aside as a reserve. That is the method of "loss ratio." In addition there is a "suit test" for the first three of the five years. It is assumed that most claims developed from policies issued more than two years ago have become suits; and from past experience it is further assumed that the average cost of settling a suit is to be about \$750. If the remainder computed by the loss ratio method does not prove sufficient to provide \$750 for each suit outstanding, a sufficient amount must be set aside to equal this \$750 per suit. If the remainder is excessive it must nevertheless be set aside as a whole. In other words of the two amounts separately computed (remainder, or difference between probable loss and loss already sustained, and \$750 per suit) the larger must be set aside for the three years 1910-1912. This suit test is not applied to the last two years' business, since many claims have not yet developed into suits and the average cost of recent suits is smaller.

Finally, if any suits are still outstanding on policies issued from five to ten years ago, \$750 per suit is set aside as a reserve, and if there are any suits over ten years old, \$1,000 per suit.

This being the law, the reserve in each of the preceding ten years' business may be analyzed. It may be impossible to ascertain on December 31, 1914, whether the reserve of December 31, 1913, on 1913 business is sufficient, but for the old years there should be no such difficulty.

Taking the experience of nine large casualty companies as disclosed in their 1913 and 1914 financial statements, the following comparisons have been made:

1. For suits outstanding on policies issued earlier than 1905, a reserve of \$1,000 per suit is required. Thirty-seven suits were outstanding on December 31, 1913, for policies issued in 1903 and 1904. By December, 1914, the number of suits outstanding in the same companies was 19, showing that 18 suits were closed. What payments were necessary to effect this?

Total payments on policies issued in 1903 and 1904 for nine large casualty companies:

By December 31, 1913	12,621,375
By December 31, 1914	12,674,628
Payments made in 1914	53,253

This places the average cost of a suit of 1903 and 1904 as \$2,958 nearly \$3,000 or three times larger than the legal reserve provided for by law.

2. Taking the five years 1905-1909 the total payments in the policies issued during those years by December 31, 1913, amounted to \$54,296,687. By December 31, 1914, the payments on the same years' account had increased to \$54,979,801. In other words during 1914 \$683,114 was paid in losses on policies written from 1905 to 1909 inclusive (Table I).

Years of Issue.	Total Payments by Dec. 81, 1913.	Total Payments by Dec. 31, 1914.	Payments During 1914.
1905 1906 1907 1908 1909	8,950,546 10,534,125 10,442,211 10,368,605 14,001,200	9,002,199 10,570,989 10,531,799 10,568,984 14,305,830	51,653 36,864 89,588 200,379 304,630
	54,296,687	54,979,801	683,114

TABLE I.

For these five years' business 1,021 suits were outstanding on December 31, 1913. By December 31, 1914, there remained on the same years' business 527 suits outstanding. It is reasonable to assume that no (or very few) new suits were created in 1914 on policies written from five to ten years earlier. It follows, therefore, that 494 suits were settled. These cost \$683,114 or over \$1,400 per suit—nearly 85 per cent. more than the reserve required by law (Table II).

TABLE II.

Suits Outstanding Dec. 31, 1913.	Suits Outstanding Dec. 31, 1914.	Number of Suits Closed.	Average Cost per Sult Closed.
36	15	21	\$2,460
139 139	71	40 68	922 1,316
471	143 244	138	1,452 1,342
1,021	527	494	1,382

The analysis establishes that the requirement of an average amount of \$750 in suits outstanding policies over five years old is inadequate, since the average cost is so very much higher.

The test of the reserves on the recent years is more difficult. In these recent years new suits are created, even new claims arise, and on the other hand a good many additional premiums arise, as some of the policies run over the period. For the years 1910-1913, therefore, the comparison must be made by a somewhat different method (Table III).

TABLE III.

	Years of Issue.							
	1910.	1911.	1912.	1913.				
Payments up to Dec., 1914 Payments up to Dec., 1913	16,946,680 16,017,848	$16,223,328 \\ 14,581,749$	18,127,816 14,140,677	$14,481,591 \\ 5,014,215$				
Payments made in 1914	928,832	1,641,579	3,987,139	9,467,376				
Reserve of Dec. 31, 1914	462,800	1,036,555	2,556,883	4,366,441				
Total	1,391,632	2,678,134	6,544,022	13,833,817				
Reserve of Dec. 31, 1913	916,676	1,929,120	4,640,315	3,462,211				
Difference	474,966	749,014	1,803,707	10,371,606				
Additional premiums earned	70,656	86,058	1,354.596	8,826,541				

In regard to each one of the four years the same condition prevails: The payments made during 1914 added to the reserve at the end of the year exceed the reserve at the beginning of the year by very substantial amounts.

As against this apparent loss the item of additional earned premiums must be taken into consideration as shown in the last line of the table. This item is most important in the last year's issue. Naturally almost all policies written in 1913 were in force at the close of 1913 and part of their premium unearned.

But the evidence furnished by this table is not conclusive. It is impossible to state with certainty that the reserves as on December 31, 1913, were inadequate, because the reserves at the close of the following year may be overestimated. Moreover, in regard to the last year in the table, the final results depend largely upon what happened in 1914, and not in 1913, while it is obvious that the reserves of 1913 must be judged only by what happened prior to the close of that year. In a slighter degree that is true even of the results for 1912.

Therefore, to check up our conclusions, a more detailed analysis of the results by separate years of issue becomes necessary.

1910. The reserve as per December 31, 1913, amounting to \$916,676 was intended to provide for 1,211 suits. There may have been some other claims not yet maturing into suits, but their number could not be very great. The reserve amounted therefore to \$757 on an average. By December 31, 1914, the number of suits outstanding was reduced to 608; showing a closing of 603 suits. The payments on these amounted to \$916,676 or \$1,520 per suit. Table III indicates a deficit of \$474,966 on that year. That is as far as the developments of one year indicate. If we are to assume that the remaining 608 will also cost about \$1,500 per case (and the cost of outstanding suits is not improving with age) then the reserve on December 31, 1913, should have been some \$1,816,500 and the actual amount was only a little over 50 per cent. of that amount. The additional premium earnings represented scarcely 8 per cent. of the deficit, and after commissions have been deducted perhaps only 6 per cent.

1911. The situation is somewhat similar though perhaps less striking. Disregarding claims not suits, the average reserve per suit on December 31, 1913, was $(1,929,120:1,976 \Longrightarrow)$ \$976 and would therefore appear ample. On December 31, 1914, the reserve per case was $(1,036,555:984 \Longrightarrow)$ \$1,053 or only slightly higher. The number of suits closed was 992 or about one half. Other claims, not suits, must have been settled and altogether not over one half the liability was disposed of. This cost \$1,641,579, which equalled 82 per cent. of the total reserve. Evidently the reserve as on December 31, 1913, was altogether insufficient, and probably the amount set aside on December 31, 1914, is still below the mark.

1912 and 1913. For the last two years there are so many claims in addition to suits that without knowing the actual figures an analysis of suit statistics alone is insufficient as a test. So many claims on policies of these years' issue may have turned into suits during 1914, that it is impossible to ascertain how many suits were closed. Yet the following facts are significant:

The reserve on policies of 1912 at December 31, 1913, amounted to \$4,640,315. Yet the payments in 1914 alone amounted to \$3,-987,139 or almost equalled the reserves. It is true that an additional income from earned premiums of \$1,354,596 was available, so that the loss payments minus this income (with adjustment for commissions, etc.) were about \$3,000,000. The question as to whether the reserves on December 31, 1913, were sufficient or not depends upon the reserves on the same year's business at December 31, 1914, being excessive or not. After the close of 1914 the additional premium income to be expected is slight. There were outstanding on December 31, 1914, on policies of 1912, compensation claims to the amount of \$574,587 according to individual estimates of cases. This left as reserve for liability claims only \$1,972,296 which was to cover the liability on 2,156 suits, providing on an average about \$915 per suit. Since we found that the suits of 1911 year's issue closed in 1914 cost on an average \$1,053, and that the suits become more expensive as they grow older, it is quite evident that a reserve of \$915 per suit will surely not be excessive in 1915. Thus the inadequacy of the reserves as on December, 1913, is established.

As to the reserve for the current year's policies, it is somewhat difficult to judge. But at any rate it is significant that taking the experience of any year's issue, the loss ratio constantly rises from year to year. We have taken the year 1911, and computed the combined loss ratio of ten casualty companies. In computing the loss ratio only the earned premiums were considered and the legal loss reserve was added to the loss payments and loss expense.

The results indicate that the loss ratio in the policies issued in 1913 was:

On	December	31,	1911	• • •	 			• •	• •	••	• •		••	•••	•	44.5
On	December	31,	1912		 			••	••	••			••	••		56.3
On	December	31,	1913		 		•••				• •	• •	••		•	58.8
On	December	31,	1914		 	•••		••	••	••						61.3

This rising loss ratio can only be explained by the insufficiency of reserves and the increase in the loss ratio being greatest in the second year, seems to prove that the reserves on the last year's business are most inadequate.

It has thus been established that on the whole the loss reserves are insufficient and that neither the average reserve of \$750 per suit, nor the assumed loss ratio are supported by actual conditions. But this does not complete the indictment against the present reserve law. In the statistical computations given above the totals for ten of the largest companies were used, and averages derived from, such totals. It would be obviously improper to draw attention here to individual companies. But it is quite evident that the purpose of reserve laws is not to make reserves sufficient on an average, but individually for each company, since the solvency of one company does not help in case of insolvency of the other.

Now the reserves of each company are based upon two factors, (1) a uniform suit reserve of \$750 and (2) a variable loss ratio for old companies, and a uniform ratio of 50-55 per cent. (in 1914-53 per cent.) for companies less than ten years old.

Let us subject both these factors to some test of actual results. Five hundred and thirteen suits on issues of 1903-1909 were closed by ten companies in 1914. The cost of these was \$706,367 or \$1,377 per suit. But for individual companies the average cost per suit fluctuated between \$627 and \$2,706 as follows:

Company.	Outstanding Suits Closed in 1914.	Average Cost.
1	18	\$ 627
2	74	689
3	67	1,156
4	128	1,383
5	59	1,415
6	35	1,497
7	23 ·	1,824
8	52	1,843
9	52	1,965
10	5	2,706

This seems to furnish fairly strong evidence that one average for all companies is misleading.

The long and short of this is that the reserve computed on the basis of a uniform loss ratio is likely to be accidental—either accidentally small, or accidentally large. As the loss ratio is admittedly inaccurate, more dependence is placed upon the suit test. But it is very easy to point out a number of reasons why a uniform average allowance per suit is not satisfactory.

1. The method is altogether inapplicable to compensation business, and this is already recognized, the financial statements requiring individual estimates on outstanding compensation cases.

2. It is a well-known fact that while legally a liability policy indemnifies only against judgments, most claims are never permitted to go to suit, but are settled in advance. The number of suits does not at all represent the full liability of a company.

