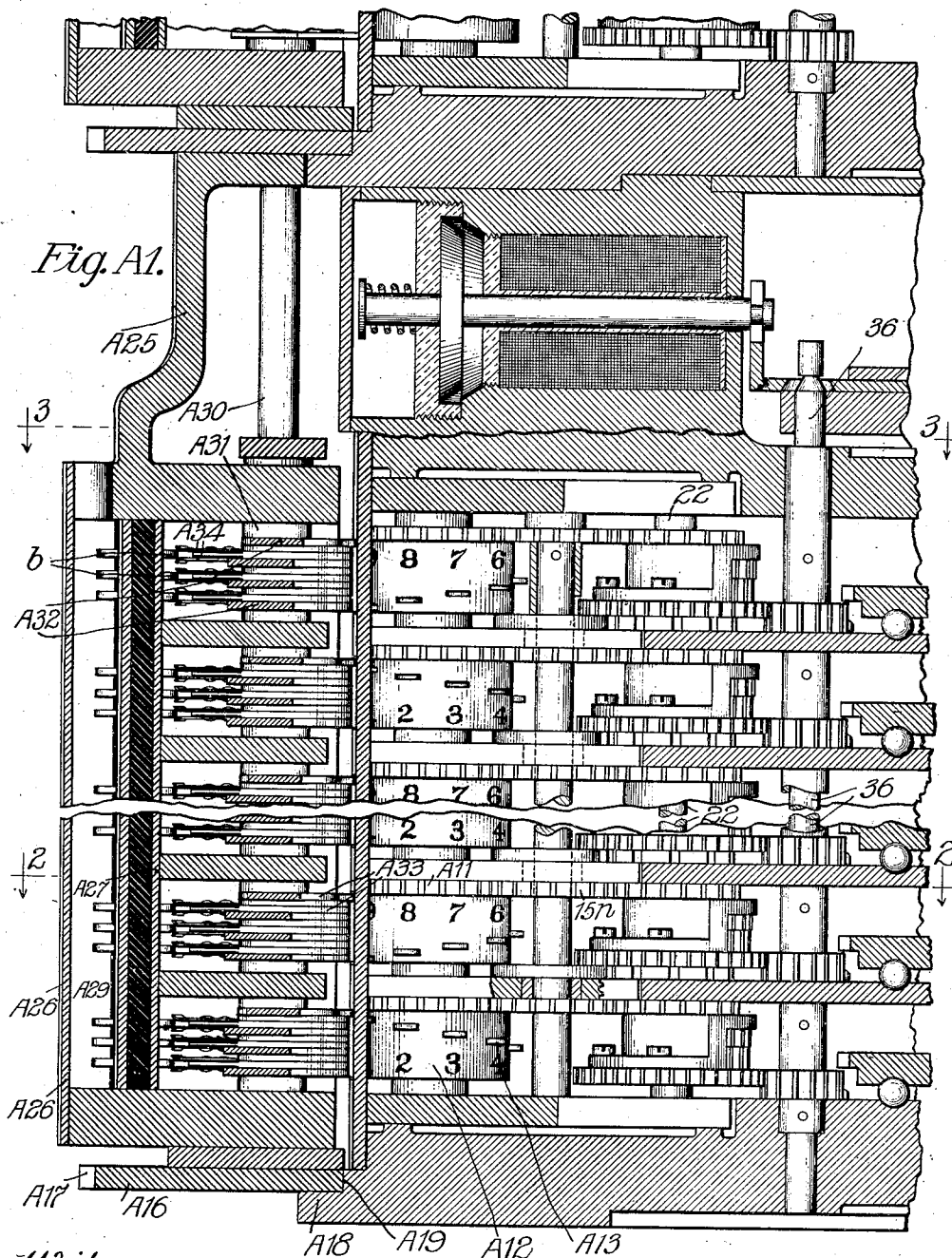


W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 1.



Witnesses:
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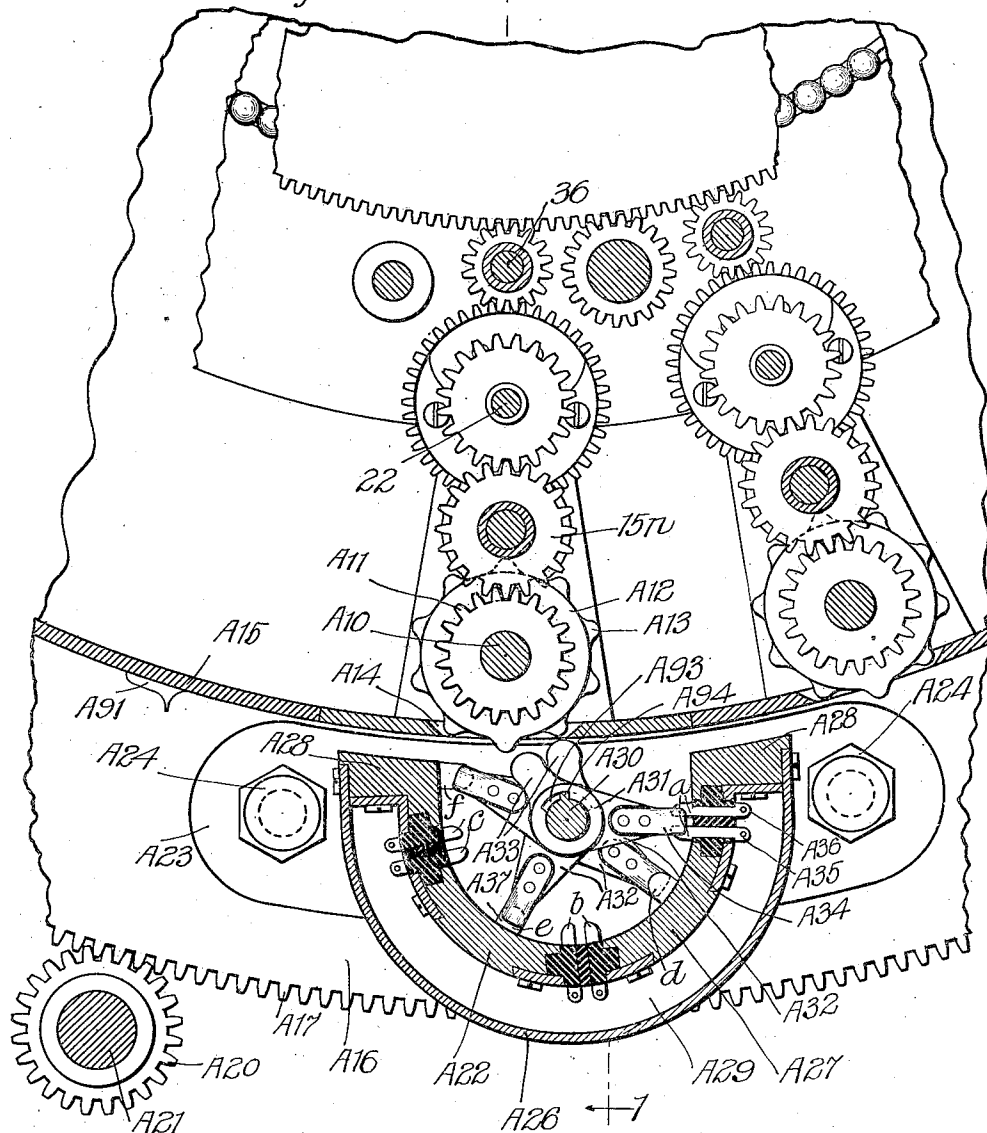
W. J. CRUMPTON.
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APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.

30 SHEETS—SHEET 2.

Fig. A2. +1



Witnesses:
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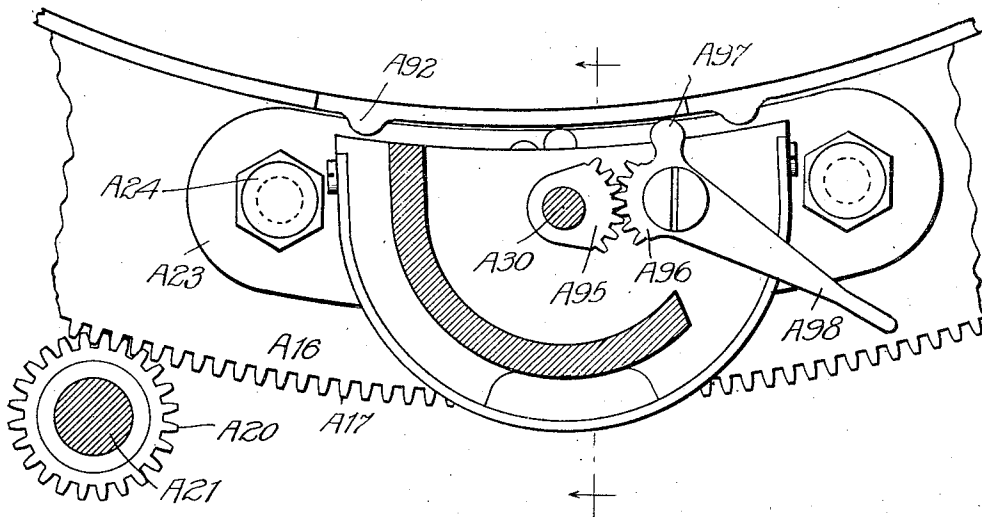
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
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1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 3.

Fig. A3.



Witnesses:
Albert L. McCaleb,
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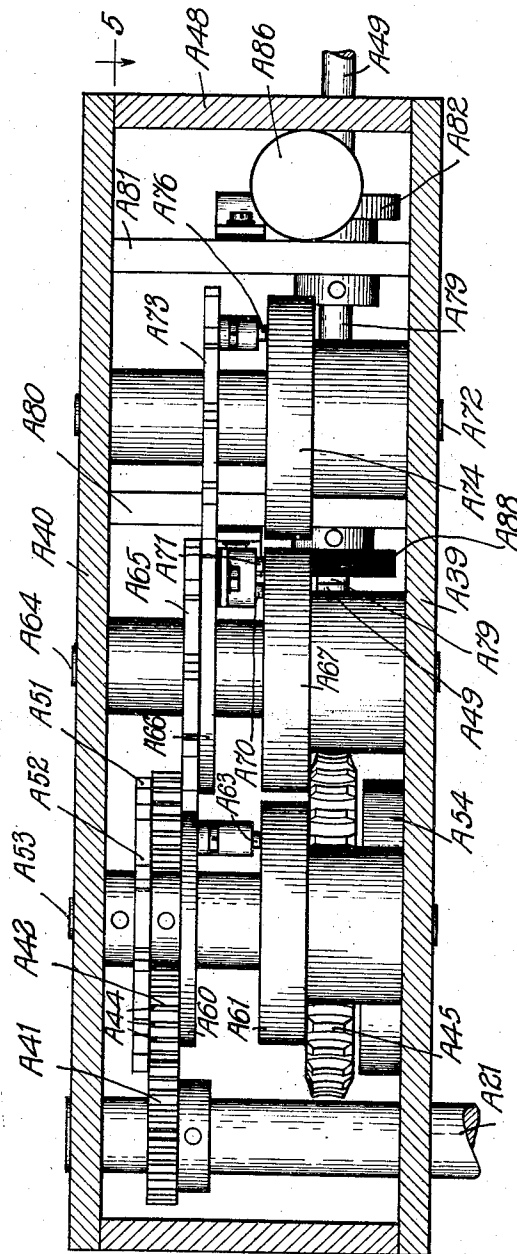
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W. J. CRUMPTON.
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1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 4.

Fig. A4.



Witnesses:
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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.

1,138,089.

30 SHEETS—SHEET 5.



Fig. A5.

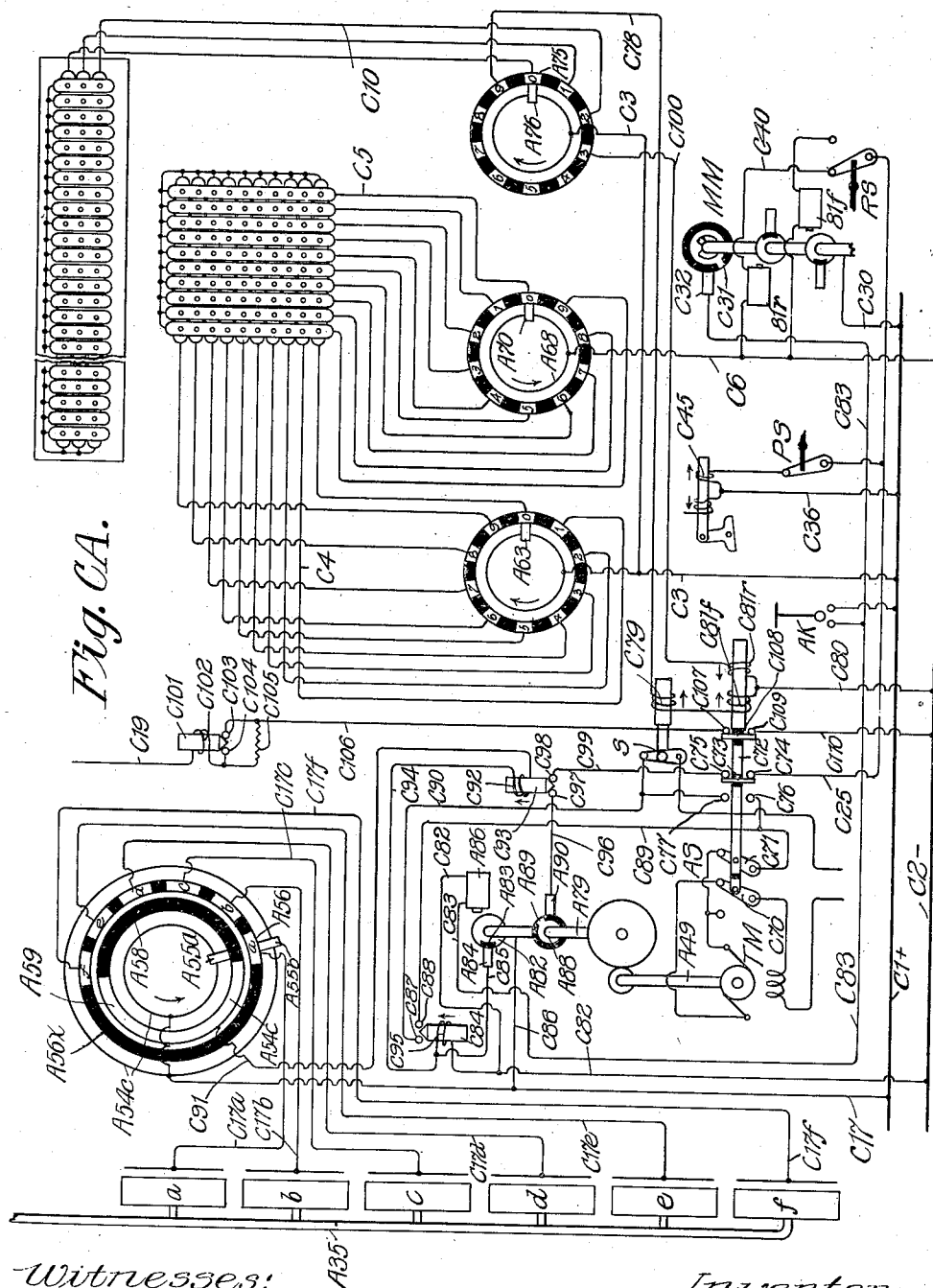
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30 SHEETS--SHEET 6.



Witnesses: A33
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
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Patented May 4, 1915.

30 SHEETS—SHEET 7.

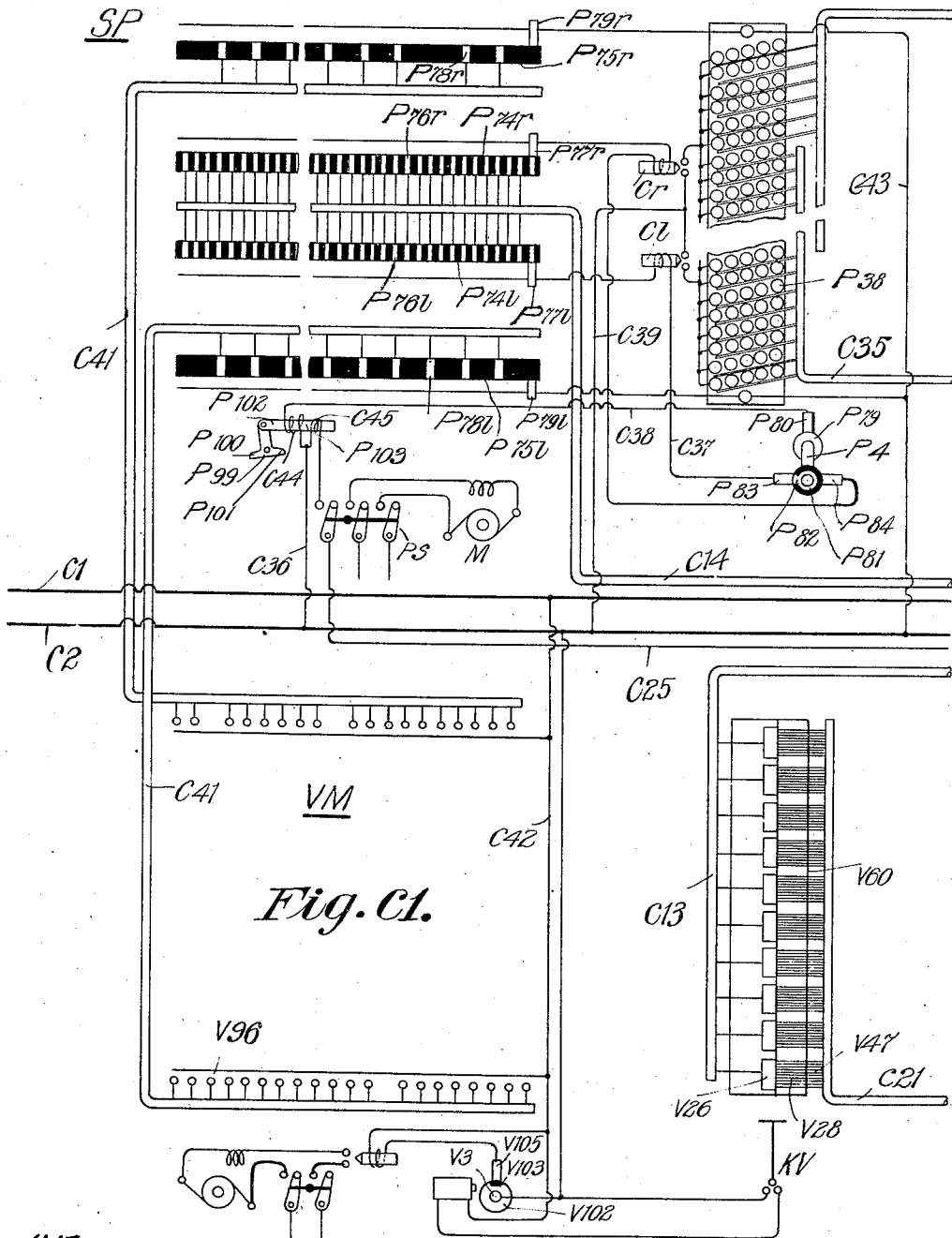


Fig. C1.

Witnesses:
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R. A. White.

Inventor:
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Witnesses
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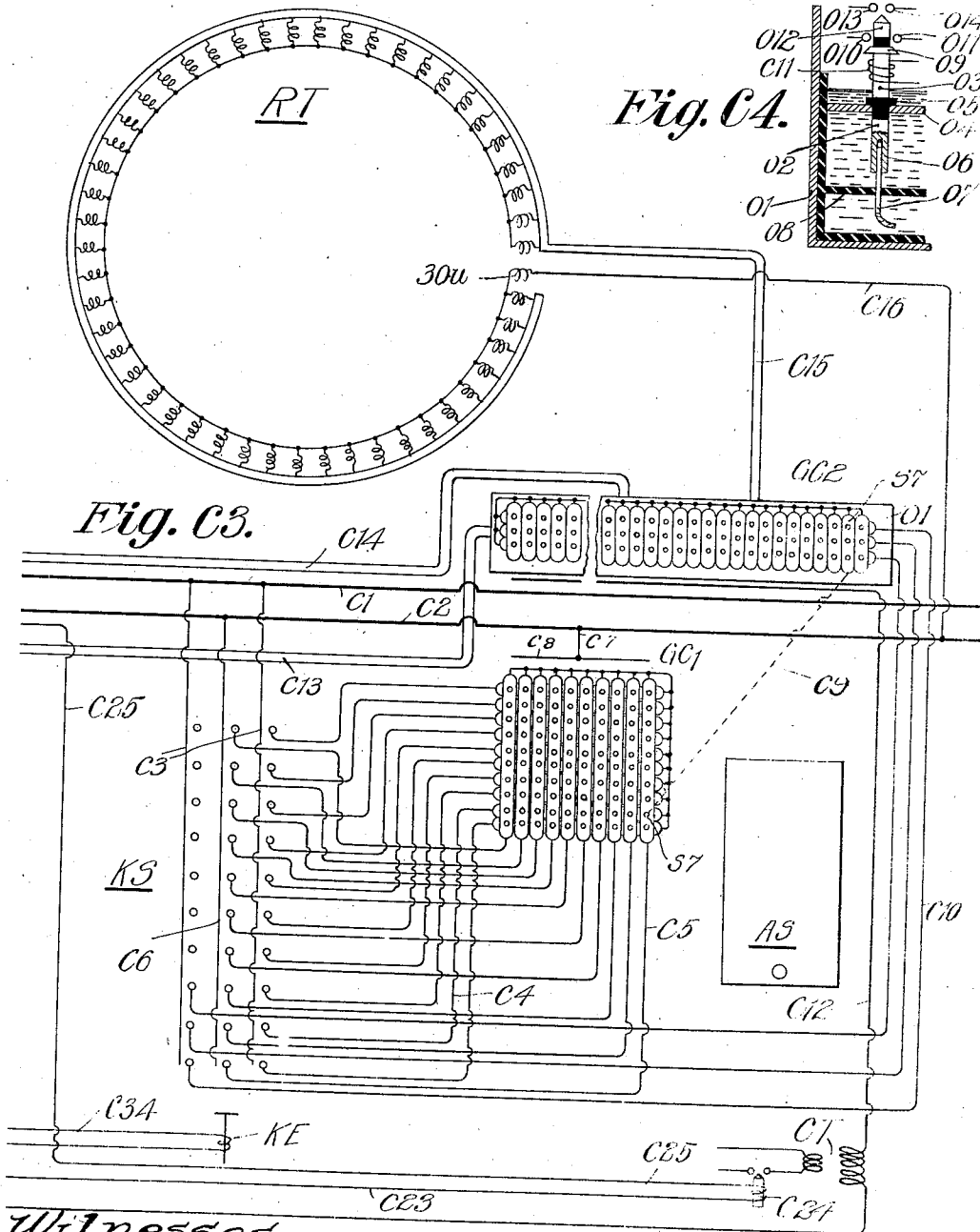
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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
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30 SHEETS—SHEET 9.

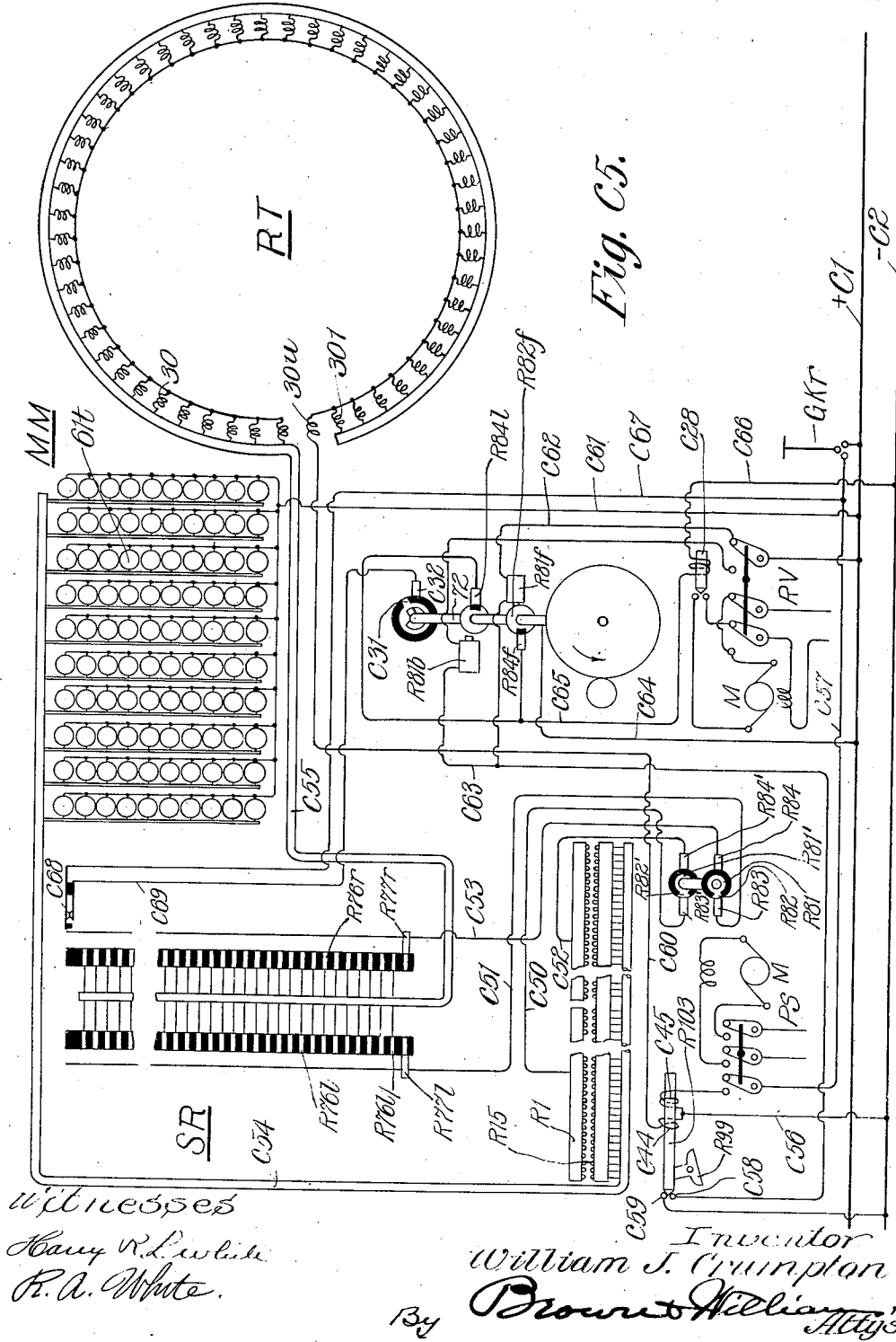


Witnessed
Harry R. Lovelace
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1,138,089.

Fig. C5.

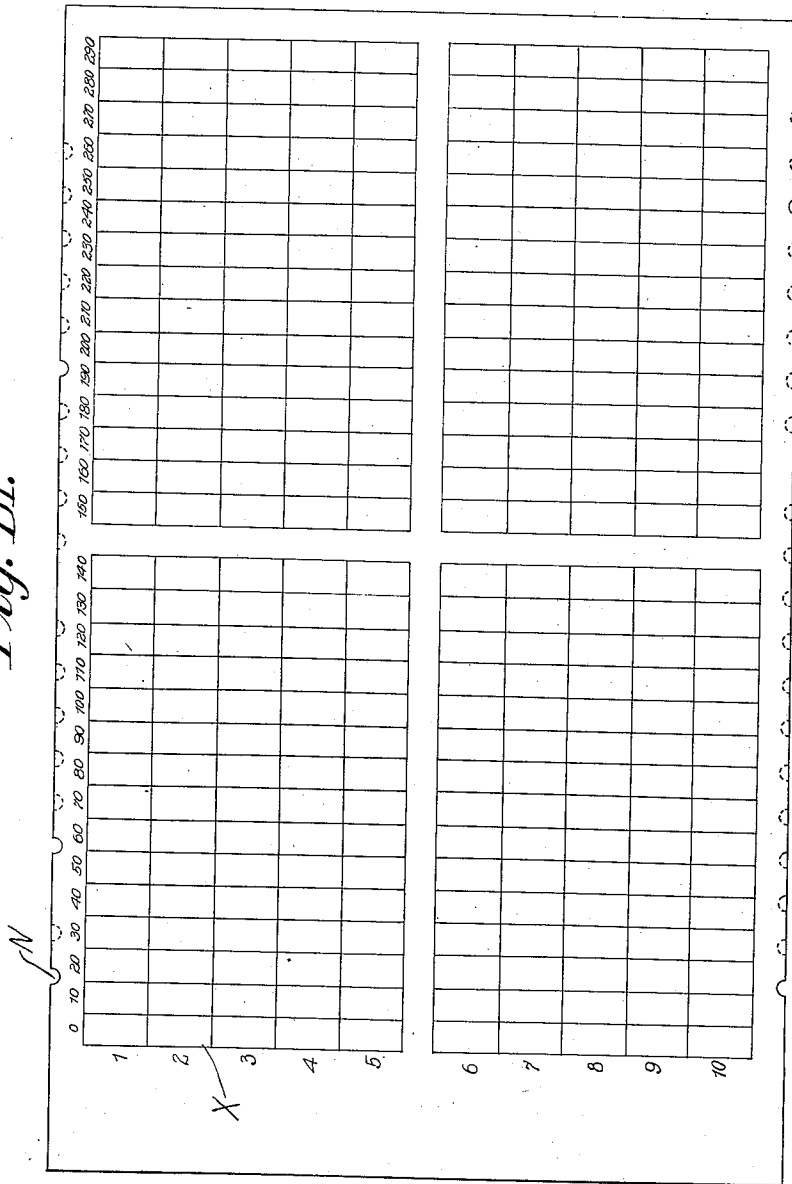


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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 11.

Fig. 11.



Witnesses:
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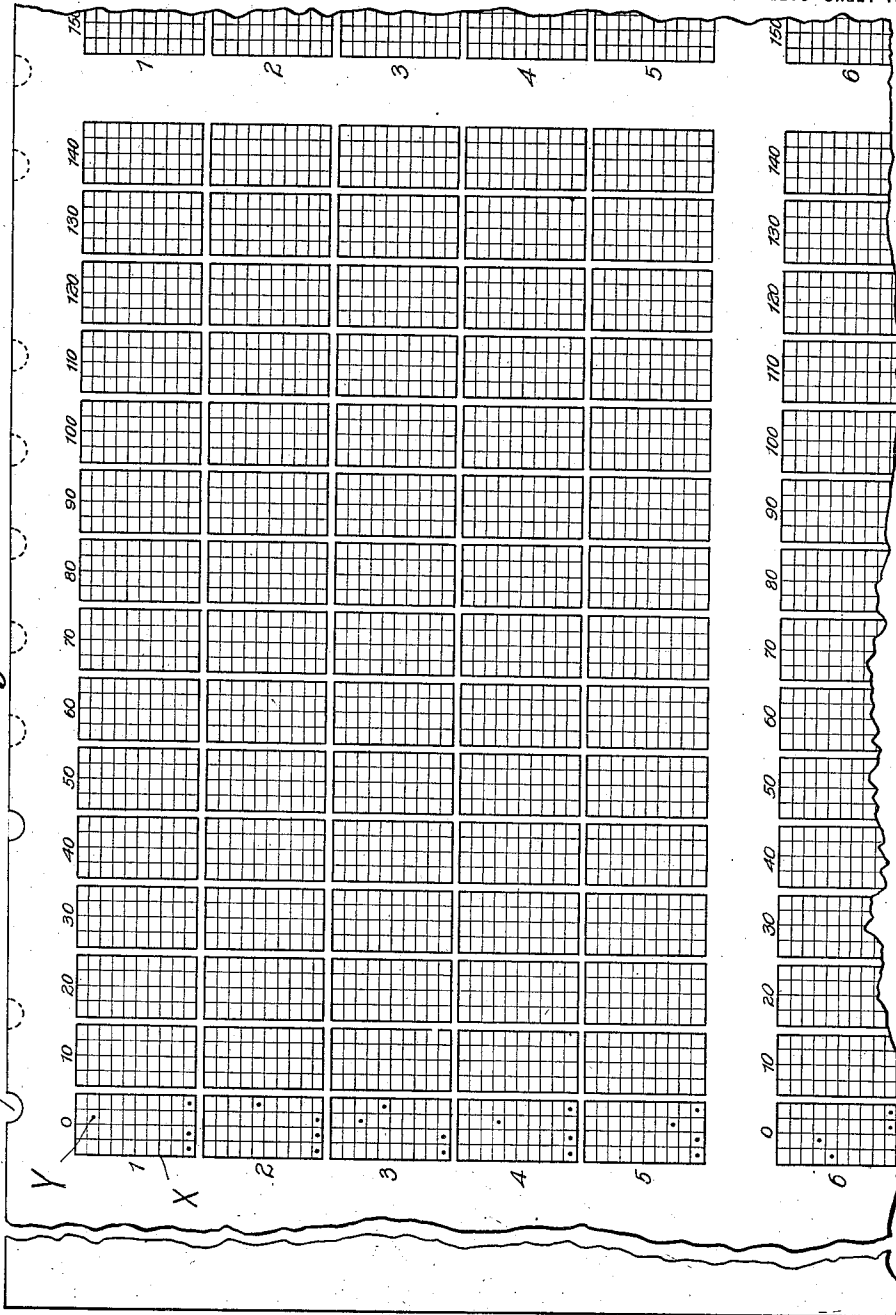
W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.

30 SHEETS—SHEET 12.

Fig. D2.



Witnesses:

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Inventor

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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

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Patented May 4, 1915.
30 SHEETS—SHEET 13.

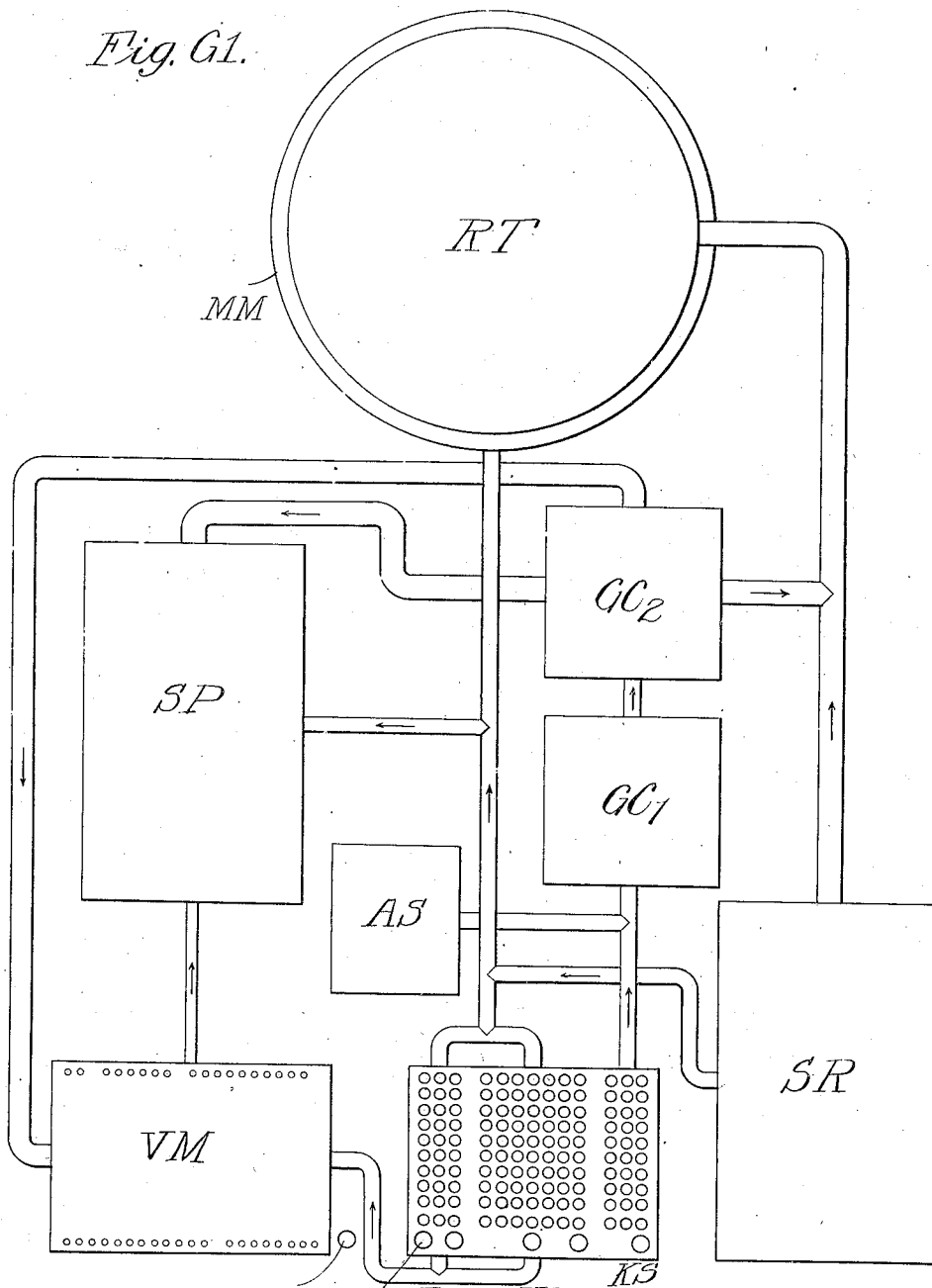
Fig. D3.

Witnesses: Leonard W. Novaudier, Albert H. McCaleb.
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1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 14.

Fig. G1.