3. The proportion of claims going to suit is not uniform for all companies. Usually companies have very different experiences in that respect. Some are known to prefer early settlements, and attorneys may delay entering suits in the hope of affecting an amicable settlement. Others are known to resist payments stubbornly, and in their experience suits accumulate even on the slightest claims.

If then neither the method of an arbitrary average per suit nor that of assumed loss ratio seem to give satisfactory results, the indications are that it may be better to accept some method of valuation of the actual claims outstanding, as is done for all other branches of casualty insurance.

It is admitted that this method may be used in regard to compensation claims. The law in regard to a compensation claim is specific. Granted that all factors in connection with an accident are known, the amount of benefits and of the present value of future payments permits of a fairly accurate computation. The application of actuarial principles may give proper consideration to the effect of mortality, or remarriage, to compound interest, and make for still higher accuracy. Errors of course are possible, but with an increased experience they should not be great. The individual errors should cancel themselves to a large extent, and in large volume of business the total estimate should not be very far from the true cost.*

In liability cases the accurate estimating of the final cost presents greater difficulties. But it is not impossible. In fact ability to estimate accurately is a necessary requirement of an adjuster, not only because without such estimating a company is entirely at sea as to underwriting results, but because an adjuster really cannot make satisfactory adjustments unless he can fairly accurately estimate the probable cost of cases.

And for this reason: theoretically a liability policy is an indemnity policy. The casualty company undertakes to indemnify the assured for judgments against him arising out of personal injury liability suits. Practically, however, it is well known that a casualty company which should refuse to assume any liability until the time when the judgment should be rendered would go bankrupt in a very few years. The vast majority of claims must be settled

* There seems to be an almost unanimous agreement that this should be done on older compensation cases. The question at issue is whether it can be done for recent cases, where information is neither complete and final, and therefore actuarial valuation either more difficult or altogether impossible. in advance of the trial or even law suit, and in accomplishing this the adjuster must not be in the dark as to the probable cost of the case. The bargaining is not always between an expert adjuster and an inexperienced injured. More frequently it is between two expert lawyers. If the adjuster should persistently overestimate the probable cost of claims, this would undoubtedly tend to extravagance in settlements. If the tendency should be systematically to underestimate, the adjuster will find himself in the position where he cannot effect the settlement at all, and the number of suits will increase, thus eventually resulting in higher losses.

Assuming then, that every large casualty company must have a system of individual estimates of its outstanding liabilities and an organization of persons capable of making such estimates, why cannot the total sum of such estimates be used to determine the loss reserve?

Of course, some obvious objections may be raised. Granted claim officers who are able to make good accurate estimates, and granted a management willing to present the actual state of affairs, without any intention to misrepresent them, the method of individual estimates may work. But either of these conditions or both of them may be absent. The estimates (and the total loss reserve dependent upon them) may be erroneous, and again they may be wilfully wrong.

This is so evident that unless the writer had a remedy for it, he would have refrained from making any of this argument. If a check upon individual estimates were impossible, the method would be worthless.

But as a matter of fact a check is possible, and does not appear too difficult. By means of this check of accuracy, a method may be devised to control almost automatically the accuracy of the true loss reserve as computed by the company.

This is the essence of the constructive suggestion offered here.

First as to the check. In the present blank, schedule O demands this check for all other lines except liability. The omission of liability and compensation in this table is, in my opinion, a very serious error. The table requires information as to estimates made on cases outstanding at the beginning of the year, and payments made on such cases during the year. If compiled accurately—and that of course is subject to audit of the state's authorities—it will show whether the previous year's reserves were sufficient, excessive, or approximately correct. A similar statement can be compiled for the liability and compensation estimates, is in fact compiled in some companies to test the accuracy of the estimates. Thus a method exists for checking up the accuracy of the liability reserves.

Such a check will demonstrate whether any tendency exists to minimize or exaggerate the loss reserves. Suppose it demonstrated that the losses were 10 per cent. higher than the reserves provided for. It may be established therefore that the company's rate of underestimating was 10 per cent. and therefore, its estimated reserves should be increased by 10 per cent. If the tendency is in the other direction then the reserves derived from individual estimates would be decreased. In this way an automatic formula would correct the estimates of the insurance company, and in addition there could be a stimulus for the making of fairer estimates.

In applying this method, another difficulty may be met: all outstanding liability cases are not settled within one year, so that the check upon the reserve of one year will not be complete by the expiration of the next year.

Assuming, for instance, that 1,000 cases were outstanding on December 31, 1913, and of these 750 were closed during the year 1914, and 250 remained outstanding on December 31, 1914, how can a proper check of the reserve of 1913 be made? The results are known only as far as the closed cases are concerned. But it would evidently be improper to have the coefficient of accuracy on such cases only, because the tendency is always for the early settlement of easy cases, where a saving can be effected against the original estimate, while on the more serious cases settlement may be postponed for a long time. If based upon the closed cases only, the results of the test might appear too favorable, and therefore, in the case of the open claims the estimates on these, after thorough review, must be included.

In other words, the reserve would be equal to the estimates made by the company $(R_n^n \text{ standing for the reserve on December 31, of}$ the vear on cases outstanding on that date) multiplied by a factor

$$\frac{P_{n-1}^n + R_{n-1}^n}{R_{n-1}^{n-1}}$$

(proportion of payments made in the year n on cases outstanding at the end of year (n-1) (P_{n-1}^{n}) plus estimated reserve at the end

of year n on cases still outstanding from the year n-1, to the estimates outstanding at the end of the preceding year).*

The necessity of including estimates on old reserve cases introduces an additional complication. These cases belong to the old reserve. Being over a year old, they have usually developed so that their expected cost may be better estimated than the year before. But if a conscious effect at underestimating them should be made this not only would reduce the new reserve, but also minimize the error of the preceding year's reserve.

It is possible to meet this difficulty by taking into consideration the check not only upon the last year's reserves, but also that of the preceding year, in other words, by getting the advantage of two years' experience. In two years such a large proportion of the outstanding cases is settled that the results are almost final and will not be subject to very much change. Besides the comparison of results of the two preceding reserves will produce an additional automatic check.

Let us assume for instance that at the close of 1913 a company with a tendency for underestimating shows a reserve of \$500,000, while as a matter of fact the outstanding liabilities would be nearer to \$750,000. By the end of 1914 some 70 per cent. of the claims are settled by a payment of \$400,000, and the remaining 30 per cent. with an original estimate of \$150,000 may appear to be worth \$350,000. If the estimate made at the end of 1914 is adequate, then the results of 1913 reserves by the end of December, 1914, will appear as $\frac{$400,000 + $350,000}{500,000} = 1.50$. In other words the results of the results of 1012 mill indicate that the animined estimates of

of the reserve of 1913 will indicate that the original estimates of the Company should be increased by 50 per cent. As a matter of fact the Company will not of itself indicate the full amount of the underestimating of the preceding year. It is possible that the outstanding cases of the 1913 reserve will be valued on December, 1912, as say, \$200,000 and the formula will be

$$\frac{400,000+200,000}{500,000} = 1.20,$$

* The writer has no apology to offer for the awkward symbols, except that there is as yet no accepted set of casualty insurance symbols. The appointment of a Committee on Terms, Definitions and Symbols by this Society promises that in the near future the situation will be remedied and there will be no necessity of inventing new symbols for every paper.
and the correction will be 20 per cent., which may be insufficient. In another year most of the cases of 1913 will be settled. By December, 1915, the results of the underestimating of 1913 may appear to have been 40 per cent. and of the underestimating of 1914 20 per cent. This should indicate the correction of the 1915 estimates by $\frac{40+20}{20} = 30$ per cent.

The evident result of such a system would be that the knowledge that results of estimating on outstanding claims are subject to frequent checks will make the work estimates very much more careful. Insofar as some companies should persist in systematically underestimating, the formula will necessitate an automatic loading. The only way of avoiding the loading of the outstanding liability, as a punishment for past underestimating, will be to make an effort at more liberal estimating of outstanding liability. The formula then briefly is this:

The reserve at the end of the year is equal to the total of estimates on outstanding cases multiplied by a factor, equal to one half the sum of the following two quantities:

1. Payments on cases outstanding a year before (P_{n-1}^n) plus estimates on open cases outstanding since a year before (R_{n-1}^n) divided by reserve set aside a year before (R_{n-1}^{n-1}) , i. e.,

$$\frac{P_{n-1}^n + R_{n-1}^n}{R_{n-1}^{n-1}}.$$

2. Payments during two years on cases outstanding since two years ago $(P_{n-2}^{n-1} + P_{n-2}^{n})$ plus estimates on cases outstanding since two years ago (R_{n-2}^{n}) divided by reserve of two years ago (R_{n-2}^{n}) , i. e.,

$$\frac{P_{n-1}^{n-1} + P_{n-2}^{n} + R_{n-2}^{n}}{R_{n-2}^{n-2}}$$

The mean of the two ratios may be applied to the sum of the total estimates. The result may not be absolutely correct; but it will have the effect of counteracting any tendency to error in either direction. If the Company's claim department is inclined to overestimate, the formula developed above will effect a reduction; if the company should try to underestimate the result of this method will be to increase the reserve.

Finally, the question remains how to reserve for the cases which

do not appear to be claims at the end of the year, what may be called the "hidden liability." This may consist of cases under the following three groups.

1. Cases supposed to have been finally settled, which may be reopened on various legal grounds.

2. Accidents reported and known to the company, but which appear to be trivial, or for any other reason not likely to develop into claims, but do so develop during the next year, and

3. Accidents altogether unknown on the last day of the year because of the delay either in the making and transmission of the report.

The "loss ratio" method pretends to cover all these cases, while the method of individual estimates does not, and this seems to be an additional difficulty in the way of the method suggested here. But the difficulty is a seeming one only. It can be met in a variety of ways.

1. It is doubtful if it is really necessary to reserve for this hidden liability. As against it each casualty insurance company has much larger hidden asset in premiums earned but not yet reported by the employers. Of the additional premiums collected on payroll audits during the first six months of any year, some 50 to 60 per cent. have probably been earned during the preceding year.

2. If, however, it is not thought desirable to disregard the hidden liability because of the hidden assets, the amount can be easily computed from the experience of the preceding years. From actual calculation the writer is convinced that this hidden liability, though depending upon a variety of fortuitous circumstances, fluctuates but little from year to year. It may be affected by a sudden increase or decrease in volume of business, but then it will remain in a definite constant percentage to payments made during the preceding year.

3. Finally, all these cases may be automatically provided for in the formulæ above given, by a slight modification of the definition of the terms P_{n-1}^n and R_{n-1}^n .

If P_{n-1}^{n} be defined to stand for all payments made in the year n on all accidents occurring before the close of the year n-1, and R_{n-1}^{n} similarly be defined to stand for the estimates at the end of the year n on cases occurring before the close of the year n-1, whether, in either case, those cases had been included in the reserves for the year n-1, the correction for the hidden liability will be

included in the one factor by which the estimates of the year will have to be adjusted.

It may be added that the method here suggested is one of extreme simplicity. It does not require any additional labor. Each casualty company should (and most do) compile its own estimates for the purpose of checking the so-called legal reserve. Each company should (and a good many do) check the accuracy of its estimates by comparing them with payments made on the cases in subsequent years. Each company should (and a few do) make an effort to ascertain the value of its hidden liabilities as well as its hidden assets.

Moreover, the present mechanical methods of statistical tabulations make such checks very simple and inexpensive. By the simple expedient of punching the date of the accident on the card carrying the payment, can the payments on all reserve cases be segregated. Often it can be done even on the basis of the accident number alone. Thus considerations of accuracy, speed, simplicity and cheapness can all be brought forth in support of the plan here outlined.

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DISCUSSION OF PAPERS.

ORAL DISCUSSION, MAY 19, 1915.

SCHEDULE RATING OF WORKMEN'S COMPENSATION RISKS.

THE PRESIDENT: The floor is open for the subject of schedule rating, which is the main topic for to-day.

MR. FISHER: Mr. Hansen is to be congratulated for the lucid and instructive paper he has presented to the society, and criticism of any kind seems rather superfluous. There is, however, one statement to which I from the standpoint of mathematical statistics take a somewhat skeptical attitude. Mr. Hansen says in part: "That the effect on the human body of an accident from a given cause under similar conditions is the same whether it occurs in Europe or in the United States, a fact which should dispel in the minds of some gentlemen the idea that European statistics are necessarily dangerous. If properly used these foreign records which are known to be authentic and scientifically compiled would undoubtedly prove of great value to the solution of our problems as to accident frequency were it not for our hesitancy in availing ourselves of them."

In the complete absence of numerical data and mathematical criteria in support of this rather sweeping statement it seems to me that further light ought to be thrown on this vital question. Every statistical investigation consists of two distinct operations. First the collection and tabulation of the statistical data, secondly the analysis of the material. The first part belongs to the practical statistician, the second-and by no means the least important-to the domain of mathematical statistics. The rapid development of this science during the last five or ten years through the researches of the English biometricians and the Scandinavian statisticians has placed a very powerful, and at the same time a very sensitive, instrument in our hands in the analysis of the statistical mass series. The chief characteristic of a statistical series are the mean, the dispersion, the Lexian ratio, the Charlier coefficient of disturbancy, the skewness, the excess and the coefficient of correlation.* A good many statisticians-not to say the majority-have contented themselves with the use of the mean, applying only once in a great while the dispersion. Neither of these two characteristics suffice, however, to explain fully the variations-periodically and otherwise-of the series. I shall illustrate this by a simple example. A recent investigation of the number of twin births in Sweden from 1881-1900 resulted in a mean equal to 2,015 and a dispersion equal to 95.2. A similar computation for a small Swedish city of about 20,000 people gave a dispersion of 4.7. This would at first sight seem to indicate that the

^{*} These quantities are fully discussed in my forthcoming book "The Mathematical Theory of Probabilities and its Application to Frequency Curves and Statistical Methods," to be published by the Macmillan Company, New York.

occurrence of a twin birth was much more regular in the small town than in the whole kingdom. Yet no *a priori* reasons are evident why the causes governing the twin births should be more stable in that particular city than in the kingdom as a whole. The Swedish statistician and astronomer, Charlier, has, however, recently introduced a quantity known as the *coefficient of disturbancy* which furnishes a powerful and sensitive criterion in measuring the fluctuations to which a statistical series is subject. The Charlier coefficient is denoted by the symbol 100ρ , where

$$\rho = \frac{\sqrt{\sigma^2 - \sigma_B^2}}{M},$$

 σ being the actual dispersion, σ_B the Bernouillian dispersion equal to $\forall sp_0q_0$, and M the mean of the statistical series. Now for a value of ρ equal to or close to zero the series follow the simple laws of probabilities as given in the Bernouillian Theorem. For larger and real values of ρ the fluctuations in the statistical material will be greater than the fluctuations in games of chance as exhibited in the Bernouillian Theorem, while for imaginary values of ρ the series is exceedingly stable and subject to small fluctuations only. The Charlier coefficient for the above mentioned series of twin births gave a value equal to 4.17 for the whole country and 3.69 for the smaller town, which goes to show that the perturbating influences were practically the same.

In accident statistics it is different, however. A preliminary investigation I undertook some time ago in regard to accidents and length of period of disablement from the statistics of Scandinavian, German and Austrian shipbuilding plants showed that the Charlier coefficient for Austria is much greater than the other countries, clearly indicating that the perturbating influences are much greater in the dual monarchy. Below I give some preliminary calculations as to fatal coal mine accidents in various countries showing the value of the Charlier coefficient for the period 1901-1910.

Country.	.م100
Austria	13.85
Germany	9.27
Belgium	2.55
Great Britain	4.71
France	34.19
United States	12.07

Belgium and Great Britain show small fluctuations indicating rather stable conditions. In all the other countries the series is over-normal, indicating outside disturbing influences. It is exceedingly great in France, showing violent perturbations. Looking over the statistical data we find the great Courrieres mine accident of 1906 included. This, the greatest disaster in the whole history of coal mining, resulted in the loss of 1,099 lives. Eliminating this from the material, we find that for the same period $100\rho = 2.45i$, where $i = \sqrt{-1}$. Here we thus have an imaginary Charlier coefficient, which goes to show that mine conditions in France are very stable. The Austrian statistics exhibit no such catastrophes, yet the high value of ρ indicates very unstable conditions, the United States being a bad second in this respect.

For some states I give the Charlier coefficient below:

 Missouri
 2.30

 Michigan
 2.18i $(i = \sqrt{-1})$

 Ohio
 8.35

 Washington
 20.7

 Iowa
 14.7

 Kentucky
 31.4

By an elimination of the Browder powder explosion in 1910, which resulted in the loss of 34 lives, the coefficient for Kentucky is brought down to 10.08. Michigan is to be congratulated for the imaginary coefficient of 2.81*i*, showing that the mine protection in this state, or other conditions, are better than in the rest of the union.

I think that the above results, although far from complete, show sufficiently that one must be exceedingly careful in applying statistical data from foreign countries to home conditions. There is, however, a method which is safe, even from a critical mathematical point of view. I refer here to the correlation method. By having given the true value of the coefficient of correlation we are enabled to solve the following important problem: Assuming we know the values of the various elements in a certain statistical series, what is the most probable value of the corresponding elements in another series?

About a year ago I started a statistical research of this kind. Other duties and lack of proper facilities prevented me from finishing this rescarch. Since it is evident that I shall not be able to touch this problem for a long time to come, I hope that some other member of this society might be induced to carry such research to a successful conclusion.

MR. HANSEN: I trust the last speaker appreciates exactly what I meant by the use of European statistics in this relation. I did not endeavor to establish on a general scale accident frequency and severity by causes from the European statistics which I reviewed. What I endeavored to do was to correlate the causes and the accidents from causes in Europe to the causes and accidents from causes available for our research in this country; and the thesis that the effect upon the human body is the same in both countries, I find, is not even originated by me. I so explained when I read my paper. I think it is due to the ingenuity of our worthy president, more than anybody else. On studying the causes in Europe, comparing them with the causes in this country, and studying at the same time the accidents produced by these causes, we find that the result on the average to the human body and the duration of disability from the same cause is very similar. I therefore believe there is a fundamental analogy which may be discovered if we have the requisite engineering knowledge to translate the European names for accident causes into American terms, which I fortunately am able to do. I think that the thesis as here set forth is fundamental, that the result on the human body from an accident from a given cause with the same physical conditions existing in the injured person, will be on the average the same, whether it occurs in Europe or the United States.

THE PRESIDENT: In regard to this matter that was brought up by Mr. Fisher—the identity of results due to the same causes in different countries—fortunately I think there is sufficient data to prove that that is not an assumption. If you will examine a paper printed in the last number of the American Statistical Association's publication you will find that the distribution of accidents according to results or gravity in such vastly different localities as Russia, Italy, the city of Leipzig, and the state of Massachusetts for various industrics gives substantially the same proportion of fatalities, and of accidents resulting in disability of from four to thirteen weeks.

MR. HANSEN: Mr. Chairman, I have one point on Mr. Whitney's paper which I would like to have some light on from Mr. Whitney. Mr. Whitney says that in fire insurance the hazard can readily be recognized as separable into three independent processes, viz .: ignition, combustion and damage production. There is a serious doubt in my mind whether or not the statistical departments of the underwriters, as well as of our state departments are on the right track. I know a tremendous amount of work has been put into that phase of the subject during the last year, but I still believe, after a study of the classification of causes, that we will not be able from these causes to properly allocate accidents to the fundamental cause. I hold that most accidents when occurring, have three distinct causes, and that the elimination of either one of these causes will annul the other two. I had submitted to me, a few days ago, several elevator accidents which brought it home to me. It stated that the persons were injured getting on or off elevators. That was all it said. I had an investigation made, and found in four of the cases that the accidents were actually due to slippery floor, not due to the elevator at all, although they are going into your statistics as elevator accidents. I found in five cases that the accidents were due to stumbling on the entrance to the elevator, due to the absence of proper light. Now, that was also elassified as an elevator accident, whereas it should not be. The predisposing cause of that accident was necessarily poor light, not a defect in the elevator at all, although it goes in as such. And I believe that statistical departments should exercise effort to determine, upon the occurrence of any accident, what was the predisposing cause of that accident, what was the immediate cause of the accident, and what was the inciting cause of the accident. I hold that if we have a pair of unguarded gears on a machine, and if we have a careful workman who has been around these gears for years, he will not get injured in that set of gears unless perchance the light is poor. Then the absence of light is the predisposing cause. That would still not produce an accident unless we had an inciting cause; he must come in the immediate vicinity of the gears. The gears themselves should not be assessed in the rate: the charge ought to be distributed to the poor light. I would like, if Mr. Whitney will be good enough, to have him discuss the theory of probability as applied to this matter.

MR. WHITNEY: Well, I can seen the justice in dividing up the fire hazard into three different processes, ignition, combustion and damage; so perhaps, this hazard can be analyzed in a similar way. I haven't thought of it enough to know just what the elements would be, but it seems to me Mr. Hansen's analysis is pretty good. At any rate, those three elements are there. Of course, it makes an exceedingly complicated statistical problem when you attempt to split the thing up in that way. It can't see now what all the consequences of it would be, and just how it could be carried out, but I think there is the same kind of analysis possible as in the case of fire insurance, and these elements apparently stand together in the same kind of relationship. If you have the hazard as a whole, undoubtedly these three elements, or whatever elements you decide upon, stand to each other, so far as their probability goes, in a multiplicative relationship. That is about all I can say, with the little thought I have given to it. I should say there was a chance there to make an analysis, and it would be rather fruitful.