Witnesses: RV
Albert S. McCobb
Roy Johnson

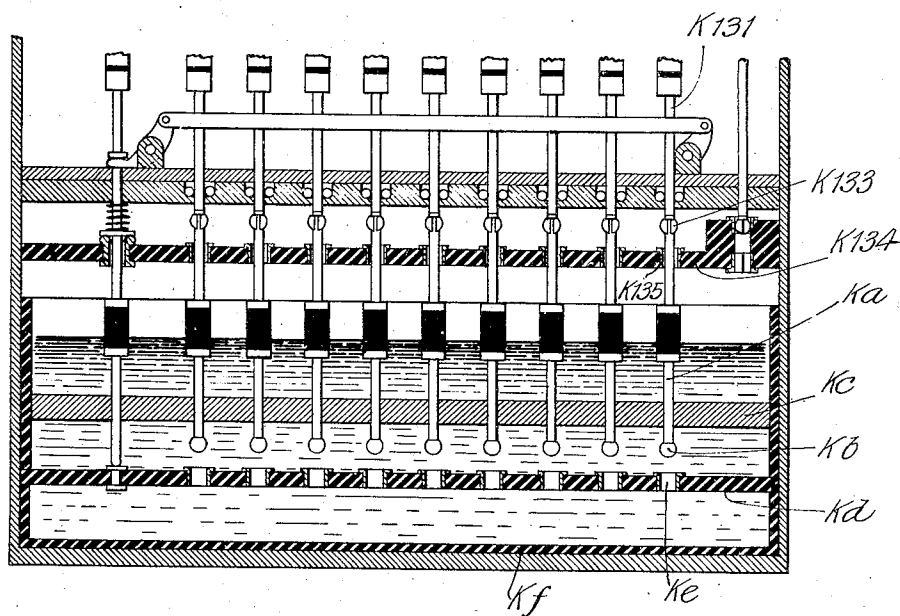
KC KA KS
KRC
Inventor
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1,138,089.

W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

Patented May 4, 1915.
30 SHEETS—SHEET 15.

Fig. K1.



Witnesses:
Albert H. McCaleb
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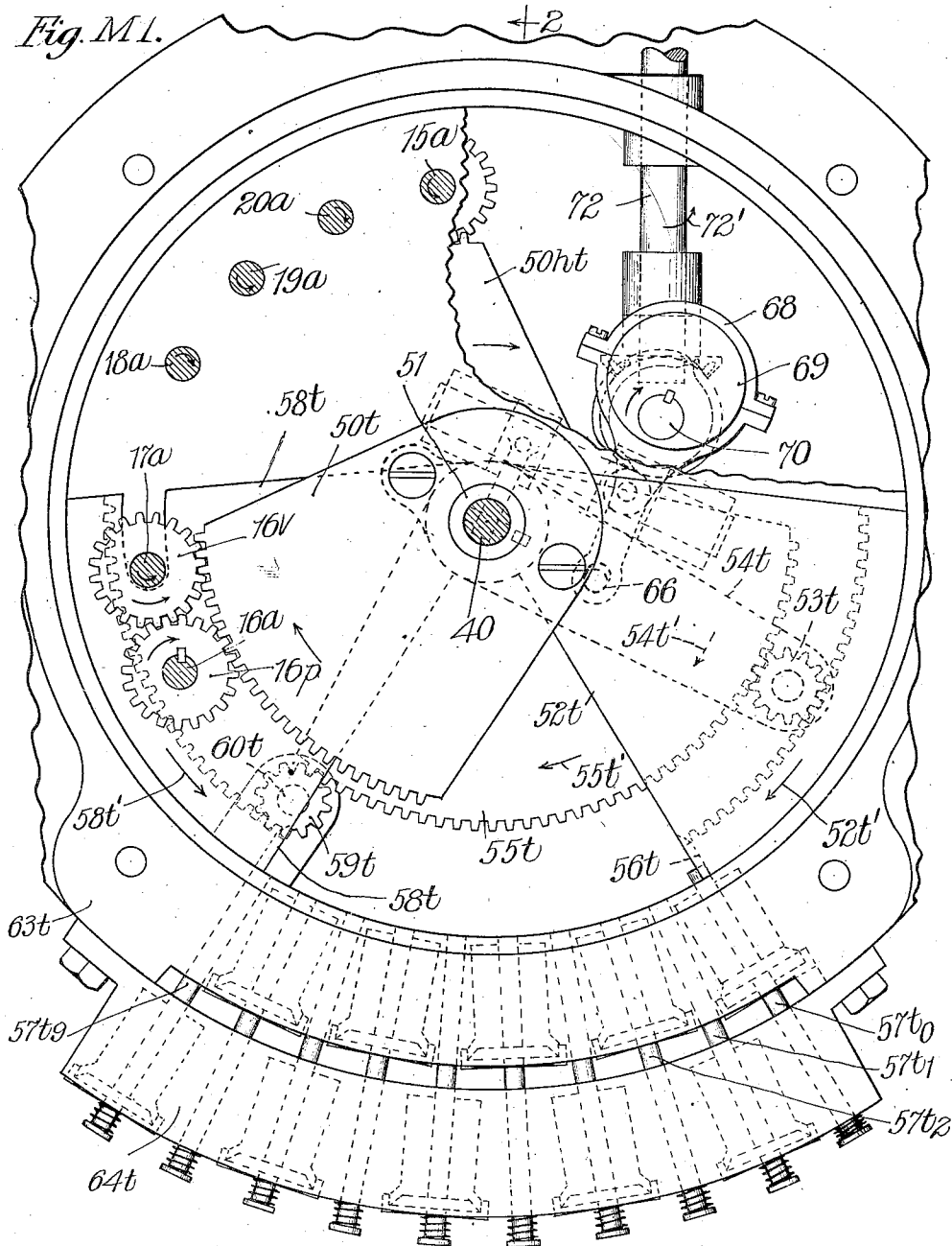
W. J. CRUMPTON.
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APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.

30 SHEETS—SHEET 16.

Fig. M1.



Witnesses:
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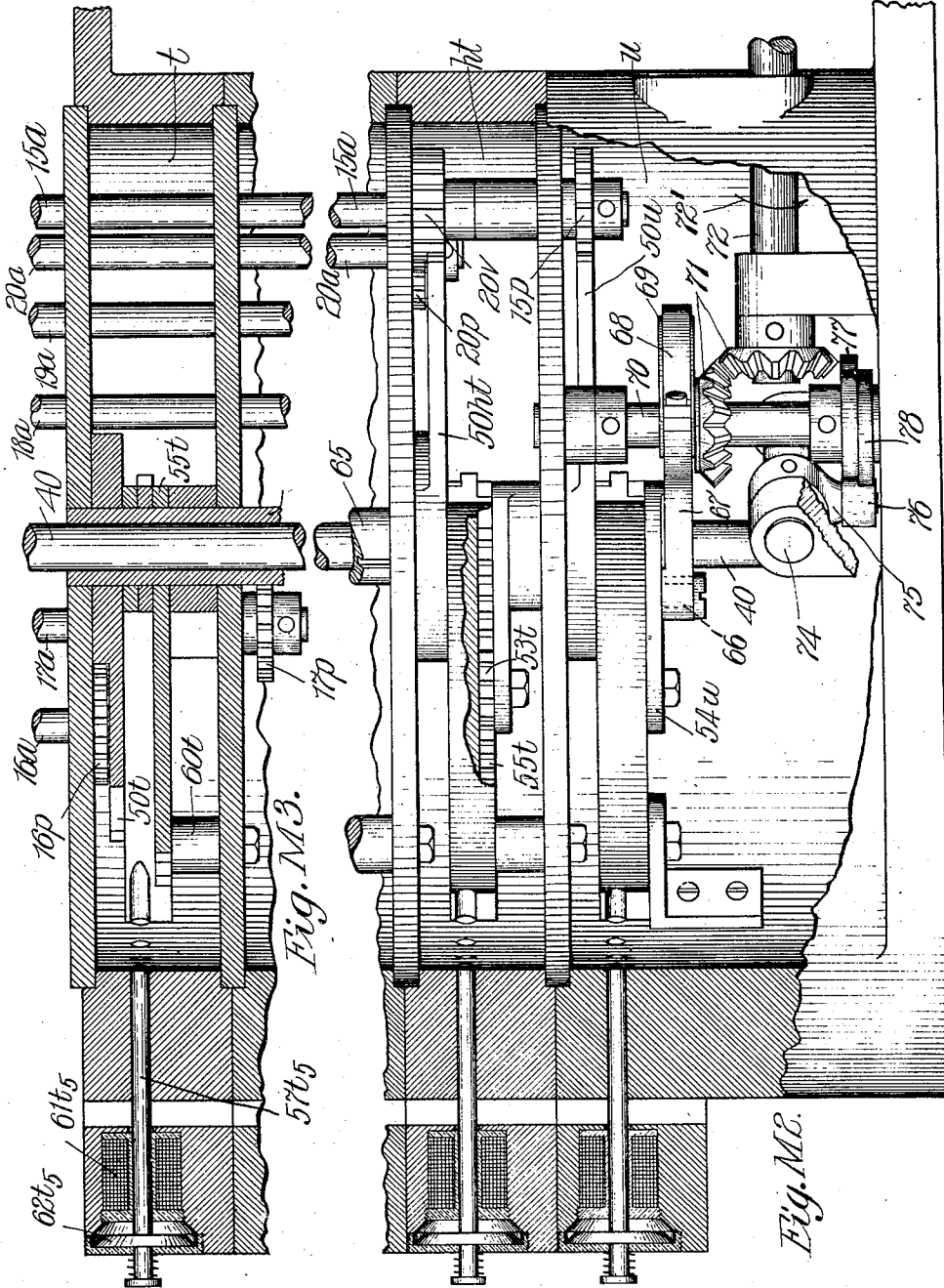
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W. J. CRUMPTON.
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APPLICATION FILED OCT. 20, 1908.

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Patented May 4, 1915.

30 SHEETS—SHEET 17.



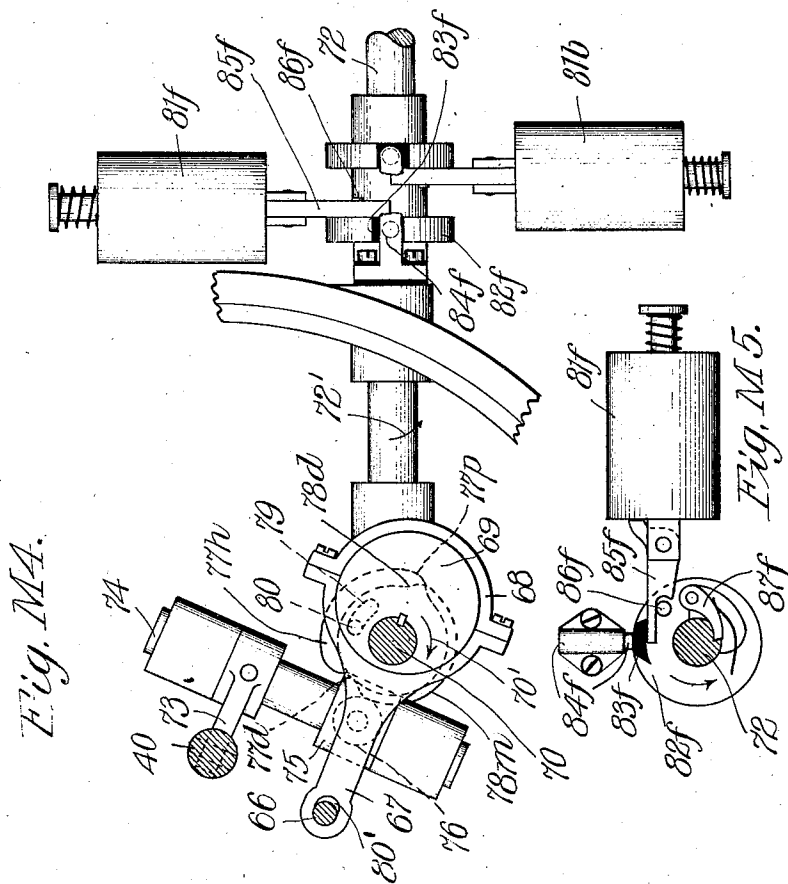
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

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30 SHEETS—SHEET 18.



Witnesses
Albert G. McCall
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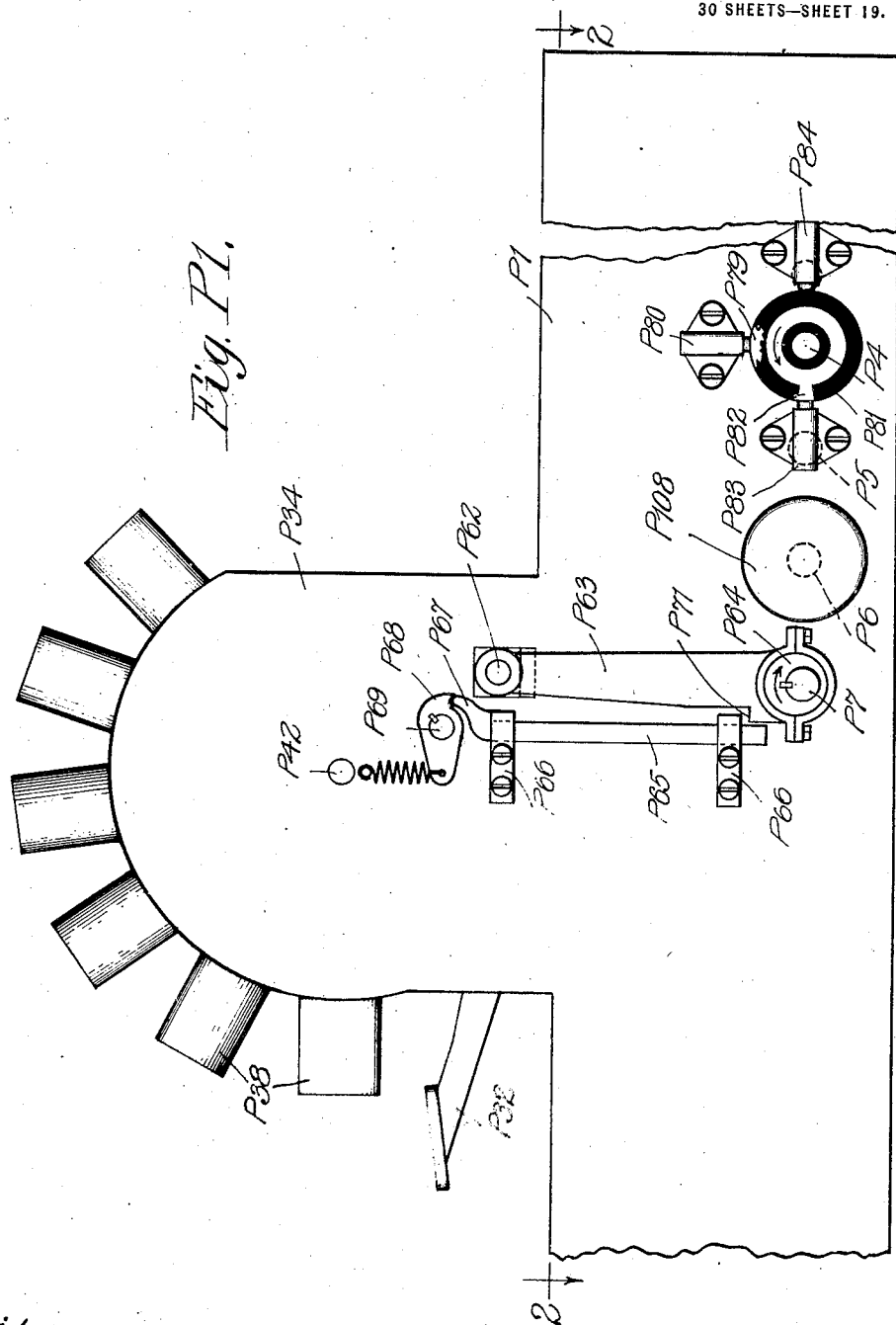
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
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1,138,089.

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30 SHEETS—SHEET 19.



Witnesses:
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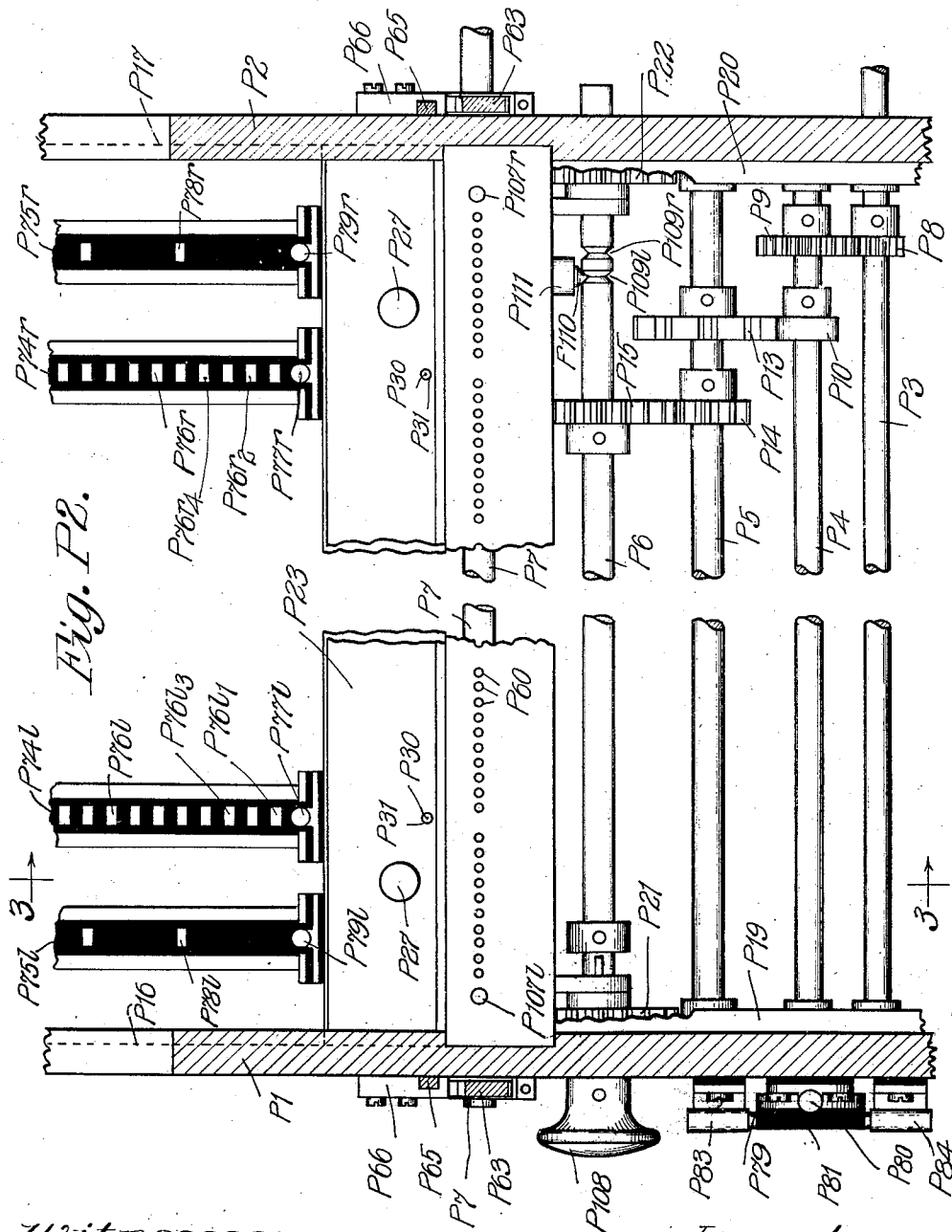
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W. J. CRUMPTON.
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APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.

30 SHEETS—SHEET 20.



Witnesses:
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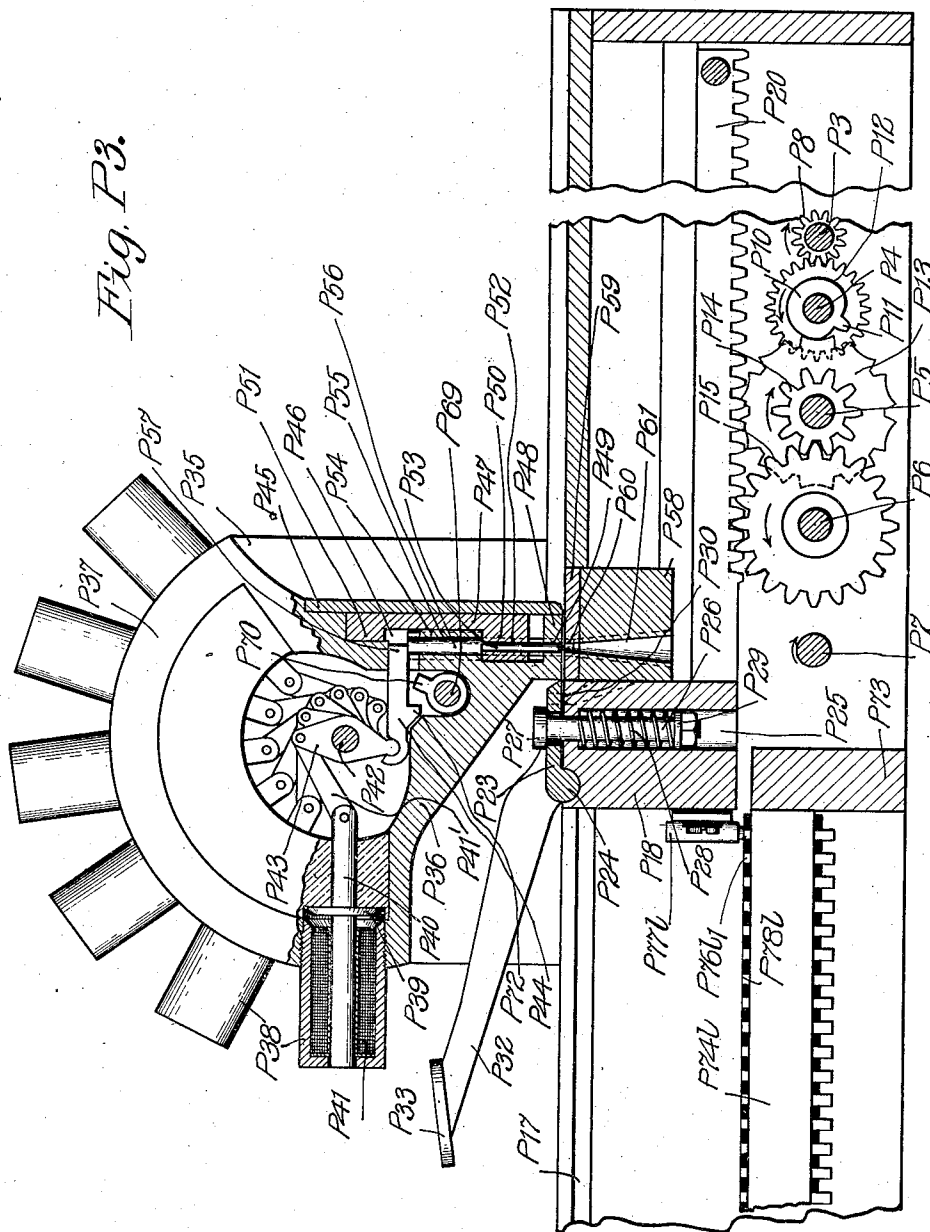
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APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.

30 SHEETS—SHEET 21.



Witnesses:
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 22.

Fig. P4.

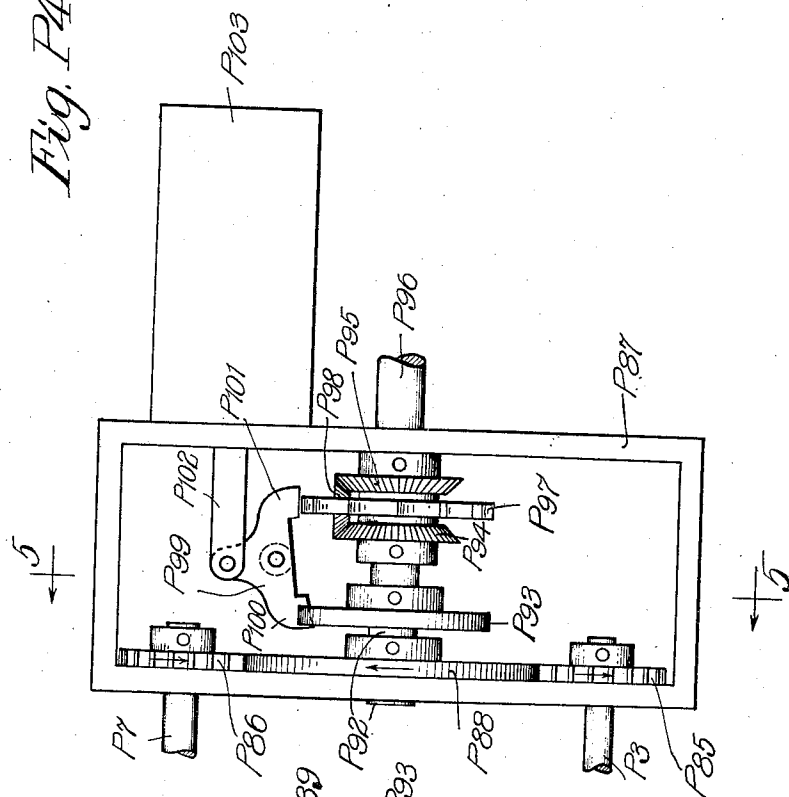
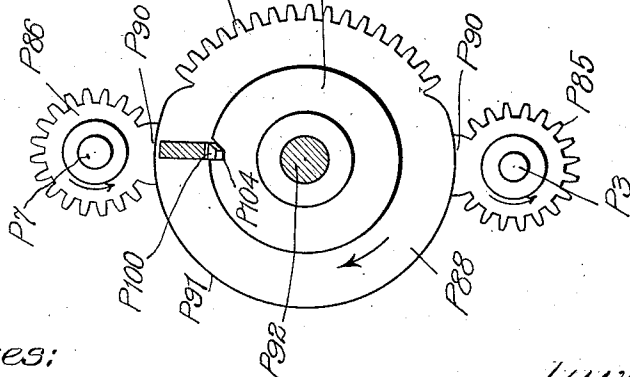


Fig. P5.



Witnesses:
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Ray Johnson

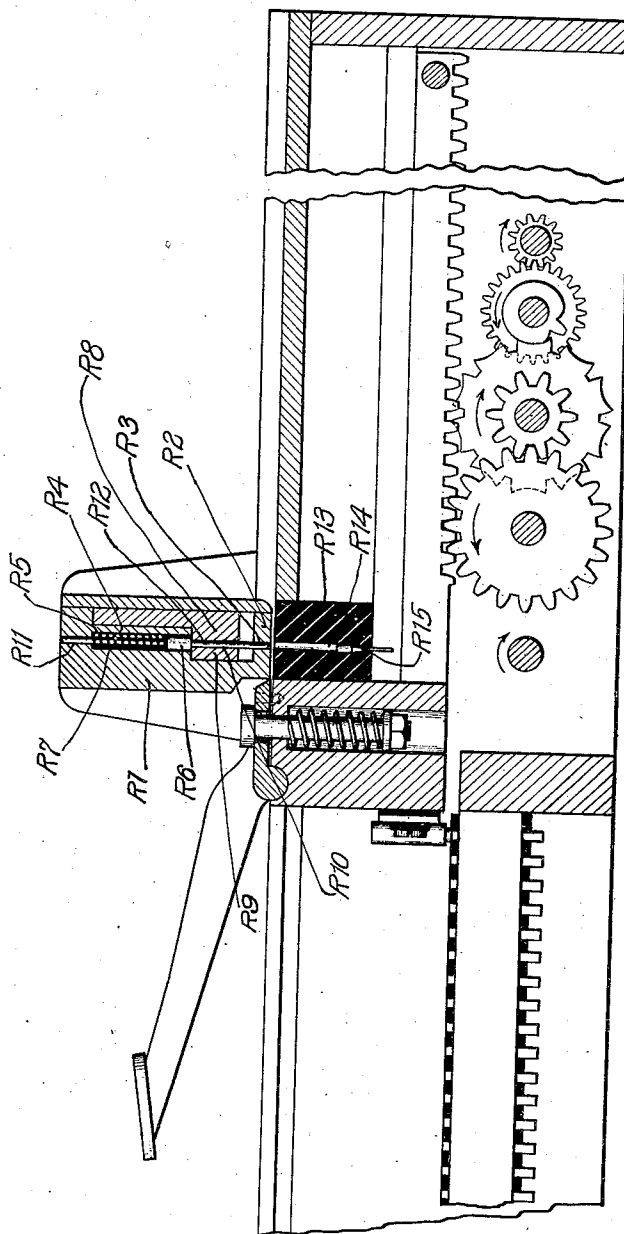
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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

Patented May 4, 1915.
30 SHEETS—SHEET 23.

Fig. R1.



Witnesses:
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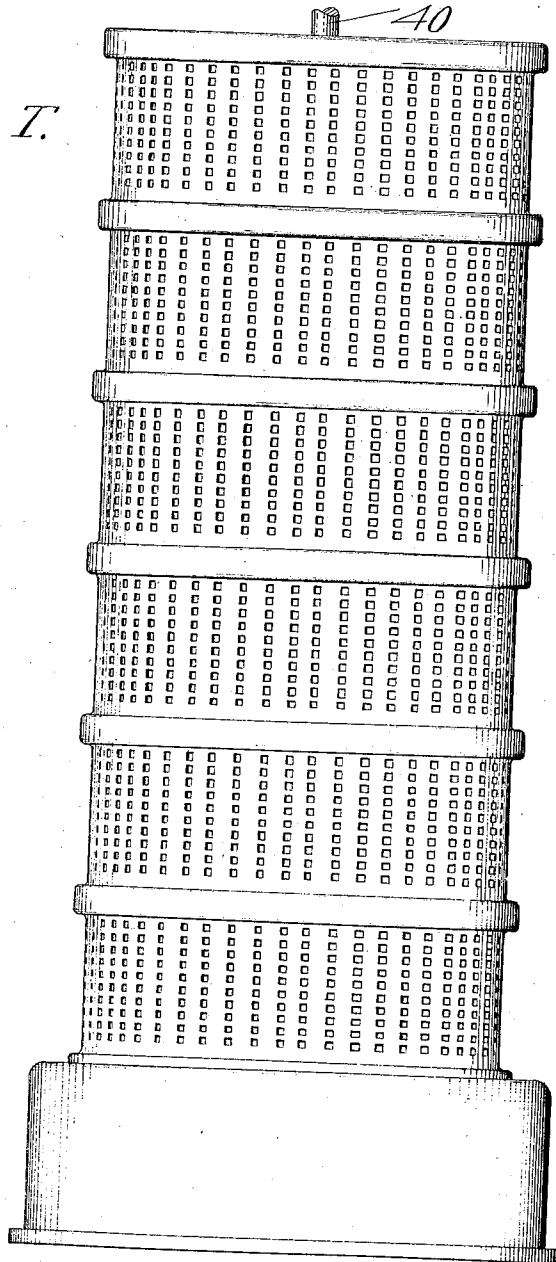
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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 24.

Fig. 1.



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1,138,089.

30 SHEETS--SHEET 25.

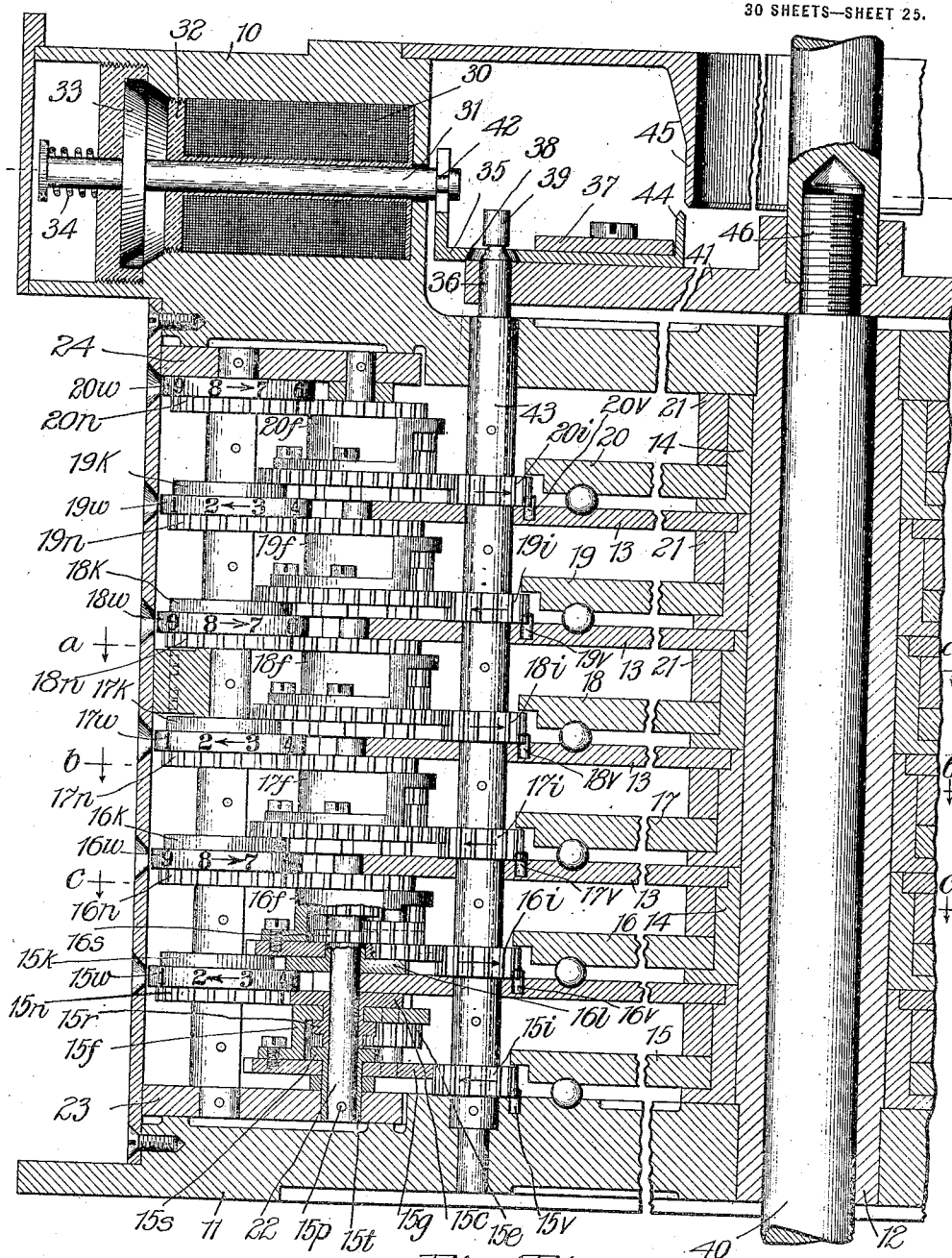
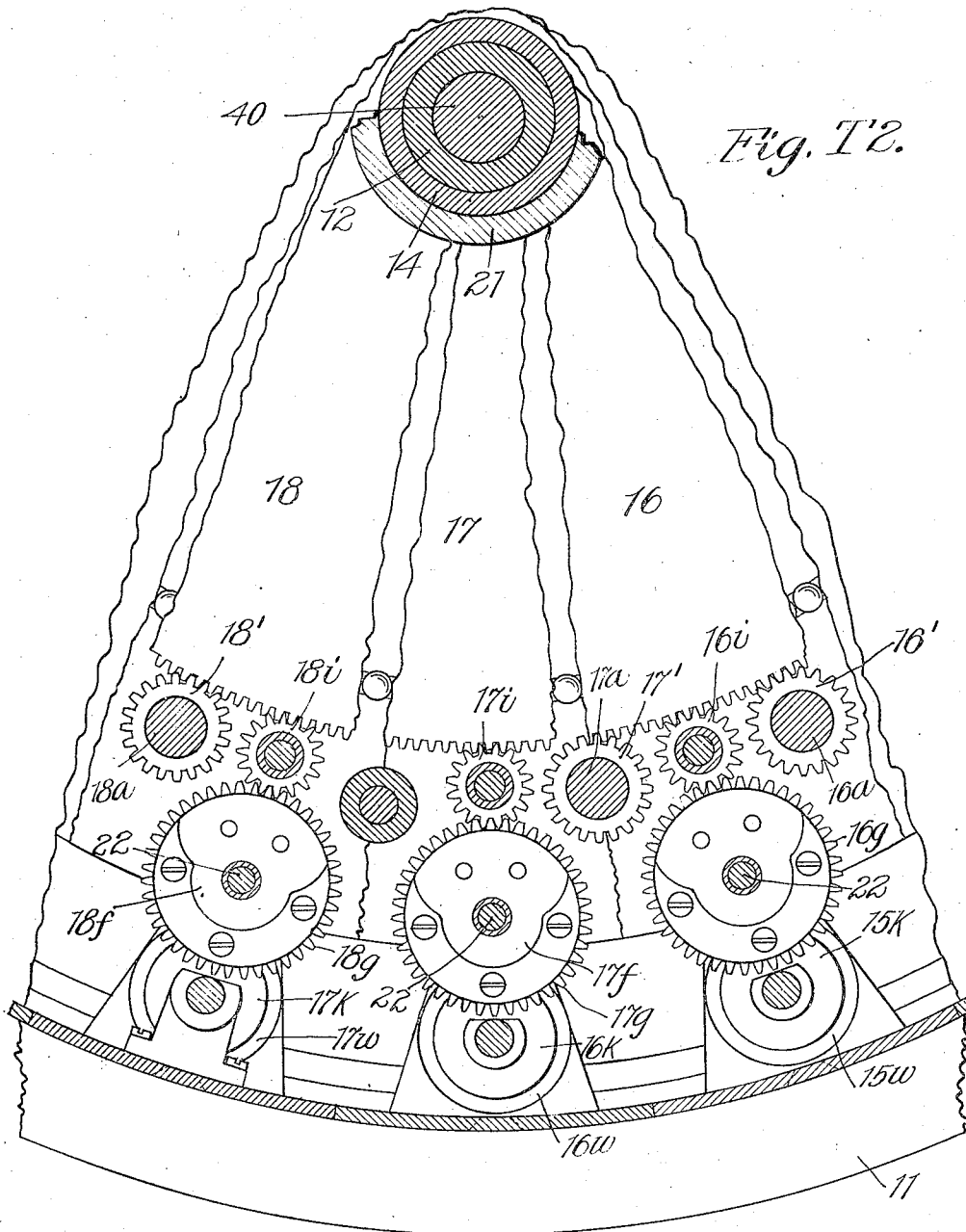


Fig. T1.