THE PRESIDENT: What has been said shifts the center of gravity of the discussion from schedule rating to accident statistics. They are extremely complex. A particular accident may be due to bad light, poor floor and unguarded gears. You may have even more conditions. And yet we must devise some method by which we can analyze accidents according to cause. The absolutely accurate assignment of accidents to cause is much less important than a uniform method of assigning accidents to cause. I am very much afraid that so long as you have your statistics compiled in thirty different offices without any definite uniform standard of rules beyond the standard of rules for mechanical compilation your results are bound to be faulty. There is only one statistical way out of it and that is the building up of a body of very definite decisions, which are as important in accident statistics as they are in making compensation awards. I know that the casualty companies are trying to effect that by establishing a central office for the compilation of final tables, which is a step in advance, but we are far from the ideal situation as yet, because statistics can be no better than the original material collected. I am afraid that in the collection of original material there is going to be a violent fluctuation of decisions, unless there is a central authority to which individual accidents may be referred. Such a body of decisions is being built up in such statistical offices as the Census office or New York Bureau of Labor. Large numbers of phenomena are studied. It is impossible to leave it to the individual clerk. That means a large expense. If you expect corporations to go into that expense, you may have a difficult time to justify it, but I think it is idle to hope for accurate statistics without a substantial expense.

I should like, turning to the other matter of schedule rating, to emphasize that as actuaries we are more concerned in the effect on premiums than with individual causes. I am sorry that the tables of Mr. Senior's paper are not in print before you, because if you saw the tables you would see the important bearing of those tables. Let me emphasize two or three points. Let us take a definite example: automobile manufacturers. There is a manual rate of 1.10. Working back from the multiplier of 3.24 the

Massachusetts cost was probably something like .35,-1.10 divided by 3.24. The important fact that must be emphasized is that by the method of schedule rating the premiums on this classification were reduced 26 per cent. That means that your premium cost has been assumed to be 26 per cent. less than was demonstrated by actual experience. You cannot by any manner of means assume that three or four or six months of schedule rating could revolutionize industry to such an extent as to reduce your accident loss 26 per cent. We cannot assume that New York automobile manufacturers are so much better than Massachusetts manufacturers. There is only one apparent explanation of that reduction, and that is that the schedule for some reason or other struck several general conditions which are quite normal in automobile manufacturing which properly should not be credits. These credits are not rewards to the individual employer for being above the average. You have therefore disturbed your pure premium, and so theoretically should expect to have a loss on that classification. Whoever knows the conditions of the clothing industry in this city or state will not assume for a moment that the average condition is nearly 13 per cent. above the average cost. We know that sanitary conditions, while they have been improved considerably in the cloak-making industry, would not lead us to expect any such improvement. On the other hand, we have two or three classifications on which the schedule rating has resulted in increase. Here is the crucial point to be discussed: how far does this reduction, a very substantial reduction of premiums on some classifications, affect the general results of underwriting?

MR. DEKAY: In the application of the schedule rating system it would seem that credits for guards and automatic machinery should be considered in connection with the following thought: Industries in which a large preponderance of automatic machinery has existed for a number of years would naturally disclose an average rate based on average conditions involving the use of such automatic machinery. It would therefore seem to be in the nature of a double credit to make a schedule rating allowance for automatic machinery in addition to the low manual rate allowed for such industries. As improvements in plants and development of precautionary ideas progress, the experience will be bound to show improvement up to a maximum beyond which no additional guards or plant esprit will benefit the employer. The carrier will benefit thereby, and his profitable experience will, in turn, result in a decrease in the average rate. The point is, if you get a continually decreasing average rate due to profitable conditions and then in addition to that give credit for guards, you will reach a point where your cost has come down to a point where those credits could not be applied unless you are going to come below the cost price.

MR. WOODWARD: I should like to ask Mr. Senior as to whether his average reduction of 12 per cent. applies to all risks or only to risks meritrated on the basis of an inspection.

MR. SENIOR: It represents purely the average reduction on risks that have been rated on basis of inspection alone. In this connection, the remarks that have been made have aroused the idea in my mind that perhaps the solution of the question which you have presented is a schedule divided into several parts, a schedule which would fit a number of industries, instead of a schedule which is applied to all industries. There is evidently something wrong with a schedule of that kind. Isn't it a true answer that in order to get a proper system of schedule rating we must have a schedule which will apply to metal classifications, another to the classifications in the clothing industry, another in the paper industry, etc. Isn't that the answer to the question which you have presented here? In other words, you have here a wide fluctuation of reductions in various classifications. Does that mean that the schedule is not subject to universal application? The answer would seem to be that we must have schedules on the same plan as the fire insurance companies have, that is, various schedules for particular lines of work.

THE PRESIDENT: Do I understand that those figures cover the entire experience of the Compensation Inspection Rating Board?

MR. SENIOR: The investigation was for a certain period.

THE PRESIDENT: On clothing industries I should expect a larger payroll. MR. SENIOR: That represents the risks rated during a given period. I believe the period covers from August 1 to December 1, four months. This does not represent the entire volume of risks that have been inspected on the basis of estimated premiums.

MR. HANSEN: The schedule we are using is applicable on the average to practically every classification. The automobile manufacturing industry is one of the modern industries. Automobile manufacturing is nothing more or less than a machine shop with foundry. These establishments are so far above, however, in equipment, in light, and on account of the nature of their operations, the ordinary machine shop and foundry, that credits naturally will run much higher. It would be futile, however, to endeavor to analyze the reason for that seemingly large reduction in the manual rate, unless we had the data before us on what particular items in the schedule these risks have received their reduction. I hold with a fair degree of conviction that a schedule is a universal schedule, a schedule generally applicable to all manufacturing industries, because the hazards, the causes of accidents, are the same.' A belt is a belt anywhere; a gear is a gear anywhere; a set screw is a set screw anywhere; and as the deviation from manual rate produced by the inherent hazard in the industry is on a percentage basis of manual rate, it truly reflects it. It may not be the correct amount that we are using. There may be and undoubtedly is room for improvement in the actual rate values we have put on the items. But it is the fundamental correctness of the principle which I would like to see discussed at length here, because we are in the beginning of it and if our principle is wrong we cannot build on it for the future. It is, if you please, the foundation, and if our foundation is not sound, now is the time to change it. I hold to this principle, and I have been more than gratified to see mathematically proven today that it is correct. If it is a matter of values, then let us get the data together, indicating under what headings in that schedule those particular risks that seem to have been receiving an undue amount of credit have come. It would also be beneficial to see whether or not experience has been applied there or whether or not the discretionary credits have been applied without being substantiated by experience. That would be very interesting and would have a considerable influence upon the final result.

THE PRESIDENT: Another line of investigation is suggested by this table. If all the classifications with low rates are considered together you will find that the reduction is very much larger than on the classifications with high rates. Most of the classifications with high reduction are classifications of low hazards. Of course, this criticism may, perhaps, more properly be made against the basic rates. We are talking of adjusting the schedules to the basic rates, but the same result may be accomplished by adjusting the basic rates to the schedule.

MR. HANSEN: That is one of the things that we have advocated from the beginning.

MR. MOWBRAY: One point that Mr. Senior raised seems to have considerable light thrown on it by some of the formulae of my paper. Take general formula three. We might take simply one term in that: let k be considered the cause of gear accidents. Now, practically every classification pure premium involves a certain amount of gear action. So you have a certain value for that product, $\lambda \rho \phi$, which will vary with the classifications. For example, take the boot and shoe industry. The machines arc rather light machines, run by single operatives, manufactured largely by one concern, which has given a great deal of attention to accident prevention work. Take the textile industry: one operative operates a large number of machines; there are a large number of gears in each machine; so that the exposure to operatives is very much larger in that classification, and that particular factory carries a heavier rate in the pure premium. The Industrial Accident Board of Massachusetts has recently made a number of compilations comparing the number of days lost from gear accidents per thousand employes in the different industries, and the number of days lost in the textile industries was about four times as large as in the boot and shoe industries. Now, if you have a universal schedule which allows approximately the same credits either on the whole rate or as a proportion to payroll rate for each gear covered you may give the same credit for covering in the boot and shoe industry as in the textile industry, but it corresponds to a different reduction in the accident hazard. As to another point that Mr. Hansen spoke of, I am inclined to agree with him that from the engineering point of view you want to get your accident causes run down to the primary cause as closely as possible. But there is another factor which I think probably Dr. Rubinow had in mind. No matter how we tabulate our accidents, we get our material in reports from the employer's establishment, which is the testimony of eye witnesses or perhaps the statement of the injured party afterwards. We know from listening to evidence in court, how individual personality affects testimony. We cannot spend the money to have an engineering investigation of every accident to get at the prime cause, so we have to be content with approximations anyway, and to be content with the material that we have.

MR. HANSEN: Mr. Mowbray evidently is assuming that we are treating the gears on working machines in the boot and shoe industry and in the textile industry on the same basis. He is fundamentally wrong there. We are not. The working machine hazard, whether it be at the point of operation or whether it be in the construction of the working machine is the pure or inherent hazard in the industry and it is treated under the schedule as a percentage of basis rate. Therefore, we get a charge and credit under that heading in direct ratio to our basis rate. We must, in considering this, distinguish between power transmission, equipment, gears, and belts on power equipment and in gears and belts on working machines, because they are two entirely separate and distinct items in the schedule, and I do not think Mr. Mowbray appreciated that, or his remarks would at least so indicate.

MR. MOWBRAY: I will admit that I am not as familiar with the application of the schedule as some of you in New York. It was my understanding that the credits were on the basis of the number of gears covered and not on the gear hazard in the working machine. If it is based on the number of gears covered, then it seems to me that the point is good.

MR. PHELPS: Mr. President, it occurred to me when Mr. Hansen was speaking about the variety of contributory causes in the case of elevator accidents that possibly the question of industrial accidents is subject to the same limitations as is the question of cause of death. Of course, as we all know, the doctor attendant upon the person who dies, in filling in the death certificate is only compelled to state as the cause the immediate cause, the evidence of which he saw and which he treated, whereas as those of us who are familiar with the unfortunate discrepancies between the showings of autopsics and bedside diagnoses are aware, there is apt to be a wide differentiation. I cannot say that it is clear to me how in a general, sweeping way we can apply to a question of causes of industrial accidents, in a working fashion, any reliable method of naming secondary and tertiary causes. For illustration, it occurred to me while Mr. Hansen was speaking, that if a gentleman with one eye is getting into an elevator and he stubs his toe, is that a case of too much elevator or too little eye? Secondly, when you get on to the question, is it due to defective light, how can you authoritatively or specifically pass on the question unless you have some standard of light? In other words, it occurs to me after listening to the discussion of the afternoon and morning, that there is at least a possibility of trying to get down to too finely differentiated a basis, and thereby have a case of confusion worse confounded. As we all know, with the public as well as the companies, fundamentally it is a case of cost and return, and so far as my observation goes, neither end to the discussion is fundamentally concerned with an infinite amount of detail. The company naturally wants to be sure of an absolutely safe and sufficient premium, and the insured naturally wants to get the lowest possible rate. That being the fact, isn't there a possible danger of attempting to work out too large a number of minor problems and thereby cloud the whole issue?

MR. SCATTERGOOD: Mr. President, I was quite impressed by the figures in Mr. Senior's paper, if I remember them correctly, showing that the reduction in premium due to rating by experience was about 24 per cent. on risks

not subject to inspection-rating. Now with regard to schedule rating by experience, I would like to have brought out some opinions in conflict with what I am about to state. We take the liability experience, and we have a schedule form drawn up, showing that we must assign a number of tabulatable accidents. A tabulatable accident is one which occasions loss of time of more than the balance of the day on which the workman was injured. We must find out how many workmen lost their arms or their legs or their hands, how many died. Now, as to the records of the liability companies-there may be some that in their liability statistics went into the matter very carefully, there may be others who did not-but it seems to me that no matter how carefully they went into the investigations of liability accidents, there was not the incentive at that time to secure the information which is called for by this report. In numbers of cases, as soon as it was discovered that the workman would probably not make a claim or if the claim were made that the employer was amply defended, the data was entirely lost sight of, and the same might even be true with regard to the loss of members of the body, and even with regard to death occurring after a lapse of time. Taking into account the fact that we endeavor as far as possible to keep our liability records accurate and yet despite that attempt we could not get all that was necessary for an experience rating schedule under the best of conditions, and couple with that the fact that it was not necessary for a liability company to so keep its records and the company naturally desired to reduce expenses, it doesn't seem to me that the application of schedule rating according to the experience under liability policies is very trustworthy.

MR. FLYNN: I think what Mr. Scattergood has said is true, to a large extent. I do not know exactly what I can add to that. It is simply a matter of opinion regarding the value of liability statistics, as a basis for the returns of the company. A very thorough analysis of the causes of accidents was made, and it was recognized in drawing the form, I think, that we would not be able to get a very fine division of the various kinds of claims. Therefore the division was made as to death, to serious disability and dismemberments, clearly definable injuries, and then all others were thrown into a large group with an average value to be applied. The value of those statistics is of course questionable. It is a matter of opinion as to whether they are good or not good, but probably they are good enough to serve the general purpose of rating a risk which cannot well be rated another way, such as a contractor's risk, where experience is the only guide. The value of the statistics should be sufficient to act as rough guide to the proper modification of the rate. That was all that was elaimed when the plan was started and that is probably true.

MR. WOODWARD: On this subject of experience rating, it seems to me that the question of the theoretical validity of the method which is used is very closely connected up with the subject of the extremely valuable paper, ''How Extensive a Payroll Exposure is Necessary to Give a Dependable Pure Premium?'' which was read by Mr. Mowbray at the first meeting of this Society. I confess that I share the doubts which I think were expressed by our President this morning, as to the theoretical soundness of any experience rating of compensation risks whatever, as it is practically carried out at the present time. Those of us who are practically dealing with this business every day know the tremendous pressure which is brought to bear on the part of employers and on the part of agents and brokers to secure reductions in the premium on risks where the experience is alleged to be good but where the payroll is by no means great enough to make that experience of any real significance at all. I cannot help feeling that there is great danger, even though the intent of a system of experience rating may be to secure greater equity to the policyholders, that nevertheless the real effect may only be to intensify a discrimination in rates. I feel that it is likely to result that unless the system is very carefully guarded it will result in giving to certain employers, particularly large employers whom a carrier is anxious to hold and conciliate, an undue advantage as compared with other and in particular small employers. I was impressed with the statement made by Mr. Senior that only 230 risks had been rated by the Compensation Inspection Rating Board during the period covered by his statistics on the basis of experience only, and that the average reduction in rate on those risks amounted to 24 per cent. Now, since the total reduction permissible cannot exceed 30 per cent., it is obvious that the largest number of those cases were cases where the maximum reduction was secured and I think the reason for that is probably because the payrolls, while they may seem large, are really not large enough to be susceptible to an experience rating, particularly when we consider the fact that in New York the experience on a risk depends very largely on whether or not there have been one or more death claims. If there are no deaths, you have good experience. If you have one death or more, the experience is apt to be bad, and it is quite evident that the experience on the bad risks is not reported for penalty. It is also obvious from the figures that only a very small proportion of the risks that are really entitled to a credit for experience, if that credit is to be extended universally and without discrimination, receive the benefit of an experience rating, and if all risks entitled under the rules to receive an experience rating should be reported for rating I should be fearful that a dangerous and formidable reduction in premium income would result.

A MEMBER: May I ask Mr. Hansen whether, in view of the fact that we have had a reassurance of catastrophes for the last two or three years, and that notwithstanding the enormous exposure there has been no catastrophe, there is not a possibility that the allowances for catastrophe charge are really too high?

MR. HANSEN: That does not devolve upon me to state, because the premium is loaded with a catastrophe percentage, is it not? That is spread over all classifications. All that the schedule is doing is to distribute that. We are not inserting anything there, we are endeavoring to distribute that catastrophe loading in the manual premium where it properly belongs.

MR. MOWBRAY: I realize that those of us who are criticizing, should endeavor to be constructive. I realize that when you first put up the proposition of using European statistics, it was regarded as rather revolutionary, and what I am going to suggest may be regarded as equally revolutionary. When we are bringing in experience rating, we are endeavoring to find some measure of determining the factor which practically uniformly affects all causes of accidents, that is, the psychological factor. It occurs to me that we may get at least as approximate justice as our schedules give us, if we arbitrarily select certain conditions which are indices of the psychological hazard and affix absolute values to those and substitute a measure of that kind for the experience rating. It will be approximate, of course; we cannot get absolute justice anywhere, but it seems to me it is worthy of very serious consideration, whether we cannot assign a value to such factors as the relative ability of staff, the financial standing of the establishment, the rate of wages paid relative to the rate of wages in the industry as a whole, etc.

WRITTEN DISCUSSION.

VALUATION OF THE DEATH BENEFITS PROVIDED BY THE NEW YORK COMPENSA-TION LAW-WINFIELD W. GREENE, VOL. I, PAGE 31.

MR. MOWBRAY:

This paper presents a solution of a practical problem arising under the New York Compensation Law, although at the outset it is pointed out that the same problem arises in a slightly different form under the law of W. Virginia and Washington, and the compensation laws of various European countries. In view of the length of time the latter laws have been in operation it seems a little ambitious to assume that they will look to us for the solution of this problem, and it may be that a greater familiarity with the practice in these countries will help us in the solution of this problem for ourselves.

The practical problem does not present difficulties until the number and relationship of dependents is such as to bring into operation the 663 per cent. total limitation. Mr. Greene gives simple formulae and an illustrative example which is easy to follow. When, after citing an example of a case in which the limits are operative he proceeds to consideration of the cases when those limits become operative and the amount of deduction from the value first given by his first four formulae, the work begins to look formidable. The notation used, though more or less unfamiliar to some of our members, is the standard notation of the International Congress of Actuaries. It becomes difficult, however, to keep clearly in mind the percentage deductions for the different cases, and this difficulty is increased when we pass to the contracted work in which the Z notation is used. The introduction of this notation and the subsequent work with detached symbols is a convenient way of passing from the survivorship annuities to joint-life annuities. While apparently complicated and confusing, if the memory is refreshed by references to the explanation of principles in the section of the Institute of Actuaries text-book cited by Mr. Greene, it is not difficult to follow his work.

While the number of joint-life annuities to be calculated, as noted on page 40, seems exceedingly large, it must be borne in mind that the problem is one of survivorships aganist combinations of joint-lives, and as the numbers from which the combinations are to be made are increased, the number of combinations very rapidly increase. Of course if survivorship annuities were directly computed the number of such annuities to be found would be much less than as shown in Table A, but such annuities would have to be calculated by using the calculus of finite differences and approximate methods, and be much more laborious even than to calculate the full number of joint temporary annuities.

Mr. Greene's suggestion of disregarding, as regards mortality, differences in age among children seems to be justified by the slight differences in values of μ_x for the ages which will usually come under consideration. The suggestion is ingenious and of great value. Mr. Greene is also to be complimented on his further suggestion for considering $\bar{a}_{r:18-\nu_t}$ as a function of r, which enables him to develop the formula in Table B. The further contractions by which he arrives at Table C from Table B also seem to be justified. Since the publication of this paper he has furnished me with a further note of contraction in Table C, which he will doubtless present during the course of this discussion.

Reviewing the paper as a whole, one is struck at once with the fact that the burden of the work is involved in obtaining a figure to be deducted from the value as first computed in order to take out of such value the excess over statutory limitations under certain conditions. This brings to the mind the suggestion that a shorter method would probably be found by directly computing the present value of the amount payable while the statutory limitation of 663 per cent. is in effect and computing the balance as the present value of survivorships. Were all the annutities whole life annuities, this would give a distinct reduction in the volume of work as the deductions in deriving the survivorship values would be uniform. As most of the annuities, however, are temporary running only until the annuitant attains the age of eighteen, the deductions in computing the value of survivorship annuities differ with each life, since the amount deducted is only the present value of the joint status, while he is a member of that status. I have carefully investigated the computation by this method and find that full calculation would involve as many annuities as would full calculation by Mr. Greene's method, and while the suggestion he has made for reducing the volume of work will equally reduce the volume of work by that method. the ultimate formula is no shorter than obtained by him.

Mr. Greene has kindly furnished me copies of his calculations of three typical cases involving respectively a widow and five children, a widow and six children and a widow and seven children. In each of these cases I find that the present value of the annuities which would be payable in respect of the widow (until remarriage) and three youngest children, if there were no other, amount to over 90 per cent. of the total present value. As these annuities would be calculated under the first four simple formulae, the extensive formulae worked out by Mr. Greene are merely for accurately determining the remaining 10 per cent. of the value.

Although I do not wish to rank myself among the advocates of the use of empirical formulae and rough approximate methods where accuracy can be obtained at the expense of reasonable labor, it seems to me that here is a case for use of such formulae:

1. In the absence of American experience we do not know and cannot

know for some years to come whether our remarriage table will correspond to American experience.

2. Neither do we know whether our mortality table will fit the experience in this country, although we have very good reason for using both these tables as an approximate measure.