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1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 26.



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1,138,089.

W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

Patented May 4, 1915.
30 SHEETS—SHEET 27.

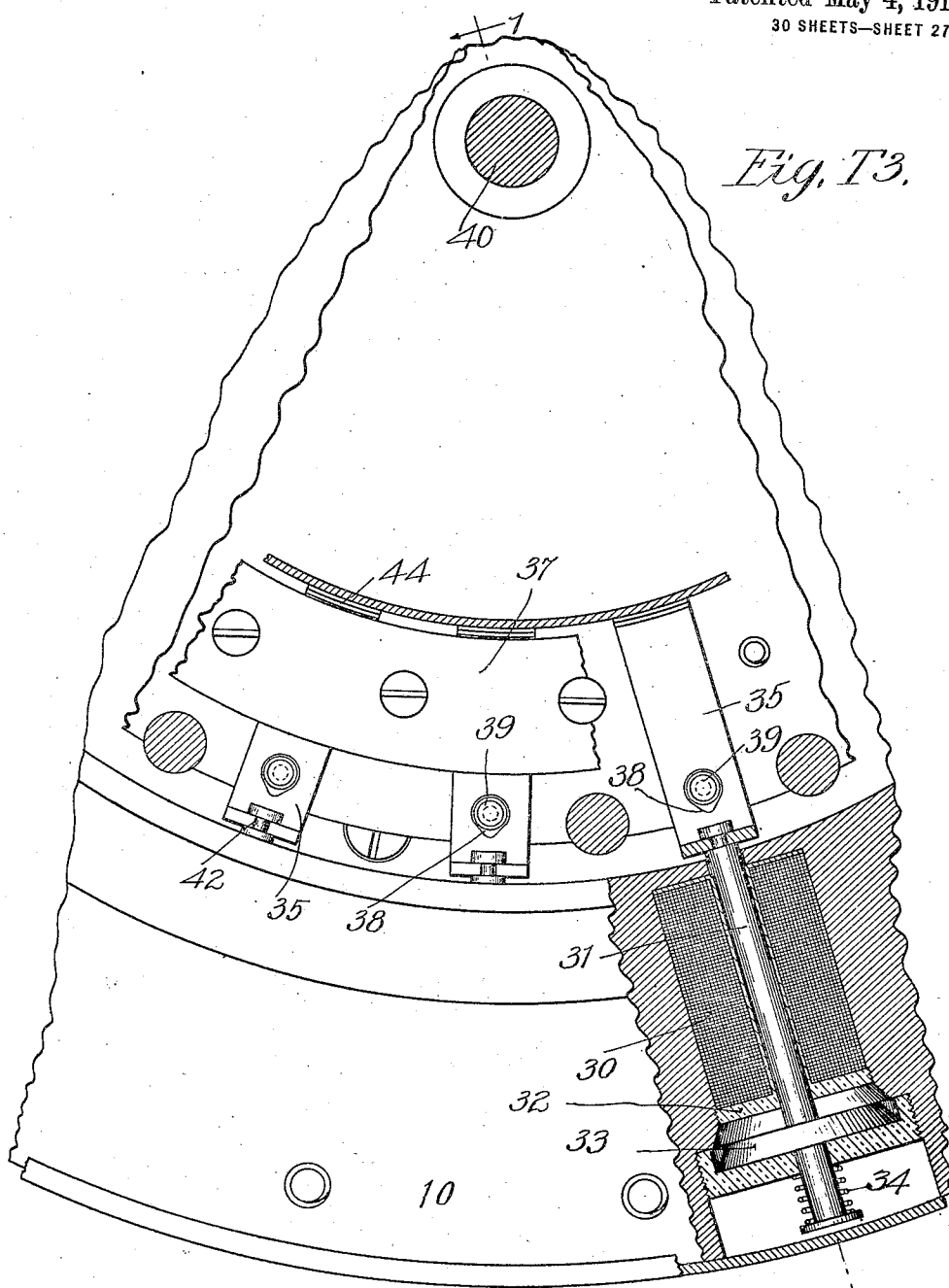


Fig. T3.

Witnesses:
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W. J. CRUMPTON.
METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

Patented May 4, 1915.
30 SHEETS—SHEET 28.

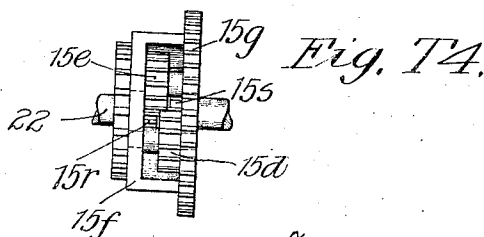


Fig. T4.

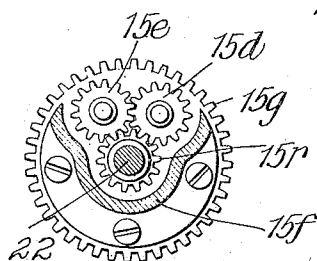


Fig. T6

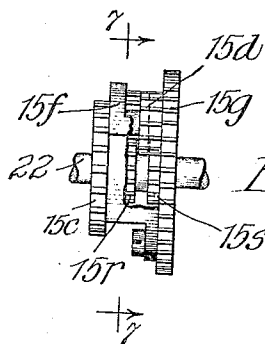


Fig. T5.

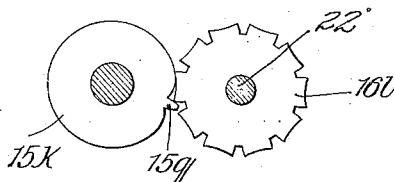


Fig. T7.

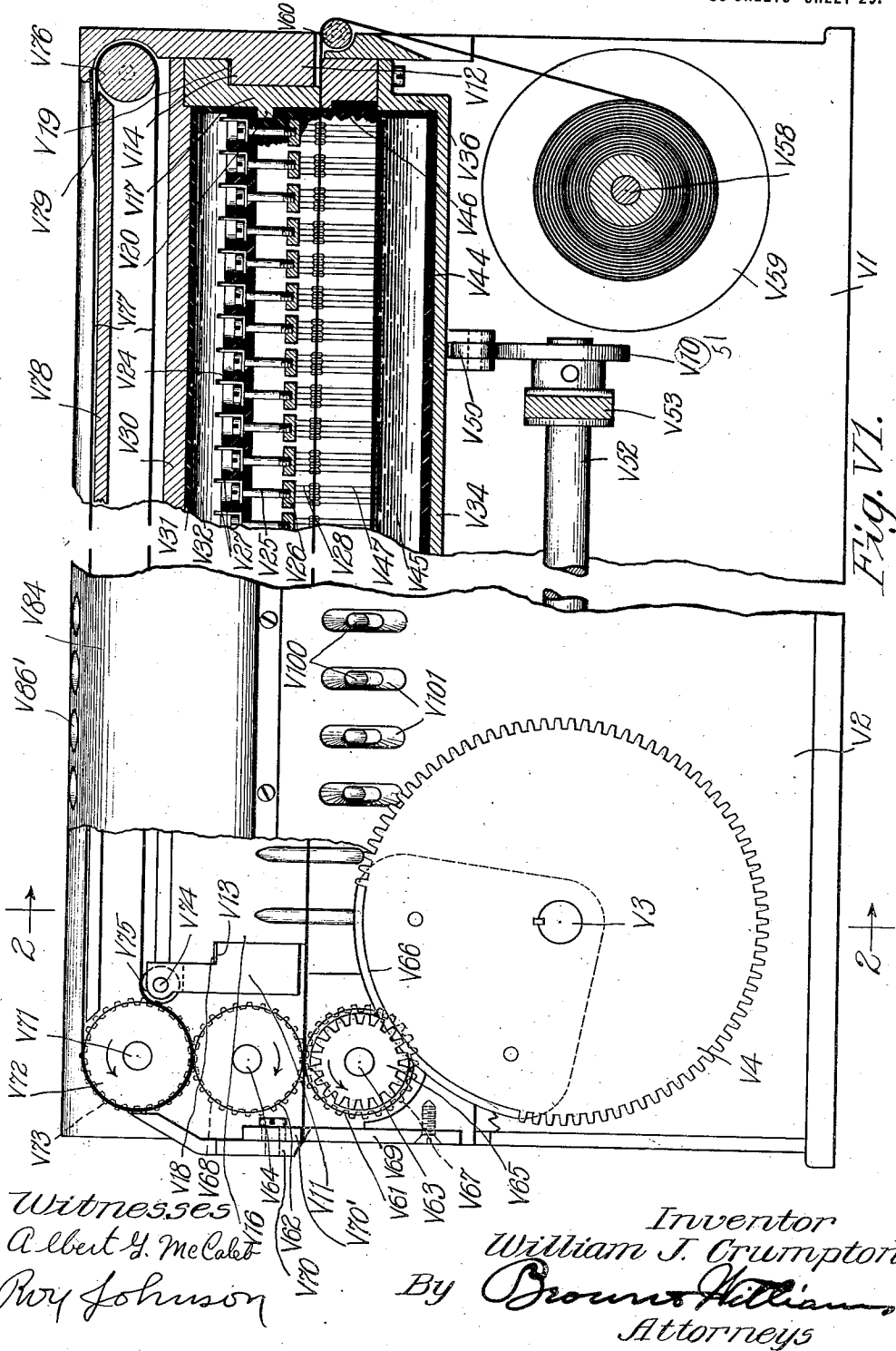
Witnesses:
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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 29.



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METHOD AND MEANS FOR STATISTICAL ACCOUNTING.
APPLICATION FILED OCT. 20, 1908.

1,138,089.

Patented May 4, 1915.
30 SHEETS—SHEET 30.

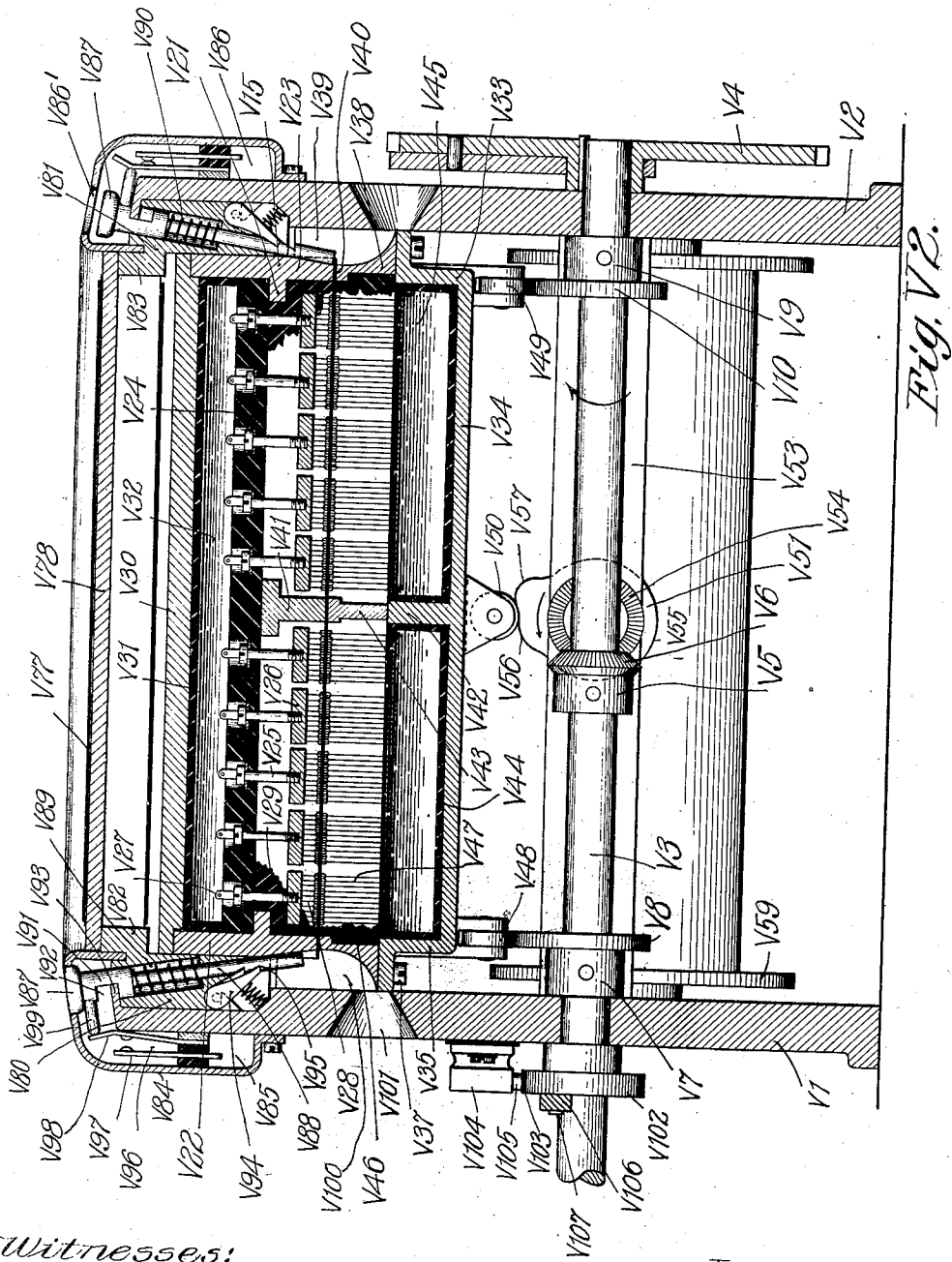


Fig. V2.

Witnesses:
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UNITED STATES PATENT OFFICE.

WILLIAM J. CRUMPTON, OF SUPERIOR, WISCONSIN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WILLIAM R. HEATH, OF BUFFALO, NEW YORK.

METHOD AND MEANS FOR STATISTICAL ACCOUNTING.

1,138,089.

Specification of Letters Patent.

Patented May 4, 1915.

Application filed October 20, 1902. Serial No. 458,650.

To all whom it may concern:

Be it known that I, WILLIAM J. CRUMPTON, a citizen of the United States, residing at Superior, in the county of Douglas and State of Wisconsin, have invented a certain new and useful Improvement in Methods and Means for Statistical Accounting of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to methods and means for statistical accounting and provides generally the means and method for handling statistical data in accordance with an improved plan, and generally by the substitution of automatically controlled mechanical operations for many of the operations which in the prior art have been performed manually or mentally.

Furthermore, my invention provides mechanism for securing statistical results which by the methods of the prior art have been practically impossible on account of the large amount of clerical labor which the attainment of such results would have involved. A well-known system of statistical ac-

counting is that which was used in the tabulation of the agricultural data for the census of 1900. Because of the enormous bulk and variety of the data and the great complexity of the classifications involved in that work, and because of the peculiar adaptability of my invention to the handling of such comprehensive tabulations, a brief outline of the method and means employed in the tabulation of that census is given, preliminary to the description of the improved manner and means which I employ in doing similar work. This practical comparative illustration, while perhaps more extended than necessary to state my invention in the briefest terms, is best calculated to set forth clearly its principal features. In the system employed in that work, a great mass of statistical data pertaining to numerous classes of farms was transferred to cards, the cards were sorted into the desired classes and the data on the cards was tabulated independently for each class. The number and variety of farm classes theoretically possible under the classification plan prescribed by the Census Bureau are shown in the following scheme:

Group.	Sub-group (basis).	No. of classes.	Example.
I. Primary (one character)	1. Race.....	2	White, colored. Owner, manager. 10-acre, 100-acre. Grain, cotton. \$100, \$1,000.
	2. Tenure.....	6	
	3. Area.....	10	
	4. Product.....	12	
	5. Income.....	8	
II. Secondary (two characters)	6. Race—tenure.....	12	White, owner. White, ten-acre. White, grain. White, \$100. Owner, ten-acre. Owner, grain. Owner, \$100. 10-a., grain. 10-a., \$100. Grain, \$100.
	7. Race—area.....	20	
	8. Race—product.....	24	
	9. Race—income.....	16	
	10. Tenure—area.....	60	
	11. Tenure—product.....	72	
	12. Tenure—income.....	48	
	13. Area—product.....	120	
	14. Area—income.....	80	
	15. Product—income.....	96	
III. Tertiary (three characters)	16. Race—tenure—area.....	120	White, owner, 10-a. White, owner, grain. White, owner, \$100. White, 10-a., grain. White, 10-a., \$100. White, grain, \$100. Owner, 10-a., grain. Owner, 10-a., \$100. Owner, grain, \$100. 10-a., grain, \$100.
	17. Race—tenure—product.....	144	
	18. Race—tenure—income.....	96	
	19. Race—area—product.....	240	
	20. Race—area—income.....	160	
	21. Race—product—income.....	192	
	22. Tenure—area—product.....	720	
	23. Tenure—area—income.....	480	
	24. Tenure—product—income.....	576	
	25. Area—product—income.....	960	
IV. Quaternary (four characters)	26. Race—tenure—area—product.....	1,440	Wh., own., 10-a., grain. Wh., own., 10-a., \$100. Wh., own., grain, \$100. Wh., 10-a., grain, \$100. Own., 10-a., grain, \$100.
	27. Race—tenure—area—income.....	960	
	28. Race—tenure—product—income.....	1,152	
	29. Race—area—product—income.....	1,920	
V. Quinquenary	30. Tenure—area—product—income.....	5,760	Own., 10-a., grain, \$100.
	31. Race—tenure—area—product—income.....	11,520	
Grand total number of possible classes, of all ranks.....		27,024	Wh., ow., 10-a., gr., \$100.

(The final, five-character group has only one sub-group possible, with the extreme number of possible classes, and, typically, the smallest number of individuals in a class.)

In a complete tabulation, each farm must be included in each group and in each subgroup; that is, in 31 of the 27,026 theoretical classes. The vast proportion of these theoretical classes are, as a matter of fact, non-existent; but scores of them are existent in a county, hundreds of them in a State and a thousand or more, in the nation. The tabulation of the numerous statistical data in all of these existent classes, for each county, each State, and the nation as a whole, involves so much labor by existing methods and means as to be impracticable. It is the general purpose of my invention to supply the means whereby, in connection with improved methods, such complete tabulation becomes practicable.

Each schedule or field return for a farm may possibly contain a large number of statistical items or data (approximately 300), for the most part divided into crop-groups, or their equivalent, as

Corn: Number of acres, Number of bushels and value.
Cotton: Number of acres, Number of bales and value.
Calves: ----- Number ----- and value.

There are upward of one hundred of these crop-groups possible for a given farm, but in point of fact the average at the last census was about twenty crop-groups per farm. Each group of crop data, typically containing three items, is transferred to a crop card by the wellknown method of punching holes to indicate amounts, there thus being one crop card for each crop reported on each farm schedule. There were approximately 6,000,000 of these schedules, and approximately 120,000,000 crop cards.

In addition to the statistical data, necessary for the tabulation, each card was punched with eight classification punchings, of which there are three kinds: one for the crop number; two for the State and county, and five for the farm classes, to indicate the class of farm in each of the five primary sub-groups.

The schedules for each county were sorted into the twelve race-tenure (secondary) classes before transference to the cards, and each of the twelve classes was separately transferred, the cards of each class being gang-punched for State, county, race and tenure after the transcription. The purpose of sorting the schedules before transcription is to avoid the greater labor of sorting the cards into the same classes after transcription. Obviously, the assorting into farm classes before doing the statistical punching may be carried further, to any desired degree; and when so done the cards of each class so assorted may have their class perforations gang-punched. In practice, however, it was found desirable to carry the sorting of the schedules only as far as above stated, in view of the restricted

tabulations to be made and the method and means employed therefor.

Having sorted the schedules into the twelve preliminary classes, the operator takes a schedule of a certain class and punches a card for its first crop-group, the punching covering the crop number and the (three) statistical items; then another card for the second crop-group listed on the schedule; then a third, and so on, until he has transferred to twenty cards the twenty crop-groups of that schedule. Then he takes a second schedule of that class and proceeds as before. The sorting of the schedules into race and tenure classes before transference practically results in a similar sorting of the cards after transference; but no further sorting of the cards is made as the punching proceeds, as that would divert the operator's attention from the punching work, and it is of prime importance that this work should be accurately done. Where the operator must insert a new card for each crop-group and must volitionally punch its crop-member, it is inevitable that the actual punching of the crop data themselves must be seriously hindered and rendered more fallible, and that the volitional entry of the crop number in each case must also be subject to considerable liability to error. As a matter of record, nearly one-fifth of all errors in punching detected in the work of the last census were stated to be errors in punching the number of the crop. Such errors, if not detected, must seriously impair the value of the results.

When the operator has finished transferring the schedules of a given class, he has twenty times as many cards as schedules. All these cards belong to the same State, the same county, the same race class and the same tenure class, and they may therefore be gang-punched accordingly. The twenty cards for a given schedule belong to a given area class, a given product class and a given income class, and these twenty cards may therefore be gang-punched for these latter classes; but as the next schedule may not and ordinarily will not belong to these same three classes, so its twenty cards while agreeing with each other in this respect, will probably differ from the preceding twenty cards and from the following twenty cards. It is necessary that all cards should have the area, product and income punchings, and where those of each schedule are handled separately for this purpose, with changes as the rule, there is unavoidably introduced a considerable element of fallibility as to these three class punchings, and an error in this respect is all the more serious because it affects all twenty crop-cards. One purpose of my invention is to practically eliminate this

liability to error, and to greatly minimize the liability to error in crop-numbers.

Substantially similar to the crop cards in the manner of handling are the farm cards, one for each schedule, containing the classification punchings and the punchings for the general statistical data of the farm, as area, farm values, etc. Each farm card contains approximately a dozen of these general statistical items, in lieu of the two or three special items on the crop card.

In comparing the transcript on the cards with the schedule for verification, it is necessary to preserve the twenty crop cards and the one farm card in association with the schedule until the comparison has been made, and in making the comparison it is necessary to compare each of the twenty-one cards with its appropriate portion of the schedule. Such a comparison is obviously rendered more laborious and less trustworthy by the mere fact of the numerous cards and the necessity of having to identify the number of each crop-group volitionally. One purpose of my invention is to render such comparison less laborious and more trustworthy.

After verification, the several cards of a schedule are completely and finally dissociated from each other being sorted into their several farm classes or crop classes. The dozen data on a farm card are physically consociated, as are the three on a corn card; but any association of the farm cards of a given class with the corn cards of that class, or of the tabulations of such cards, must be entirely volitional, as must be any interassociation of the several crop-groups of a class. One purpose of my invention is to provide for the physical and permanent interassociation or consociation of all the crop-groups of a class, and for a similar consociation of the farm data with all the crop data.

The cards of a given crop group (or the farm cards) of a given class are run through an automatic tabulating machine whereby the statistical data for that class, as acres, bushels, value, or the like, are mechanically summated. These summations are then manually transferred by pen or pencil to sheets, but without any mechanical check on the accuracy of the summation-transference, or on the accuracy of the notation or other record-indication of the class to which the summations belong. The tabulating mechanism is then cleared, another set of cards are run through the machine, and the tabulation, transference and clearance are repeated. The importance of correctly transferring these valuable summations, and the even greater importance of correctly identifying the class of summations after the transfer has been made will

be apparent. Nevertheless, in a work of the magnitude of the one under consideration, it is a matter of some difficulty of performance and of an inherent dubiousness after the transfer has become cold, when performed in the best manner of the prior art. My invention provides improved means for transferring the summations, a physical check on the accuracy of the transference, and a permanent automatic entry on the record of the transfer of the proper classification notations according to the class of the data last put into the tabulating mechanism.

It is true that the physical consociation of the statistical data of a schedule may, with the means of the prior art, be carried further than it has been; but my mechanism is specially designed to carry it further than is believed to be practicable with the prior means. Novel means are also used for securing the transference of a large number of data to a single card or record for each individual schedule, and for the correct entry of the classification indications on such individual record. The complete consociation of the data of a given schedule after transference, and of a given class after summation, is of great value; and, while it may be secured manually and volitionally by the prior methods and means, it is at a practically prohibitive cost and with great liability to error. The general purpose of my invention as applied to census work, is to supply the means for securing these consociations physically, automatically, with mechanical accuracy and at greatly reduced cost, and to make it practicable to secure all such consociations of data for all existent classes of farms, in all the usual geographical divisions. This is accomplished, briefly, by consociating the necessary number of proper summing mechanisms or registers, with selective means for operatively connecting the proper registers successively with a common "data" keyboard by means of which are entered the quantities or values of the successive statistical items, one item to a register. A master machine is interposed between the data keyboard and the several registers, to supply the common means for actuating the particular register which has been connected-in by the selecting keyboard to receive a particular statistical item. Means are provided for skipping one or more registers if on a given schedule there are no items proper to be entered therein; and for resuming the automatic succession at the proper point, thus reducing to a minimum the labor of entering crop numbers and greatly reducing the liability of error. A "counting" register is associated with each statistical register with an appropriate keyboard which may be op-

erated automatically while accumulating, and manually when clearing.

I also provide means for producing an improved record of the transfer entries for each schedule, upon a single sheet, of moderate size, which may be compared as a unit with the schedule. This individual record is also punched to show race, tenure, area, product and income indications, with special precaution against disagreement with the indicated classifications of the schedule itself,—all in one simple operation for each schedule of a given class. The schedule record thus becomes a complete duplicate of the schedule itself as far as classification and statistical data are concerned, but without any of the personal data of the original.

In lieu of the manual transcription of the summation totals by pen or pencil, with the attendant labor and risk, I provide for discharging the registers and automatically producing a total class record including all crop or farm items belonging to that class and including also the number of the items entered in any general or crop statistical register. These total-class-records have classification notations which are mechanically in agreement with the class notations on each of the schedules and the schedule-records of that class. They are preferably in the form of stencils, which also serve for the automatic tabulation of the inferior classes to secure the superior-class totals. The two record mechanisms and the tabulating mechanism as a whole may be operatively connected or disconnected from the keyboards, in any combination. With this combination of mechanisms and with other devices described later, it becomes feasible to transcribe the several statistical items of a schedule without any interruption in the work of simply striking such items on the statistical data keyboard (whether the amount be acres, quantity produced, value or whatnot).—with the single exception of occasional entries on the selecting keyboard of a crop number where the enumerated crops are not consecutively listed on the schedule. With my machine, also, the original entry of a statistical item immediately and automatically secures the tabulation of the same,—that is, its summation with preceding entries of the same crop class from other schedules of the same farm class. In other words, the “punching” operations of the prior art, when performed upon my machine, also secure the tabulation which in the prior art requires a subsequent operation. There is thus no chance for punched data to become lost before tabulation, or to be dissociated in any way from their related farm or crop data, or from the classification data of their particular schedule, as entered. With these provisions for reducing the labor of entering, verifying, tabulat-

ing, recording and physically consociating the complete statistical data of a given class, a practical way is provided for the tabulation of census or other bulky data of many classes and ranks of classes, in a more comprehensive manner than has heretofore been practicable.

The schedules as received from a county are assorted, first, into their two race classes; second, those of each race into the six tenure classes; third, those of each race-tenure class into the ten area classes; fourth, those of each race-tenure-area class into the twelve product classes; fifth, those of each race-tenure-area-product class into the eight income classes, thus securing the assorting of the schedules into their ultimate classes. These schedules are punched to indicate their classes, as shown in the drawings, and each final class is transferred (and tabulated) separately, and its totals are transferred to a class-total operative stencil record. There are theoretically 11,520 of these ultimate classes, but since the typical county contains only about two thousand schedules, and a schedule can belong to only one of the ultimate classes, obviously the great majority of the possible classes exist only in theory.—such, for example, as the colored-manager-three acre-hay-\$2500 class. Not only is this true of the ultimate classes, but the same thing is true of very many of the superior classes. Without going further into the detail of the non-existent classes, inferior or superior, I will summarize the situation and generalize the manner of handling the work after obtaining the quinquenary class summations, as follows: We have—A. Geographical divisions: county, State and nation. B. Farm classes in each of these divisions, the farm classes being of five general groups or ranks: I. Primary: various one-element classes, on each of the five fundamental bases (race, tenure, area, product and income) forming five sub-groups. II. Secondary: various two-element combinations of the primary characters, ten sub-groups in all. III. Tertiary: various three-element combinations of the primary characters, also ten sub-groups. IV. Quaternary: Various four-element combinations of the primary characters, five sub-groups. V. Finally, various quinquenary or five-element combinations of the primary characters, only one sub-group.

As the State classes are generic with reference to the county classes and specific to the national class, so the various farm classes are complexly related to each other as genus and species: *e. g.*, the secondary classes are, loosely speaking, specific to the primary classes and generic to the tertiaries, . . . and the quaternaries are specific to the tertiaries and generic to the quinquenaries. To put it in other words, and more

accurately: Each quinquenary class has all five elements. Ignoring one element, as income, the quinquenary classes may be re-sorted into the classes of one of the quaternary sub-groups, No. 26, on the race-tenure-area-product basis; ignoring another element, product, the same quinquenary classes may be sorted into the classes of No. 27; ignoring area, into the classes of No. 28; ignoring tenure, into the classes of No. 29; and ignoring race, they may finally be sorted into the classes of No. 30, on the tenure-area-product-income basis. Thus each of the quinquenary classes must fall into some class within each of the five quaternary sub-groups. Either the 26th or the 27th sub-group may be used to build up the first tertiary sub-group, No. 16, in which race, tenure, and area are the only elements, and the 27th may preferably be taken, as having the smallest number of classes to handle. This same quaternary sub-group may also be run for the classes of several other tertiary sub-groups, as Nos. 18, 20 and 23. The next smallest quaternary sub-group, No. 28, may preferably be run for the several tertiaries whose elements are found therein, namely, Nos. 17, 21 and 24. In like manner, No. 26, may be selected and run for Nos. 19 and 22, and No. 29 for No. 25. This leaves the most formidable quaternary subgroup, No. 30, without having to be handled at all in securing the tertiaries. So, likewise, the smallest of the tertiary subgroups, No. 18, may be run for secondaries 6, 9, and 12; No. 16 for 7 and 10; No. 17 for 8 and 11; No. 19 for 13, 20 for 14 and 21 for 15, leaving the largest four tertiaries without being rehandled. And, finally, the primary classes may be built up as follows: sub-groups Nos. 1 and 2 from No. 6; 3 from 7; 4 from 8, and 5 from 9, leaving the largest six secondaries without being rehandled. The higher classes may be built up by using other subordinate classes; but, assuming for this purpose that the actual classes in each sub-group are approximately in proportion to the possible classes; this plan of building up will result in the least work of handling the specifics to get the generics.

Bearing in mind the great number of non-existent classes, especially in the lower groups, and the rapidity with which the consolidation proceeds from group to group, the formidable showing of classes becomes much more moderate. The process of securing the superior classes from the inferiors is further simplified by these considerations:

(a) Many of the quinquenaries will normally comprise but a single schedule, which will not be run through the tabulating mechanism, but may be transferred directly to the class record or operative stencil. This single-schedule quinquenary class will

in many cases also comprise a single-schedule class in one or more of the higher groups.

(b) The class records, being operative stencils, may be run for the higher classes automatically, at a high speed and with great accuracy.

(c) These class records may be produced, and the tabulating mechanisms may be cleared, automatically, in the manner reserved for and described in a separate application.

(d) The handling of the schedules, and of the individual and class records thereof, may be greatly facilitated, and much class information concerning them may be uniquely displayed in accordance with a companion invention by Charles H. Tallmadge, as set forth in his copending application, numbered 423,284 and filed Mar. 26, 1908

Having secured the complete class records of each county in a State, the State totals are obtained by a single running of the county totals. In like manner, a single running of State totals gives the national totals, or the intermediate section totals, if desired.

The physical check on the accuracy of the transference of the class data from the tabulating mechanisms to the stencil record, mentioned hereinbefore, is secured as follows: All entries for a given farm class, whatever the specific register in which entered, are automatically duplicated in a grand total register by means of a permanent connection of such register with the selective keyboard. When a class accumulation has been completed, the heterogeneous sum of all the statistical data will show in the grand total statistical register, and the number of entries in all the associated "counting" registers will show in the grand total counting register. When several specific registers (statistical and counting) are returned to zero, as in producing the stencil class-record, the progressive decumulation of the specific registers will be duplicated in the two grand total registers; with the result that if all the specifics are cleared the grand totals will also be cleared, and a zero showing in the latter will evidence the proper clearance of the individual registers and the correctness of the stencil record.

A further novel feature of the system herein disclosed, resulting in a considerable saving of time in handling the schedules and a very great saving in subsequent labor, is to be found in my method of automatically checking the accuracy of each schedule as entered, and of automatically producing valuable generic and sub-generic showings for the class, in practically unlimited numbers. For example: Each schedule typically lists, *a*, the total number of acres; *b*, the number of unimproved acres; *b'*, the number of improved acres; *c*, the number of

acres owned; c' , the number of acres leased. Obviously a should equal b plus b' , and likewise c plus c' ; and this agreement should be ascertained before or during transference. I ascertain the agreement (or disagreement) during transference, as follows: I enter a negatively in three registers, say, No. 1, 1^b and 1^c ; enter b positively in registers 2 and 1^b ; enter b' positively in registers 3 and 1^b ; enter c positively in registers 4 and 1^c and enter c' positively in registers 5 and 1^c . By this method and means registers 1, 2, 3, 4 and 5 will show their appropriate quantities at all times; the showing in 1^b after the first of the five entries under consideration will be the amount of such first entry, which will normally be reduced to zero after the third of the five entries, while 1^c will equal 1^b after the first entry and will normally be reduced to zero after the fifth. By normally I mean on the assumption that the schedule itself is consistent and has been correctly transcribed. An error in either respect will be indicated by a failure of 1^b or 1^c to return to zero.

The negative entry of item a in registers 1, 1^b and 1^c may be secured by merely reversing the electrical connections for these three entries, so that the normal or accumulating entry is negative, while the discharging or clearing entry is positive, in its mechanical action. The reading of registers 1, 1^b and 1^c may also be reversed, so that while the accumulating action is negative the reading will normally be positive. The return of the checking registers to zero may be audibly indicated in accordance with means set forth in my copending application numbered 333,658, filed September 7, 1906, so that the transcriber need not even inspect the registers to be assured that the verification of items b , b' , c and c' is complete. Other automatic checkings of the schedule itself, simpler in their mechanical and electrical details, but even more effective in the saving of preliminary labor, are easily established on the same general principles, which are fully covered in said copending application and are, therefore, not further described herein. As showing the practical bearing of these things, it may be stated that in the work of the last census approximately as much time was consumed in the preliminary checking of the schedule as in its transference, and a great part of this preliminary work may be saved by the automatic or semi-automatic operation of the system herein disclosed. This great saving seems to be rendered feasible only by the simultaneous transferring and tabulating of a schedule.

Of slightly different nature, but highly valuable and still more easily secured, in practically any desired degree, by means of the comprehensive mechanism herein disclosed, are the very numerous generic and

sub-generic totals which may be obtained without any effort or even consciousness on the part of the transcriber, by permanently duplicating (or multiplying) the operation of the selective means in the desired manner. These results, likewise, seem practically to rest on the simultaneous transference and tabulation, greatly reinforced by the physical consociation of the class data. The value of these automatic generic crop-class showings is greatly increased where the farm-class showings are as numerous as herein contemplated.

In the drawings which illustrate the construction, operation and coöperation of the various mechanisms of the system: Figure A^1 is a sectional view taken on the same plane as Fig. T^1 , except that modifications are shown which adapt it for association with the automatic transferrer, Fig. A^2 is a sectional view taken on plane 2—2 of Fig. A^1 , Fig. A^3 is a sectional view taken on plane 3—3 of Fig. A^1 , Fig. A^4 is a side view of a selective commutator mechanism, showing the inclosing frame broken away, Fig. A^5 is a sectional view taken on plane 5—5 of Fig. A^4 , Fig. A^6 is a plan view of a circuit controlling part of the commutator mechanism, Fig. C^A shows the circuit arrangements and connections for the transferrer, Figs. C^1 , C^2 and C^3 show the circuit arrangement and connection of the various parts, Fig. C^4 diagrammatically illustrates an oil switch in combination with other switches controlled by the geometric selector unit switches, Fig. C^5 shows the circuit arrangement and connection of the various parts, Fig. D^1 shows a complete verification blank, Fig. D^2 shows a corner of a blank after passage through the verification machine, Fig. D^3 shows a corner of a stencil blank after passage through the stencil punching machine, Fig. G^1 is a diagrammatic layout showing the interconnection of the various mechanisms, Fig. K^1 is a sectional view of the amount keyboard showing the contact arrangement, Fig. M^1 is a plan view of the master machine showing the general arrangement of the mechanism, Fig. M^2 is a cross sectional view taken on plane 2—2, Fig. M^1 , Fig. M^3 is a similar cross sectional view of one tier of the mechanism upon plane 2—2, Fig. M^1 , the interior mechanism being also shown in cross-section, Fig. M^4 is a detail plan view of certain controlling mechanisms, Fig. M^5 is a detail elevation of a part of the controlling mechanism, Fig. P^1 is a side elevation of the stencil punching machine, Fig. P^2 is a plan view with the upper part of the mechanism removed, Fig. P^3 is a sectional view taken on plane 3—3, Fig. P^2 , Fig. P^4 shows the clutch controlling mechanism for the driving motor, Fig. P^5 is a sectional view taken on plane 5—5, Fig. P^4 , Fig. R^1 is a sectional view of the stencil

reading machine corresponding to Fig. P³ of the stencil punching machine, Fig. T is an elevation view of the register turret, Fig. T¹ is a central cross section view of one half of a turret section taken on plane 1—1, Fig. T², Fig. T³ illustrates sectional views taken partly on plane *a—*a**, partly on plane *b—*b**, and partly on plane *c—*c** of Fig. T¹, Fig. T³ is a top view of Fig. T¹, parts being broken away, Figs. T⁴ and T⁵ are elevation views of the differential gear mechanism utilized in the register mechanisms, Fig. T⁶ is a sectional view taken on plane 7—7, Fig. T⁷, Fig. T⁸ shows the locking disk and carrying disk used in the register mechanisms, Fig. V¹ is a side elevation of the verification machine with parts removed to show interior mechanisms, and Fig. V² is a vertical sectional view taken on plane 2—2, Fig. V¹.

Operation.—The general operation of the mechanism as a whole can best be followed perhaps by reference to Fig. G¹, in which the various mechanisms and their lines of connection are somewhat diagrammatically indicated. The register turret is shown at RT in association with the master machine MM. The primary and secondary geometric connectors at GC₁ and GC₂ are interposed in the path of an effective connection of the selector keyboard KS with the electro-magnetic controllers of the registers and other mechanisms. The amount keyboard is shown at KA, the counter keyboard at KC. The verification machine is shown at VM and SP shows the stencil punching and SR the stencil reading machine. At AS is indicated the synchronous connector or automatic shifting mechanism.

The mode of operation is substantially as follows: The keyboard operator places a notched schedule in the schedule tray of the verification machine. If this happens to be the first of a group of similarly notched schedules, the notching keys are depressed to correspond with the notching upon the schedules. This causes a potential set-up of the side notching punches for subsequent use in causing the actual punching of the verification sheet which is automatically fed through the machine. The schedule and the verification sheet having thus been placed in position, and all of the registers being cleared to their zero positions, the keyboard operator may strike keys upon the selector keyboard to select the first register in the turret. This is the register which is intended to accumulate the first class of statistical data upon the schedules. The register having been selected and potentially connected with the master machine MM, the amount keyboard KA is operated in accordance with the reading taken from the schedule in the schedule rack. The amount keyboard operates to cause a set-up in the master machine which will cause the machine to involve any

connected register with the entry corresponding with the amount which has been struck upon the amount keyboard. The No. 1 units key of the counter keyboard KC will also be struck to cause one count in the counter register associated with the first of the tabulating registers which has been selected and connected with the master machine. These keys having been struck, the "go" button of the keyboards is depressed, whereupon the mechanism is set in operation to involve the selected register with an entry corresponding with the amount read from the schedule. The second item of the schedule is read by the operator in the same manner, the selecting keyboard is actuated to connect the second tabulating register with the master machine, the amount is set up upon the amount keyboard, the No. 1 units key of the counting keyboard is again depressed to register one in the counter associated with the second register. In like manner the operator continues through the various items of the schedule, thereby causing the various registers to be involved with entries corresponding with the items read from the schedule.

In describing the operation thus far I have assumed that it is necessary for the operator to select the successive registers which are to be involved with entries, and manually to control their connection with the master machine in proper order. When the automatic shift mechanism shown at AS is used, however, the selection and connection of the registers in proper order with the master machine is automatically effected. That is to say, the first register having been connected with the master machine, and having been involved with the appropriate entry, the automatic shift mechanism serves automatically to connect the second register with the master machine so that no attention on the part of the operator is required to this detail. The erasing contact associated with the master machine serves normally, upon the completion of one entry, to effect the automatic restoration of the keys to their normal positions. Furthermore, the actuation of the No. 1 key of the units order on the counting keyboard is automatically effected, due to the depression of the repeat key KR², so that the operator is not required in each instance to depress this key for counting purposes. The attention of the operator may, ordinarily, therefore, be confined to the amount keyboard upon which he strikes keys corresponding with the items read from the schedule.

While in this manner the automatic shift machine serves to select and connect the registers in proper order with the master machine corresponding with the order in which the items are read from the schedule, there may be instances in which there are

no items with which registers are to be involved, in which instance the operator may strike keys upon the selector keyboard corresponding with the number of the register next to be involved with an entry, whereupon the selection by the automatic shift mechanism is skipped to the number of the register corresponding with the keys which have been depressed upon the selector keyboard. The operation would be substantially as follows: Assume a schedule having items which are to be entered in the first, second and third, and tenth, eleventh and twelfth registers; the operator will set up upon the amount keyboard an amount corresponding with the item to be entered in the first register, immediately thereafter the amount to be entered in the second register, and thereafter the amount to be entered in the third register, these keys being struck in accordance with the readings taken from the schedule. Thereupon the operator will effect the automatic shift to the tenth register by striking keys corresponding with the No. 10 register upon the selecting keyboard, the erasing key having first been struck in order to permit this automatic shift to be effected. The mechanism will be actuated to skip the registers 4 to 9 inclusive and to operatively connect the tenth register with the master machine upon the raising of the master column in the manner described in connection with the master machine. After having effected this automatic skip and the selection and connection of the appropriate register with the master machine, the operator strikes the amount of the No. 10 item upon the amount keyboard and then proceeds as before with the items which are to be entered in registers Nos. 11 and 12. While for purposes of explanation it seems simpler to describe the actuation of the keyboards in the order previously described, it will be understood from the description of the circuit arrangement that in actual practice the three keyboards may be connected so as to require actuation in a predetermined order, the counting keyboard being first actuated (in case such actuation is requisite), the selector keyboard being next actuated, and last of all, the amount keyboard. Ordinarily, of course, it will be necessary to manually actuate only the keys of the amount keyboard. During all of these entries in the appropriate registers the verification machine will have been active in perforating or marking the verification record in accordance with the actuation of the registers. That is to say, when the first register is selected and connected with the master machine, the first field of perforating points in operatively connected in circuit by the secondary geometric connector, so that the depression of the keys of the amount keyboard will serve to close the circuit through the perforating points of this field to mark the verification record at points which can be read as an index of the entry which has been made in the selected register. The selection of the second register will in like manner automatically effect the selection of the second field of perforating points and the actuation of the amount keyboard will cause sparks to pass over the perforating contacts of this field to mark the record with an entry which will show positively and without mistake the amount of the entry which has been made in the second register. So on throughout the entry of all of the items of the first schedule, the verification record will be marked to indicate the amounts which have been entered in the registers corresponding with the various fields of the verification sheet. When the complete schedule has thus been entered and the entries recorded upon the verification sheet, the "go" key associated with the verification machine is depressed thus causing the side punching mechanism to become active, thereby to notch the verification sheet in accordance with the notching of the schedule, the side notching keys having at the outset been depressed in accordance with the notching upon the schedule as it comes to the schedule tray. After the notching has been accomplished, the operation of the verification machine continues to deliver the verification sheet from its frame or die, and also to deliver the schedule from the schedule tray by means of the schedule carrying belt. In this manner the schedule is in each instance delivered immediately upon top of the corresponding verification sheet. The verification sheets and their accompanying schedules may thereafter be compared in order to verify the accuracy with which the registers have been involved with entries corresponding with the items upon the schedules. The delivery of the schedule in immediate juxtaposition with the verification sheet enables this comparison to be made without any very great amount of labor in bringing together the corresponding sheets. One schedule having been taken care of in this manner, the operator places the next schedule of the group in the schedule tray; this schedule being of the same group as the first, and consequently having the same side notching, it will not require any manipulation of the side notching keys of the verification machine. The operator will proceed immediately to strike upon the amount keyboard the amount of the first item, subsequently the amount of the second item, and of the third, fourth, fifth, sixth, etc., except where, as before, some of the entries may be skipped.

It will, of course, be apparent that since the registers have not been cleared after the entry of the first schedule, they will, in

many instances, become involved with additional entries so that each register will accumulate or add the items of any one class as read from the successive schedules. When, therefore, ten or a dozen schedules of a group have been entered and the corresponding verification sheets made, the registers in the turret will show the totals of the various classes of items upon the schedules. When all of the schedules of the group have in this manner been entered in the registers of the turret, a second operator inserts the blank operative stencil sheet in the stencil punching machine. The reverse switch RS is then depressed to cause the master machine to drive the registers in the backward direction for the purpose of clearing the registers when connected with the master machine. This done the reader calls off the amount of the total which appears through the windows of the first register in the turret. The keyboard operator strikes the amount keys in accordance with this reading and then strikes the "go" key, which sets in motion the master machine to run the selected register back by an amount corresponding with the set-up. If the reading and set-up have been made with accuracy the first register will, of course, be returned to zero. At the same time that the reading of the total is made, the reader will call off also the number of entries in the first register, as shown by the counter. This number of entries will be set up also upon the counting keyboard by the keyboard operator so that the counter will be returned to zero, as is the associated register. The reader then calls off the total entry in the second register, and so on throughout the entire bank of registers in the turret machine, each register and associated counter being cleared in the manner described. This clearance of the registers is automatically accompanied by the operation of the stencil punching machine to prepare a stencil in accordance with the tabulation of all of the schedules of the group which have been entered in the registers. The depression of the keys of the counting keyboard and the depression of the keys of the main keyboard act, by means of the circuits leading to the stencil punching machine, to cause the punches of this machine to be set up in accordance with the keyboard set-ups. When the "go" key associated with the keyboards is operated to set the mechanism in motion to clear a register, the bank of punches of the stencil punching machine is set in motion to punch the stencil in accordance with the set-up of the punches. It will be seen that in this manner the operative stencil will be punched with an entry corresponding precisely with the amount which has been run out of the selected register. If the readings have been properly made and

the keyboards properly actuated, the register will clear and the stencil will be punched accordingly without any more attention on the part of the operators than is required for the mere clearance of the registers.

The statistical punching of the stencil is in some instances accompanied by the actuation of the side notching punches, the actuation of these punches being controlled by the set-up of the side notching punches on the verification machine, the commutator and circuits being so arranged that the operative stencil will be side notched whenever it is fed to a position in which a notch should be made in order to correspond with the notching of the schedules and verification sheets of the corresponding group. Any of the side notching punches having been set up by this commutator mechanism, they will cause the side punching of the stencil in the manner set forth in the detailed description of the stencil punching machine.

The stencil punching machine is required to advance the stencil sheet as the entries are made. The stencil sheet may be regarded as divided into a number of fields corresponding with the number of registers in the register turret. When the first register is returned to zero, a corresponding entry is to be made in the first field of the stencil sheet. This is accomplished by punching the entry on the first line of the sheet and in the first column of the sheet. The first line in the second column is devoted to the total in the second register. The second line in the first column is devoted to the total in the third register, and so on. It becomes necessary, therefore, that the stencil sheet be advanced after certain operations so that the proper field will be brought into line with the punches which are to make the entry corresponding with the amount by which the corresponding register is returned to zero. The geometric connector operates not only to cause the connection of the appropriate registers with the master machine, but also by means of the circuits leading to the stencil punching machine to control the feeding of the stencil so that the appropriate field will be brought into the punching position to correspond with the registers which are selected for decumulation. In this manner the stencil sheet is punched with entries corresponding with the tabulation of the data in the registers of the turret. The operative stencil sheet is automatically completed merely upon the performance of the acts necessary to clear the registers and get them in condition for the reception of data from the next group of schedules. The register reader will remove the completed operative stencil and put a blank stencil sheet in the stencil punching machine. While the key-

board operator is engaged in reading the next group of schedules and entering them in the registers, the stencil-punching machine is ordinarily disconnected and inoperative. The verification machine may, of course, be operated if desired during the punching of the operative stencil to produce a record of the punching of that stencil.

There will be many instances in which there is but one schedule to a group. In this case the stencil punching machine may be connected in lieu of the registers of the turret during what would otherwise be the entering operation, that is to say, the keyboard operator in reading a single schedule and striking each of the keyboards as in the act of entering items in the register of the turret may cause the operative stencil to be punched immediately, rather than with the separate act of clearing the registers. Preferably the registers will not be involved with the entries in the cases of this kind, and the stencil punching machine will be connected with the keyboards as in the same general case in which the items are first tabulated in the registers and thereafter cleared from the registers while being entered by the stencil punching machine.

We come now to the use which is to be made of the operative stencils. The stencil reading machine is diagrammatically indicated at SR. The quinquenary stencils which have been produced in the stencil punching machine SP as a result of the tabulation of the schedules are fed one by one through the stencil reading machine. This stencil reading machine may be described generally as a mechanism which serves automatically to control the mechanism previously described in lieu of a control manually effected from the keyboards. It will be understood, of course, that the stencil reading machine can be used with the same registers, etc., only while the keyboards are not being used. The quinquenary stencil having been fed to the stencil reading machine, the mechanism operates in the manner elsewhere described successively to establish connections through the punchings in the various fields. Connections are first established in accordance with the punchings in the first field, these connections serving to control the master machine as does the main keyboard. The stencil feeding mechanism serves also to control the successive connection of the registers with the master machine, the succession of the connection of the registers corresponding with the succession in which the punchings of the fields of the stencils are automatically read. The result, therefore, of feeding a group of quinquenary stencils through the stencil reading machine is to tabulate in the registers of the turret the items which have been entered upon the quinquenary stencils.

When all of the quinquenary stencils forming a quaternary group have been run through the stencil reading machine in this manner the reader will call off the totals which have been entered in the various registers, the keyboard operator will operate the keys in the manner previously described to control the operation of the stencil punching machine to punch a quaternary stencil. The side punching of the quaternary stencil is controlled by the side punching keys of the verification machine as above. The quaternary stencil will differ from the quinquenary stencil in having but four side notches in place of five.

Other groups of quinquenary stencils are automatically read and entered in the tabulating mechanism, whereupon the registers of the tabulating mechanism are cleared and other quaternary stencils punched in accordance with such clearance. The quaternary stencils may then be assorted into tertiary classes and each class or group may then be run through the stencil reading machine to aid in the production of tertiary stencils just as the mechanism was utilized in the production of the quaternary stencils. This operation may be continued until the primary stencils have been made and these may in turn be run through the stencil reading machine to cause the tabulation of the grand total.

The various stencils serve, of course, as records of the various classes. If the data as to any class are desired they may be read by one skilled in the interpretation of the punchings or, if preferred, the stencil may be run through the stencil reading machine, whereupon the tabulating mechanism will cause the registers of the turret to indicate the amounts entered by suitable punchings in the various fields of the stencil. These, in many instances, will be the final data for which result the work has been carried on. The detail construction and operation of the various machines will be described in the following chapters.

Register turret.—The tabulating registers and the frame in which they are carried are illustrated in Figs. T¹ to T⁷, inclusive. This device comprises essentially a plurality of totalizing registers capable of running either forward or back, and means for connecting any desired register with the panel shafts for driving them, these panel shafts being controlled and driven from the master machine, in the manner elsewhere described.

For convenience, I have arranged the registers in tiers, each tier comprising a plurality of registers arranged in a circle around a central axis. With each register there is associated an electromagnetic controlling device, by means of which the register may be connected with the panel shafts. The controlling electromagnets are governed by the

keys of the selector keyboard which is elsewhere described, each electromagnet being connected with one of the keys and with a source of current, whereby an operator may control the selection and connection of the registers with the master machine, which, when operated, involves any connected register with an appropriate entry. The tiers of registers serve to form a turret of registers, any of which may be actuated by the common master machine.

Each tier of registers is like all of the others, and the frames of the tiers are so formed that any number of tiers may be stacked one upon another. It will be sufficient, for the purposes of description, to describe one tier, and to point out wherein another tier may be fitted upon it. One such tier is illustrated in central cross-section in Fig. T¹. It will be noted that the upper surface of the top plate 10 corresponds with the lower surface of the bottom plate 11, so that the bottom plate of any tier may be placed upon the top plate of any other tier, and the two will register together. The bottom plate of the lowest tier of registers fits in the same way upon the top plate of the master machine. The frame of the tier comprises not only the members 10 and 11, but also the tubular center piece 12 and the supporting plates 13, 13, which are clamped between the thimbles 14, 14 which are stacked one upon another around the tubular center piece 12. The disk-like driving gears 15, 16, 17, 18, 19 and 20 are adapted to rotate about the thimbles, the bushings 21, 21 serving, with the flanges of the thimbles, to maintain the driving gears in proper position. The ball races and balls near the peripheries of the driving gears serve to support these gears and to permit their easy rotation. Each driving gear is adapted to be operated by a pinion, as, for instance, 16', 17', and 18', these pinions being mounted at a proper height upon their respective panel shafts 16^a, 17^a and 18^a, these panel shafts being driven by the master machine in the manner elsewhere described. It will be understood in a general way, therefore, that each panel shaft controls through its pinion one of the disk-like driving gears. I shall now describe the register mechanism and explain how the numeral wheels of any register may be connected with the common driving disks or gears, so that any selected register may be operatively connected with the panel shafts of the master machine to be driven thereby. One such register is illustrated in Fig. T¹. It comprises a set or ordered numeral wheels designated respectively as 15^w, 16^w, 17^w, 18^w, 19^w and 20^w. Each of these numeral wheels is adapted to be driven by the associated driving disk through gearing which will now be described. Each numeral wheel is provided also with carrying mecha-

nism or disks, so that every complete revolution of a numeral wheel will cause a one-step advancement of the numeral wheel of next higher order. The register mechanism and carry-over mechanism involves the invention set forth and claimed in my co-pending application Serial No. 443,802, filed July 16, 1908.

The rotary movement of the driving disk 15 is conveyed to the numeral wheel 15^w through an idler pinion 15ⁱ, when this idler is raised into mesh with the teeth on the periphery of the disk 15 in the manner subsequently to be described. The idler pinion is at all times in mesh with the intermediate driving gear 15^a. Upon this intermediate driving gear is mounted a frame work 15^f, which aids in supporting the pinions of a differential gear. These pinions are perhaps best illustrated in Fig. T⁶, which is a top elevation of the differential gear. The two pinions of the differential gear marked respectively 15^d and 15^e are pivotally mounted upon the intermediate driving gear 15^a, and the associated frame 15^f, the frame revolving with the gear 15^a. The two differential pinions are in mesh with one another at one end of their teeth, the differential gear 15^d meshing at the other end of its teeth with the spur gear 15^r, which is formed upon the inner end of the tubular bearing member 15^t. This tubular bearing member is held stationary by the pin 15^p, which extends through the supporting shaft 22 and into the frame piece 23, the other end of the shaft being supported in the frame piece 24. All of the intermediate gearing and carry-over mechanism is mounted to rotate about this auxiliary shaft 22, the shaft remaining stationary. Upon this auxiliary shaft is rotably mounted the connecting gear 15^c, which is formed integrally with a tubular support which, at the inner end, is formed into a spur gear 15^r. It will be understood that when the driving disk 15 causes the idler gear 15ⁱ to be rotated in the direction of the arrow upon this idler, the intermediate gear 15^a will also be rotated. This gear will, in turn, cause the differential pinion 15^d to be rotated around the stationary spur gear 15^r, thereby causing a rotation of the differential pinion with respect to the intermediate gear 15^a upon which is pivotally mounted and carried. The rotation of the differential pinion 15^d, since it is in mesh at the inner end of its teeth with the differential pinion 15^e, will cause a reverse rotation of this other pinion. This differential pinion 15^e is in mesh with the spur gear 15^r, and serves by its rotation to rotate the spur gear 15^r and with it the connecting gear 15^c. The connecting gear 15^c is permanently in mesh with the gear 15^a, which is attached to the numeral wheel 15^w. Thus, it will be seen

that the rotation of the disk 15 when the idler pinion 15ⁱ is in its uppermost position, causes, by means of the differential gearing, a forward rotation in the direction of the arrow of the numeral wheel 15^w.

It will be unnecessary to describe in detail the differential gearing associated with the other numeral wheels. It is in all respects identical with that described in connection with the numeral wheel for the units order. There is, however, this difference in the differential gearing and driving gearing associated with the numeral wheels of higher order: It will be remembered that the driving of the units order wheel depends upon the fact that the spur gear 15^s is prevented from rotating, the movement of the differential gearing re-acting upon this stationary spur gear. There is in association with each of the order numeral wheels a corresponding spur gear, as, for example, 16^s, but this spur gear in the case of the numeral wheels of higher order, instead of being affixed to the frame, is rigidly connected by a tubular sleeve with a locking and carrying disk 16ⁱ. This locking and carrying disk coöperates in the well known manner with the carrying gear 15^k, this carrying gear being attached to the side of the numeral wheel 15^w. The outlines of the locking and carrying disk 16ⁱ and the carrying gear 15^k are illustrated in Fig. T⁷. It will be seen that the circular contour of the carrying gear fits normally in one of the curved seats of the locking disk, so that the locking disk cannot be rotated by a pressure applied to the teeth of the spur gear 16^s. The carrying gear also will rotate through all but a 1/10th part of its revolution, without causing any movement of the locking disk 16ⁱ. When, however, the carrying tooth 15^a passes the line connecting the axes of the disk and carrying gear, the locking disk will be given a 1/10th revolution because of the mesh of the carrying tooth 15^a in one of the carrying notches in the locking disk. Such a 1/10th revolution of the locking disk causes a corresponding 1/10th revolution of the numeral wheel of next higher order, the motion being transmitted through the differential pinions and the connecting gear in the manner which will be understood from the previous description of the mechanism associated with the numeral wheel of units order. Each of the numeral wheels except that of highest order is provided with carrying mechanism of this kind, whereby each complete revolution of a numeral wheel of lower order causes the onestep advancement of the numeral wheel of next higher order. So, also, the completion of each backward revolution of a numeral wheel of lower order will cause a one-step backward ro-

tation of the numeral wheel of next higher order.

It will be noted that all of the driving disks 15, 16, 17, 18, etc., are brought into co-operative relation with the intermediate driving gears 15^s, 16^s, 17^s, etc., when the idler pinions 15ⁱ, 16ⁱ, 17ⁱ, etc., are raised into their uppermost positions. It will be apparent, furthermore, that two or more of the driving gears may be actuated at the same instant so that any number of the numeral wheels may be directly driven at a given time, and the differential gearing provides a means also whereby the carry-over mechanisms may be actuated simultaneously with the direct driving of a numeral wheel to cause the proper advancement of the numeral wheel not only to take care of the motion transmitted to it directly from its driving gear, but also to take care of the one-step advancement which may be transmitted to it through the carry-over mechanism from the numeral wheel of next lower order.

The result of this construction of the register is that the panel shafts of the master machine which control the driving disks may be run simultaneously, each an appropriate amount, and the register mechanism will be actuated to indicate the proper total. If, for example, the register shown in Fig. T¹ is to be involved with an entry of 84, the panel shaft 15^a will be rotated an amount sufficient to transmit a rotary motion equal to 4/10ths of a revolution of the numeral wheel 15^w, this motion being transmitted through the intermediate gear 15^s, the differential pinions, the connecting gear 15^c and the numeral wheel gear 15ⁿ. At the same time also the panel shaft 16^a may be rotated to transmit motion through the driving disk 16, the idler pinion 16ⁱ, the intermediate gear 16^s, the differential pinions 16^d and 16^e, the spur gear 16^s, the connecting gear 16^c and the numeral wheel gear 16ⁿ, to the numeral wheel 16^w, the amount of rotation of the panel shaft being sufficient to cause the eight-step advancement of the numeral wheel 16^w. The result is that the amount 84 can be read through the windows from the numeral wheels of the units and tens orders. If, now, another entry of 58 is subsequently made in the same register, the units panel shaft will be rotated an amount sufficient to cause the eight-step advancement of the units numeral wheel 15^w. This wheel stands initially at a position such that the number 4 will be displayed through the window in the casing. The further eight-step advancement of this numeral wheel will swing it around into a position where the number 2 will be displayed. In passing from the initial position to this final position, the carrying tooth will be

moved through the position in which the
 carry-over disk 16¹ is given a one-step ad-
 vancement. Regardless, therefore, of the
 tens panel shaft, the carry-over mechanism
 5 will advance the tens numeral wheel from
 the eighth to the ninth position. The rota-
 tion of the tens panel shaft takes place also
 to cause the five-step advancement of the
 tens numeral wheel, so that the completion
 10 of the operation will leave the tens numeral
 wheel in a position wherein the number 4 will
 be displayed through the window. The units
 numeral wheel will be left in a position to
 display the number 2. It will be apparent,
 15 of course, that the tens numeral wheel may
 be driven simultaneously with the units nu-
 meral wheel, and the carrying over will take
 place simultaneously with the direct driv-
 ing of the tens numeral wheel, so that the
 20 only effect of the carrying will be to in-
 crease the speed of the tens numeral wheel
 during the carrying operation, the doubled
 speed being attained by virtue of the com-
 bined driving from the panel shaft and the
 25 associated mechanism and from the carry-
 over mechanism associated with the numeral
 wheel of next lower order.

It will be apparent, of course, that the
 fourteen space or step advancement of the
 30 tens numeral wheel will cause the carrying
 tooth of the carrying gear 16² to pass once
 through the carrying position, whereby the
 hundreds numeral wheel will be given a one-
 step advancement. The proper total, there-
 35 fore, of the amounts 84 and 58 will be dis-
 played through the windows, the final read-
 ing of the register being 000142.

It will be understood that registers iden-
 tical with that described in connection with
 40 Fig. T¹ are distributed around the periphery
 of each tier of the turret. The object in
 having driving disks of very large diameter
 which rotate about the axis of the turret is
 to enable the operator to effect the connec-
 45 tion of any register in a tier with the master
 machine mechanism, this connection being
 established, of course, through the driving
 disks and the panel shafts. The panel shafts
 extend through the various tiers of regis-
 50 ters, each panel shaft connecting with one
 driving disk in each tier. Fig. T² illustrates
 sectional views taken partly on plane *a-a*,
 partly on plane *b-b* and partly on plane
c-c of Fig. T¹, this Fig. T² illustrating
 55 three of the pinions by means of which the
 panel shafts are connected with the driving
 disks or gears. The alternate panel shafts,
 and therefore the alternate driving disks,
 are rotated in reverse directions, as indi-
 60 cated by the arrows applied to these parts
 in the various figures.

We come now to a consideration of the
 means whereby the operator may connect a
 register with the master machine, it being

understood that the master machine will 65
 operate any register or registers which may
 be connected therewith. The means for ac-
 complishing this operative connection of any
 normally disconnected register with the
 driving mechanism is preferably electro- 70
 magnetic in form. At the top of each tier,
 as illustrated in Figs. T¹ and T³, there is a
 circle of electromagnets, one electromagnet
 being provided for each register. Referring
 more particularly to these figures, it will be 75
 seen that the electromagnet winding 30 sur-
 rounds a movable core or plunger 31. The
 electromagnet winding is dropped into a
 socket or opening in the iron frame 10, where
 it is retained by the screw-threaded spool 80
 head 32. The core 31 and the iron frame
 which surrounds the coil serve as a path for
 the magnetic lines of force from the coil 30,
 so that the energization of the winding
 serves to attract the iron armature 33 into 85
 its alternate position, this attraction being
 effected against the force of the retracting
 spring 34. To the inner end of the core 31
 is attached a sliding catch plate 35, which
 coöperates with the controlling stem 36 of 90
 the associated register. The sliding catch
 plate 35 is guided in its movement by the
 guide plate 37. The mechanism will best
 be understood by a brief reference to the
 mode of operation of the same. The opera- 95
 tor first energizes the electromagnet wind-
 ing by closing a circuit controlled at the key-
 board. This energization of the winding
 forces the catch plate 35 toward the center
 of the turret, thereby bringing the edge 100
 38 of the catch underneath the head 39 of
 the stem 36. After this energization of the
 electromagnet has been effected (and the
 electromagnets of any other of the registers
 may also have been energized), the master 105
 connecting shaft 40 is raised by the master
 machine. This shaft is raised sufficiently to
 cause the plate 41 to raise all of the catch
 plates 35 of all of the registers through a
 distance such that the catch plates of the 110
 energized magnets will raise the controlling
 stems 36 to bring the idler gears 15¹, 16¹,
 etc., into mesh with the driving gears 15,
 16, etc. Thus, it will be seen that the energiza-
 tion of any electromagnet causes the asso- 115
 ciated register to be connected with the driv-
 ing gears when the master machine causes
 the master connecting shaft 40 to be raised.
 The slotted connection of the core 31 with
 the catch 35 at 42 permits the movement of 120
 the catch plate relative to the electromagnet
 core. There is, therefore, no interference
 with this up and down movement of the
 catch plates. The description of the master
 machine makes it clear that the vertical 125
 master shaft is first raised an amount suffi-
 cient to throw into mesh with the driving
 gears any selected register. Thereupon, the

master shaft 40 remains in the uppermost position, while the panel shafts are rotated to involve the connected registers with the proper entries. Thereupon, the master shaft 40 is dropped to its lowermost position,—a position somewhat below that shown in Fig. 1^a. This downward movement of the master column 40 and the catches 35 which are carried thereby, causes the beveled edge 38 of the catch to engage the tapered surface below the head 39 of the stem 36, whereby the catch plate 35 is forced toward the left, thus insuring the disengagement of the armature 33 from the polar surfaces of the electromagnet in case there should be any tendency to stick. This downward movement of the master column 40 below its normal position serves, therefore, to force the return of the electromagnet armature, even though the retracting spring 34 be broken or not present. It will be understood, of course, that the operation of the keyboard mechanism has served to deenergize the winding 30 before the downward movement of the master column takes place. The bushing 43 which is pinned to the stem 36 is also struck by the plate 41, whereby the downward movement of the column 40 serves to return the stem 36 and all of the idler gears 15ⁱ, 16ⁱ, etc., to their normal position, as shown in the drawings, the stop pins 15^v, 16^v, 17^v, etc., serving to prevent the rotation of the idler gears and the gears in mesh therewith, except when they are driven by the driving disks.

The projection 44 upon the inner end of the catch 35 is provided with a knife edge surface at its upper end. This projection on the catch coöperates with the cylindrical rim 45 also provided with a knife edge surface of engagement to insure the proper location of the catch at each stage of the operation. If, when the master column 40 is raised, the electromagnet associated with the catch 35 has not been energized, the projections 44 and 45 will serve to insure the maintenance of the catch in the position shown in the drawing, whereby there can be no danger of an actuation of the stem 36. If, on the other hand, the electromagnet has been energized to engage the head 39 of the stem 36 by the edge 38 of the catch, the projection 44 will be brought inside the rim 45 and the engagement of these projections will serve to maintain the catch in the innermost position, while the master column 40 is in its uppermost position. The maintenance of the connection between the driving gears and the registers does not, therefore, depend solely upon the energization of the controlling electromagnet, but, except for the initial part of the operation, upon the positive action of the projections 44 and 45. After the master column 40 has returned to its lowermost position, it is brought back

to the position shown in the drawings, where it is ready for a subsequent series of operations such as that already described. It will be apparent that the energization of any electromagnet will serve to bring about the connection of the associated registers with the driving mechanism upon the upward movement of the master column 40. In this manner, any of the registers may be connected simultaneously with the master machine mechanism by the suitable energization of the controlling electromagnets.

At 46 is indicated a screw-threaded junction of two sections of the master column 40. It will be understood that as many sections of this column will be added as there are tiers of registers in the turret.

It may be desired, in some cases, to provide each register with an associated counter which will indicate the number of actuations of the associated register. Such a counter is readily provided by omitting the carry-over mechanism between two of the numeral wheels. If, for example, the carry-over gear 18^k were omitted, the device shown would form substantially two separate registers, the lower one having four numeral wheels and the upper one two numeral wheels. It will be understood, of course, that if the carry-over gear 18^k is omitted, it will be necessary to fix the locking disk 19ⁱ against rotation so that the associated spur gear 19^s will not rotate idly. It will be necessary, of course, for the spur gear 19^s to be fixed in order to give the differential pinions a purchase for driving their numeral wheels. With this slight omission in the mechanism shown in these drawings, it will be understood that the driving gear 19 may be advanced sufficiently to cause the one step rotation of the numeral wheel 19^w each time that the associated register is involved with an entry, whereupon the two upper numeral wheels will serve as a register or counter of the number of actuations of the register which comprises the lower four numeral wheels and the associated mechanism. If, in this manner, the upper two numeral wheels are used only as a counter, it will ordinarily be desirable to dispense with the driving disk 20. This disk may, however, be retained for clearing the registers, if so desired.

It will be readily understood that the rotation of the driving mechanism in a reverse direction will serve to decumulate the registers and to return them toward their zero positions. The clearing operation and the occasion for its use will be understood from a description of the general operation of the system of my invention.

Master machine.—The master machine for actuating any of the registers which may be connected therewith is illustrated in de-

tail in Figs. M¹, M², M³, M⁴ and M⁵, Fig. M¹ being a plan view of the master machine, Fig. M² being a cross-sectional view on plane 2—2 of Fig. M¹, the interior mechanism being shown in elevation, Fig. M³ being a cross-sectional view of one tier of the mechanism upon the same plane, the interior mechanism being shown also in cross-section, Fig. M⁴ being a detail plan view of certain controlling mechanism, and Fig. M⁵ being a detail elevation of a part of the same controlling mechanism.

The general scheme upon which the master machine operates is as follows: There is a panel shaft for directly actuating any of the units numeral wheels of the registers, another panel shaft for directly actuating the tens numeral wheel of any of the registers; so also other panel shafts each adapted to actuate the numeral wheels of one order. These panel shafts lead from the master machine proper to the register turret. The master machine is equipped with mechanism for controlling the rotation of each panel shaft. These controlling mechanisms are preferably arranged in tiers, each tier containing the mechanism for operating one panel shaft. The mechanism for controlling any one panel shaft comprises essentially a series of ten electromagnets, each controlling an armature and thereby a stop pin, which determines the actuation of the operating mechanism. Each of the ten electromagnets associated with the controlling mechanism of any order is connected with correspondingly ordered keys upon the amount keyboard. The depression of any key upon the amount keyboard causes an energization of the corresponding controlling magnet in the master machine and the subsequent operation of the master machine is thereby made to correspond with the significance of the key which may be depressed. Any one of the electromagnets of a given tier having been energized and having thrown its stop pin into its effective position, a pair of arms are caused by differential gearing to approach each other until they meet at the point at which the stop pin has been inserted by the controlling electromagnet. After reaching this junction point, the two arms return to their normal positions. One of the arms is connected by suitable gearing with the associated panel shaft, whereupon the amount of rotation of the panel shaft will correspond to the distance through which the controlling arm has moved before meeting the other arm at the point at which the stop pin is inserted. The panel shaft is caused to rotate first in one direction and then in the reverse direction. The numeral wheels of the registers may be connected with the panel shaft during its forward rotation when an amount is to be added to that already indicated in the register, and

during its rotation in the reverse direction when subtraction is to be effected. In association with the motor means for driving the controlling arms and thence the panel shafts is cam mechanism for connecting in the selected register or registers during the proper phase in the cycle of the panel shaft movements. The effective connection of the registers with the panel shafts so that they will be actuated forwardly or backwardly, as may be required, is controlled from the keyboard in the manner elsewhere described. It being generally understood, therefore, that it is the function of the master machine to involve any register which may be connected with it with an entry corresponding with the amount set up upon the amount keyboard, I shall proceed to the detailed description of the mechanism.

The panel shafts which are ultimately to be actuated by the controlling mechanism are shown at 16^a, 17^a, 18^a, 19^a, 20^a and 15^a. Each panel shaft terminates in a separate section or tier of the master machine. It will be seen, for example, that the pinion 16^b on the end of the panel shaft 16^a is located in tier *t*, whereas the pinion 20^b upon the end of panel shaft 20^a is located in tier *ht* and the pinion 15^b is located in the lowermost tier *u* of the master machine. Except for a slight angular displacement corresponding with the angular displacement of the panel shafts, the mechanism in each tier of the master machine is substantially alike and one description may therefore serve for all.

Fig. M¹ illustrates in plan the mechanism of tier *t*, parts being broken away, however, to illustrate certain eccentric and cam mechanism in the lowermost tier. The pinion 16^b upon the end of the panel shaft 16^a is in mesh with an idler pinion 16^v, which is rotatably mounted upon the conveniently located panel shaft 17^a. The face of the idler 16^v is considerably wider than that of the driving pinion 16^b so that while the teeth of the idler pinion mesh at one end with the teeth of the driving sector 50^t, the pinion 16^b does not mesh directly with this sector. The result is that the motion of the sector 50^t is transmitted to the panel shaft 16^b in a direction the reverse of that in which the motion would be transmitted if the connection were direct rather than by way of the reversing idler 16^v.