3. As a matter of convenience both these tables have been graduated by the Makeham formula and in such graduation certain features which may well be characteristic of our American experience, both as regards mortality and remarriage, have been eliminated. The mortality table we use shows a slightly increasing mortality beginning at birth, whereas we know that the mortality curve takes a downward trend during the early years of life. A study of the comparative tables on pages 309-310 of Vol. XV of The Actuarial Society *Transactions* (Mr. Dawson's paper) will show that the graduated values of the remarriage table and the annuities payable until death or remarriage show considerable departures from the ungraduated values which are perhaps not entirely negligible.

For the above reasons we may well expect, perhaps, a considerable departure in the value of our table from what that value would be if it were possible to compute it by tables which would accurately represent American experience.

Although the time at my disposal has been limited, I have given some consideration to the development of an approximate formula which would materially shorten the labor in this calculation. I have found that in two of the cases furnished me by Mr. Greene if to the value of the primary annuities for the widow (until remarriage, with remarriage portion) and the three youngest children there be added 663 per cent. of the wages multiplied by the difference between an annuity certain for the term until the fifth child attains age eighteen, and the joint-life annuity of the widow (until remarriage) and the three youngest children for the same period, the result is the same as Mr. Greene's within 1 per cent. In the third case there were five children and the fifth child was seventeen years of age, so that the formula broke down in that case, but using the term (three years) until the fourth child became eighteen, the value agreed with Mr. Greene within 1 per cent. In this case a different rule gave a value within a per cent. This rule was to add to the value of the primary annuities as above noted, 663 per cent. of wages as a temporary annuity during the joint-life of the widow (until remarriage) and the three youngest children for the term until the fourth child attained the age of eighteen, and add further 15 per cent. of the wages as a survivorship annuity on the life of the fourth child in survivorship against the widow.

The considerations which suggested these formulae are perhaps obvious. I do not claim that they are always accurate within the percentages named, nor that other and better approximate formulae may not be obtained, but they seem to serve sufficiently well for these cases, and reduce the work to the simple calculation of one joint-life annuity and one annuity certain, which latter will already be found tabulated except that it must be modified in order to give the continuous value. Since writing the above a further approximate formula has suggested itself as follows:

To the present value of an annuity certain of 663 per cent. wages for the term until the fifth youngest child attains the age of eighteen, add the present value of the widow's remarriage portion and a deferred life annuity (until remarriage) of 30 per cent. of wages commencing after expiration of the term certain noted above, and add further deferred temporary life annuities on the lives of the two (or perhaps three) youngest children, commencing at the end of the term certain noted above, these latter to include, of course, their survivorship benefit against the mother. I suggest the survivorship annuities for the two or three youngest children only, allowing survivorship for the fourth or third and fourth, to offset the excess of the annuity certain over the various combinations of joint-life annuities for which the maximum amount would be payable.

If this formula is available, it entirely avoids computation of joint-life annuities except the annuities on two lives necessary to compute the survivorship benefit of children against their mother. These joint-life annuities do not involve the remarriage element so that the determination of equal ages is simplified. At most, there are two or three of these to compute. The deferred life annuity on the widow and the deferred temporary annuities on the children are quite as easy to compute as are temporary annuities.

Further, under this formula it is not necessary that the remarriage table be graduated so as to have the same value of c as the mortality table, and in fact need not be graduated by the Makeham Law. Using this formula, we are free to change our remarriage table when circumstances seem to indicate that it is desirable, though of course the applicability of the formula under the new remarriage table will have to be again tested. Again, if we find the mortality table for the younger ages now in use is not appropriate we may substitute a new table, and if this be graduated by the Makeham formula so that the constant c is the same as the mortality table used in computing the widow's portion, the extra work in computing the survivorship will be greatly reduced. I have not had the time to test the probable accuracy of this formula, but Mr. Greene has kindly consented to make a few tests for me.

MR. OLIFIERS:

I consider that the amount of work is excessive by the method Mr. Greene has propounded in his paper, if it be borne in mind that this work has to be repeated at each valuation.

It may be interesting to note that the present value of the benefits payable to a widow and any number of children may be found in a few minutes by the following process:

Refer to one table for a widow and one child; and an additional table for each additional child; entering those tables with the attained age, at valuation, of the widow, and a term of eighteen minus the ages of the children at the valuation date and adding together these tabulated values, the present value of the reserve to be put on the basis of say \$100, is found.

Those tables are constructed by using the mathematical properties of the frequency curve, which expresses the rates of mortality from ages 0 to 18,

as for instance, by making the rate of interest a variable depending on the number of children involved in the term annuity.

This device has been applied to the Danish Survivorship Table and the error is negligible.

The advantage of using the above principle is that it avoids the necessity for joint life commutation columns and annuities, allows a wide application to any mortality table and enables one to construct tables which may be used by persons who have no technical knowledge.

MR. GREENE:

(IN REPLY TO MR. MOWBRAY.)

After reading Mr. Mowbray's very courteous discussion of my paper, for which I am much indebted to him, I wish to elaborate upon several of the questions which he raises.

In the first place, I agree with him that the method developed in my paper (Tables B and C) for determining the reduction in present value on account of the 66§ per cent. limit as to compensation involves an amount of labor by no means inconsiderable where the dependents include a wife and five or more children. In presenting the paper, I was not satisfied that these formulae were the best possible from a practical standpoint, but I did feel that they represented a means of accurately determining the present value required, and to this, I take it, Mr. Mowbray agrees. Several months' experience in the application of these formulae has put the office with which I am connected in a position to test the accuracy of less laborious methods.

Of such methods Mr. Mowbray suggests three. The first method he suggests is applicable in cases where the dependents are a wife and six or seven minor children and may be written as follows:

$$\begin{aligned} 30\bar{a}_{x'} + 60\overline{E}_{x''} \\ &+ 15(\bar{a}_{y_1}\overline{_{15-y_1}} + \bar{a}_{y_2}\overline{_{15-y_2}} + \bar{a}_{y_3}\overline{_{15-y_3}}) \\ &- 5(\bar{a}_{xy_1}\overline{_{15-y_1}} + \bar{a}_{xy_2}\overline{_{15-y_2}} + \bar{a}_{xy_3}\overline{_{15-y_3}}) \\ &+ 66\frac{2}{3}(\bar{a}_{\overline{15-y_5}} - \bar{a}_{x'y_1y_2y_5}\overline{_{15-y_5}}). \end{aligned}$$

The result is the present value per \$100 of annual wage of the deceased. I have carefully tested this method in four cases where the dependents were a widow and seven children and I find the results to be as follows:

"Table C" Method.	Mowbray (A).	Error.	• Age of Fifth Child.	Ratio of Error to Present Value.	Error per \$1,000 Annual Wage.
879.396 909.058 867.902 845.412	$\begin{array}{r} 869.315\\ 987.450\\ 861.223\\ 825.510\end{array}$	-10.081 +78.392 - 6.679 - 19.903	$ \begin{array}{r} 12 \\ 6 \\ 11 \\ 12 \end{array} $	-1.1% +8.6% 8 of 1% -2.3%	$\begin{array}{r} -\$100.81 \\ + 783.92 \\ - 66.79 \\ - 199.02 \end{array}$

PRESENT VALUE PER \$100 ANNUAL WAGE OF DECEASED.

The second formula proposed by Mr. Mowbray applies where the dependents are a widow and five children and may be written as follows:

$$\begin{aligned} 30\bar{a}_{x'} + 60E_{x''} \\ &+ 15(\bar{a}_{y_1\overline{18-y_1}} + \bar{a}_{y_2\overline{18-y_2}} + \bar{a}_{y_8\overline{18-y_8}}) \\ &- 5(\bar{a}_{xy_1\overline{18-y_1}} + \bar{a}_{xy_2\overline{18-y_2}} + \bar{a}_{xy_2\overline{18-y_8}}) \\ &+ 66\frac{2}{3}(\bar{a}_{\overline{18-y_4}} - \bar{a}_{x'y_1y_2y_3\overline{18-y_4}}) \\ &+ 15(\bar{a}_{y_4\overline{18-y_4}} - \bar{a}_{xy_4\overline{18-y_4}}). \end{aligned}$$

The results of the use of this formula are shown below.

"Table C" Method.	Mowbray (B).	Error.	Age of Fourth Child.	Ratio of Error to Present Value.	Error per \$1,000 Annual Wage.
$762.316 \\ 699.124 \\ 691.782 \\ 712.378 \\ 891.605$	752.285 691.050 685.477 721.672 913.635	-10.031 - 8.074 - 6.305 + 9.294 +22.030	14 15 15 13 8	-1.3% -1.1% 9 of 1% +1.1% +2.2%	$\begin{array}{rrr} -\$100.31 \\ - \$0.74 \\ - 63.05 \\ + 92.94 \\ + 220.30 \end{array}$

PRESENT VALUE PER \$100 ANNUAL WAGE OF DECEASED.

The third formula proposed by Mr. Mowbray may be written as follows:

$$\begin{aligned} 66\bar{3}_{3}\bar{a}_{1\overline{3}-\overline{y_{6}}} + 60\bar{E}_{x''} + 30_{18-y_{6}} |\bar{a}_{x'} \\ &+ 15(_{18-y_{6}} |\bar{a}_{y_{1}\overline{y_{6}-y_{1}}}| + _{18-y_{5}} |\bar{a}_{y_{2}\overline{y_{6}-y_{2}}}| \\ &+ _{18-y_{5}} |\bar{a}_{y_{3}\overline{y_{5}-y_{3}}}| + _{18-y_{6}} |\bar{a}_{y_{4}\overline{y_{6}-y_{4}}}|) \\ &- 5(_{18-y_{6}} |\bar{a}_{xy_{1}\overline{y_{5}-y_{1}}}| + _{18-y_{5}} |\bar{a}_{xy_{2}\overline{y_{5}-y_{2}}}| \\ &+ _{18-y_{6}} |\bar{a}_{xy_{2}\overline{y_{5}-y_{3}}}| + _{18-y_{6}} |\bar{a}_{xy_{4}\overline{y_{5}-y_{4}}}|). \end{aligned}$$

Time has been lacking to apply this method in very many instances, but I did apply it in two cases, which resulted in positive errors of about \$210 and \$270, respectively, on the basis of \$1,000 annual wage. Mr. Mowbray suggests that the error resulting from the use of this formula may be minimized by omitting any account of the present value of the additional 5 per cent. paid to each child after the death of the mother. In both of the cases where I applied this formula, leaving out these deferred reversionary annuities altogether—that is, omitting the last term of the above formula and changing the coefficient of the second term from 15 to 10 reduced the error somewhat; in fact, the error was reduced to not more than \$200 in each case, which would be approximately 2 per cent. of the entire present value.

The greatest source of error in this formula is in the assumption that 663

per cent. of the wages will certainly be payable until the fifth child attains age 18. It is quite evident that if the widow remarries only 50 per cent. of the wages will be payable as long as she is living and only five children are entitled to compensation, while only 60 per cent. will be payable while the beneficiaries are six children. I am inclined to believe, therefore, that the error resulting from the use of this formula where the widow is relatively young, say 25 years of age, would be considerably greater than it proved to be in the cases which I have cited.