The driving sector 50^t is rotatably mounted upon the sleeve 51. This sector is, however, attached to the plate-like controlling arm 52^t, whereby the rotation of the driving sector 50^t corresponds precisely with that of the controlling arm 52^t. The motion of the controlling arm is effected immediately by a differential pinion 53^t, this pinion being pivotally mounted in the end of a driving arm 54^t. When power is applied to this driving

arm to swing it in the direction of the dotted arrow 54^t in a manner subsequently to be described, the differential pinion 53^t, gaining a purchase upon the teeth of the purchase disk or sector 55^t, causes the rotation of the controlling arm 52^t in the direction of the arrow 52^v, such rotation of the controlling arm continuing until its edge 56^t engages one of the stop pins, which are numbered 57^t, 57^t₁, 57^t₂, etc., it being understood that the energization of an electromagnet corresponding with any of the significant figures will be accompanied by the energization of an electromagnet associated with the stop pin 57^t, to withdraw this pin from its normal position shown in the drawings in which it would serve to prevent the advancement of the controlling arm 52^t. As soon as the forward edge of the controlling arm 56^t engages the stop pin, as, for example, at the point indicated by the dotted lines in Fig. M¹, this controlling arm will be stopped in its rotation. The further swing of the driving arm 54^t causes the differential pinion 53^t to take purchase upon the teeth of the internal gear of the controlling arm 52^t to cause the rotation of the purchase disk 55^t in the direction of the arrow 55^v. At 58^t there is an idler arm corresponding with the controlling arm 52^t, the idler arm being provided with an internal gear corresponding with that upon the controlling arm 52^t. There is also a reverse pinion 59^t rotatably mounted upon the stud 60^t, the axis of this pinion being fixed in position. When, therefore, the purchase disk 55^t is rotated in the direction of the arrow 55^v, the reversing pinion will cause the idler arm 58^t to be swung in the direction of the arrow 58^v until the idler arm meets the driving arm at the point at which a stop pin has been forced into the paths of these swinging arms. The angle through which the power is applied to drive the oscillating lever 54^t, upon which the differential pinion is carried, is just sufficient to cause the controlling arm 52^t and its mate, the idler arm 58^t, to be brought snugly together at their engaging surfaces. It is to be noted that no matter which of the stop pins has been advanced into its effective position, the controlling arm 52^t will be swung through an angle sufficient to reach this pin. Since the stop pins are equally spaced, the angle through which the controlling arm is swung forward and back will correspond with the number of the particular stop pin which is engaged at the end of the forward stroke. Since the driving sector 50^t is mounted to rotate with the controlling arm 52^t, the amount of rotation of the panel shaft which is geared to the driving sector will correspond with the distance through which the driving arm 52^t is swung, and consequently with the number of the stop pin which has been thrust into the

effective position upon the energization of the associated electromagnet.

Each of the stop pins is associated with electromagnetic controlling mechanism such as that illustrated in cross-section at 61^t, the armature 62^t being attracted to move the stop pin inwardly upon the energization of the electromagnet. The retracting spring acts upon the head of the stop pin to return it to normal position shown in the drawings as soon as the associated magnet becomes de-energized. It will be noted from the dotted lines in Fig. M¹ that the location of the electromagnets is alternated between the main rack 63^t and the auxiliary rack 64^t, this alternation being desirable in order that room may be provided for the various magnets. Each tier of the master machine is provided with its row of electromagnets and stop pins such as that already described.

Each of the tiers is provided with controlling and driving mechanism, substantially like that described in connection with the tier *t*. The necessary angular displacement of the various panel shafts requires corresponding displacement of the associated driving sectors; *e. g.*, the sector 50^{ht} shown in Fig. M² is always in a position in which it will engage the idler pinion 20^v, this pinion meshing with the driving pinion 20^p of the panel shaft 20^a. The idler pinion is in this instance loosely mounted upon the panel shaft 15^a. So also the driving sector 50^u is always in a position where it will mesh with the pinion 15^p upon the lower end of the panel shaft 15^a. The different angular positions of the driving sectors do not require a corresponding angular displacement of the balance of the driving and controlling mechanisms, because the driving sector may be screwed to the associated controlling arm in any position which the location of the associated panel shaft may require.

One thing further is to be noted in connection with the controlling and driving mechanism, namely, that the alternate panel shafts are connected through idler gears or pinions with their driving sectors, the intervening panel shaft being connected directly. Thus, for example, the panel shaft 16^a is geared to its driving sector only through the idler gear 16^p, which has the effect of reversing the direction of rotation. The position of the driving pinion 17^p is such, however, that it will mesh directly with the teeth of its driving sector, whereupon the transmitted motion will not undergo reversal. The result is that the alternate panel shafts will be caused to rotate in reverse directions corresponding with the necessary reverse direction of rotation of the driving disks of the register turret as elsewhere described.

We come now to a consideration of the mechanism which causes the power levers 54 to swing. All of these lever arms are

keyed to the tubular bushing 65. When, therefore, one of the arms is caused to swing about its axis, all of the other arms will have the same motion. In accordance with my invention, the motor mechanism is connected directly with the lowermost lever arm of the master machine, and the motion and power required for the other arms is transmitted to them through this rotatable bushing. A crank pin 66, attached to the lever arm 54^a, serves as a point of connection for the connecting rod 67 which terminates in eccentric straps 68 surrounding eccentric 69. This eccentric, mounted upon the countershaft 70, is driven by the miter gears 71, power being supplied from an electric motor by way of the main shaft 72 and suitable controlling mechanism subsequently to be described. It will be apparent that each complete rotation of the shaft 70 will cause a forward and back swing of all of the lever arms 54. The throw of the eccentric is such that the swing of the lever arms will be sufficient to transmit a nine step rotation to any of the panel shafts where the ninth stop has been thrust into its alternative position. These various features of the mechanism and their mode of operation will therefore be readily understood when it is explained that the main shaft 72 is for the purposes of each registration caused to revolve by an amount sufficient to cause a single complete revolution of the shaft 70. One such revolution is effected every time that a register-controlling magnet (or magnets) has been energized for the purpose of involving the associated register with an appropriate entry.

As explained in connection with the register mechanism, the master machine controls also the longitudinal movement of a master column 40, the up and down movement of this column serving to complete the operative connection of any selected registers with the common driving mechanism which is controlled by the panel shafts of the master machine. The mechanism for controlling the master column is illustrated in the lower part of Fig. M², and in Figs. M⁴ and M⁵, all of this mechanism being shown in these figures on a scale only one-half as large as is the mechanism in the figures specific to the register turret. The lower end of the master column is forked and pivoted to a crank arm 73, this crank arm being mounted upon a suitably journaled rock shaft 74. Upon this rock shaft also is mounted a lever arm 75, at the lower end of which is rotatably mounted a cam roller 76. This roller coöperates with the main cam 77 and the auxiliary cam 78 to swing the rock shaft 74 and thus to raise and lower the master column 40. The main cam 77 is a driver with respect to the auxiliary cam 78, the main cam being pinned fixedly to the shaft 70, while the auxiliary cam

is rotatably mounted upon this shaft. There is, however, pin and slot connection between the main and the auxiliary cams, this connection being best illustrated in Fig. M⁴, where is shown in dotted lines the slot 79 in the uppermost or driving cam 77 and the pin 80 in the lowermost or auxiliary cam 78. Considering first the operation of this cam mechanism when the main shaft is rotated in the direction of the arrow 72' to cause the forward actuation of the connected registers, it will be seen that the main cam 77 will be driven in the direction of the arrow 70', thereby causing the roller 76 to ride upon the surface 78^m of the auxiliary cam 78 during approximately one-half of the revolution of the countershaft 70 and the eccentric 69. Thereupon the point 77^p of the main cam 77 will strike the roller and force it into a position in which the master column will be raised to its uppermost position. The cam roller will continue to ride upon this high surface 77^a of the main cam during approximately a half revolution of the eccentric. It is only when the master column is in its uppermost position that the selected registers in the turret are actually connected with the panel shafts of the master machine. The cams are so laid off that the master column will be maintained in this uppermost position throughout the return swing of the lever arms 54 as brought about by the rotation of the eccentric 69. By the time the lever arms have been returned to their normal position the main cam will have reached a point at which the cam roller 76 will drop into the depression 77^d. It is this movement of the cam roller which permits the master column to drop into its lowermost position in which the controlling electromagnetic mechanisms of the registers are positively returned to their normal positions and in which the idler pinions for connecting the numeral wheels of the registers of the other driving disks are positively returned to their normal positions. A slight angular advance of the shaft 70 raises the cam roller to the normal intermediate position shown in the drawings. It will be seen that this cam mechanism serves therefor automatically to connect any selected register or registers with the panel shafts throughout the time during which the actuating levers 54 are being returned from their forward to their normal positions. It is during this return stroke of these arms that the advancement of the connected registers occurs.

The utility of the compound cam mechanism will be appreciated when it is understood that the registers must be connected with the panel shafts during the forward movement of the actuating levers 54 in case the registers are to be decumulatively operated. Consider, therefore, the result of re-

verse rotation of the main shaft 72: The shaft 70 will be driven in the reverse direction, causing at once the rotation of the main cam 77. Rotation of the auxiliary cam will not, however, be commenced immediately on account of the lost motion in the pin and slot connection between these cams. While, therefore, the main cam is rotated for a slight distance, the cam roller 76 will remain in its normal position upon the surface 78^m of the temporarily stationary auxiliary cam. When the main cam has been turned in this direction through a slight angle, its depression 77^a will have moved behind the surface 78^m of the auxiliary cam, whereupon the surface 77^a of the main cam will raise the cam roller into its uppermost position without its having dropped into the depression 77^a. Immediately at the commencement, therefore, of the forward swing of the actuating lever 54, the master column will be raised into its uppermost position, thereby connecting any selected registers with the panel shafts. This connection will be continued until the surface 77^a of the main cam has passed the cam roller 76, whereupon the cam roller will drop into a depression which has been formed at the point 78^a by virtue of the angular displacement of the main and auxiliary cams relative to each other. This depression is of such depth that the master column is dropped promptly to its lowermost position, after which it is raised to the intermediate position by the effect of the cam surface 78^m upon the cam roller 76. The master column having therefore been dropped to the lowermost position to insure the return of the selecting and connecting mechanisms of the turret to their normal position, it is returned to the intermediate position where it awaits completion of the backward revolution of the eccentric 69. Such a backward revolution of the driving mechanism automatically causes in this manner the connection of the registers with the panel shafts only during the forward swing of the actuating levers 54, whereby the registers are reversely operated as in the act of subtraction. If after such a subtractive actuation of the mechanism a forward operation ensues, the slack of the slot and pin connection between the cams will first be taken up, whereupon the operation will take place as previously described.

In order that the master column may be in its uppermost position throughout the forward swing or throughout the return swing of the actuating levers 54, a certain amount of lost motion is introduced between the crank pin 66 and the connecting rod at 80^l. The lost motion which ensues at either end of the stroke of the connecting rod affords the cam mechanism an opportunity to complete its actuation of the master column.

The controlling mechanism for governing the rotation of the main shaft 72 is shown in

Figs. M⁴ and M⁵. The electromagnet 81^f controls an armature which upon the energization of the magnet is advanced to cause the rotation of the associated commutator disk 82^f upon the main shaft 72. This connector disk is provided at 83^f with a segment of insulating material. The brush 84^f rides normally upon this segment. When, however, the electromagnet is energized the connecting arm 85^f, acting upon the pin 86^f, swings the connector ring around into a position where circuit is closed between the brush 84^f and the metallic surface of the connector ring. It is the closure of this circuit which causes the energization of the electric driving motor, to cause the rotation of the shaft 72, the connections being such that the shaft will be rotated in the direction indicated by the arrow 72^f. A pawl and ratchet connection 87^f between the connector ring and the main shaft 72 permits the angular advancement of the connector disk upon the shaft. When, however, the motor has commenced to drive the shaft the friction of the brush 84^f will retain the connector disk in fixed position until the ratchet tooth upon the main shaft has engaged the end of the pawl 87^f, whereupon the rotation of the connector disk will continue with the shaft until the insulating segment has again reached the position underneath the brush where energizing current in the motor will be cut off, thus bringing the mechanism to rest. A succeeding energization of the starting magnet 81^f will effect the closure of the motor circuit, whereupon the motor will again run to turn the main shaft through one complete revolution in a forward direction. The backward starting magnet 81^b is substantially like the forward starting magnet 81^f. So also the brush and connector disk mechanism are substantially like that already described. The circuit connections, however, are such that when the backward starting magnet 81^b is energized by a current controlled from the keyboard the driving motor will be caused to run in a reverse direction, the rotation being stopped automatically upon the completion of a single revolution of the main shaft, as before.

It is explained in connection with the register turret that certain of the numeral wheels of each register may be used as mere counters to count the number of actuations of the associated register. In such case the master machine mechanism may be identical with that already described, in which case the No. 1 stop pin associated with the panel shaft leading to the numeral wheel of the counter must be thrown into its effective position during each forward actuation of the master machine. The balance of the master machine mechanism, which would not be of any particular service in connection with mere counters, might be dispensed with, ex-

cept that it is used in restoring the counters to zero when the registers are cleared, as elsewhere described.

Verification machine.—This machine is used to produce a verification record of the entries made from the schedules on the key-boards by the operator, and the record produced serves as a check on the operator's accuracy in making the entries. The relation of this machine in the system has already been described in the chapter on operation, and will also be shown in the chapter on circuits. The construction of the machine is shown in Figs. V¹ and V², Fig. V¹ being a side elevation with parts removed to show interior mechanisms and arrangement, and Fig. V² being a vertical sectional view taken on the plane 2—2, Fig. V¹.

The machine comprises the side supporting and inclosing walls V¹ and V². Journalled in the side walls is the driving shaft V³ carrying at its end the driving gear V⁴, and near its central part having a collar V⁵ pinned thereto and supporting the bevel gear V⁶. At the left end of the drive shaft, just within the wall V¹ is pinned the hub V⁷ supporting a cam V⁸, and on said shaft, just within the wall V² is the hub V⁹ carrying the cam V¹⁰. Extending between the side walls, near the top and at the front thereof is the supporting cross bar V¹¹, and extending between the side walls near the top and at the rear thereof is the supporting cross bar V¹², the bar V¹¹ having the supporting ledge V¹³, and the bar V¹² having the supporting ledge V¹⁴. Between said cross bars is arranged the terminal supporting frame V¹⁵, whose front and rear inclosing walls V¹⁶ and V¹⁷ have the offsets V¹⁸ and V¹⁹ for engaging the ledges V¹³ and V¹⁴. The walls V¹⁶ and V¹⁷ also each have an inwardly extending supporting ledge V²⁰, which ledges are in line with the ledges V²¹ extending inwardly from the side walls V²² and V²³ of its terminal frame. The ledges V²⁰ and V²¹ form supports for the insulating plate V²⁴, which plate supports rows of supporting members V²⁵, each of said supporting members carrying at its lower end a contact square V²⁶. These supporting members may be screws threading into the squares as shown. The contact clip V²⁷ is held under the head of each supporting member and forms a common terminal for the square supported by the screw. Extending downwardly from each square are other rows of contact terminals V²⁸, each square being shown as supporting four rows of said terminals, each row having ten terminals. The terminals of all these squares terminate in a common plane, and the screws, square and terminal are entirely surrounded by insulating material V²⁹, the insulating material at the end of each terminal wire being cut away to leave an air cup. A cover V³⁰ en-

gages the end and side walls of the terminal frame, these end and side walls and the inner face of the cover being lined with insulation V³¹, as shown, to form a chamber entirely insulated from the frame, in which chamber, oil V³² is held, to thus thoroughly insulate the contact clips V²⁷ from each other, and to also insulate the conductors passing from said clips to the exterior. Below this upper terminal frame is a lower terminal frame V³³ comprising the lower wall V³⁴, the lower sections V³⁵ of the side walls, and the lower sections V³⁶ of the front and rear walls. Carried on the front, side and rear walls, secured thereto by screws V³⁷, is the upper inclosing sections V³⁸, whose side walls have the upward extensions V³⁹ for engaging the sides of the top terminal frame V¹⁵ to hold the lower edge of said frame in alinement with the top edge V⁴⁰ of the top frame section V³⁸ of the lower terminal frame. To afford additional strength to the various frames, the top terminal frame has the central rib V⁴¹, and the lower frame has the lower central rib V⁴² and the upper center rib V⁴³, these ribs being all in alinement, as shown. The lower section of the lower terminal frame V³³ is lined with insulation V⁴⁴, and contains insulating oil V⁴⁵. The upper frame part V³⁸ of the lower terminal frame V³³ is filled with insulating material V⁴⁶, through which pass the terminal wires V⁴⁷, all terminating in the plane of the upper edge V⁴⁰ of the terminal frame. The terminal wires V⁴⁷ are grouped so that there will be a terminal for each of the terminal conductors V²⁸, extending from the terminal squares V²⁶ and the insulation V⁴⁶ is also cut away at the end of each wire V⁴⁷, so that when the two terminal frames are brought together with the record paper between them, the corresponding terminal chambers cut in the insulation, and the terminal ends therein will be opposite each other. A conductor leads from each of the wires V⁴⁷ through the insulating oil to the exterior, the oil serving to maintain thorough insulation between these conductors, and between the wire terminals V⁴⁷.

The lower terminal frame V³³ is supported by means of side cam rollers V⁴⁸ and V⁴⁹, and by the center cam roller V⁵⁰, these cam rollers being suitably pivoted to the frame as shown. The cam roller V⁴⁸ operates with the cam V⁸, the cam roller V⁴⁹ coöperates with the cam V¹⁰, and the roller V⁵⁰ coöperates with the central cam V⁵¹. This central cam is carried on a cross shaft V⁵² suitably journalled in cross bars V⁵³. The shaft V⁵² also carries a bevel pinion V⁵⁴ which meshes with the bevel pinion V⁶, mounted on the main drive shaft V³. The cams are alike and their contour is illustrated by the central cam V⁵¹. Each cam has the cylindrical peripheral part V⁵⁵, the intermediate cam

ridge, V^{66} and the highest cam ridge V^{57} , the rollers normally resting on the cam between the intermediate and high ridges, as indicated. Pivoted on the shaft V^{58} , extending
 5 between the side walls at the lower end thereof, and below the terminal frames, is supported the spool V^{59} carrying the roll of record paper. This record paper passes over the roller V^{60} , extending between the side
 10 walls at the end thereof, and in position to guide the record paper between the terminal frames. At the front of the machine this paper passes between the rubber rollers V^{61} and V^{62} , suitably pivoted on shafts V^{63} and
 15 V^{64} , extending between the side walls of the machine. A pinion V^{65} is secured to shaft V^{63} , and is adapted to mesh with the driving gear V^4 mounted on the main shaft V^3 . The arc V^{66} of this gear (about 90°) has no
 20 teeth, and normally the pinion V^{65} is at the center of this toothless arc so that the gear V^4 may rotate a distance in either direction before its teeth engage the pinion. Also mounted on shafts V^{63} and V^{64} are gears
 25 V^{67} and V^{68} , which gears mesh with each other to maintain proper relations and proper speed of rotation of the feed rollers. When the pinion V^{65} is rotated by the main
 30 gear in the direction of the arrow, the rubber rollers will be rotated as indicated by the arrows, and the record paper will be drawn forwardly. Mounted across the front of the lower terminal frame is the shear
 35 blade V^{69} . Mounted to the machine frame above this shear blade is the cutting blade V^{70} , whose edge is just above the plane of the record paper. A gravity bar $V^{70'}$ tends to keep the paper below the edge of the
 40 blade V^{70} , thus preventing the paper coming against the blade when it is fed. As will be described later, the shear blade V^{69} is carried upwardly with the lower terminal
 45 frame, and the cutting edges of the shear blade and cutting member pass by each other to cut from the main record paper, the section which has been drawn from the machine by the rubber rollers. Above shaft V^{64}
 50 is a third shaft V^{71} , carrying a friction roller V^{72} which engages with the roller V^{62} . The shaft V^{71} also has a gear V^{73} meshing with gear V^{68} . Mounted on the pivot
 55 shaft V^{74} which extends across the upper front edge of the upper terminal frame is a guide roller V^{75} , and pivoted at the end of the machine frame, near the lower wall V^{12}
 60 is the roller V^{76} . About this roller and the drive roller V^{72} passes the conveyer belt V^{77} , this belt passing also over the roller V^{75} . The supporting shelf or apron V^{78} extends
 65 between the front and rear rollers and between the side walls V^1 and V^2 of the machine. This conveyer belt receives the schedules and the apron V^{79} extending from the rear wall V^{12} , and over the rear edge of the
 70 plate V^{78} prevents the schedules from slid-

ing rearwardly over the roller V^{76} . The driving roller V^{72} is driven simultaneously with the rollers V^{61} and V^{62} , and therefore a schedule sheet laid on the conveyer belt will be delivered from the machine simulta- 70
 neously with the delivery of the verification record paper, both sheets falling one on top of the other at the end of the machine.

The side walls along their top edge are pocketed and in these pockets support the 75
 bars V^{80} , V^{81} , the upper terminal frame being held between these bars, but allowed to reciprocate vertically as far as the offsets V^{82} and V^{83} from said bars. The supporting
 80 plate or apron V^{78} above mentioned, rests on the top of these offsets, as shown. A sheet metal frame V^{84} extends upwardly from the bars V^{80} , V^{81} , and curls over laterally and downwardly, and is secured at its
 85 lower edge to the side walls V^1 , V^2 , this sheet metal shell forming chambers V^{85} and V^{86} . Through the tops of these shells at each side of the machine are rows of openings V^{861} , through which extend the heads
 90 V^{87} of the punch rods V^{88} . In the bars V^{80} and V^{81} , pockets are formed registering with the openings V^{861} , the punch rods extending
 95 through the bars and below said pockets. Within each pocket is a spring V^{90} bearing against the base of the pocket, and the body V^{91} of the punch rod. A notch V^{92} in each
 100 punch body coöperates with the extension V^{93} from the upper edge of the corresponding side wall of the machine to limit the longitudinal movement of the punch. Normally the punch heads V^{87} are within the
 105 openings V^{861} , the spring holding the lower wall of the slot V^{92} against the extension V^{93} . The punches are divided into groups and for each group is provided a universal
 110 detent bar V^{94} , suitably pivoted from the side walls to engage notches V^{95} in the punch bars. When one punch is depressed, it will be held in its depressed position by the associated
 115 detent bar, but all other punches of the same group which have been depressed will be released upon swinging of the detent bar by the lastly pressed punch. Within the
 120 chambers V^{85} and V^{86} a series of switch mechanisms V^{96} are arranged, and suitably supported, there being a switch mechanism for each punch. Each switch mechanism
 125 comprises a short contact spring V^{97} and a longer contact spring V^{98} , adapted to be engaged by a stud V^{99} extending
 130 from the body of the corresponding punch so that when a punch is depressed the stud will cause the lower spring V^{98} to be carried into contact with the shorter spring,
 thus closing a circuit controlled by said springs. In the upper frame section V^{83} , and below each punch rod, a slot or groove
 135 V^{100} is cut, this slot being extended a distance into the lower edge of the upper terminal frame V^{15} . Also cut in the side walls 130

V^1 and V^2 in a line with the lower part of the notches V^{100} are outlet openings V^{101} . The record paper V^{60} has the same width as the upper terminal frame V^{23} and the edges of the record paper will, therefore, pass through the notches V^{100} below the ends of the punch rods, and, therefore, when the terminal frames are raised after the punches have been depressed, the paper edges will be carried upwardly beyond the cutting ends of the punches and notches cut in said edges. As shown in Fig. V^2 the punch at the right has been depressed so that when the terminal frames are raised, a notch will be cut in the right edge of the record paper.

At the left end of the main drive shaft V^3 , circuit controlling mechanism is arranged, which construction is the same as that illustrated in Fig. M^5 , although all the parts are not shown in Fig. V^2 . There is shown, however, the commutator disk V^{102} having the segment V^{103} of insulating material, this commutator being mounted on the drive shaft V^3 . A brush frame V^{104} is secured to the side wall V^1 , and supports a brush V^{105} , which normally engages the insulating segment. The electro-magnet and the pawl mechanism, corresponding to the parts 81^1 and 87^1 in Fig. M^5 , are not shown here but the connecting arm V^{106} , corresponding to the part 85^1 , Fig. M^5 , is shown and engages the crank pin V^{107} extending from the commutator disk. Upon energization of the electro-magnet associated with the connecting member V^{106} , the commutator disk is rotated and the metallic part thereof carried into engagement with the brush in order to close the circuit of the motor controlling the operation of the shaft V^3 .

Normally the parts are in the relative positions as shown. The cam rollers engage the cams between the intermediate and high cam ridges, the lower terminal frame being held against the upper terminal frame and the section of the record paper tightly clamped between the frames on which the terminals and pockets at the ends of such terminals are in perfect register. It may be stated here that the record paper may be treated or untreated so that the passage of current or sparks between the opposite terminals will cause a mark to be left on the record paper. The paper may be chemically treated so as to be discolored at the spots where the current or sparks pass through. Coloring matter, such as carbon, may also be applied to the paper, which would be withdrawn from the paper or discolored upon passage of sparks therethrough. The pockets cut in the insulation at the terminal ends serve as spark pockets and upon passage of current between opposite terminals, the associated pockets more or less determine the area of rupture or discoloration on the record sheet. After the opera-

tor places a schedule on the conveyer belt in the tray formed at the top of the machine by the shell V^{84} , the operator depresses the punch members to give the desired notching in the record sheet. The operator then selects a register for receiving the first entry, and then actuates the main keyboard to carry the first schedule entry into the selected register. When the register is selected, the corresponding field or square of spark points is automatically selected, and when the number to be entered is set up on the main keyboard, suitable circuits are closed to cause current flow through circuits containing corresponding terminals in the selected spark field, corresponding to the number set up on the main keyboard, and sparks passing between the selected contacts and through the interposed record paper, will mark the record paper to indicate the number selected on the main keyboard, and entered in the selected register. The operator then takes a second item on the schedule, selects a register therefor, enters the item on the register, and automatically the spark field in the verification machine will be selected, and contacts automatically included in circuits to mark the record paper to indicate the number entered in the selected register. This goes on until the entire schedule items have been entered in registers, and the record sections in the spark fields marked with characters indicative of the items set up on the main keyboard and entered in the registers. When the complete schedule has been entered, and the entries recorded upon the verification sheet, a "go" key associated with the verification machine, elsewhere shown, is actuated to close circuit through the electromagnet controlling the connection of the drive shaft V^3 , with a suitable motor. Upon energization of such relay, the commutator is advanced to carry its metallic part into engagement with the brush V^{106} , thereby closing the motor circuit. The shaft V^3 is therefore rotated and drive gears V^4 and the cams V^8 , V^{10} and V^{51} rotated. The rotation of the gear V^4 will primarily have no effect, as normally the toothless arc V^{66} is adjacent the roller gear V^{65} . The cams, however, carry their high ridges under the cam rollers and the terminal frames are lifted upwardly, the edges of the paper held between said frames being notched, as they are carried past the cutting edges of the depressed punches, the punched out pieces falling out of the machine through the slots V^{100} and outlets V^{101} . After this punching operation, the cams have brought their cylindrical surfaces into engagement with the cam rollers, the terminal frames having then dropped to their lowermost position, the top terminal frame then resting against the ledges V^{18} and V^{19} , and the lower terminal frame sep-

arating from the upper terminal frame to release the record paper. When the cam rollers reach the cylindrical part of the cams the teeth of the gear V^4 will reach the roller gear V^{63} and will cause rotation of the roller train, which results in the withdrawal from the machine of the section of the record paper which has just received the verification marks, and simultaneous withdrawal of the schedule from the tray by the conveyer belt. When the end of the cylindrical cam surface is reached the intermediate ridges of the cams engage the cam rollers and the terminal frames are raised to their normal intermediate position. During this upper movement of the terminal frames the cutting blade V^{60} is raised past the cutting blade V^{70} , and the record section just withdrawn from the sheet is sheared and drops into a suitable tray below the schedule. As soon as the rollers leave the cylindrical cam surfaces, the toothless arc of the gear V^4 again reaches the gear V^{63} , and the roller train is stopped. As explained in connection with Fig. M^5 , the pawl mechanism associated with the clutch mechanism in Fig. V^2 becomes effective after a complete revolution of the shaft V^3 to again carry the insulating segment of the commutator into engagement with the brush to thereby disrupt the circuit of the electromagnet controlling the rotation of the driving shaft and the machine comes to rest. A new section of record paper having been drawn into position between the terminal frames and the contact terminals carried thereby, the machine is ready for another schedule. The verification sheet and the schedule falling one on top of the other into the receptacle can be very readily compared. If the indication on the verification sheet differs from the corresponding entries on the schedule, it shows that the operator has made some mistake in reading the schedule and in transferring the entries thereon to the keyboards. A check on the reliability of the operators is therefore afforded by the verification sheet, although as far as the operation of other parts of the system is concerned, this machine could be entirely eliminated. The operation of the machine in relation to other parts of the system will be more fully described in another chapter.

Fig. K^1 shows a part of the amount keyboard whose construction is modified so that set-up of its keys will cause a like set-up of the high pressure contact terminals of the verification machine. The top part of the keyboard is identical with the keyboard disclosed in my co-pending application Serial No. 333,657, filed September 7, 1906, but the contact mechanism at the lower part of the keyboard is somewhat modified. Each of the key stems K^{131} has an extension K^a insulated from the key stem and having a con-

tact head K^b . The extensions all pass through common contact plate K^c . Below this contact plate is a contact supporting shelf K^d supporting a plurality of contact thimbles K^e adapted to be engaged by the corresponding contact K^b upon depression of keys. This contact mechanism controls the connection of one terminal of the transformer CT with the terminals of the verification machine. The current flowing through these contacts being of high pressure, special provision must be made for insulation. The bottom of the keyboard frame is, therefore, lined with insulating material K^f , and is filled with insulating oil so that make and break between the contacts takes place within the oil. The operation of the keyboard is otherwise identical with that of the keyboards disclosed in the co-pending application referred to.

Stencil punching machine.—As has been pointed out in the description in the chapter on operation, the stencil punching machine serves to punch sheets with character representative of the readings on the turreted registers after the various entries have been made therein. This stencil punching machine is automatically controlled and set up upon actuation of the keyboards. The numbers indicated on the registers are set up on the amount keyboard and the numbers on the counters are set up on the counting keyboard, this setting up automatically causing closure of circuits through electro-magnets controlling the set-up on the stencil punching machine. The construction of this machine is represented in Figs. P^1 to P^5 . As best shown in Fig. P^2 , which is a section taken on plane 2—2 of Fig. P^1 , the machine has the main supporting side walls P^1 and P^2 , and journaled in the sides, near the front thereof are the shafts P^3 , P^4 , P^5 , P^6 and P^7 , these shafts being all in a common plane. On shaft P^3 is mounted the pinion P^8 , which meshes with the gear P^9 on shaft P^4 . Also keyed to the shaft P^4 is the pinion P^{10} , having one tooth P^{11} and the locking surface P^{12} . This pinion P^{10} engages the ten tooth locking gear P^{13} mounted on shaft P^5 . A pinion P^{14} also pinned to shaft P^5 meshes with the gear P^{15} on the shaft P^6 . The ratio of gearing is such that two revolutions of shaft P^3 will result in a one-twentieth revolution of the shaft P^6 . In the side walls P^1 and P^2 , near the top thereof are the guide ways P^{16} and P^{17} , in which engage the ends of a supporting block P^{18} extending transversely across the machine between the side walls. Carried by and extending forwardly from the lower part of the guide block P^{18} , at the ends thereof, are the racks P^{19} and P^{20} , whose teeth engage respectively with the gears P^{21} and P^{22} secured to rotate with shaft P^6 . These gears have the same dimensions as the gear P^{15} ,

and upon rotation of shaft P⁶ by gear P¹⁵, the racks are moved longitudinally to carry with them the supporting block P¹⁸. On top of the block P¹⁸ is a clamping plate P²³ pivoted at its rear edge P²⁴ along the rear edge of the block P¹⁸. In the block P¹⁸ are a number of pockets P²⁵ in each of which is a rod P²⁶ extending upwardly through the clamping plate P²³ and terminating in a head P²⁷. In each pocket is a spring P²⁸ engaging between the upper wall of the pocket and the collar P²⁹ on the corresponding rod, the tendency of the springs being to hold the rods down in order to hold the clamping frame P²³ against the top of block P¹⁸. Extending downwardly from near the front edge of the clamping plate are punch ends P³⁰, which engage in punch openings P³¹ in block P¹⁸. Extending rearwardly from the plate P²³ are one or more arms P³² connected by a bar P³³, pressure on said bar causing the clamping plate P²³ to be swung about its pivot to carry the punch ends out of the punch openings so that a stencil sheet may be applied between the clamping plate and supporting block. Upon release of the bar P³³, the plate is drawn to its normal position and the punch ends are carried through the paper to punch holes therein, the paper being then held clamped between the plate and block and held in perfect alinement by these punches.

Extensions P³⁴ and P³⁵ from the side walls P¹ and P² carry the transverse supporting shelf P³⁶ and the circular magnet supporting plate P³⁷. Suitably fastened to and extending radially from the supporting plate P³⁷ are a plurality of electro-magnet frames P³⁸, each having an armature P³⁹ secured to an actuating rod P⁴⁰, the energizing winding P⁴¹ being also provided. Extending through the center of the electro-magnet frame is the shaft P⁴² on which are pivoted a plurality of levers P⁴³, there being one lever for each electro-magnet. The levers are pivoted to the shaft at an intermediate point, one end of each lever connecting with the rod P⁴⁰ or its electro-magnet through the crank rod P⁴¹¹, while the lower end of each lever has a pivotal connection with the inner end of a selecting bar P⁴⁴. A cross plate P⁴⁵ extending between the extension P³⁴, P³⁵, forms the pocket P⁴⁶ with the shelf P³⁶. In this pocket a cross bar P⁴⁷ is adapted to reciprocate vertically. The shelf P³⁶ has a forward extension P⁴⁸ along its lower edge forming the base of the opening P⁴⁹, and through said base are punch openings P⁴⁹ arranged in groups, but being all in a common line. The bar P⁴⁷ has a lower shelf P⁵⁰ and a top extension P⁵¹. In the lower shelf P⁵⁰, openings P⁵² are arranged to register with the punch openings through the extension P⁴⁸, and through each opening P⁵² extends a punch rod P⁵³ whose lower end

extends into the registering punch opening P⁴⁹. The shelf P³⁶ has also the upper forward extension P⁵⁴ which overhangs the shelf P⁴⁸ and is provided with a plurality of guide openings P⁵⁵ registering with the openings P⁵². Each punch rod terminates in the guide head P⁵⁶ extending through one of the guide openings P⁵⁵, the guide heads normally extending beyond the upper face of the shelf P³⁶, and being normally engaged at their upper end each by one of the selecting bars P⁴⁴. In the normal position of the bars P⁴⁴ their ends P⁵⁷ are outside the path of the extension P⁵¹, so that they will not be engaged by said extension upon downward movement of the bar P⁴⁷. However, upon energization of electro-magnets, the corresponding levers P⁴³ are rotated and the bars pivoted moved forwardly to carry their ends P⁵⁷ under the extensions P⁵¹, and, therefore, when the bar P⁴⁷ is carried downwardly the bars P⁴⁴ will be swung, and being in engagement with the tops of the punch rod guide heads, the corresponding punch rods will be carried downwardly and the stencil sheet punched. Below the punch rods, a supporting bar P⁵⁸ extends across the machine, being secured at its ends to the side walls P¹ and P². Upon this supporting bar is the die plate P⁵⁹ containing a plurality of punch holes P⁶⁰ connected through openings P⁶¹ with the exterior, so that the punched pieces can fall from the punch die.

The mechanism for causing reciprocation of the bar P⁴⁷ is best shown in Fig. P¹. Pivot studs P⁶² extend from the ends of the bar P⁴⁷ and are engaged by the upper end of eccentric rods P⁶³, whose lower ends engage the eccentrics P⁶⁴ secured to shaft P⁷, and upon rotation of this shaft, the bar P⁴⁷ is vertically reciprocated. At each side of the machine, adjacent the connecting rod is a bar P⁶⁵ guided in guide members P⁶⁶, having at its upper end an extension P⁶⁷ for engaging the arm P⁶⁸ secured to a shaft P⁶⁹, which carries a universal restoring bar P⁷⁰. Each eccentric rod at its lower end has a step P⁷¹ adapted to engage under the end of rod P⁶⁵ when the eccentric rod is in its lower position so that upon ascent of the eccentric rod the step will engage the adjacent rod P⁶⁵ to carry the end of said rod into engagement with the arm P⁶⁸, thereby causing rotation of shaft P⁶⁹ and of the restoring bar P⁷⁰. Each selector bar P⁴⁴ has a tooth P⁷² which is engaged by the universal bar when it is rotated to the left. After the bar P⁴⁷ has been drawn downwardly by the eccentric mechanism and the paper punched, the shaft P⁶⁹ is rocked during the "up" stroke of the bar P⁴⁷, and the universal bar rocked from its normal position to carry all the selector bars P⁴⁴ to their normal position.

Below the supporting bar P¹⁸ is a parallel stationary bar P⁷³, and secured to and ex-

tending from this bar at the end thereof are the contact supporting bars P^{741} and P^{751} , while at the other end are the contact supporting bars P^{74r} and P^{75r} . Carried by the bar P^{741} are the contact pieces P^{761} , whose spacing is the same as the spacing of the lines on the record sheet. The bar P^{74r} carries similar contact members P^{76r} . Suitably supported from the bar P^{18} are the brush holders P^{771} and P^{77r} carrying brushes for successively engaging with the contacts P^{761} and P^{76r} as the bar P^{18} travels. The bars P^{751} and P^{75r} carry the contact pieces P^{781} and P^{78r} respectively, adapted to be engaged by brush mechanism P^{791} and P^{79r} also carried by the bar P^{18} . At the outside of the side wall P^1 and carried by the shaft P^4 is a commutator disk P^{79} which is also in electrical engagement with brush mechanism P^{80} carried from the side wall upon said commutator. Adjacent said commutator is a second commutator P^{81} having only one contact segment P^{82} . Arranged at diametrically opposite sides of this commutator are the brush mechanisms P^{83} and P^{84} suitably supported from the side wall P^1 , the brush mechanism P^{83} being now in engagement with the commutator segment P^{82} .