Perhaps we would be justified in adopting what Mr. Mowbray terms an empirical method if it were not possible to secure both accuracy and facility of operation. The following formula fulfills both requirements to a reasonable degree:

$$\begin{aligned} 30\bar{a}_{x'} + 60\bar{E}_{x''} + 15(\bar{a}_{y_1\,\overline{18-y_1}} + \bar{a}_{y_2\,\overline{18-y_2}} \cdots \bar{a}_{y_7\,\overline{18-y_7}}) \\ &- 5(\bar{a}_{xy_1\,\overline{18-y_1}} + \bar{a}_{xy_2\,\overline{18-y_2}} \cdots \bar{a}_{xy_7\,\overline{18-y_7}}) \\ &- 3\frac{1}{3}(\bar{a}_{x'y_1y_yy_8y_4\,\overline{18-y_4}} + 2\tilde{a}_{x'y_1y_2y_8y_4y_8\,\overline{18-y_6}} + \bar{a}_{x'y_6\,\overline{18-y_5}}) \\ &+ 3\bar{a}_{x'y_0\,\overline{18-y_0}} + 2\bar{a}_{x'y_7\,\overline{18-y_7}} + \bar{a}_{xy_7\,\overline{18-y_7}}). \end{aligned}$$

Of course, not all of the above terms are significant, where the number of children is less than seven.

The above formula, which may be applied when the dependents are a widow and any number of children, is derived from Table B of the paper under discussion, by several steps, the effect of which can very readily be measured.

1. Disregarding Δ^2 and higher orders of differences. In practice it has been found that Δ^2 is always very small and generally positive. The total effect of this step is therefore to introduce a small error on the safe side.

2. Reduction of expressions involving temporary annuities on several infantile lives, to expressions including annuities on one infantile life only, by use of the method of finite differences.

3. Disregarding the probability that the widow will die before the fifth child attains age 18. This probability is obviously small and leaving it out of account introduces a small positive error.

4. Substituting for the difference between an annuity on several lives, one of which is subject to remarriage, and an annuity for the same term and the same number of lives, where remarriage is not involved, the corresponding difference between temporary annuities on one life.

The foregoing formula has been tested by its application to five cases involving a widow and five children, two involving a widow and six children and four involving a widow and seven children. These cases included those to which Mr. Mowbray's formula was applied. In no case was the error greater than .7 of 1 per cent. of the total present value, which happened to be \$66 per \$1,000 annual wage, and, with one exception, the error was positive. The single negative error amounted to 2/100 of 1 per cent. of the total present value.

I am free to admit that Mr. Mowbray's formulae involve' slightly less labor than the foregoing one, provided the functions tabulated are made

312

to conform with the requirements of his formulae. I am confident, however, that since the method just suggested cannot be characterized as by any means unduly laborious, its greater reliability should make it more acceptable than those suggested by Mr. Mowbray.

Mr. Mowbray has referred to the error introduced by the graduation of the remarriage rate. In my opinion this error is not a serious matter, but reference to the rate of remarriage suggests that if we take q_x , where (x)is an infant, as being constantly equal to $q_{\mu\nu}$ it will be possible to calculate temporary annuities, conditioned upon the survival of several infants and upon the widowhood of their mother, by referring directly to the age of the mother, the number of infantile lives and the term of the annuity; and a change in the number of infantile lives would have the same effect as a change in the rate of interest. This would obviate the necessity of determining equivalent equal ages and do away altogether with the need of graduating the table of remarriage. Probably the error resulting from this practice will be less than that introduced by the graduation of the remarriage rate, and, at any rate, it will be upon the safe side, since it has a tendency to increase the reduction in present value on account of the 663 per cent. limit. Incidentally, it would reduce the labor involved in the application of the formula just suggested to a point where little more could be expected from the standpoint of facility of operation.

In conclusion, I wish to say that I did not mean to imply that actuarial problems like those arising under the New York law have not been solved by the actuaries of the various European countries having similar compensation acts. What I meant to indicate was that the actuarial problems of the New York law are essentially those of many of the European statutes, and that a solution of the New York problems may very easily be adapted to the problems of West Virginia, Oregon and Washington and several countries of continental Europe. As the day is not far distant, I take it, when insurance carriers in all states will be required to compute their liabilities on account of compensation claims which have been outstanding for some time upon an actuarial basis, and as the present tendency is in favor of rather than against compensation statutes of the New York type, this consideration did not and does not appear to me to be without considerable practical importance.

REVIEWS OF BOOKS AND PUBLICATIONS.

Social Insurance. The Question Involved in Practical Social Betterment. By Joseph J. Thompson, LL.B., Professor of Insurance, Loyola University. Chicago, Loyola University Press, 1914. Pp. 105.

This is not meant to be a review. It is a warning.

The bibliographical departments of several economic publications, including that of our *Proceedings*, reported the appearance of several (four or five) books on insurance by the same author in The titles were all attractive and of a special interest to 1914. members of the C. A. S. S. A. There was a volume on Social Insurance, one on Accident and Health Insurance, one on Employers Liability Insurance and so forth. Our scientific literature on these branches of insurance is so scant that the announcement of these volumes could not fail to create considerable interest. Unfortunately the New York Public Library did not possess any of them. A letter of inquiry to the publisher failed to bring any reply, and before the reviewer was ready to separate himself from the necessary amount of hard-earned cash, his naturally cautious spirit demanded some investigation. Through the kindness of the Library of Congress, an opportunity to examine the volume on Social Insurance presented itself. The results of this examination might be of some practical advantage to every member of the C. A. S. S. A.

In 104 pages of very large and clear type the author treats of a variety of subjects: General Principles; Workmen's Compensation; Pensions; Accidents, Sickness, Premature Deaths; Unemployment Insurance; Old Age Protection and Conclusions. There are appendices on "Notes and Citations"; "Readings on Subjects Covered" and an Index. Truly "multum in parvo," as a classical student might say. The author's ability to get all this into 104 pages is the more to be admired that fully 32 pages are devoted to "citations." Under the circumstances it is idle to hold the author to "strict accountability" for covering the entire topic of "Unemployment Insurance" in exactly fifty lines. Equally comprehensive is the treatment of Accidents, Sickness, Premature Deaths (Chapter IV, less than 2 pages). The chapter on Workmen's Compensation is unduly long-46 pages, but of these, 35 are given over to a reprint of the full text of the New York Compensation Act.

Thus books are made, and even copyrighted—the copyright including, it seems, the New York Compensation Act and the 34 pages of citations. An additional picturesque detail is the fact that while the title page bears the promising title above quoted, the cloth cover is stamped "Applied Sociology." Thus one almost gets the feeling that he obtains two books for the price of one.

The reviewer confesses that after a careful examination of this volume his curiosity as to the other studies of "Thompson on Insurance" has considerably abated. He has no information as to the academic status of "Loyola University" or the character of the instruction on insurance there given. But in the interest of responsible insurance instruction and of responsible writers alike, there should be some way of suppressing such speculative bookmaking.

I. M. R.

THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA

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 - i

ABSTRACT FROM THE MINUTES OF THE MEETING

MAY 19, 1915

The third regular meeting of the Casualty Actuarial and Statistical Society of America was held at the City Club, New York City, on May 19, 1915. President Rubinow called the meeting to order at 10:50 A.M.

The roll was called, showing the following forty Fellows present:

W. A. BUDLONG	HARRY FURZE	A. H. MOWBRAY
E. E. CAMMACK	E. S. Goodwin	F. R. MULLANEY
GORDON CASE	W. J. GRAHAM	E. OLIFIERS
HENRY COLLINS	W. H. GOULD	Robert K. Orr
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B. D. Flynn	W. J. MONTGOMERY	A. W. WHITNEY
RICHARD FONDILLER	G. D. MOORE	J. H. WOODWARD
C. S. Forbes		

Messrs. M. A. Brooks, Percy L. Davis, James Fairlie, R. H. Gunagan, Roland Hillas, H. L. Kelly, and Marcus Meltzer were present as guests.

The Council reported to the Society on its work since the last meeting, and recommended the following names for election to Fellowship in the Society without examination, under the terms of Article III of the constitution:

T. Bradshaw, Toronto, Ontario.

S. Deutschberger, New York Insurance Department.

Earl O. Dunlap, Actuary, Pittsburgh Life & Trust Co.

Arne Fisher, Actuarial Department of Equitable Life Assurance Society.

James W. Glover, Consulting Actuary, University of Michigan. William C. Johnson, Vice-President, Columbian National Life Insurance Co. F. W. Lawson, General Manager, American Branch, London Guarantee and Accident Co., Ltd.

E. B. Morris, Actuary, Travelers Insurance Co.

H. C. Thiselton, Manager London, Guarantee and Accident Co., London, England.

Miss Emma C. Maycrink, New York Insurance Department.

After ballot these nominees were declared duly elected Fellows.

The Editor made a statement as to what had been done in connection with the *Proceedings* and the success which had been made in securing subscriptions.

The chairman of the Examination Committee explained the work of that committee.

The papers prepared for this meeting were then read and discussed and discussion was also had of papers read at previous meetings.

A motion was carried that the next meeting of the Society should be the annual meeting to be held during October, 1915.

It was decided that for the next meeting papers on all branches of casualty insurance be invited and that members be urged especially to present papers on subjects of casualty and social insurance other than workmen's compensation.

A motion was carried that in each number of the *Proceedings* a list of all members of the Society, with their addresses, shall appear.

During the course of the meeting a luncheon was served at the City Club.

Upon motion the meeting adjourned.

CONSTITUTION.

Adopted February 19, 1915.

ARTICLE I.—Name. This organization shall be called THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA.

ARTICLE II.—Object. The object of the Society shall be the promotion of actuarial and statistical science as applied to the problems of casualty and social insurance by means of personal intercourse, the presentation and discussion of appropriate papers, the collection of a library and such other means as may be found desirable.

The Society shall take no partisan attitude, by resolution or otherwise, upon any question relating to casualty or social insurance.

ARTICLE III.—Membership. The membership of the Society shall be composed of two classes, Fellows and Associates. Fellows only shall be eligible to office or have the right to vote.

The Fellows of the Society shall be the present members and those who may be duly admitted to Fellowship as hereinafter provided. Any Associate of the Society may apply to the Council for admission to Fellowship. If his or her application shall be approved by the Council with not more than one negative vote he or she shall become a Fellow on passing such final examination as the Council may prescribe. Otherwise no one shall be admitted as a Fellow unless recommended by a duly called meeting of the Council with not more than one negative vote followed by a ballot of the Society with not more than four negative votes and not less than twenty affirmative votes.