In Figs. P^4 and P^5 is shown the mechanism for alternately driving shafts P^3 and P^7 to cause alternate operation of the gears P^{21} and P^{22} to move the stencil sheet and operation of the punch mechanism to punch holes in the stencil sheet after it has been brought into position. Mounted on shaft P^3 is the intermittent pinion P^{85} , and mounted on shaft P^7 is the intermittent pinion P^{86} . The ends of these shafts and the intermittent pinions thereon extend into a bearing frame P^{87} , as shown in Fig. P^4 . Pivoted between the intermittent pinions is a driving gear P^{88} having teeth extending over an arc thereof, the number of teeth being the same as the number of teeth on the intermittent pinions, so that each passage of the gear teeth past an intermittent pinion will cause a complete revolution of said pinions. Normally locking surfaces P^{90} on said pinions engage the locking surfaces P^{91} on the driving gear. The gear P^{88} is mounted on the shaft P^{92} , which supports the locking disk P^{93} , the shaft terminating in a differential bevel gear P^{94} . A companion differential bevel gear P^{95} is secured to the motor shaft P^{96} and between said differential gears is a ratchet wheel P^{97} carrying the differential pinion P^{98} which meshes with the differential gears. Pivoted above and between the wheels P^{93} and P^{97} is the locking plate P^{99} having the two locking ends P^{100} and P^{101} . The top of the plate is pivoted to a rod P^{102} connecting with the armature of the electro-magnet P^{103} , which electro-magnet has two windings C^{44} and C^{45} , these windings acting oppositely, the stopping winding having a

greater power. The stopping winding C^{44} tends to move the armature inwardly to hold the locking plate in the position shown, with its end P^{100} engaging in the locking notch P^{104} of the wheel P^{93} , while the starting winding C^{45} tends to pull the armature out to disconnect the end P^{100} from the wheel P^{93} , and to bring the end P^{101} into locking engagement with the ratchet wheel P^{97} . The differential mechanism is interposed in the driving train for the reason that the motor which is used to drive the shaft P^{96} operates continuously. In the position shown, the ratchet wheel rotates with the motor shaft, but when this wheel is engaged by the locking end P^{101} it stops, and rotation from the motor shaft is transmitted through the differential train to the shaft section P^{92} and to the driving gear P^{88} .

When the machine is to be operated, the bar P^{33} is depressed to raise the clamping plate P^{23} , in order that a sheet may be slipped under the clamping plate. Upon release of the bar, the clamping plate is drawn down by the force of the springs P^{28} and the punch ends P^{30} caused to perforate the sheet which is then securely held in place. Each register in the turret machine is cleared and its indication transferred to the stencil sheet. When the stencil sheet is inserted in the machine, the top line thereof is just in front of the row of punch openings. In order to better arrange the entries on the stencil sheet, and to give it a more convenient size, it is divided into two columns, the lines of the left column being intended for receiving indications from the odd registers, and the lines of the right column being intended for receiving the entries from the even registers. The punch rows are correspondingly grouped. As shown, these punches are grouped into order sets, each set comprising ten orders, and there may be as many number of sets for each half of the stencil sheet as desired. As stated in connection with the turret mechanism, the last few orders of each register may be set aside to serve as counters and in the same way these last orders of each of the sets of the punching machine may serve as counter orders to punch in the stencil the number of entries in the associated register. When register No. 1, for instance, is to be cleared and its indication transferred to the left column, line one of the stencil sheet, the operator sets up on the main keyboard the indication of register No. 1, and on the counting board sets up indication on the counting orders. Having set up the amount and counter keyboards, the operator sets up on the selector board the register desired to be cleared, which is in this case register No. 1, and in making this number set-up potentially connects contact P^{101} with a circuit, which circuit will

be closed upon connection of brush mechanism P^{771} with said contact P^{761} , at a time when the brush mechanism P^{83} connects with contact P^{82} . As will be shown in the circuit diagrams, this circuit also includes a relay C^1 whose contacts control a circuit set up upon actuation of the amount and counter keyboards, the circuit also including the electro-magnets of the punching mechanism. Having made all the set-ups, the operator actuates the "go" key to close circuit containing the starting winding C^{45} of electro-magnet P^{103} and this electro-magnet is energized to draw in its armature to lock the locking plate P^{99} to thereby withdraw its end P^{100} from the notch P^{104} and to carry its end P^{101} into engagement with ratchet wheel P^{97} . The locking disk P^{93} and main gear P^{88} are now rotated by the motor and gear P^{85} and shaft P^3 is given one revolution, which will result in a half revolution of shaft P^4 and the carrying of contact P^{82} into engagement with brush mechanism P^{84} . This engagement of contact P^{82} with brush mechanism P^{84} will not result in the closure of any circuit, as the brush mechanism P^{77r} connected with said brush mechanism P^{84} is insulated at this period. Having rotated shaft P^3 , this shaft becomes locked and the main gear teeth brought into engagement with the gear P^{86} to cause one revolution of shaft P^7 , which controls the reciprocation of the punches. The punch bar P^{47} , therefore, is given one reciprocation, but as electro-magnets P^{38} have not yet been energized, there will be no effect on the record sheet. The circuit including relay C^1 also includes the stopping winding C^{44} of electro-magnet P^{103} , which winding is stronger than starting winding C^{45} , and acting in an opposite direction. However, this circuit is still open, and therefore the plate P^{99} still is effective to hold the wheel P^{97} , and allow the gear P^{88} to start on the second revolution. This second revolution results in another complete revolution of shaft P^3 , and in a second half revolution of shaft P^4 . During this second half revolution of shaft P^4 , tooth P^{11} on pinion P^{10} carried by said shaft engages with the gear P^{13} to rotate shaft P^5 one-tenth revolution, which results in one-twentieth revolution of shaft P^6 , and in one-twentieth revolution of gear P^{15} and the rack gears P^{21} and P^{22} , thus causing the racks and the bar P^{18} to be carried one space to carry line 1 of the record sheet in register with the punches. During the second revolution of shaft P^3 , contact P^{82} is returned into engagement with brush mechanism P^{83} to again close at this point the circuit for relay C^1 . Also upon movement of the stencil sheet carriage one space, the brush mechanism P^{771} comes into engagement with contact P^{761} , and the relay circuit is finally closed. Upon energization of the relay the

keyboard circuit is closed, which results in the energization of the selected magnets P^{38} and in the set-up of the corresponding punches in the manner described. Closure of the relay circuit also results in the energization of winding C^{44} , and this winding being stronger than winding C^{45} , the locking plate is restored to its normal position to re-engage its locking end P^{100} with the wheel P^{93} . This wheel P^{93} , however, will keep on rotating until the notch P^{104} comes into position to receive the end P^{100} , and this does not take place until after the main gear teeth have engaged the gear P^{86} to give the punch operating shaft a revolution. During this revolution of the punch operating shaft P^7 , the punch bar P^{47} is reciprocated and the set-up punches drawn down to punch the stencil sheet and to place on line 1 in the left column of the stencil sheet an indication representative of the number cleared out of register No. 1, and out of the counter for register No. 1. Upon return stroke of the punching bar P^{47} , the universal restoring bar P^{70} is actuated, as above described, to restore the selecting bars P^{44} and the electro-magnet mechanism to normal position, the circuit through the electro-magnets having become broken immediately after set-up, in the manner which will be shown in the description of the circuits.

Suppose now the register No. 2 is to be cleared. As before, the operator sets up the register indication on the main board, and the counter indication on the counter board, causing, at the same time, the selection of the punching machine electro-magnets. The indication for register No. 2 should appear on the first line in the right column of the stencil sheet, but this line has already been brought under the punching line when receiving the entry of register No. 1. Brush mechanism P^{77r} is also already in engagement with contact P^{76r} ; but the circuit for relay C^r is still open as contact P^{82} is not in engagement with brush mechanism P^{84} , and winding C^{44} is therefore open. Upon energization of the starting winding C^{45} it becomes effective to release the driving mechanism and shaft P^3 is first given one revolution to cause a half revolution of the shaft P^4 to carry contact P^{82} into engagement with brush mechanism P^{84} , thereby causing the relay circuit to be closed. This results in closure of the keyboard circuit and in energization of winding C^{44} to restore the locking mechanism. The main gear P^{88} , however, completes its rotation and causes rotation of the punch operating shaft P^7 , which results in operation of those punches which were set up by electro-magnets included in circuit upon closure of the keyboard circuit. We have in the first line in the right hand column of the stencil sheet a set-up indicative of the entry in register

No. 2 and of the entry of the counter orders for this register. The mechanism again becomes locked, and the tooth P^{11} for the half revolution of shaft P^4 will be 180 degrees from the position shown in Fig. P^3 .

Suppose, now, that we wish to clear register No. 3. The indication on the register and the indication on its counter are set up on the proper boards, the set-up circuits including the corresponding electro-magnets of the punch mechanism. Key 3 is now depressed on the selector board and contact P^{761} , potentially connected with the circuit of the relay controlling the selector keyboard circuit. Brush mechanism P^{771} is, however, in engagement with contact P^{761} , and the relay circuit is therefore open at this point, and commutator P^{82} will be in engagement with contact brush P^{84} after the punching of the entry for register No. 2. Upon actuation of the "go" key the driving mechanism is unlocked and main gear P^{88} rotated. Shaft P^3 is first given one revolution, which results in a half revolution of shaft P^4 , returning contact P^{82} into engagement with brush mechanism P^{83} to close, at this point, the relay circuit for register No. 3. During this half revolution of shaft P^4 , the tooth P^{11} of pinion P^{10} is carried to its original position after having caused a one-tenth revolution of shaft P^5 and a one-twentieth revolution of shaft P^6 . This one-twentieth revolution of shaft P^6 results in one-twentieth revolution of the rack gears P^{21} and P^{22} and movement of the record sheet carriage one space to carry line 2 under the punch dies, and to carry brush mechanisms P^{771} and P^{77r} into engagement with contacts P^{761} , and P^{76r} , respectively. The relay circuit at position 3 is therefore closed and the keyboard circuit closed, which results in energization of winding C^{44} to stop the driving mechanism and set-up of electro-magnets P^{38} to select the proper punches. The main gear P^{88} during the completion of its revolution gives the punch operating shaft P^7 one revolution and the selected punches are carried down to punch the stencil at points indicative of the entry cleared from register No. 3 and its counter.

The operation for clearing register No. 4 will now be the same as the operation for clearing register No. 2, which has already been described. In the arrangement shown the clearance of an odd numbered register results in shifting of the stencil sheet carriage, but when an even numbered register is to be cleared, the carriage is not shifted, shaft P^4 being given only a half revolution to carry the contact P^{82} into engagement with brush mechanism P^{84} and shaft P^7 given a complete revolution to actuate the selected punches.

Contacts P^{781} and P^{78r} are successively engaged by the brush mechanism P^{791} and

P^{79r} as the stencil sheet carriage travels, and these contacts are placed in accordance with the notching of the verification sheet. At the ends of the row of punch dies P^{60} are the notching punch dies P^{1071} and P^{107r} . These punches pass through notch punch dies to notch the edges of the stencil sheet. Each notch punch is controlled by one of the electro-magnets P^{38} . The circuits for these electro-magnets are controlled by the engagement of the brush mechanism P^{79} with the contacts P^{78} , and by the closure of contacts V^{96} controlled by the notch punching keys in the verification machine. The adjustment is such that after the verification machine notching punches have been set up the brush mechanisms in the stencil punching machine will engage with its contacts to close the circuit of the notching punch electro-magnets of the stencil machine to actuate the notching punches to notch the stencil sheet in correspondence with the notching of the verification sheet. After all the registers in the turret machine have been cleared and their indication recorded on the stencil sheet, the stencil sheet is withdrawn from the machine by depressing bar P^{33} , thereby releasing the stencil sheet. The return of the stencil carriage is manually accomplished upon disengagement of gears P^{14} and P^{15} . The shaft P^6 , as shown in Fig. P^2 , has the head P^{108} whereby the shaft can be pulled to the left to disengage the gear P^{15} from the gear P^{14} . The shaft, however, has slotted connection with the rack gears so that these will not be disturbed upon longitudinal movement of the shaft, and therefore upon reverse rotation of the shaft P^6 , the stencil sheet carriage can be restored to normal position. Shaft P^6 also has locking notches P^{1091} and P^{109r} adapted for engagement by the spring actuated locking pin P^{110} , carried in the barrel P^{111} suitably supported from the main framework, the shaft being thus held against accidental displacement when in either its normal or reversing position.

After a stencil sheet has been punched in the manner described, it will form a record of and indicate all the readings cleared from the turret registers and register counters. To enable these indications in the form of perforations to be readily read or tabulated, a stencil reading machine is provided which, however, is the subject of the next chapter.

Stencil reading machine.—The construction of the stencil reading machine is shown in Fig. R^1 , taken together with Figs. P^1 to P^6 . The apparatus is the same with the exception of the punching mechanism which is here omitted, and in its place only a row of spring feelers and an actuating bar therefor being shown. The cross-section of the shelf P^{36} is revised into the form R^1 , as

shown in Fig. R¹. The shelf R² corresponds to the shelf P⁴⁸, having the openings R³, while the extension R⁴ corresponds to the extension P⁵⁴, and has a plurality of pockets R⁵, in which a plunger R⁶ may reciprocate, a spring R⁷ being in each pocket, tending to press the plunger down. There is also the bar R⁸ corresponding to the bar P⁴⁷, which has a shelf R⁹ through which are the guide openings R¹⁰, which register with the openings R³. On the top of the shelf R¹ in register with the openings R¹⁰, are the guide openings R¹¹. Through each set of openings R³, R¹⁰ and R¹¹, a rod R¹² passes, each rod passing through a pocket R⁵ and carrying the plunger R⁶ in said pocket. As will be shown later, the bar R⁸ is shown in its upper position to hold the shelf R⁹ against the lower face of the extension R⁴, and to hold all the feeler rods R¹² in their upper position with their ends within the openings R³. Below the shelf R¹ and supported between the side walls of the machine is a bar R¹³ of insulating material having a plurality of perforations R¹⁴ registering with the openings R³. Each perforation has a contact terminal R¹⁵ in its lower end for connection with circuits leading to the set-up magnets of the master machine. The cups formed in the bar R¹³ above the contact terminals R¹⁵ are filled with mercury so that when a feeler rod is carried downwardly into engagement with the mercury, connection will be established between the shelf R¹ as the common conductor and the corresponding contact terminals R¹⁵.

The circuit connections between this stencil reading machine and the apparatus controlled thereby will be shown in full detail in the circuit description. Referring to Figs. P¹ to P⁵ and Fig. R¹, a stencil sheet to be read is clamped to the carriage P¹⁸, and the "go" key actuated to connect winding C⁴⁵ in circuit, whereupon the driving mechanism is connected with the driving motor. The first line for perforation when the stencil sheet is inserted will be one space in front of the openings R³. When the driving mechanism starts, shaft P³ is first given one revolution to cause a half revolution of shaft P⁴, contacts R⁸² and R^{82'} being thereby carried into engagement with brush mechanism R⁸⁴ and R^{84'}. The carriage will not be moved during this half revolution of shaft P⁴. During the next part of the revolution of the main gear P⁸⁸, shaft P⁷ will be given a revolution, which results in the reciprocation of the eccentric rods P⁶³. When the bar R⁸ connected with the eccentric rods P⁶³ is moved to its lowermost position, all the plungers R⁶ and the feeler rods R¹² fall by force of the springs R⁷. The stencil sheet, however, not having been moved, the feeler rods will not encounter

any perforations, and therefore no circuits will be closed. The driving mechanism remains effective and during the next revolution of the gear P⁸⁸, shaft P³ will first be given another revolution, and then shaft P⁷ given another revolution. During this second revolution of shaft P³, shaft P⁴ was rotated the second half of its revolution, causing the contacts R⁸² and R^{82'} to be carried into engagement with brush mechanism R⁸⁸ and R^{88'}, the pinion P¹⁰ having also during this half revolution caused one-tenth revolution of shaft P⁵ and one-twentieth revolution of shaft P⁶. Upon this one-twentieth revolution of shaft P⁶, the carriage P¹⁸ is moved one step to carry the perforations in the first line of the stencil sheet in line with the openings R³ and brush mechanism P⁷⁷¹ and P^{77r} are carried into engagement with contacts P⁷⁶¹ and P^{76r}. The contacts P⁷⁶¹ or P^{76r} are connected for selecting the registers and we now have the circuit closed at this point for register No. 1, so that this register in the turret will be selected for receiving an entry. When shaft P⁷ is rotated during the last part of the revolution of gear P⁸⁸, bar R⁸ is again reciprocated and those feeler rods R¹² which are over the perforations in the stencil sheet arranged below the openings R³ will pass through the perforations and into the mercury cups, and the master machine electro-magnet circuits are finally closed and held closed until the entry is completed in the register by the master machine. The gearing is held at rest with feelers down while the master machine is operating and this is accomplished by having the slot P¹⁰⁴ in the disk P⁹³ adjacent to the center of the set of teeth or main gear P⁸⁸. The master machine set-up will, therefore, be in accordance with the stencil indication in line 1 in the left column of the stencil sheet. The master machine then operates to carry its set-up entry into register No. 1. After this entry in register No. 1, a circuit through winding C⁴⁴ is automatically closed by the master machine so that the clutch mechanism of the stencil reading machine will be thrown in immediately upon closure of said circuit, and thus the reading machine will operate automatically to set up all its stencil readings in the master machine and cause its proper actuation. During the next revolution of the gear P⁸⁸, shafts P³ and P⁷ will each be given a complete revolution, the revolution of shaft P³ results in a half revolution of the shaft P⁴, and contacts R⁸² and R^{82'} are carried around to brush mechanism R⁸⁴ and R^{84'}. However, the brush mechanism R^{77r} is already in engagement with the 2 contact, and, therefore, circuit through the register No. 2 is selected to receive the entry. Now, when the shaft P⁷ is revolved the bar R⁸ is reciprocated

and the feeler rods R^{12} over the perforations will pass through the perforations to close circuits and to effect a set-up in the master machine, which set-up is carried into register No. 2.

The operation of feeding and selective reading of the stencil by the stencil reading machine is identical with the corresponding operations in the stencil punching machine as before described. Thus the stencil sheet can be run through the reading machine and these stencil indications reproduced in figures and tabulated in the turret registers. The withdrawal of the stencil sheet after reading thereof is accomplished in the same manner as has been described with reference to the stencil punching machine.

Circuits.—The circuits connecting together the various mechanism of the system are shown in Figs. C^1 , C^2 and C^3 . Only those parts of the various machines are shown which are actually connected with or in some electrical circuit. The main conductors C^1 , C^2 , supply direct current for the various sub-circuits. The various circuits will be traced more or less in connection with the preceding description of the operation of the system. The operator first places a schedule in the schedule tray of the verification machine VM and presses the proper notching keys V^{88} , corresponding to the marginal marking or notchings upon the schedules. This set-up, as before stated, so far as the verification machine is concerned, is a mechanical set-up, punches being merely depressed so that when the terminal frames of the verification machine are raised, the edges of the schedule will be carried past the punch ends to be notched. The registers all being in a zero position, the keyboard operator strikes keys upon the selector keyboard KS to select a register in the turret for receiving the first item on the schedule, this register usually being No. 1. Upon such set-up on the selector keyboard, the following circuits are established: from the positive battery wire C^1 , through conductor C^3 , (through the contacts of key No. 1, in the units order), through conductor C^4 , through the file and rank windings of the primary geometric connector GC^1 , through conductor C^5 , through the zero keyboard contacts in the tens order, and through conductor C^6 to the negative battery wire C^2 . This circuit causes closure of the electro-magnetic unit-switch S^7 of the primary unit-switches and closure of this magnetic unit-switch closes the following circuit: from battery conductor C^2 , through conductor C^7 , common conductor C^8 , electro-magnetic unit-switch S^7 , through conductor C^9 , through the rank and file coils of the secondary geometric connector GC^2 , through conductor C^{10} , through the zero contacts in the hundreds order of the selector keyboard,

and through conductor C^3 to battery conductor C^1 . Energization of the rank and file coils in the secondary geometric connector causes closure of the No. 1 secondary electro-magnetic unit-switch S^7 . Associated with the secondary geometric connector is switch mechanism, shown more in detail in Fig. C^4 . An oil switch receptacle O^1 contains a plurality of switch mechanisms O^2 , each controlled by a circuit closed by the corresponding magnetic unit-switch of the secondary connector. Each switch mechanism has an armature section O^3 surrounded by a winding C^{11} . Extending across the receptacle O^1 is a terminal plate O^4 , having openings in which the insulated section O^5 of the switch members normally engages. The end O^6 of each switch mechanism is of conducting material, and has telescoped in its end a contact terminal O^7 , the contact terminals being all supported in the insulating plate O^8 , and each being connected with a conductor leading to the corresponding spark terminals V^{26} in the verification machine. The plate O^4 is connected with the positive terminal of a high pressure source of current through conductor C^{12} , and the ends O^6 of the switch members are normally disengaged therefrom, but when the switch member is raised, upon energization of its winding C^{11} , the end O^6 is brought into contact with the plate O^4 , and therefore the contact terminal O^7 is also connected with said plate. Carried at the upper end of the armature part O^3 is a contact member O^9 for connecting together contacts O^{10} and O^{11} upon energization of the winding C^{11} . The upper end O^{12} of each switch member is insulated, and upon energization of winding C^{11} is carried to connect together contacts O^{13} and O^{14} . The circuit for each winding C^{11} includes the corresponding geometric magnetic unit-switch and a source of current, so that upon closure of the unit-switch, the circuit is closed and the winding energized to raise the armature, and to thereby close three sets of contacts. Each of the contact terminals O^7 is connected with one of the terminal squares V^{26} in the verification machine, the connected conductors being all contained in the cable C^{13} . All of contacts O^{11} connect with the positive battery conductor C^1 , while each contact O^{10} connects through a conductor with the corresponding contact P^{76} in the stencil punching machine, the conductor being all contained in cable C^{14} . All of contacts O^{14} are connected with the positive conductor of the battery and each of contacts O^{13} connects with one terminal of the electro-magnet windings 30 in the register turret, the conductors being all contained in cable C^{15} . The other terminals of the register windings all connect with common conductor C^{16} with the negative battery conductor

C². Therefore, upon selection of No. 1 secondary magnetic unit-switch S⁷, circuit is closed through the corresponding winding C¹¹, which results in register No. 1 of the turret being selected for receiving an entry. Contact No. 1 in the stencil punching machine also is selected and terminal square No. 1 in the verification machine is selected.

Having selected the register for receiving an item from the schedule, the operator sets up the entry on the main board KA. Upon actuation of the keys indicative of the entry, the following circuit is set up: From battery conductor C¹, through common conductor or frame C¹⁷, through the selected keys, through wires in cable C¹⁸, through the corresponding master machine magnets 61¹, through common conductor C¹⁹, to battery wire C², the master machine therefore receiving the entry set-up. As shown in Fig. K¹ which illustrates the amount keyboard construction, actuation of the keys also engages high pressure contacts K^b and K^c, plate K^c being connected with the common conductor C²⁰ which connects with one terminal of the high pressure source, and each of the contacts K^c connecting with the corresponding contact terminal V⁴⁷ of the verification machine, the connecting conductors all passing through cable C²¹. The units key in the counting keyboard KC is struck so that the counter register associated with No. 1 tabulating register selected in the turret receives an entry. The actuations having been made in the various keyboard, the general operating key K¹¹⁵ is either automatically depressed upon closure of contact K¹²⁷, or manually depressed. The actuation of the general operating key and the contact K¹²⁷ and their connection in circuit are fully described in my copending application, Case No. 1, Serial No. 333,657, filed Sept. 7, 1906. The switch mechanism RS, having been moved to the position indicated to cause actuation of the registers, closure of the key K¹¹⁵ results in closure of the following circuit: From battery conductor C¹, through conductor C²², through general operating key contacts K¹¹⁹, K¹²⁰, through conductor C²³, through winding of relay C²⁴, through conductor C²⁵, through the switch RS to conductor C²⁶, through starting electro-magnet 81¹, and through conductor C¹⁹ to battery conductor C². Actuation of electro-magnet 81¹ results in connection of commutator 82¹ with brush 84¹, and the following circuit is therefore closed: Battery conductor C², through conductor C²⁷, through the winding of relay C²⁸, through conductor C²⁹, brush 84¹, commutator 82¹, through conductor C³⁰ to battery conductor C¹. Upon actuation of the general operating key K¹¹⁵ the relay C²⁴ connects in the transformer CT, which is connected with the verification machine and the verification sheet is there-

by electrically marked to indicate the set-up on the amount keyboard, which is being carried into register No. 1 of the turret. Upon actuation of relay C²⁸, the circuit for motor M is closed and the master machine driven. With the position of switch mechanism as shown, the motor will drive the master machine in a positive direction so that the entry set up in the master machine will be carried cumulatively into register No. 1. The set-up on the counter keyboard is also carried through the master machine and into the counter associated with register No. 1. No. 1 register having therefore received this entry, No. 2 is selected on the selector keyboard, and the keyboards set up in accordance with the schedule item to be entered. The verification sheet in field No. 2 will receive marks indicative of the entry. The selection of the registers can be carried out automatically by means of the automatic synchronous connector mechanism AS, described in my copending application referred to. By setting this automatic synchronous connector, the registers can be automatically selected for receiving entries. The erasing contact C³¹ carried by the shaft 72 comes into engagement with the brush C³² at the end of the revolution of said shaft and a circuit is momentarily closed as follows: from battery conductor C², through conductor C³³, through winding of the counter board erasing key KE, through winding of the amount keyboard erasing key KE, through winding of the selector keyboard erasing key KE, through conductor C³⁴, brush C³², commutator C³¹, shaft 72, and through conductor C³⁰ to battery conductor C¹. As explained in my copending application referred to, actuation of these erasing keys will cause release of the depressed keyboard keys, and erasure of the set-up on the keyboards. At the counting keyboard, however, the repeat key KR can be actuated to short-circuit the winding of the erasing key KE so that the set-up on the counter board will be retained upon actuation of the erasing contacts, and the operator is thereby not required in each instance to set up the counting keyboard. The operator need only pay attention to setting up the amount keyboard if the items are regular on the schedule, all other set-ups being carried out automatically. After one schedule has been entered on the registers, the operator actuates the "go" key KV of the verification machine to cause starting of the drive motor for said machine. This results in moving the verification record sheet past the cutting ends of the set up notching punches and the verification sheet is notched in accordance with the schedule notching or classification marking. After such notching the schedule, together with the section of the sheet which has received the verifying entries is automatically fed

from the verification machine, and a new schedule is then placed on the verification machine and its items carried into the tabulating registers, which cumulatively receives items to eventually show the totals of a set of schedules.

In the register turret there is also a universal or grand totalizing register 30^u which is serially included in the common conductor C¹, and which, therefore, cumulatively receives every entry in the turret.

When all the schedules of a group have been entered in the registers and verification sheets made thereof, a second operator inserts a blank stencil sheet in the stencil punching machine and moves the switch mechanism RS to the left so that the master machine will travel in the negative direction to decumulatively actuate the connected in registers in order that the registers may be cleared. Take the register No. 1 for example, the operator notes its indication and sets up the corresponding keys on the amount keyboard, and also notes the indication on the counter for No. 1 register and sets this up on the counter keyboard, also setting up register No. 1 on the selector keyboard. The starting switch PS associated with the stencil punching machine to connect the driving motor M in circuit is closed. When the amount keyboard is actuated, the energization of the electro-magnets in the stencil punching machine corresponds with the set-up on the amount board and the indication on the No. 1 register. The selected electro-magnets P³⁸ are connected potentially with battery conductor C¹, as follows: From said battery conductor, through common conductor C¹⁷, through the contacts of keys set up on the amount keyboard, through the conductors in cable C³⁵ and to electro-magnets P³⁸. In like manner electro-magnets P³⁸ indicative of the counter board set-up are potentially connected with positive battery conductor C¹. As has been already pointed out, contact P⁷⁶¹ is potentially connected with the positive battery conductor C¹ when register No. 1 is selected on the selector keyboard. Upon actuation of the "go" key, circuit is closed as follows through winding C⁴⁵: from battery conductor C¹, through conductor C²², through the general operating key contacts, through relay C²⁴, conductor C²⁵, starting winding C⁴⁵, and through conductor C³⁶ to the battery conductor C². As has been shown in the detailed description of the stencil punching machine, this results in actuation of the locking plate P⁹⁹ to unlock the clutch mechanism so that the motor may drive the punching machine. As explained, this driving of the machine results first in carrying of brush P⁷⁷¹ into engagement with contact No. 1. The connection of contact 1 with positive battery conductor C¹ has already

been traced, and when the brush engages this contact, the circuit will be completed to the negative battery conductor through relay C¹, through conductor C³⁷, brush P⁸³, contact P⁸², shaft P⁴, contact wheel P⁷⁹, brush P⁸⁰, conductor C³⁸, winding C⁴⁴, and through conductor C³⁶ to battery conductor C². Upon closure of this circuit, relay C¹ is energized and the circuit traced from the positive battery conductor to the selected electro-magnets P³⁸, is completed to the negative battery conductor through conductor C³⁹. Although energization of winding C⁴⁴ results in restoration of the locking member P⁹⁹ to the locking position, the clutch mechanism will not be locked until the full cycle has been completed, during which time the selected punches controlled by the connected in electro-magnets will be carried down and the stencil sheet punched with characters indicative of the amount set up on the amount and counter keyboards. After actuation of the amount keyboard upon closure of key K¹¹⁵, the master machine reversing switch RS having been shifted to its left-hand position, circuit is closed as follows through the reversing electro-magnet 81^b: from battery conductor C¹, through conductor C²², the general operating key contacts, through relay C²⁴, through conductor C²⁵, through switch RS to conductor C⁴⁰, through electro-magnet 81^b, and through conductor C¹⁹ to battery conductor C². As soon as commutator 82^b is brought into engagement with brush 84^b, circuit is also closed from battery conductor C², through conductor C²⁷, through relay winding C²⁸, conductor C²⁹, brush 84^b, commutator 82^b, and through conductor C³⁰ to battery conductor C¹. The switch RS having been moved to its reverse position, the motor is connected in for reverse operation, and the master machine subtracts from the connected register, and restores it to zero indication, provided the various set-ups have been properly made. In other words, the entry in register No. 1 is transferred to the stencil and the register cleared. Upon selection of the next register either manually or automatically by the automatic connector, the stencil punching machine carriage is first moved to carry one of the brushes into engagement with the contact corresponding to the selected register. If it is an odd numbered register, brush P⁷⁷¹ determines the operation of the punching machine, and if it is an even numbered register brush P⁷⁷⁵ determines the operation and in the latter case relay C¹ is included in circuit instead of relay C¹, and the punching record made in the right column of the stencil punching machine. As has been shown in the detailed description of the stencil punching machine, the position of the contact P⁸² with reference to brushes P⁸³ and P⁸⁴ determines which

of the relays O^1 or C^r is to be connected in circuit. If the contact is engaged by brush P^{83} , relay C^1 is effective, and if the contact engages brush P^{84} , relay C^r controls. In this way the registers are successively cleared and their entry transferred to the proper place on the stencil. If set-ups are properly made for each register, it will be restored to zero and if after such clearing operation universal register 30^u indicates zero, it will show that the clearing operations have been accurately performed.

The stencil punching machine carriage also carries brushes P^{79l} and P^{79r} over contacts P^{78l} and P^{78r} respectively. These contacts are connected with the notching punches in the verification machine through conductors contained in the cables C^{41} . Contact springs V^{98} of the verification machine switches are all connected through common conductor C^{42} with the positive battery conductor C^1 , and brushes P^{79l} and P^{79r} connected through conductor C^{43} with the negative battery conductor C^2 so that when either brush P^{79l} or P^{79r} connects with one of its contacts, and the corresponding verification machine punch has been set up, the corresponding notching controlling electro-magnet of the punching machine included in circuit will be actuated and the record paper notched in accordance with the punch set up on the verification machine.

The stencil punching machine is ordinarily disconnected and inoperative during the forward actuation of the turret registers, but is connected for operation when the registers are cleared. The verification machine may be connected in for service to produce a record of the punching of the stencil. There may also be cases where there is but one schedule to a group, and in this case the stencil punching machine may be connected in place of the turret registers. In this case the operator causes disconnection of the master machine and set-up is made on the punching machine magnets so that entry is made directly on the stencil record instead of having this record made during the clearing operation of the registers. The verification machine during this operation may or may not be connected in for service.

Fig. C⁵ shows a circuit layout for the stencil reading machine. The punched stencil sheets are fed to this machine which as previously described has contact feelers for connecting through the perforations in the stencil, the machine automatically setting up on the master machine electro-magnets the entries thus automatically selected and also selecting the corresponding register to receive the entry. The readings of the stencil machine are therefore transformed into actual readings on registers. The left half of frame R^1 supporting the feeler rods connects through conductor C^{50} with brush

mechanism $R^{83'}$, this brush being here shown in engagement with commutator $R^{81'}$, which is connected with commutator R^{81} engaged by brush mechanism R^{83} , this brush mechanism being connected through conductor C^{51} with the brush R^{77l} . The right half of frame R^1 connects through conductor C^{52} with brush $R^{84'}$ which is shown disconnected from commutator $R^{81'}$. Upon rotation of the commutators this brush becomes engaged with contact $R^{82'}$, and commutator R^{81} comes into engagement with brush R^{84} , which brushes connect with brush R^{77r} through conductor C^{53} . The individual contacts R^{15} connect with corresponding electro-magnets 61^1 of the master machine through conductors contained in cable C^{54} . The various contacts R^{70l} and R^{70r} connect with corresponding turret register windings 30 through conductors contained in cable C^{55} . The electro-magnet R^{103} controlling the locking member R^{99} has the two windings C^{44} and C^{45} . After a stencil sheet is inserted in the reading machine, the switch PS is thrown to the left to connect the motor with the supply circuit, and the "go" key GK^r is depressed to close the following circuit: from battery conductor C^2 , through conductor C^{56} , winding C^{45} , the switch PS, conductor C^{57} , and through the "go" key GK^r to conductor C^1 . Immediately upon energization of winding C^{45} , the core of electro-magnet R^{103} is thrown to the right to disconnect said core from contact $C^{58}-C^{59}$ to open a circuit which would otherwise be closed through the forward starting electro-magnet $R^{81'}$. The motor M immediately starts to move the traveling carriage of the machine to carry brushes R^{77l} and R^{77r} over contacts R^{70l} and R^{70r} , and the stencil record sheet travels between the feeler terminals. As soon as a line is reached which has perforations, the feeler rods close a circuit. If these perforations occur, for example, in line 1 in the left column of the sheet, the circuit will be closed as follows: from battery conductor C^2 , through conductor C^{56} , winding C^{44} , conductor C^{60} , through the universal electro-magnet 30^u , through winding of electro-magnet No. 1, through cable C^{58} to contact R^{70l} , to brush R^{77l} , conductor C^{51} , brush R^{83} , commutators R^{81} and $R^{81'}$, brush $R^{83'}$, conductor C^{50} , the left half of frame R^1 , through the depressed feeler rods, through the individual conductors running through cable C^{54} , through the master machine electro-magnets corresponding to the contacting feeler rods, and through common conductors C^{61} to battery conductor C^1 . The master machine is therefore set up and register No. 1 selected to receive the entry. Upon current flow through the winding C^{44} , the core of electro-magnet R^{103} is thrown to the left to lock the clutch mechanism between the motor and the reading machine

and to engage contacts C^{58} — C^{59} , to close the following circuit through electro-magnet R^{81f} : from battery conductor C^1 , through the switch RV, through conductor C^{62} , electro-magnet R^{81f} , conductor C^{63} , and through contacts C^{58} — C^{59} to battery conductor C^2 . Commutator R^{82f} is therefore rotated into engagement with brush R^{84f} to close the following circuit: from battery conductor C^1 , through conductor C^{64} , commutator R^{82f} , brush R^{84f} , conductor C^{65} , winding of relay C^{28} , through conductor C^{66} to battery conductor C^2 . The master machine motor M is therefore connected in to drive the master machine in the direction indicated by the arrow, and the entry set up on the master machine electro-magnets is carried into register No. 1. Also driven by the master machine is the commutator C^{31} which has engagement with brush C^{32} just before the master machine completes a revolution, and the circuit will be closed as follows: from battery conductor C^2 , conductor C^{56} , winding C^{45} , switch PS, conductor C^{57} , conductor C^{67} , contact C^{68} , conductor C^{69} , brush C^{32} , commutator C^{31} , conductor C^{64} to battery conductor C^1 . The "go" key GK^r after its first actuation to momentarily close circuit through winding C^{45} , immediately reopens its circuit, but the winding C^{45} is again energized through the circuit last traced during the last part of each operation of the master machine, and this winding being stronger than winding C^{44} , the magnet R^{103} will again unlock the clutch mechanism between the motor M and the reading machine, and contacts C^{58} — C^{59} will again be disconnected to open circuit through starting electro-magnet R^{81f} . After the master machine makes one revolution, the brushes engage the insulated segments and the machine stops upon deenergization of relay C^{28} . The reading machine therefore operates to connect in the master machine and the master machine in turn operates to connect in the reading machine. Upon unlocking of the clutch mechanism, energization of winding C^{45} again connects the motor M with the reading machine, whose carriage again advances until the feeler contacts reach the next line having perforations. Suppose that these perforations are those in the right column along line 1. As was shown in the detailed description of the reading machine, the brush R^{77r} is already on contact No. 2 and the carriage will, therefore, not be advanced, but during the second cycle of operation, when the contact supporting frames are reciprocated, the feeler rods will pass through the perforations already in line under the said rods, and circuit will immediately be closed through the master machine electro-magnets and through the winding of register No. 2, brush R^{77r} and contact 2, however, being included instead

of the brush R^{77i} and contact No. 1 in the circuit previously traced. As will be understood from the detailed description of the reading machine in a previous chapter, brushes R^{83} and $R^{83'}$ control the circuit for the odd numbered contacts and the brushes R^{84} and $R^{84'}$ control the circuits for the even numbered contacts, contacts R^{82} and $R^{82'}$ being automatically connected with these brushes at proper times by the driving shafts of the reading machine. The circuit through the master machine electro-magnets and the winding 30 of register No. 2 also includes the circuit closed through winding C^{44} by conductor C^{56} . This winding again controls to cause locking of the clutch mechanism and reclosure of contact C^{58} — C^{59} , to again throw in the starting magnet R^{81f} , whereupon the master machine is started and its set-up from the stencil is carried into register No. 2. Thus a stencil may be run through the reading machine and the records in the stencil carried successively into the turret registers, the operation being entirely automatic, the reading machine after its selective work is completed automatically setting the master machine in operation, and the master machine after its entry work is completed automatically setting the reading machine in operation.

If the registers in the turret had the same indications as were on a stencil sheet, the registers could be cleared by inserting the stencil sheet in the reading machine and shifting the switch RV to the left to its reverse position. The operation would then be the same except that the reverse starting electro-magnet R^{81b} would be connected in circuit upon closure of contact C^{58} — C^{59} , so that the selected registers would be driven in reverse direction in correspondence with the entry set up in the master machine as determined by the stencil, and thus all the registers automatically cleared.

The forward shifting motion of the stencil reading machine is limited by the contact C^{68} , which upon being opened by the final motion of the stencil carriage prevents the master machine again starting the stencil reading machine.

Fig. D¹ is a plan view of a blank verification sheet. Each blank is divided into fields or squares, X, each representative of a register. The side notches N are also shown and by means of dotted semicircles other possible classification marginal notches.

Fig. D² shows a corner of a blank after having been passed through the verification machine. Here each square or field is shown divided into four order rows of ten digits each, and on the first six squares the dots Y represent the marks produced by the current or sparks, and these marks appearing in the various sub-squares are representations of the number entered in the associ-

ated register. It is preferable to have marks made in the zero squares in all orders in which there is no characteristic digit, thus marks will always appear in one square of each order. This will be a check on the operativeness of the marking apparatus as each order must always appear marked. In square No. 1 the dots represent the number 80, while in square No. 2 the dots represent the number 5, and so on, the position of the dots providing an easy method of reading the entry which has been made in the registers.

In Fig. D³ is shown the corner of a blank after having passed through the stencil punching machine. Here we have perforations Z formed by punches instead of marks formed electrically. As shown here, and as has been described in the chapter on the stencil punching machine, the sheet is divided into left and right columns, the left column receiving entries from the odd numbered registers, and the right hand column receiving entries from the even numbered registers. Each line is divided into ten sub-divisions, representing the orders zero to nine, and each order sub-division is again divided from zero to nine. As has been shown in the description of the turret register, the last few orders could be reserved for counting orders for each particular register, and on the sheet as shown in Fig. D³ sub-columns in each main column could be reserved as counter columns. Take, for example, line 1 which represents register No. 1. Reading three divisions from left to right, the perforations represent the number 12, which indicates the number of entries in register No. 1. In the other seven sub-divisions, the perforations represent the number 963, which is the entry from register No. 1. In line 5, representing register No. 5, the number of entries as indicated by the perforations is four, and the entry taken from such register is 120. This same perforated stencil is passed through the stencil reading machine, and the feeler contact rods will pass through the perforations and close contact indicative of the number represented by the perforations.

Automatic transverse mechanism and associated circuits.—In the system as described in the preceding pages, there are steps included which are not automatically accomplished. In the clearing operation, when the register readings are to be transferred to the stencil punching machine, it is necessary to physically read the registers. The way this would usually be accomplished would be for one operator to read off the register indications to another operator, who sets up the amounts on the keyboards, there being therefore two steps depending upon human agency for accuracy. However, automatic means are provided which may be

called a reading or transferring attachment, which attachment is applied to the turret and driven about the turret into successive association with the rows of registers. During such movement, contact mechanism is controlled in accordance with the register indications of the engaged register, and selector mechanism is also operated to select the particular register which is to be cleared, and also to select the position on the stencil sheet which is to receive the amount cleared from the register. The apparatus which carries out this automatic transfer feature is first described, and then the circuits necessary for including the mechanism in the main system. The apparatus is illustrated in Figs. A¹ to A⁶.

Referring particularly to Figs. A¹ and A², it will be seen that additional shafts A¹⁰ have been provided, each associated with one of the shafts on which are mounted the number disks 15^w, the carry-over disks 15^k and the gears 15^a. The number disks are omitted when the automatic transfer mechanism is applied, and each gear 15^a caused to mesh with a gear A¹¹, which gears A¹¹ are pivoted on the respective shafts A¹⁰. With each gear A¹¹ is associated a cam cylinder A¹², having ten cam projections A¹³ which run spirally about the cam cylinder, so that each lies in a different plane and each is separated from the adjacent ones by a polar angle of 36 degrees. These cam cylinders extend into openings A¹⁴ through an inclosing shell A¹⁵, so that the cam projections will extend beyond the outer surface of the shell when in a radial line with reference to the center of the turret. The turret, as planned, is divided into fifty divisions, forty-nine of which are occupied by registers, the remaining one being the rest position for the transferer.

Surrounding the base of each tier is an annular gear plate A¹⁶, having teeth A¹⁷. The gear plate rests on the flange A¹⁸ and bears against the shoulder A¹⁹. Meshing with the teeth A¹⁷, is a driving pinion A²⁰ mounted on a shaft A²¹, which extends vertically in a position in front of the rest position of the transferer. Upon rotation of shaft A²¹, the gears A²⁰ will rotate the gear plates A¹⁶ about the tier bases. Carried by each gear plate is the frame A²² of the transferer unit. The method of securing the units in place is shown in Fig. A², each unit extending between the gear plate A¹⁶ of the tier with which the unit is associated, and between the gear plate of the tier next above. As shown, the lower part of each unit has a flange A²³ secured to the adjacent gear plate A¹⁶ by means of screws A²⁴. The units are disposed in a vertical row, one for each tier, and the upper end of each unit has a frame extension A²⁵ which receives the lower end of the screws A²⁴ which secures the unit

above to the corresponding gear plate, each unit being thus securely and rigidly supported. Each unit is semi-cylindrical in form, comprising an outer shell A²⁶ and an inner semi-cylindrical shell A²⁷, whose ends A²⁸ extend radially to be secured to the ends of the outer shell A²⁶, there being the semi-circular passageway A²⁹ formed between the shells. Extending through the entire row of units and through the center thereof is the shaft A³⁰, which pivots a plurality of contact levers A³¹, one for each cam extension on the cam cylinders. Each contact lever pivots at an intermediate point to the shaft A³⁰, its ends forming a contact arm A³² and a cam arm A³³. At the end of each contact arm is a contact jaw A³⁴ for connecting together contact members A³⁵ and A³⁶, which contact members are supported from the inner wall A²⁷ with their contact arms extending radially inward. These contact pairs are arranged in three rows, *a*, *b*, and *c*, as shown. Secured to the inside of the shell A²⁷, there are also three rows, *d*, *e*, and *f*, of locking blades A³⁷, the row *d* being adjacent the row *a* of contacts, and the rows *e* and *f* being similarly placed with reference to the rows *b* and *c* of contacts.

The contact levers are divided into sets of three each, and the contact arms of the three levers of each set are displaced angularly by an angle equal to the angular displacement of the contact rows or the locking blade rows. As will be shown, the levers are adapted to assume two positions: In one position, the contact jaws connect together the contact members A³⁵ and A³⁶, and in the other position, the contact jaws engage the locking blades. When the locking jaws of all the levers are in engagement with their respective locking blades, the cam ends A³³ of all the levers will be in a plane which is radial with reference to the turret center. The cam ends in this position extend into the path of the cam extensions, which lie in a radial plane, so that when the units are carried past a row of registers, and projecting cam ends of the cam cylinders will strike the cam extensions of the corresponding levers, and will rotate said levers to carry their jaws into position to connect the associated contacts A³⁵ and A³⁶. As shown in Fig. A², the row of selector units has been moved from its normal position into an operative position adjacent the first row of registers, the row of cam ends having passed through the plane of the protruding cam extensions. As shown, the cam extension corresponding to zero indication of the register protrudes, and has rotated the top lever shown, the jaw end of which lever has been carried to connect together the associated contact members A³⁵ and A³⁶.

The mechanism for moving the row of transferrer units from one row of registers

to the other is shown in Figs. A⁴, A⁵ and A⁶. This mechanism is all mounted in a box A³⁸, placed at the top of the turret, so that it may drive the shaft A²¹ which controls the rotation of the gear plates A¹⁶ and movement of the transferrer units from one register row to the other. The upper end of shaft A²¹ bears in the bottom and top walls A³⁹ and A⁴⁰, and carries the intermittent pinion A⁴¹. This pinion coöperates with the intermittent gear A⁴², pivoted on shaft A⁴³, which also bears in the walls A³⁹ and A⁴⁰. This gear A⁴² has the teeth A⁴⁴, equal in number to the teeth of the pinion A⁴¹, so that the shaft A²¹ will be rotated once for each complete revolution of the gear A⁴². Also pivoted on said shaft A⁴³ is a worm wheel A⁴⁵, a bushing connecting said worm wheel with the gear A⁴². Pivoted to the end wall A⁴³ and in bearings is a shaft A⁴⁶, carrying the worm A⁵⁰ which meshes with the worm wheel A⁴⁵, the driving operation of which will be explained later. Secured to the shaft A⁴³ is also an intermittent gear A⁵¹, which coöperates with the intermittent gear A⁵² pivoted on shaft A⁵³, which also bears in the walls A³⁹ and A⁴⁰. Mounted concentrically with the shaft A⁴³, but held stationary with reference to the framework A³⁸ is a commutator disk A⁵⁴, divided into three sections, A^{54a}, A^{54b} and A^{54c}, separated from each other by insulation, as shown in Fig. A⁶. Carried by the worm gear A⁴⁶ are three brushes, A^{55a}, A^{55b} and A^{55c}, engaging respectively with the commutator sections A^{54a}—*a*—*b*—*c*. The inner section A^{54a} is continuous. The outer section A^{54b} is divided into commutating segments, A^{56a}—*a*—*b*—*c*—*d*—*e*—*f*, insulated from each other by insulating sections A⁵⁷. These commutator segments extend only part way about the outer ring A^{54b}, the remainder of the section A^{56x} being insulated from the commutator segments by the insulating sections A^{57a} and A^{57x}. The middle commutator ring A^{54a} is divided into two sections, A⁵⁸ and A⁵⁹, best shown in Fig. A⁶, separated by the insulating segments A^{58a} and A^{59x}, the segment A^{58a} being in a radial line with the segment A^{57a}, and the segment A^{58x} being in a radial line with the insulating section A^{57x}. When the mechanism is in its initial position, the brushes A^{55a} and A^{55b} will rest on sections A⁵⁸ and A^{56a} respectively, and brush A^{55c} engages the continuous contact section A^{54a}. Each of the six commutator segments A^{56a} *a* to *f* controls the common circuit for the contact mechanism of one of the transferrer units of which there are six, one for each tier. As will appear more clearly in the description of the circuits, the mechanism in the position shown has been moved to carry the brushes A^{55a}—*a*—*b*—*c* into engagement with the sections A⁵⁸, A^{56a} and A^{54c}, respectively, which means that the top

transferrer unit has its common terminals connected with the current supply circuit.

Secured so as to rotate with the intermittent gear A^{52} is a carrying gear A^{60} , and disposed concentrically with said gears but secured to the frame A^{38} , is the commutator frame A^{61} , carrying ten segments A^{62} , 0 to 9, equally spaced and insulated from each other, these segments being successively connected with the brush A^{63} , carried by the carrying gear A^{60} , the brush bearing initially on the zero segment, as will be shown more clearly later. The segments A^{62} , 0 to 9, control the same circuits as the units order contacts of the selector keyboard K^s .

Parallel with the shaft A^{53} is a shaft A^{64} , which mounts an intermittent gear A^{65} and a carrying gear A^{66} , which gears are connected together, the intermittent gear co-operating with the carrying gear A^{60} . Disposed concentrically with the shaft A^{64} but secured to the framework A^{38} is a commutator A^{67} , having an outer continuous ring A^{68} and an inner circle of contact segments A^{69} , 0 to 9, insulated from each other. The gears A^{65} , A^{66} carry two brushes A^{70} , A^{71} insulated therefrom, for engaging respectively with the segments A^{69} , 0 to 9, and the continuous contact segment A^{68} , as best shown in Fig. A^5 . The segments A^{69} , 0 to 9, are adapted for controlling the same circuits as the individual contacts in the tens order of the selector keyboard K^s . Parallel with shaft A^{64} is the shaft A^{72} , which pivots the intermittent gear A^{73} meshing with the carrying gear A^{66} . Concentric with this shaft A^{72} , but secured to the frame A^{38} , is a commutator A^{74} having the segments A^{75} , 0 to 9, adapted to be engaged by the brush A^{76} , carried by the gear A^{73} . The segments A^{75} are adapted for controlling the same circuits as the individual contacts in the hundreds order of selector keyboard K^s .

The shaft A^{49} mounting the worm A^{50} and connected with the transferrer motor TM is connected with starting mechanism similar to that shown in Fig. M^5 . Referring to Fig. A^5 , the shaft A^{49} carries a pinion A^{77} which meshes with a gear A^{78} carried on the starting shaft A^{79} pivoted in the support A^{80} and intermediate wall A^{81} . At the end of the shaft A^{79} is a starting commutator A^{82} whose insulating segment A^{83} co-operates with a brush A^{84} . The armature A^{85} of the starting magnet A^{86} co-operates with the pin A^{87} , energization of the electro-magnet causing the armature to engage the pin to advance the commutator to connect the metallic part thereof with the brush A^{84} , thereby controlling the motor circuit. Also carried on the shaft A^{79} is a commutator disk A^{88} having one contact segment A^{89} shown in Fig. C^A , a brush A^{90} co-operating with said commutator disk and being normally disconnected therefrom but brought into

connection therewith just before the shaft A^{79} completes a revolution in the direction indicated by the arrow. The gearing relation between the pinion A^{77} and gear A^{78} is 3 to 1 and the gearing relation between the worm wheel A^{45} and the worm A^{50} is 1 to 33. Therefore, one revolution of the commutator disk shaft A^{79} results in 1/11th revolution of the worm wheel A^{45} .

The operation and circuit arrangement can now be understood. Referring to Fig. A^5 and to the circuit diagram, Fig. C^A , the positions of the various parts there indicated are those assumed after the row of transferrer units is in position before the first row of registers. When the transferrer units are in their rest position, the corresponding position of the gear A^{51} will be such that the tooth 5 will be in the position now occupied by the zero tooth in Fig. A^5 , and the brushes A^{55} $a-b-c$ will be vertically above the center of said gear in engagement respectively with the commutator sections A^{58} , A^{56t} and A^{54c} . The brushes A^{63} , A^{70} and A^{76} of the units, tens and hundreds commutators respectively will be in engagement with the nine commutator segments.

Referring to Fig. C^A , the six contacts a to f are connected through conductors C^{17a} to C^{17f} with the common contacts A^{35} of the transferrer units a to f respectively. The inner commutator section A^{54c} connects through conductor C^{17} with the positive battery wire C^1 . The contacts A^{35} correspond to the common contacts of the amount keyboard KA and the counter keyboard KC . The other contacts A^{36} of the transferrer units connect with individual conductors which pass through the cable C^{35} (Figs. C^1 and C^2) to connect with one terminal of set-up magnets in the master machine and one terminal of the punch set-up magnets in the stencil punching machine. The other terminals of the master machine electro-magnets, as shown in Fig. C^2 , connect through conductor C^{10} with the negative battery wire C^2 , and therefore when any of the contacts A^{36} are connected with their common contacts A^{35} , circuit will be closed through the corresponding master machine set-up magnets. As has been shown in the main circuit system, the common terminals of the stencil punching machine magnets are adapted for connection with the negative battery wire and upon closure of the transferrer unit contacts, the corresponding punch controlling magnets are connected in circuit. As has been already stated, the commutator segments of the units, tens and hundreds commutators correspond to the individual contacts of the keyboard K^s and these contacts therefore connect similarly with the winding of the geometric connectors. The brushes A^{63} and A^{76} of the units

and hundredths commutators correspond to the common contact or conductor C^3 of the selector keyboard, which conductor connects with the positive battery wire C^1 . The brushes A^{70} and A^{71} of the tens commutator corresponds to common conductor C^6 of the selector keyboard connecting with the negative battery wire C^2 .

The transferrer motor TM has its direction of rotation controlled by the switch AS and its circuit is controlled partly by the motor relay C^{84} and the switch relay S. The switch members C^{70} , C^{71} , are pivoted to an armature rod C^{72} surrounded by two windings C^{81r} and C^{81l} , which windings, when energized, tend to move the armature in the direction indicated by the arrows. On the armature rod is a contact member C^{73} which, in the position shown, connects together contacts C^{74} and C^{75} , but when the armature rod is moved to the left, the contact member connects together contacts C^{76} and C^{77} .

The 9 segment A^{75} of the hundredths commutator is connected with the battery wire C^2 through the following circuit; conductor C^{78} , winding of switch relay C^{79} , forward winding C^{81r} and conductors C^{80} . Therefore, when the transferrer units are in their rest position, the circuit just traced will be completed to the battery wire C^1 through the brush A^{70} and conductor C^3 , the brushes of the order commutators, as has been explained, being on the 9 segments during the rest position of the transferrer. During this rest position the switch relay C^{79} and the forward winding C^{81r} would be energized and the switch relay acting in the direction of the arrow will open the switch S, while the forward winding C^{81r} will move the armature rod C^{72} to close contacts C^{74} , C^{75} .

To start the operation of the automatic transferrer, the operator first touches the "go" key AK and closes circuit from battery wire C^1 , to conductor C^{83} , the starting magnet A^{86} , conductor C^{82} to the battery wire C^2 . As has been explained, energization of this starting magnet will advance the commutator A^{82} sufficiently to connect electrically with its brush A^{84} so that circuit will be closed as follows through the motor starting relay C^{84} : battery wire C^2 , conductor C^{82} , winding C^{95} of relay C^{84} , conductor C^{85} , brush A^{84} , commutator A^{82} , conductor C^{86} and conductor C^{87} to battery wire C^1 . The motor relay C^{84} is therefore actuated to close the motor relay contact C^{87} , C^{88} . The motor circuit, however, is still open at switch S and the operator therefore manually closes this switch against the pull of its electro-magnet. The motor circuit is then closed and may be traced as follows: from a suitable source through the motor field through the switch blade C^{70} , the armature of motor TM, the

switch blade C^{71} , conductor C^{89} , through contacts C^{88} , C^{87} , and through conductor C^{90} , through the switch S, back to the source. The motor now operates and continues the rotation of shaft A^{49} , carrying the worm A^{50} . During the first 1/11th revolution of the gear wheel A^{51} , the tooth 5 is moved to directly rotate the units gear A^{52} forwardly. At the hundredths commutator disconnection of its brush from the 9 segment A^{75} , takes place, causing opening of the circuit previously traced, and including the winding of the switch relay C^{79} . Upon such deenergization of the switch relay, the operator is no longer required to hold the switch closed against the force of the winding C^{79} and the motor circuit then remains closed at this point. When the brush of the units order engages the zero segment, the zero position of the primary geometric selector is brought into action and the zero position of the secondary geometric selector also is brought into operation, which results in the selection of the zero register in the turret, and also in the selection of the zero contact in the stencil punching machine. These selecting circuits have all been traced in connection with the main system circuits in Figs. C^1 to C^5 , it being remembered that instead of the individual contacts of the selector keyboard, we have the commutator segments, and in place of the common contacts of this keyboard, we have the commutator brushes. The zero register just selected is in the first row in the turret, but during the next 5/11ths revolution of the gear wheel A^{51} , the teeth A^{44} of the gear A^{42} will engage with the pinion A^{21} to cause a complete revolution thereof, which results in movement of the transferrer units row from the rest position to its first position in front of the first row of registers. During this 5/11ths revolution of the gear wheel A^{51} , the brushes A^{55a} and A^{55b} were carried into engagement with the segments A^{50a} and A^{50b} respectively and a circuit is closed as follows: From the battery wire C^1 , through conductor C^{17} , brush A^{55a} , commutator segment A^{50} , conductor C^{91} , winding C^{92} of relay C^{93} , conductor C^{94} , winding C^{95} of relay C^{84} , and conductor C^{82} to battery wire C^2 . This circuit may be called the sustaining circuit for the motor relay C^{84} to prevent deenergization of this relay after the first revolution of the starting commutator A^{82} when this commutator disconnects during each revolution from its brush. During the same time, relay C^{93} holds open the master machine starting circuit, thereby preventing its actuation. The first 6/11ths revolution of the gear A^{51} will then be continuous and during this part revolution the zero register in the first row has been selected, the zero line has been selected in the stencil

punching machine for receiving the register entry and the transferrer units have been carried into position adjacent the first row of registers. At the end of the sixth 1/11th revolution the zero tooth of the gear A⁵¹ will just come into engagement with the units order gear wheel A⁵², but the brushes A^{55a} and A^{55b} will have been carried into engagement respectively with the commutator segments A⁵⁸ and A^{56a}. As soon as the brush A^{55a} leaves commutator segments A⁵⁸, the sustaining circuit already traced will be broken but the motor relay will not become deenergized until the starting commutator A⁸² has completed its full revolution, and then when the brush A⁸⁴ comes into engagement with the insulating segment A⁸³, all circuits through the motor relay will be opened and the motor stopped. Just before the shaft A⁷⁰ completes its last revolution, the segment A⁸⁹ of commutator A⁸⁸ makes contact with its brush A⁹⁰, and the following circuit is closed: from battery wire C¹, conductor C¹⁷, conductor C⁸⁶, commutator A⁸⁸, segment A⁸⁹, brush A⁹⁰, conductor C⁹⁶, contacts C⁹⁷, C⁹⁸, conductor C⁹⁹, contacts C⁷⁵, C⁷³, C⁷⁴, conductor C²⁵, switch RS, conductor C⁴⁰, reverse starting electro-magnet 81^r for the master machine, conductor C⁶, to battery wire C². As the registers may be cleared by the master machine, the switch RS has been previously moved to the reverse position and the reverse starting magnet 81^r being energized by the circuit just traced the master machine will travel in reverse direction to clear the zero register, the reading of the zero register having been set up in the master machine upon passage of the brush A^{55b} into engagement with the contact A^{56a}. If the stencil punching machine is also to be operated, the switch PS will have been closed and current will also flow from conductor C²⁵, through the starting winding C⁴⁵ in parallel with the master machine starting electro-magnet 81^r and the stencil punching machine is set in operation and when its brush connects with the zero contact, the punch magnets already selected will be actuated. During the first 6/11ths revolution of the gear A⁵¹, the shaft A⁷⁰ makes six revolutions, and therefore, unless provision is made to prevent it, the master machine and stencil punching machine starting circuits would be closed six times. To prevent this, the winding C⁹² in the sustaining circuit controls a relay C⁹³ opening contacts C⁹⁷, C⁹⁸, during this period, then by opening the master machine or stencil machine starting circuits. However, during the sixth 1/11th revolution, the sustaining circuit is opened and the starting circuits can then be closed when the commutator segment A⁸⁹ engages the brush A⁹⁰. The sequence thus far is, therefore, first the selection of the zero

register, second, the movement of the transferrer units by the first row of registers, and third, the operation of the master machine and stencil punching machine to clear the selected register and to punch the register 70 indication in the stencil.

Just before the master machine comes to rest, contact segment C³¹ engages the brush C³², the brush C³² being connected with conductor C⁸³ and the segment C³¹ being connected with conductor C³⁰; therefore, just before the master machine comes to rest, it will energize the circuit through the starting magnet A⁸⁰ and the motor TM will be automatically started, the switch S remaining closed as the switch relay circuit is opened. The shaft A⁷⁹ makes a complete revolution during which the gear A⁵¹ makes its seventh 1/11th revolution, so that the zero tooth of said gear causes a second 1/10th rotation of the gear A⁵², which carries its brush A⁶³ to the 1 contact and register No. 1 is selected for clearance and therefore the 1 line in the stencil machine will be selected for receiving the cleared 90 sum. The sustaining circuit still being open, the transferrer motor starting circuit is again opened at the end of the revolution of shaft A⁷⁹ by commutator A⁸². The master machine and stencil machine starting circuits are, however, again closed at the end of the revolution of shaft A⁷⁹, the master machine set up, the selected register 1 cleared, and its indication transferred to line 1 in the stencil record. During the 8th, 9th, 10th 100 and 11th 1/11th revolutions of the gear wheel A⁵¹, the units gear wheel A⁵² will be advanced to successively select registers 2, 3, 4, and 5, and after the selection of each register, the master machine and stencil machine are actuated, the commutator operating mechanism automatically controlling the operation of the master and stencil machines, and the mechanism operating these machines automatically controlling the operation of the commutator mechanism. A full 110 revolution of the gear wheel A⁵¹ having now been completed, the gear A⁵¹ is in its initial position with its tooth 5 ready to again engage with the units gear A⁵². When the 5 115 register is cleared by the master machine, the commutator starting mechanism is automatically connected in and the gear A⁵¹ will now be given the first 1/11th part of its second revolution, and the brushes A^{55a} and A^{55b} will again be carried into engagement with segments A⁵⁸ and insulated segment A^{56x} to again close the sustaining circuit for the motor relay. Also during this first 1/11th rotation, the units gear wheel A⁵² 125 will have been rotated 1/10th revolution to carry its brush to the 6th segment, and register No. 6 will have been selected, this register being in the second row of registers in the turret. During the next 5/11ths revo- 130

lution the shaft A^{21} will be rotated and the reader units carried to the second position by the second row of registers. During this 5/11ths revolution the sustaining circuit is closed and the top transferrer unit a connected in circuit. The sustaining circuit having again been opened, the master machine and stencil machine starting circuits can be closed when the commutator segment A^{89} reaches the brush A^{90} and register No. 6 will be cleared and its reading transferred to the stencil record. In the same manner the registers 7, 8, 9, etc. are successively selected. When passing from the register 9 to 10, the units order wheel A^{52} passes through the carrying position and the tens commutator will have its 1 contact connected with brush A^{70} and register 10 will be selected. As has been shown before, the registers may be grouped in 49 vertical rows about the turret, each row having six registers. The brush A^{55b} keeps step with the brushes of the order commutators so that the transferrer units a to f are successively connected in circuit in step with the selection of the registers opposite which the units are disposed.

After the 49th row of registers in the turret there is a blank space in front of which the transferrer units take their rest position. In place of registers in this blank space, we have a setting bar A^{91} , which extends vertically along the entire length of the turret and which projects into the path of the cam extensions of the contact levers of the transferrer units. The particular function of this setting bar will appear a little later. After the 293rd register or last register in row 49 is cleared, the No. 5 tooth of gear A^{51} is in position before the units order gear A^{52} . This gear continues to rotate and gear A^{52} is rotated to carry its brush A^{63} into engagement with the 4th contact so that the set-up on the commutators is 294. There being no registers in the last blank or dummy row, there will be no selection. During the next 5/11ths revolution of the gear A^{51} , shaft A^{21} is given another complete rotation to move the transferrer units into the initial or rest position in front of the blank space. The gear A^{51} continues to rotate to the end of its revolution to carry teeth zero to 4 into engagement with the units order gear A^{52} and the set-up on the commutators will then be 299. The gear A^{51} then commences the next revolution, and its tooth 5 rotates the units order gear A^{52} one revolution to bring the commutator set-up to 300.

When the hundredths brush connects the 3 segment, the following circuit is closed: Battery wire C^1 , conductor C^3 , brush A^{70} , the 3 segment, conductor C^{100} , reverse winding C^{81r} , conductor C^{80} , to the battery wire C^2 . Armature rod C^{72} will therefore be thrown

to the left to open the master machine and stencil punching machine starting circuits and to close contacts C^{76} , C^{77} , connecting respectively with conductors C^{80} and C^{90} , and therefore, the motor relay contacts C^{87} , C^{88} , will be short-circuited. The switch AS will also be thrown to the reverse position and the motor immediately starts to rotate in reverse direction. The motor circuit being cut loose entirely from its automatic starting circuits will operate continuously to restore the transferrer units to their initial position. Although brushes A^{84} and A^{90} engage their commutators A^{82} and A^{88} respectively, during each revolution of shaft A^{70} , the motor circuit will not be affected on account of the short-circuit about the motor relay contacts, and the master machine and stencil punching machine will not be affected as their starting circuits were opened when the armature rod C^{72} was moved to the left. As soon, however, as the brush of the 100 order comes back to its initial position on the 9 segment, the circuit through the winding C^{79} will be closed again and the switch S will be opened and the motor stopped. As the forward winding C^{81r} is also included in this switch relay circuit, the armature rod C^{72} will be moved to the right to bring the circuits in proper condition for subsequent forward movement of the transferrer units.

After the passage of the transferrer units into position by a row of registers, some of the reader contact levers will have been swung into contact position, depending upon the indication of the engaged registers, and before the transferrer can take readings from the next row of registers, the contact levers must be restored to the normal position with their cam ends extending radially. This resetting of the cam levers to their unoperated position is controlled by the cam ridges A^{92} which extend radially in a circle around the turret from each register so as to engage the cam lever A^{97} . The contact levers have each an arcular slot A^{93} in their hubs engaged by the key A^{94} on the shaft A^{30} . At the top of said shaft A^{30} is secured a segmental gear A^{95} which meshes with a segmental gear A^{96} mounted on the top of the transferrer unit, this segmental gear A^{96} having a cam lever A^{97} . When the cam ends of the contact levers are in their unoperated position, the key A^{94} will be at the left end of the slots A^{93} and when contact levers are rotated into their operated position by the cam extensions of the register numeral wheels, the key A^{94} will be at the right end of their slots. However, when the transferrer units pass to the next row after having read the preceding row of registers, the cam extensions A^{97} on the segmental gear A^{96} will come into engagement with the next cam ridge A^{92} immediately to

the right, and the segmental gear A^{90} will be rotated in a counter-clockwise direction to cause the clockwise rotation of the gear A^{90} and shaft A^{30} through an angle sufficient to cause the key A^{90} to carry the rotated contact levers back to their normal or unoperated position, so that when the registers of the next row are reached, the levers will all be in a radial position so that they can take the reading of the engaged registers. When the contact levers are again rotated during the reading operation they will carry with them the shaft A^{30} to rotate the gear A^{90} and to restore the gear A^{90} to its initial central position, whereby the cam extension A^{97} is brought into position to be engaged by the next cam ridge A^{92} , so that the contact levers can be restored to the unoperated position previous to reading engagement with the next row of registers, and so on. As has been described before, the transferrer units finally reach a position before the blank space to be then started on their return trip upon reversal of the motor. It is necessary, however, before the return trip begins that the contact lever cam ends should be rotated so as to be out of the path of the projecting cam extensions of the register numeral wheels. Otherwise these contact levers would be rotated in a reverse direction, which would result in binding and breakage. This rotation of the contact levers is accomplished by the resetting bar A^{91} , which bar is engaged by the cam extension of all of the contact levers after the shaft A^{21} has been given its last revolution during the forward rotation of the motor. After the motor is then reversed, the transferrer units would travel back to their initial position without engaging with the cam extensions on the register mechanisms. Upon arriving at the initial position, the rotated cam extensions of the contact levers engage the other side of the resetting bar A^{91} and the cam ends are restored to their unoperated position to be ready for reading engagement with the first row of registers when the motor is again started in the forward direction. A lever A^{98} also extends from the gear A^{90} which enables the contact levers to be rotated manually if desired, and this lever also serves somewhat as an indicating means during the automatic setting and resetting operations.

When the contact levers are all rotated to their contact position upon engagement of their cam ends with the resetting bar A^{91} when the transferrer units have reached their last position in the forward direction, all the setting-up circuits will be closed and all the master machine electromagnets will be connected, which will, of, course, practically amount to a short-circuit of the battery. To prevent this an overload circuit breaker, having an armature C^{101} , and a

winding C^{102} , is connected in conductor C^{19} . If current of an extraordinary amount passes through the winding C^{101} , the contacts C^{103} , C^{104} , are opened and are held open by the small amount of current passing through the resistance shunt C^{105} around these contacts. The conductor C^{106} leads from contact C^{103} to contact C^{107} , C^{108} , C^{109} , which are controlled by the armature rod C^{72} of the switch AS, and are closed only when the transferrer is being operated in its forward movement. These contacts connect with the battery wire C^2 by means of the conductor C^{110} , thereby completing the connection of conductor C^{10} with this side of the battery.

In order to bring the automatic transferrer into operation to automatically transfer the register readings to the stencil record, or into other registers, or to clear the registers of the turret jointly or separately, the operator need only to close the proper switches and depress the "go" key, and then close the switch S for an instant, and all the turret registers, which may be of any number, will be automatically selected in succession and mechanically read and the transferrer units then automatically restored to their initial position after the last register has been read. It will thus be seen that the transferrer units take the place of the amount and counter keyboards and that the commutator selecting devices take the place of the selector keyboard. In practice these automatic transferring and selecting devices could all be associated so that they could be switched into the circuit system by throwing a few switches.

In the description relating to the transferrer a zero register has been considered, while in the description of the system without the transferrer practically no consideration has been given to such a register. The circuits can readily be adjusted in both cases to include or exclude a zero register. The transferrer circuits as here shown in Fig. CA, when associated with the circuits of the system shown in Figs. C¹ C², C³, require the connection of the contact P^{70r} of the stencil punching machine with the zero unit switch in the secondary geometric connector GC² together with the preferable exclusion of the zero register in so far as the transferrer is concerned. However, when these automatic devices are connected in, the manual keyboards should preferably be disconnected. Also when the manual keyboards are connected into the circuit, the automatic devices should preferably be disconnected.

The various mechanisms of the system as described in the various chapters show how a schedule with the various statistical items thereon is copied item by item into the turret registers and the operation checked by the record made and shown on the verification

sheet in the verification machine. The descriptions show also that indications on the registers are automatically transferred to a stencil formed by perforations, which perforation characters can be readily re-transferred to registers for further tabulation. A great number of schedules can in a very short time be thus classified, entered and totaled, all the operations beyond the initial entries being entirely automatically performed and thoroughly checked so that accuracy is assured. The various main parts illustrated and described can, of course, be modified and changed without departing from the scope of my invention.

I desire to secure the following claims by Letters Patent:

1. In combination, a stencil punching machine, a machine for marking a verification sheet, and a common keyboard for controlling the operation of said machines.

2. In combination, a bank of registers, means for involving said registers with entries, means for decumulating said registers, a stencil punching machine, a machine for marking a verification sheet, a keyboard for controlling the register decumulating means, and means whereby the said keyboard controls the operation of said stencil punching machine and said machine for marking the verification sheet.

3. In combination, a bank of registers, means for involving said registers with entries, means for decumulating said registers, a stencil punching machine, a keyboard for controlling the register decumulating means, and means whereby the said keyboard controls the operation of said stencil punching machine.

4. In combination, a bank of registers, means for controlling the actuation of said registers, a stencil punching machine, and means for automatically controlling the actuation of the stencil punching machine in accordance with the decumulation of the registers.

5. In combination, a plurality of registers, a counter associated with each register, a master machine for involving any connected register with an entry, a keyboard for controlling the connection of any selected register with said master machine, a keyboard for controlling the amount of the actuation by the master machine, means for controlling the direction of actuation of the master machine, a stencil punching machine, and means for automatically controlling the actuation of the stencil punching machine in accordance with the actuation of the register connecting means and of the master machine when actuated in a direction adapted to decumulate the connected registers.

6. In combination, a plurality of registers, a common master machine adapted to involve any connected register with an entry,

automatic means for selectively connecting the registers in predetermined order with the master machine, a stencil punching machine, automatic means adapted to advance the stencil in said machine in accordance with the actuation of the automatic selecting and connecting means, a keyboard for controlling the master machine, a plurality of punches in the stencil punching machine, and means for automatically controlling the actuation of the stencil punches in accordance with the operation of said keyboard.

7. In combination, a master machine, a plurality of circular tiers of registers mounted upon the master machine, common driving disks around which the registers are located, means for connecting said disks with the master machine, and electromagnetic mechanism associated with each register, each adapted potentially to connect the associated register with associated driving disks, and a master column for actively connecting the selected registers with the driving means.

8. In combination, a frame for holding a verification sheet, edge notching punches for notching the verification sheet, an operative stencil punching machine containing notching punches, and automatic means for controlling the actuation of the notching punches of the stencil punching machine in accordance with the actuation of the notching punches of the verification machine.

9. In combination, a stencil punching machine having a frame adapted to receive a blank stencil sheet, a gang of punches for punching said sheet in accordance with statistical data, edge notching punches for punching said sheet in accordance with classification data, and a verification machine having a frame for receiving a verification sheet, a series of edge notching punches in the verification machine, manually operable means for setting said edge notching punches, means for actuating the mechanism of the verification machine to notch the verification sheet in accordance with the manual set-up of the edge notching punches, and means for controlling the edge notching punches of the stencil punching machine in accordance with the set-up of the edge notching punches of the verification machine.