Any person may, upon nomination to the Council by two Fellows of the Society and approval by the Council of such nomination with not more than one negative vote, become enrolled as an Associate of the Society provided that he shall pass such examination as the Council may prescribe. ARTICLE IV.—Officers and Council. The officers of the Society shall be a President, two Vice-Presidents, a Secretary-Treasurer, and an Editor-Librarian. The officers with ex-Presidents, ex-Vice-Presidents and four other Fellows shall constitute the Council.

ARTICLE V.—Election of Officers and Council. The officers shall be elected by a majority ballot at the annual meeting for the term of one year and two members of the Council shall, in a similar manner, be annually elected to serve for two years. The President and Vice-Presidents shall not be eligible for the same office for more than two consecutive years nor shall any retiring member of the Council be eligible for re-election at the same meeting.

ARTICLE VI.—Duties of Officers and Council. The duties of the officers shall be such as usually appertain to their respective offices or may be specified in the by-laws. The duties of the Council shall be to pass upon candidates for membership, to decide upon papers offered for reading at the meetings, to supervise the examination of candidates and prescribe fees therefor, to call meetings, and, in general, through the appointment of committees and otherwise, to manage the affairs of the Society.

ARTICLE VII.—Meetings. There shall be an annual meeting of the Society on such date in the month of October as may be fixed by the Council in each year, but other meetings may be called by the Council from time to time and shall be called by the President at any time upon the written request of ten Fellows. At least two weeks notice of all meetings shall be given by the Secretary.

ARTICLE VIII.—Quorum. A majority, or seven members, of the Council shall constitute a quorum. Twenty Fellows of the Society shall constitute a quorum.

ARTICLE IX.—Expulsion or Suspension of Members. Except for non-payment of dues no member of the Society shall be expelled or suspended save upon action by the Council with not more than one negative vote followed by a two-thirds ballot of the Fellows present and voting at a meeting of the Society.

ARTICLE X.—Amendments. This constitution may be amended by an affirmative vote of two-thirds of the Fellows present at any meeting held at least one month after notice of such proposed amendment shall have been sent to each Fellow by the Secretary.

BY-LAWS.

BY-LAWS.

ARTICLE I.—Order of Business. At a meeting of the Society the following order of business shall be observed unless the Society votes otherwise for the time being:

- 1. Calling of the roll.
- 2. Address or remarks by the President.
- 3. Minutes of the last meeting.
- 4. Report by the Council on business transacted by it since the last meeting of the Society.
- 5. New membership.
- 6. Reports of officers and committees.
- 7. Election of officers and Council (at annual meetings only).
- 8. Unfinished business.
- 9. New business.
- 10. Reading of papers.
- 11. Discussion of papers.

ARTICLE II.—Council Meetings. Meetings of the Council shall be called whenever the President or three members of the Council so request, but not without sending notice to each member of the Council seven or more days before the time appointed. Such notice shall state the objects intended to be brought before the meeting, and should other matter be passed upon, any member of the Council shall have the right to re-open the question at the next meeting.

ARTICLE III.—Duties of Officers. The President, or, in his absence, one of the Vice-Presidents, shall preside at meetings of the Society and of the Council. At the Society meetings the presiding officer shall vote only in case of a tie, but at the Council meetings he may vote in all cases.

The Secretary-Treasurer shall keep a full and accurate record of the proceedings at the meetings of the Society and of the Council, send out calls for the said meetings, and, with the approval of the President and Council, carry on the correspondence of the Society. Subject to the direction of the Council, he shall have immediate charge of the office and archives of the Society.

The Secretary-Treasurer shall also send out calls for annual dues and acknowledge receipt of same; pay all bills approved by the President for expenditures authorized by the Council of the Society; keep a detailed account of all receipts and expenditures, and present an abstract of the same at the annual meetings, after it has been audited by a committee of the Council.

The Editor-Librarian shall, under the general supervision of the Council, have charge of all matters connected with editing and printing the Society's publications. The *Proceedings* shall contain only the proceedings of the meetings, original papers or reviews written by members, discussions on said papers and other matter expressly authorized by the Council.

The Editor-Librarian shall also, under the general supervision of the Council, have charge of the books, pamphlets, manuscripts and other literary or scientific material collected by the Society.

ARTICLE IV.—Dues. The dues shall be ten dollars for Fellows and five dollars for Associates payable upon entrance and at each annual meeting thereafter, except in the case of Fellows not residing in the United States, Canada, or Mexico, who shall pay five dollars at the times stated.

It shall be the duty of the Secretary-Treasurer to notify by mail any Fellow or Associate whose dues may be six months in arrears, and to accompany such notice by a copy of this article. If such Fellow or Associate shall fail to pay his dues within three months from the date of mailing such notice, his name shall be stricken from the rolls, and he shall thereupon cease to be a Fellow or Associate of the Society. He may, however, be reinstated by vote of the Council, and upon payment of arrears of dues.

ARTICLE V.—*Amendments.* These by-laws may be amended by an affirmative vote of two-thirds of the Fellows present at any meeting held at least one month after notice of the proposed amendment shall have been sent to each Fellow by the Secretary.

RULES REGARDING EXAMINATIONS FOR ADMISSION TO THE SOCIETY.

The Council adopted on March 29, 1915, the following rules providing for the examination system of the Society:

1. Examinations will be held on the first Wednesday and Thursday during the month of May in each year in such cities as will be convenient for three or more candidates.

2. Application for admission to examination should be made on the Society's blank form, which may be obtained from the Secretary-Treasurer. No applications will be considered unless received before the fifteenth day of March preceding the dates of examination.

3. A fee of \$5.00 will be charged for admission to examination. This fee is the same whether the candidate sits for one or two parts and is payable for each year in which the candidate presents himself. Examination fees are payable to the Secretary-Treasurer and must be in his hands before the fifteenth day of March preceding the dates of examination.

4. The examination for Associateship consists of four parts. Not more than two parts can be taken in the same year and no credit will be given for the passing of any part unless all previous parts have been passed during the same or previous years.

5. In the case of applicants not less than thirty years of age, who have had not less than five years' experience in actuarial or statistical work in insurance offices, the Council may, upon receipt of satisfactory evidence of general education, waive the passing of Parts I, II and III of the Associateship examination. Such applicants may thereupon become Associates by passing Part IV of the Associateship examination.

6. Admission to Fellowship examinations is granted only to those who are Associates of the Society. The examination for Fellowship is divided into two parts. No candidate will be permitted to present himself for Part II unless he has previously passed in Part I or takes Parts I and II in the same year. If a candidate takes both parts in the same year and passes in one and fails in the other, he will be given credit for the part passed. 7. As an alternative to the passing of Part II of the Fellowship examination, a candidate may elect to present an original thesis on an approved subject relating to casualty or social insurance. Candidates electing this alternative should communicate with the Secretary-Treasurer as to the approval of the subject chosen. All theses must be in the hands of the Secretary-Treasurer before the first Thursday in May of the year in which they are to be considered. Where Part I of the Fellowship examination is not taken during the same year, no examination fee will be required in connection with the presentation of a thesis. All theses submitted are, if accepted, to be the property of the Society and may, with the approval of the Council, be printed in the *Proceedings*.

8. In Part II of the Fellowship examination the papers will be so arranged that it will be necessary for the candidate to write on only three of the four prescribed topics in order to obtain full credit.

9. Special attention is called to the following important exceptions to the above rules effective as respects the years 1915 and 1916. The first examinations of the Society will be held on Wednesday, October 6, 1915. In the case of candidates for Associateship presenting themselves at that time the passing of Parts I, II and III will be waived and the candidates will be required to take Part IV only. Examinations will be regularly held in May, 1916, but in the case of candidates for Associateship presenting themselves at that time the passing of Parts I and II will be waived and the candidates will be required to take Parts III and IV only. Commencing with 1917, candidates for Associateship will be expected to pass in all four Parts of the Syllabus.

Syllabus of Examinations.

For Enrollment as Associate.

Part I:

- 1. Elementary algebra up to and including the binomial theorem.
- 2. Elementary plane trigonometry including the use of logarithms.
- 3. Elementary plane analytical geometry.
- 4. Double entry bookkeeping.

Part II:

- 1. Advanced algebra.
- 2. Elementary differential and integral calculus.
- 3. Elementary calculus of finite differences.
- 4. Theory of probability and least squares.

Part III:

- 1. Compound interest and annuities-certain.
- 2. Theory of statistics.
- 3. Elements of the theory of life annuities and assurances, including the calculation of premiums and reserves for the simpler forms of policy.
- 4. Elements of economics.

Part IV:

- 1. Practical problems in statistics.
- 2. Policy forms and underwriting practice in casualty insurance, viz.: Personal accident, health, liability, workmen's compensation, fidelity, surety, plate glass, steam boiler, burglary, fly wheel, automobile, workmen's collective, credit.
- 3. Practical problems in insurance accounting and statistics, including the preparation of annual statements.
- 4. Insurance law, including the more important statutes of the United States and Canada relating to casualty insurance.

For Admission as Fellow.

- Part I:
 - 1. Calculation of premiums and reserves for accident, sickness, workmen's compensation and other branches of casualty insurance.
 - 2. Inspection of risks; adjustment and settlement of claims.
 - 3. Investments of insurance companies.
 - 4. Current problems in workmen's compensation and other branches of casualty insurance.

Part II:

- 1. Principles and history of social insurance.
- 2. Compilation and use of census or other government statistics relating to population, mortality, invalidity, sickness, unemployment, old age and allied matters.
- 3. Systems of invalidity, old age and unemployment insurance.
- 4. Calculation of premiums for and valuation of pension funds.

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The PROCEEDINGS will be mailed to persons who are not members of the Society at the following rates: per year, 83.00; per number, \$1.00.

The Society contemplates publishing at least three numbers of the PROCEEDINGS each year.

Communications regarding the PROCEEDINGS should be addressed to THE EDITOR, Casualty Actuarial and Statistical Society of America, 345 Metropolitan Tower, New York City.

CONTENTS OF THE THIRD NUMBER

ADDRESS OF THE PRESIDENT, Dr. I. M. Rubinow, "Schedule Rating in	VOE
Compensation Insurance',	207
PAPERS:	
I. Development, Application and Effect of Schedule Rating in Liability and Compensation Insurance. Carl M.	017
11. The Effect of Schedule and Experience Rating on Work- mon's Comparisation Risks in New York Leon S. Senior	217 997
III. Schedule Rating Considered from an Actuarial Point of View, Albert II. Mowbray	241
IV. Notes on the Theory of Schedule Rating. Albert W. Whitney	250
V. Schedule Rating of Permanent Injuries. G. F. Michel- bacher	257
VI. Division of Payroll. E. C. DeKny	275 279
DISCUSSION OF PAPERS	295 314
THE CASUALTY ACTUARIAL AND STATISTICAL SOCIETY OF AMERICA: Officers, Conneil and Committees	i
Minutes of Meeting May 19, 1915 Constitution and By-Laws	ii iv
Examination Pequirements List of Members, May 19, 1915	viii xi