10. In combination, a stencil punching machine having a frame adapted to receive a blank stencil sheet, a gang of punches for punching said sheet in accordance with statistical data, edge notching punches for punching said sheet in accordance with classification data, and a verification machine having a frame for receiving a verification sheet, a series of edge notching punches in the verification machine, manually operable means for setting said edge notching punches, and means for controlling the edge notching punches of the stencil punching

machine in accordance with the set-up of the edge notching punches of the verification machine.

11. The combination of a plurality of registers, driving means for actuating said registers to receive entries, electrical marking apparatus for marking a record sheet with characters indicative of the entries placed in the registers, and a common controlling means for said driving means and said electrical marking means.

12. The combination of registers for receiving entries, means for operating the registers to receive entries, electrical spark marking mechanism for marking record paper, and means for automatically causing sparks to mark the record paper with characters indicative of the entries made in the registers.

13. The combination of a plurality of registers, setting-up means for setting up entries to be made in said registers, means controlled by said setting-up means for actuating the registers to receive the set-up entries, spark contacts, and circuits for said spark contacts, said spark contacts and circuits being controlled by the set-up means to cause a record sheet associated with said spark contacts to be marked with characters indicative of the entries made in the registers.

14. The combination of a register, means for making entries in said register mechanism adapted to be moved bodily into engagement with said register to be operated in accordance with the indication of said register, and means controlled by said mechanism for indicating the entries in said register.

15. In combination, a register indicating an entry, mechanism adapted to be brought into association with said register to be operated thereby, recording apparatus, circuit connections between said mechanism and said recording apparatus whereby the operation of said mechanism causes the recording apparatus to be set up in accordance with the register indication, and means for operating the recording apparatus to record the register indication on a record-sheet.

16. The combination of a register adapted to receive an entry, electric switch mechanism normally disconnected from the register but adapted to be moved into temporary engagement therewith to be operated in accordance with the entry in said register, and recording apparatus electrically controlled by said switch mechanism to mark a record-sheet with characters corresponding to the register indication.

17. The combination of registers, means for making entries in said registers, an automatic reading device, means for moving the same into engagement with the registers, and record mechanism controlled by said reading device to indicate the entries of the

registers with which the automatic reading device is associated.

18. The combination of registers containing entries, a reading device adapted to be successively moved into mechanical engagement with said registers, and a record controlled by the reading device to indicate the entry in each register when said reading device is brought into association with said register.

19. The combination of registers for receiving entries, a common transfer mechanism for automatically transferring the indications of the register one after the other to a record sheet.

20. In combination, a bank of registers, means for involving said registers with entries, decumulating means for said registers, automatic transfer mechanism for controlling the operation of the decumulating means, and recording means also controlled by said automatic transfer mechanism, said automatic transfer mechanism being adapted to be associated with said registers to be automatically operated thereby in accordance with the entry in the registers, operation of the decumulating means causing said register to be cleared and the entries transferred to the record machine.

21. In combination, a bank of registers, means for involving said registers with entries, means for decumulating said registers, mechanism for controlling said decumulating means and adapted to be moved into engagement with the registers, whereby said decumulating means will be controlled in accordance with the register indications, a recording machine, and means whereby said mechanism controls the recording machine in accordance with the register indications.

22. In combination, a plurality of registers having entries, a record, and means for automatically clearing said registers one after the other and for transferring their indications to said record.

23. In combination, a plurality of registers, means for involving said registers with entries, a record marking machine, and automatic transfer mechanism adapted to be successively associated with said registers to be actuated in accordance with the indication thereon, said recording machine being controlled by said transfer mechanism and caused to mark a record sheet in accordance with the indications on the registers with which the transfer mechanism is associated.

24. In combination, a bank of registers, means for involving said register with entries, a record machine, electrically controlled marking members for said record machine for marking a record sheet, an automatic transfer mechanism, and a plurality of contact members for said transfer mechanism connected in circuit with said electrical marking members of the

record machine, said transferrer mechanism being adapted to be successively associated with the registers to have its contact members actuated in accordance with the register indication whereby said circuits are controlled to cause operation of the electrical marking members of the record machine to mark the record sheet in accordance with the indications on the registers associated with said transferrer mechanism.

25. In combination, a bank of registers, means for involving said registers with entries, a record machine, marking members for marking a record sheet in said record machine, electro-magnets controlling the operation of said marking members, circuits for said electro-magnets, an automatic transferrer mechanism having controlling mechanism for said circuits, and means whereby said automatic transferrer may be moved into successive engagement with the registers to have its circuit controlling mechanism actuated in accordance with the indication on the engaged register, whereby electro-magnets are energized to actuate the marking members which will cause marking of the record sheet with characters indicative of the register indication.

26. In combination, a bank of registers, means for involving said registers with entries, a recording machine, marking members for marking a record sheet in said recording machine, electro-magnets controlling the operation of said marking members, circuits for said electro-magnets, an automatic transferrer mechanism having controlling mechanism for said circuits, means whereby said automatic transferrer may be moved into successive engagement with the registers to have its circuit controlling mechanism actuated in accordance with the indication on the engaged register whereby electro-magnets are energized to actuate the marking members which will cause marking of the record sheet with characters indicative of the register indication, and means controlled by said automatic transferrer mechanism for decumulating the registers engaged by said transferrer mechanism.

27. In combination, a register indicating an entry, decumulating means for said register, and a controlling device for said decumulating means, said device being adapted to be moved into engagement with said register to be operated in accordance with the indication on said register, to control said decumulating means to clear said register.

28. In combination, a register, means for automatically marking a record-sheet in accordance with the actuation of said register, and mechanism including a keyboard for controlling the simultaneous operation of said register and said recording means in accordance with the set-up on said keyboard.

29. In combination, a plurality of registers, means for selectively actuating any register to receive an entry, electromagnetically operated means for automatically marking a record-sheet simultaneously and in accordance with the actuation of the involved register, and mechanism for controlling the simultaneous operation of said register and said recording means.

30. In combination, a register, means for actuating the same in either direction, means for automatically recording the registration of said register during accumulation, and means for automatically recording the registration of said register during decumulation.

31. In combination, a plurality of registers, means for selectively actuating any register in either direction, means for automatically recording the registration of the involved register during accumulation, and means for automatically recording the registration of said register during decumulation.

32. In combination, a register, means for automatically marking a record-sheet in accordance with the actuations of said register, keyboard mechanism, and suitable circuit connections whereby said keyboard mechanism controls the simultaneous operation of said register and said recording means.

33. In combination, a plurality of registers having entries, and mechanism for automatically bringing the registers into clearing relation and successively clearing the same.

34. In combination, a plurality of registers having entries, mechanism for automatically bringing the registers into clearing relation and successively clearing the same, and means for automatically recording the indications of said registers during decumulation.

35. In combination, a plurality of registers for receiving entries, means for clearing said registers, means for automatically marking a record sheet of the indications of any register as it is cleared, and means for automatically transferring the markings of such record sheet into the proper register.

36. In combination, a plurality of registers having entries, mechanism for automatically and successively clearing said registers, and a stencil-punching machine automatically operated as said registers are cleared to make a record of the indications of said registers.

37. In combination, a plurality of registers having entries, means for successively clearing said registers, automatic means for recording the indications of each register as it is cleared, and a common keyboard for controlling the simultaneous operation of said register-clearing means and said recording means.

38. In combination, a plurality of registers adapted to be actuated in either direction, a verification machine, mechanism for controlling the operation of said machine simultaneously with the accumulation of said registers, whereby a record is marked in accordance with such accumulation, a stencil-punching machine, and mechanism for controlling the operation thereof simultaneously with the clearing of said registers whereby a record is marked in accordance with the indications of said registers.

39. In combination, a plurality of registers having entries, mechanism for automatically and successively clearing said registers, and a stencil-punching machine for automatically recording the indication of each register as it is cleared, said machine being controlled by said clearing mechanism.

40. In combination, a plurality of registers for receiving entries, a stencil-punching machine for automatically recording the entries of said registers on a record on the stencil sheet, and means for automatically reproducing the stencil sheet in figures in the proper registers.

41. In combination, a plurality of registers, actuating means therefor, a stencil-punching machine for automatically recording the indications of said registers, automatic mechanism for selectively connecting any register with said actuating means and for adjusting the position of the stencil in said machine to correspond with the register selected for decumulation.

42. In combination, a plurality of registers having entries, means for clearing said registers, and a stencil-punching machine automatically operated during the clearing of the registers to prepare a stencil in accordance with the indications of said registers.

43. In combination, a plurality of registers having entries, mechanism for automatically and successively clearing said registers, and a stencil-punching machine controlled by said clearing mechanism to prepare a stencil in accordance with the indications of said registers.

44. The combination of summing entry receiving devices, and common transfer mechanism for automatically bringing the devices successively into transferring relation and transferring the entries to other entry receiving devices.

45. In combination, a plurality of registers arranged in circular tiers, a master-machine for involving any connected register with an entry, means for selecting any register for connection with said master-machine, a vertically movable shaft extending centrally through said circular tiers, and means whereby the movement of said shaft controls the connection between the master-machine and the selected register.

46. In combination, a turret of registers comprising a plurality of circular tiers arranged one above the other, common actuating mechanism for said registers positioned within the bottom of said turret, and a plurality of circularly disposed shafts running vertically through said turret to establish operative mechanical connection between said mechanism and any desired register.

47. In combination, a plurality of registers arranged in the form of a turret, a master machine for selecting and determining the amount of actuation of any desired register, and common connections between said registers and said master machine for actuating the selected register.

48. The combination of a register provided with a plurality of suitably-ordered numeral-wheels, differential carry-over mechanism connected with said numeral-wheels to permit actuation of the numeral-wheels independently of as well as through the carry-over mechanism, means for directly actuating each numeral-wheel independently of the other numeral-wheels, said actuating means being normally disconnected from the numeral wheels, and a plurality of simultaneously adjustable connecting members interposed between said actuating means and said numeral-wheels for establishing operative connection between said actuating means and said numeral-wheels.

49. The combination of a register provided with a plurality of suitably ordered numeral-wheels, differential carry-over mechanism connected with said numeral-wheels to permit actuation of the same independently of as well as through the carry-over mechanism, a gear-wheel for directly actuating each numeral-wheel independently of the other numeral-wheels, said gears being normally disconnected from the associated numeral-wheels, and a plurality of simultaneously adjustable idler pinions interposed between said actuating gears and said numeral-wheels for establishing operative connection between said actuating gears and said numeral-wheels.

50. The combination of a plurality of driving gears, a vertical shaft about which said gears are adapted to rotate, a plurality of registers arranged in a circle around said gears and provided with numeral-wheels so arranged that each of said driving gears is adapted to actuate one order of numeral-wheels, and means for actuating said driving gears independently of each other a predetermined amount.

51. The combination of a plurality of registers provided each with numeral-wheels of different orders, common driving mechanism associated with each order of numeral-wheels, means for controlling the actuation of the driving mechanisms to involve any desired register with a predetermined en-

try, and means for selecting any register for actuation by said driving mechanisms.

52. The combination of a plurality of registers arranged in tiers, said registers being
5 each provided with numeral-wheels of different orders, common driving mechanism for each order of numeral-wheels, the driving mechanisms being normally disconnected from the registers, means for concurrently
10 actuating the corresponding mechanisms in the different tiers a predetermined amount, and means for connecting any desired register with said driving mechanisms.

53. The combination of a plurality of registers arranged in tiers, said registers being
15 provided with numeral-wheels, common driving mechanism for each order of numeral-wheels, the driving mechanisms being normally disconnected from the registers, means for concurrently actuating the corresponding mechanisms in the different tiers
20 a predetermined amount, electromagnetic means for selecting any desired register for actuation, and means for connecting the selected register with said driving mechanisms.

54. The combination of a plurality of registers arranged in tiers, said registers being
25 provided with numeral-wheels, common driving mechanism for each order of numeral-wheels, the driving mechanisms being normally disconnected from the registers, means for concurrently actuating the corresponding mechanisms in the different tiers
30 a predetermined amount, electromagnetic means for selecting any desired register for actuation, a keyboard for controlling said selecting means, a master-machine for actuating said driving mechanisms, means operated by said master-machine for connecting
35 the selected register with said driving mechanisms, a second keyboard, connections between said master-machine and said second keyboard for controlling the operation of the master-machine in accordance with the
40 set-up on said second keyboard, and connections between said master-machine and said driving mechanisms for transmitting the actuation of the master-machine to said driving mechanisms whereby the amount set-up
45 on said second keyboard is entered into the connected register.

55. In combination, a plurality of registers each provided with numeral-wheels of different orders adapted to be directly actuated, common actuating mechanism for each
55 order of numeral-wheels, means for selecting any desired register for actuation by said mechanism, and means for actuating each mechanism a predetermined amount.

56. The combination of a plurality of series of numeral-wheels, the numeral-wheels of each series being suitably ordered, and common driving mechanism for each order
60 of numeral-wheels.

57. The combination of a plurality of reg-

isters each provided with numeral-wheels of different orders, a common driving disk associated with each order of numeral-wheels for actuating the numeral-wheels of that
70 order a predetermined amount, and means for connecting any register for actuation by said disks.

58. In an accounting system, the combination of a plurality of registers provided with numeral-wheels, a master-machine for
75 actuating any connected register, a plurality of driving shafts leading from said master-machine, there being a driving shaft for each order of numeral-wheels, means for controlling the rotation of each shaft, and gearing
80 between said numeral-wheels and said shafts for actuating any of the numeral-wheels of the different orders.

59. In an accounting system, the combination of a plurality of registers provided with
85 numeral-wheels, a master-machine for actuating any connected register, a plurality of driving shafts leading from said master-machine, there being a driving shaft for each order of numeral-wheels, a keyboard, a series of electromagnets for controlling the
90 rotation of each shaft, connections whereby the set-up on said keyboard causes the electromagnets to control the operation of the driving shaft in accordance with said set-up, and
95 gearing between said shafts and said registers for actuating the connected register or registers to enter therein the amount set up on said keyboard.

60. In a mechanism of the class described,
100 the combination of a plurality of registers provided with numeral-wheels, a plurality of shafts, one for each order of numeral-wheels, and connections between each shaft and the numeral-wheels of the associated
105 order for actuating any desired numeral-wheel of that order.

61. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality
110 of shafts, one for each order of numeral-wheels, a series of ten electromagnets associated with each shaft, actuating mechanism for each shaft, a keyboard, connections between said electromagnets and correspond-
115 ingly ordered keys upon said keyboard, whereby the actuation of any key causes the corresponding electromagnet to be energized, means controlled by each electromagnet for determining the extent of actuation of the
120 associated shaft, and connections between each of said shafts and the numeral-wheels of the associated order for actuating any desired numeral-wheel of that order an amount determined by the correspondingly ordered
125 key which was actuated.

62. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality
130 of shafts, one for each order of numeral-

wheels, connections between each shaft and the numeral-wheels of the associated order for actuating any desired numeral-wheel of that order, a keyboard provided with suitably ordered keys adapted to be actuated to set up any desired amount, and connections between said shafts and said keyboard whereby the actuation of each shaft is determined by the correspondingly ordered key which was actuated.

63. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality of shafts, one for each order of numeral-wheels, means for actuating said shafts, a keyboard, electromagnetic means associated with each shaft and controlled by said keyboard for controlling the actuation of said shafts in accordance with the set-up on said keyboard, and connections between said shafts and said registers for actuating any selected register to receive the amount set up on the keyboard.

64. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality of shafts, one for each order of numeral-wheels, connections between each shaft and the numeral-wheels of the associated order for actuating any desired numeral-wheel of that order, mechanism for actuating said shafts alternately in reverse directions, and means for connecting in the selected register during the proper phase in the cycle of the shaft movements to cause actuation of the register either in a positive or in a negative direction.

65. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality of shafts, one for each order of numeral-wheels, connections between each shaft and the numeral-wheels of the associated order for actuating any desired numeral-wheel of that order, mechanism for actuating said shafts alternately in reverse directions, means for connecting in the selected register during the proper phase in the cycle of the shaft movements to cause actuation of the register either in a positive or in a negative direction, and key-controlled means for controlling the effective connection of the registers with said shafts to actuate the registers forwardly or backwardly as desired.

66. In a mechanism of the class described, the combination of a plurality of registers provided with numeral-wheels, a plurality of shafts, one for each order of numeral-wheels, a driving member for each shaft, a source of power for actuating said driving members, controlling mechanism for governing the operation of each driving member to cause a predetermined amount of actuation of the associated shaft, a common connecting member operated by said source of

power to connect any desired register for actuation, and connections between each of said shafts and the numeral-wheels of the associated order for actuating the connected register.

67. In combination, a plurality of registers having numeral-wheels, a main power-shaft, a plurality of driving arms connected therewith, a controlling member adapted to be actuated by each driving arm, key-controlled means for predetermining the extent of movement of each controlling member independently of the other controlling members, a shaft associated with each controlling member to be actuated an amount corresponding to the movement of the controlling member, and connections between said registers and said shafts whereby each shaft is adapted to actuate the numeral-wheels of one order.

68. In an electric sparking device, the combination with a body of insulating material, of a plurality of sparking terminals embedded therein, the insulating material at the end of each terminal being cut away to leave an air-cup.

69. In a record-making machine, the combination of a pair of frames, a body of insulating material carried by each frame, said insulating bodies being separated by an air gap for receiving a record-sheet, and a plurality of cooperating sparking terminals embedded in said insulating bodies and adapted to mark the record-sheet, the insulating material at the end of each terminal being cut away to leave an air gap.

70. In a record-making device, the combination of two bodies of insulating material adapted to hold a record-sheet between them and provided with a plurality of spark pockets, and an electric conductor terminating in each spark pocket.

71. In a record-making machine, the combination of a pair of frames, a body of insulating material carried by each frame, said insulating bodies being separated by an air gap for receiving a record-sheet, a plurality of cooperating sparking terminals embedded in said insulating bodies and adapted to mark the record-sheet, the insulating material at the end of each terminal being cut away to leave an air gap, and means for automatically separating said frames after the completion of a record to release the record-sheet.

72. In a record-making machine, the combination of a pair of frames, a plurality of cooperating sparking terminals carried by said frames and properly insulated from each other, said frames being arranged to receive a record-sheet therebetween for marking by the sparks passing between said terminals, punching devices associated with said frames for cutting notches in the edges of the record-sheet, and means for moving

said frames after the completion of a record toward said punching devices to make the desired notching in the record-sheet.

73. In a record-making machine, the combination of a pair of frames, a plurality of cooperating sparking terminals carried by said frames and properly insulated from each other, said frames being arranged to receive a record-sheet therebetween for marking by the sparks passing between said terminals, mechanism for separating said frames to release the marked record-sheet, means for automatically withdrawing the marked section of the record-sheet after such release and bringing a new section between the terminals, said mechanism being adapted to bring the frames together after such withdrawal for holding the new section in operative position, and a cutting device for automatically cutting off the withdrawn section.

74. In a record-making machine, the combination of a pair of frames, a plurality of cooperating sparking terminals carried by said frames and properly insulated from each other, said frames being arranged to receive a record-sheet therebetween for marking by the sparks passing between said terminals, punching devices associated with said frame for cutting notches in the edges of the record-sheet, mechanism for moving said frames after the completion of a record toward said punching devices to make the desired notching in the record-sheet, said mechanism being adapted to separate said frames after each punching operation to release the record-sheet, and means for automatically withdrawing the marked section of the record-sheet after such release and bringing a new section between the terminals, said mechanism being further adapted to bring the frames together after such withdrawal for holding the new section in operative position.

75. In a record-making machine, the combination of a pair of frames, a plurality of cooperating sparking terminals carried by said frames and properly insulated from each other, said frames being arranged to receive a record-sheet therebetween for marking by the sparks passing between said terminals, a driving shaft, and automatic mechanism operated by said shaft for separating said frames to release the marked record-sheet, for withdrawing the marked section of the record-sheet and bringing a new section between the terminals, and for bringing the frames together again after such withdrawal to hold the new section in operative position.

76. In a record-making machine, the combination of a pair of frames, a plurality of cooperating sparking terminals carried by said frames and properly insulated from

each other, said frames being arranged to receive a record-sheet therebetween for marking by the sparks passing between said terminals, punching devices associated with said frames for cutting notches in the edges of the record-sheet, a driving shaft, and automatic mechanism operated by said shaft for separating the frames to release the marked record-sheet after the punching operation, for withdrawing the marked section of the record-sheet and bringing a new section between the terminals, and for bringing the frames together again after such withdrawal to hold the new section in operative position.

77. The combination of a plurality of sparking terminals adapted to mark a record-sheet between the same, circuit-connections for said terminals, a register, means for making any desired entry in said register, and means for automatically controlling said circuit-connections to cause marking of the record-sheet with characters indicative of the entry in the register.

78. The combination of a plurality of sparking terminals adapted to mark a record-sheet between the same, circuit-connections for said terminals, a register, a keyboard, connections between said register and said keyboard for entering into the register the amount set up on the keyboard, and means whereby the keyboard automatically controls said circuit-connections to cause marking of the record-sheet with characters indicative of the set-up on the keyboard.

79. The combination of a plurality of sparking terminals adapted to mark a record-sheet between the same, circuit-connections for said terminals, a plurality of registers, a master-machine for involving any connected register with an entry, means for selecting any desired register for actuation by said master-machine, a keyboard for controlling the operation of said master-machine in accordance with the set-up on said keyboard, and means whereby said keyboard automatically controls said circuit-connections to cause marking of the record-sheet with characters indicative of the set-up on the keyboard.

80. The combination of a plurality of suitably-ordered sparking terminals adapted to mark a record-sheet, circuit-connections for said terminals, a register adapted to receive an entry, and means for controlling said circuit-connections in accordance with the entry made in said register, whereby the marking of the record-sheet is indicative of the entry in the register.

81. The combination of a plurality of suitably-ordered sparking terminals adapted to mark a record-sheet, circuit connections for said terminals, and a keyboard for controlling said circuit-connections in accordance

with the set-up thereon, whereby the marking on the record-sheet is indicative of the set-up on the keyboard.

82. In a verification machine, the combination of means for holding a schedule, means for marking a record-sheet in accordance with said schedule, and automatic means for simultaneously withdrawing the schedule and the marked record-sheet from the machine.

83. In a record-making machine, the combination of a plurality of cooperating sparking terminals arranged in suitably-ordered groups for marking a record-sheet by the sparks passing between the terminals, said groups constituting spark fields, circuit-connections for said terminals, a plurality of registers, actuating mechanism therefor, means for selecting any desired register for actuation, means whereby the selection of the desired register automatically selects the appropriate spark field for connection in circuit, a keyboard for controlling the operation of said mechanism to enter into the selected register the amount set up on said keyboard, and circuit-controlling means for causing the set-up on said keyboard to close the circuit through such terminals in the selected spark field as correspond to the number set up on the keyboard.

84. In a record-making machine, the combination of a plurality of cooperating sparking terminals arranged in suitably-ordered groups for marking a record-sheet by the sparks passing between the terminals, said groups constituting spark fields, circuit-connections for said terminals, a plurality of registers, means for making an entry in any desired register, and circuit-controlling means for closing the circuit through such terminals in the appropriate spark field as correspond to the entry made in the register, whereby the record sheet will indicate the number entered in the register.

85. In a record-making machine, the combination of a plurality of cooperating sparking terminals arranged in suitably-ordered groups for marking a record-sheet by the sparks passing between the terminals, said groups constituting spark fields, circuit connections for said terminals, and circuit-controlling means for closing the circuit through certain terminals in a predetermined spark field, whereby the record-sheet is marked to indicate a predetermined number.

86. In a record-making machine, the combination of a plurality of cooperating sparking terminals adapted to mark a record-sheet placed between the same, and mechanism for controlling the circuit-connections of said sparking terminals to make a predetermined record.

87. In a record-making machine, a plu-

65 rality of cooperating sparking terminals arranged in suitably-ordered groups for marking a record-sheet by the sparks passing between the terminals, said groups constituting rectangular spark fields with the terminals therein arranged in rows and columns. 70

88. In a record-making machine, the combination of a plurality of cooperating sparking terminals arranged in suitably-ordered groups for marking a record-sheet by the sparks passing between the terminals, a common conductor for one set of terminals in each group, and a separate conductor for each of the opposite terminals. 75

89. In an electric sparking device, the combination of two hollow frames, a body of insulating material partly filling each frame, the unfilled space in each frame constituting a chamber adapted to contain insulating oil, and a plurality of sparking terminals carried by said insulating material, said terminals projecting through the insulation at one end to form spark points and at their other end extending into said oil chambers for connection with suitable conductors. 80 85 90

90. In an electric sparking device, the combination of a hollow frame, a body of insulating material partially filling said frame, the unfilled space constituting a chamber adapted to contain insulating oil, and a plurality of sparking terminals embedded in said insulating material, said terminals projecting through the insulation at one end to form spark points and the other end extending into said oil chamber for connection with suitable conductors. 95 100

91. In an electric sparking device, the combination of a hollow frame, a body of insulating material partially filling said frame and having cut-out portions in its exposed surfaces, the unfilled space constituting a chamber adapted to contain insulating oil, and a plurality of sparking terminals embedded in said insulating material, said terminals projecting at one end through cut-out portions to form spark points and at the other end extending into said oil chamber for connection with suitable conductors. 105 110

92. In combination, a plurality of registers, mechanism for actuating any selected register, a selector keyboard for selecting any desired register for actuation, a verification machine provided with a plurality of contacts arranged in groups, there being a group of contacts for each register, connections between said keyboard and said machine whereby the set-up on said keyboard to select the desired register automatically selects the corresponding group of contacts, a main keyboard, connections between said actuating mechanism and said main keyboard for controlling the operation of the mechanism in accordance with the set-up on 115 120 125

the main keyboard, and connections between said machine and said main keyboard whereby the set-up on the main keyboard automatically controls the contacts of the selected group.

93. In combination, a plurality of registers, mechanism for actuating any selected register, a selector keyboard for selecting any desired register for actuation, a verification machine, a main keyboard for controlling the operation of said mechanism in accordance with the set-up thereon, and connections between said machine and said keyboards whereby the set-ups on the keyboards jointly control the operation of the verification machine.

94. The combination of a machine provided with sparking terminals for marking a verification sheet, and a pair of keyboards for jointly controlling the circuit-connections of said sparking terminals.

95. The combination of a machine provided with sparking terminals for marking a verification sheet, said sparking terminals being divided into groups, a keyboard for selecting the desired group of terminals for operation, and a second keyboard for controlling the circuit-connections of the terminals in the selected group in accordance with the set-up on said second keyboard.

96. In an accounting system, the combination of a plurality of registers, a counter associated with each register for indicating the number of entries made in the register, a master-machine for involving any selected register and its counter with an entry, a keyboard for controlling the operation of said master-machine with respect to the selected register, and a second keyboard for controlling the operation of the master-machine with respect to the associated counter.

97. In an accounting system, the combination of a machine for marking a verification sheet, a plurality of registers, mechanism for actuating any desired register, a keyboard, and connections whereby said keyboard controls the operation of said marking machine and said actuating mechanism in accordance with the set-up on the keyboard.

98. In an accounting system, the combination of a plurality of registers, means for actuating the same, mechanism for making a perforated record, and connections between said actuating means and said mechanism for causing a perforated record to be made of the actuations of said registers.

99. In an accounting system, the combination of a register, means for actuating the same, and means for simultaneously making a perforated record of the actuations of said register.

100. In an accounting system, the combination of a stencil-reading machine, mechanism for operating the same, a plurality of registers, a master-machine for involving

any selected register with an entry, mechanism for operating said master-machine, and means for causing each of said mechanisms to control the other.

101. A register comprising, in combination, a series of suitably-ordered cylinders, carry-over mechanism associated with said cylinders, and cam projections arranged spirally upon the periphery of each cylinder so as to lie each in a different plane, each projection being representative of a number.

102. In combination, a register having a series of suitably-ordered cylinders, carry-over mechanism associated with said cylinders, cam projections arranged spirally upon the periphery of each cylinder so as to lie in a different plane, each projection being representative of a number, and a circuit-controlling device having a series of contact members adapted to be controlled by said cam projections.

103. The combination of a register having numeral-wheels and carry-over mechanism, means for actuating said register, and means adapted to be temporarily brought into engagement with said register for controlling the operation of said actuating means.

104. The combination of a plurality of registers adapted to receive entries, a master-machine for clearing said registers, and mechanism adapted to be temporarily associated with said registers in succession for controlling the operation of said master-machine.

105. The combination of a plurality of registers adapted to receive entries, a master-machine for clearing said registers, automatic transfer mechanism controlled by the numeral-wheels of the registers for controlling the operation of the master-machine, and driving means for moving said mechanism into temporary engagement with the registers one after the other.

106. The combination of a plurality of registers adapted to receive entries, a master-machine for clearing said registers, automatic transfer mechanism controlled by the numeral-wheels of the registers for controlling the operation of the master-machine, driving means for moving said mechanism into temporary engagement with the registers one after the other, and connections between said actuating means and said transfer mechanism for causing each to control the operation of the other.

107. The combination of a plurality of registers adapted to receive entries, a master-machine for clearing said registers, mechanism adapted to be temporarily associated with said registers in succession for controlling the operation of said master-machine, and automatic recording mechanism for making a record of the entries as they are cleared from the registers.

108. The combination of a plurality of

registers adapted to receive entries, a master-machine for clearing said registers, mechanism adapted to be temporarily associated with said registers in succession for controlling the operation of said master-machine, and driving means controlled by the master-machine for moving said mechanism into and out of engagement with the registers.

109. In an accounting system, the combination of a plurality of registers arranged in the form of a turret, a master-machine for involving any selected register with an entry and for clearing the involved register, and automatic mechanism adapted to be driven around the turret into successive engagement with the registers for controlling the master-machine during the clearing operation.

110. In combination, a register having a series of suitably-ordered cylinders, carry-over mechanism associated with said cylinders, cam projections arranged spirally upon the periphery of each cylinder so as to lie in a different plane, each projection being representative of a number, a circuit-controlling device comprising a series of pivoted contact-levers, and a series of contacts controlled thereby, said contact levers at one end engaging said cam projections and at the other end engaging said contacts.

111. In an accounting system, the combination of a plurality of registers, a master-machine for involving any selected register with an entry and clearing the involved registers, electromagnetic means for controlling the operation of said master-machine in clearing the registers, and automatic mechanism controlled by each register to be cleared for controlling said electromagnetic means in accordance with the entry in the register.

112. In an accounting system, the combination of a plurality of registers adapted to receive entries, mechanism for actuating said registers to clear the same of their entries, and means whereby the numeral-wheels of each register automatically control the operation of the clearing mechanism.

113. In an accounting system, the combination of a plurality of registers adapted to receive entries, mechanism for actuating said registers to clear the same of their entries, means whereby the numeral-wheels of each register automatically control the operation of the clearing mechanism, and a recording mechanism adapted to make a record of the entries as they are cleared.

114. In an accounting system, the combination of a plurality of registers adapted to receive entries, mechanism for actuating said registers to clear the same of their entries, means whereby the numeral-wheels of each register automatically control the operation of the clearing mechanism, and a stencil-

punching machine adapted to make a record of the entries as they are cleared.

115. In an accounting system, the combination of a plurality of registers, a master-machine for involving any selected register with an entry and clearing the involved registers, electromagnetic means for controlling the operation of said master-machine in clearing the registers, automatic mechanism controlled by each register to be cleared for controlling said electromagnetic means in accordance with the entry in the register, and a stencil-punching machine controlled by said automatic mechanism for making a record of the entries as they are cleared.

116. The combination of a plurality of registers adapted to receive entries, a master-machine for clearing said registers, mechanism adapted to be temporarily associated with said registers in succession for controlling the operation of said master-machine, and a stencil-punching machine controlled by said mechanism for making a record of the entries as they are cleared.

117. In an accounting system, the combination of a plurality of registers arranged in a circular tier and adapted to receive entries, a master-machine for clearing the registers, a rotatable annular support surrounding the tier of registers, a circuit-controlling device carried by said support to be brought into successive engagement with said registers, movable contact members carried by said device for controlling the operation of the master-machine, and cam-means provided on each register and extending into the path of travel of said contact members to control the latter in accordance with the entry in the register.

118. In combination, a register adapted to receive an entry, means for clearing said register, and a circuit-controlling device adapted to be actuated by the register in accordance with the entry to be cleared for controlling the operation of said clearing means.

119. In an accounting system, the combination of a plurality of registers arranged in a circular tier and adapted to receive entries, a master-machine for clearing the registers, a rotatable annular support surrounding the tier of registers, a circuit-controlling device carried by said support to be brought into successive engagement with said registers, movable contact members carried by said device for controlling the operation of the master-machine, cam-means provided on each register and extending into the path of travel of said contact members to control the latter in accordance with the entry in the register, and means for automatically reversing the direction of rotation of said support after the registers have been cleared to restore said circuit-controlling device to its initial position.

120. In an accounting system, the combination of a plurality of registers arranged in a circular tier and adapted to receive entries, a master-machine for clearing the registers, a rotatable annular support surrounding the tier of registers, a circuit-controlling device carried by said support to be brought into successive engagement with said registers, movable contact members carried by said device for controlling the operation of the master-machine, cam-means provided on each register and extending into the path of travel of said contact members to control the latter in accordance with the entry in the register, means for automatically reversing the direction of rotation of said support after the registers have been cleared to restore said circuit-controlling device to its initial position, and resetting means for moving said contact members out of the path of said cam-means just prior to the return movement of said support, said resetting means automatically moving the contact members back into the path of said cam-means when the circuit-controlling device has reached its initial position.

121. In an accounting system, the combination of a plurality of registers arranged in a circular tier and adapted to receive entries, a master-machine for clearing the registers, a rotatable annular support surrounding the tier of registers, a circuit-controlling device carried by said support to be brought into successive engagement with said registers, movable contact members carried by said device for controlling the operation of the master-machine, cam-means provided on each register and extending into the path of travel of said contact members to control the latter in accordance with the entry in the register, and means for automatically restoring said contact members to unoperated position after each engagement of said circuit-controlling device with a register.

122. In an accounting system, the combination of a plurality of registers adapted to receive entries, a master-machine for actuating said registers to clear the same, transferrer mechanism adapted to be brought into engagement with said registers one after the other to be operated in accordance with the entry of the engaged register, commutator mechanism for automatically selecting the registers in succession for clearing, and connections between said master-machine and said transferrer mechanism whereby the operation of the latter by the engaged register controls the operation of the master-machine with respect to said register.

123. In an accounting system, the combination of a plurality of registers adapted to receive entries, a master-machine for actuating said registers to clear the same, transferrer

mechanism adapted to be brought into engagement with said registers one after the other to be operated in accordance with the entry of the engaged register, commutator mechanism for automatically selecting the registers in succession for clearing, connections between said master-machine and said transferrer mechanism whereby the operation of the latter by the engaged register controls the operation of the master-machine with respect to said register, an electromagnetically actuated record-making device, and connections between said commutator mechanism and said record-making device for controlling the actuation of the latter in accordance with the operation of the transferrer mechanism, whereby record is made of each entry as it is cleared from the registers.

124. In an accounting system, the combination of a plurality of registers adapted to receive entries, a master-machine for actuating said registers to clear the same, transferrer mechanism adapted to be brought into engagement with said registers one after the other to be operated in accordance with the entry of the engaged register, commutator mechanism for automatically selecting the registers in succession for clearing, connections between said master-machine and said transferrer mechanism whereby the operation of the latter by the engaged register controls the operation of the master-machine with respect to said register, an electromagnetically actuated stencil-punching machine, and connections between said commutator mechanism and said stencil-punching machine for controlling the actuation of the latter in accordance with the operation of the transferrer mechanism, whereby record is made of each entry as it is cleared from the registers.

125. In an accounting system, the combination of a plurality of registers adapted to receive entries, a master-machine for actuating said registers to clear the same, transferrer mechanism adapted to be brought into engagement with said registers one after the other to be operated in accordance with the entry of the engaged register, commutator mechanism for automatically selecting the registers in succession for clearing, connections between said master-machine and said transferrer mechanism whereby the operation of the latter by the engaged register controls the operation of the master-machine with respect to said register, and means whereby said master-machine automatically controls the movement of said transferrer mechanism from one register to the other.

126. In an accounting system, the combination of a plurality of registers adapted to receive entries, a master-machine for actuating said registers to clear the same, transferrer mechanism adapted to be brought into en-

gement with said registers one after the other to be operated in accordance with the entry of the engaged register, commutator mechanism for automatically selecting the registers in succession for clearing, connections between said master-machine and said transferrer mechanism whereby the operation of the latter by the engaged register controls the operation of the master-machine with respect to said register, an electro-magnetically actuated stencil-punching machine, connections between said commutator mechanism and said stencil-punching machine for controlling the actuation of the latter in accordance with the operation of the transferrer mechanism, whereby record is made of each entry as it is cleared from the registers, and means whereby said master-machine automatically controls the movement of said transferrer mechanism from one register to the other.

127. In an accounting system, the combination of a plurality of registers arranged in circular tiers, the corresponding registers in the tiers constituting vertical rows, and automatic transferrer mechanism adapted to be moved into engagement with one row of reg-

isters after the other for clearing the engaged registers.

128. In combination, a register having numeral-wheels, a circuit-controlling device comprising a set of switches for each numeral-wheel, and means whereby each numeral-wheel controls the associated set of switches in accordance with the set-up on the wheel.

129. In combination, a plurality of registers having entries, and means for automatically clearing the registers in a common record.

130. In combination, a plurality of registers and means for automatically clearing the registers in a common record.

131. In combination, a plurality of entry receiving devices, arranged to have numbers set up thereon and devices for automatically clearing the entry receiving devices in a common record.

In witness whereof, I hereunto subscribe my name, this 17th day of October, 1908.

WILLIAM J. CRUMPTON.

Witnesses:

C. H. TALLMADGE,
LEONARD W. NOVANDER.