(No Model.)

3 Sheets—Sheet 1.

H. HOLLERITH.

ART OF COMPILING STATISTICS.

No. 395,782. Patented Jan. 8, 1889.

Fig. 1.

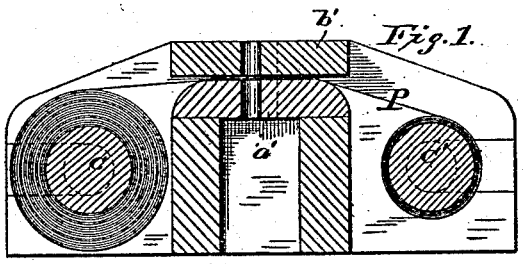


Fig. 2.

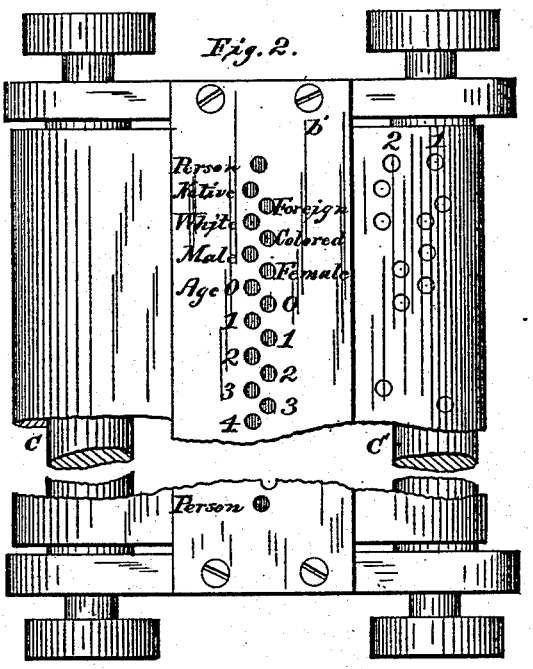


Fig. 3

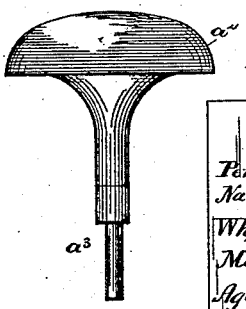


Fig. 4.

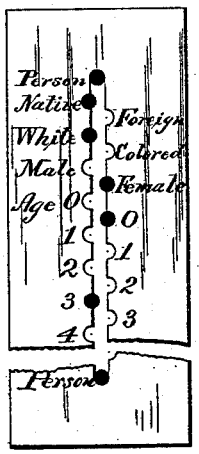


Fig. 6.

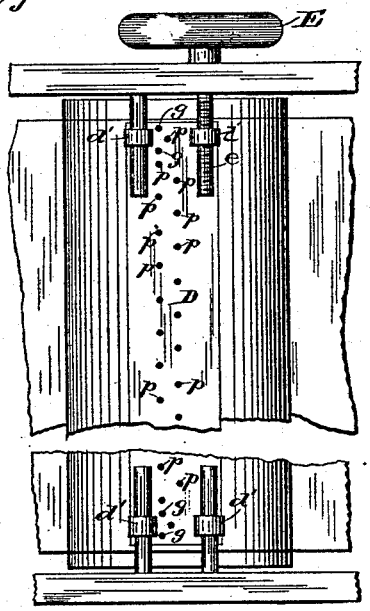
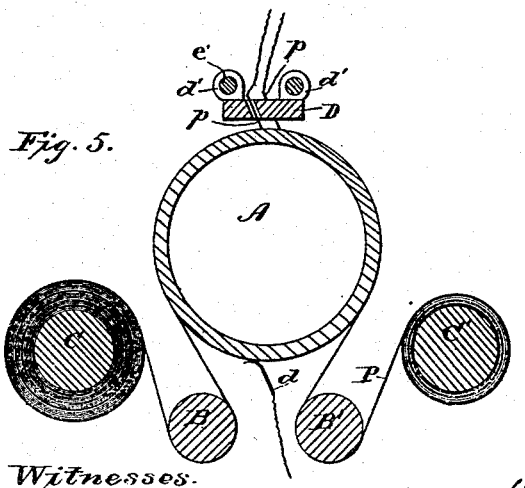


Fig. 5.



Witnesses.
Chas. R. Burr.
A. J. Stewart.

Inventor
Herman Hollerith
by Church & Church
his Attorneys.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 3 Sheets—Sheet 2.

H. HOLLERITH.

ART OF COMPILING STATISTICS.

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Fig. 7.

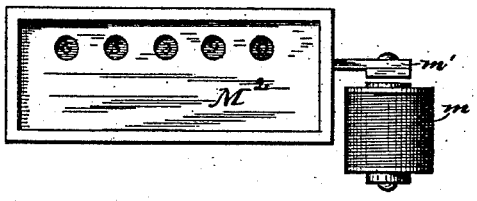


Fig. 8.

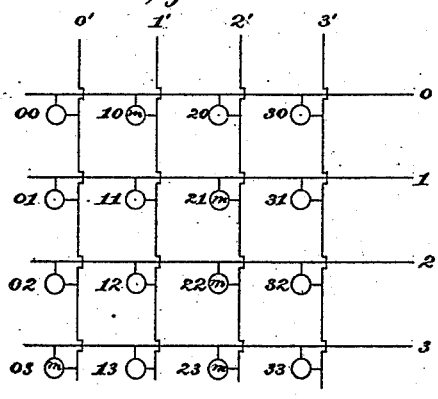


Fig. 9.

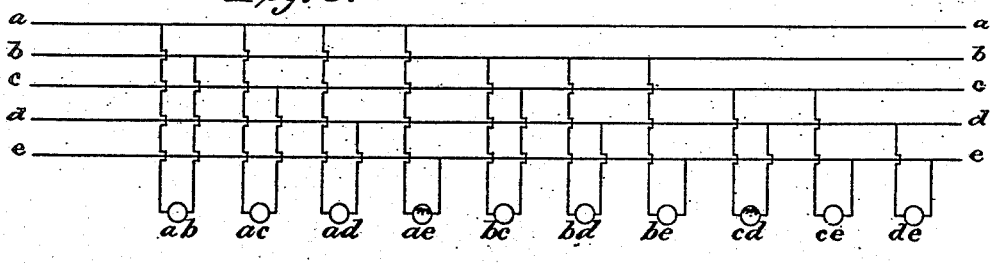
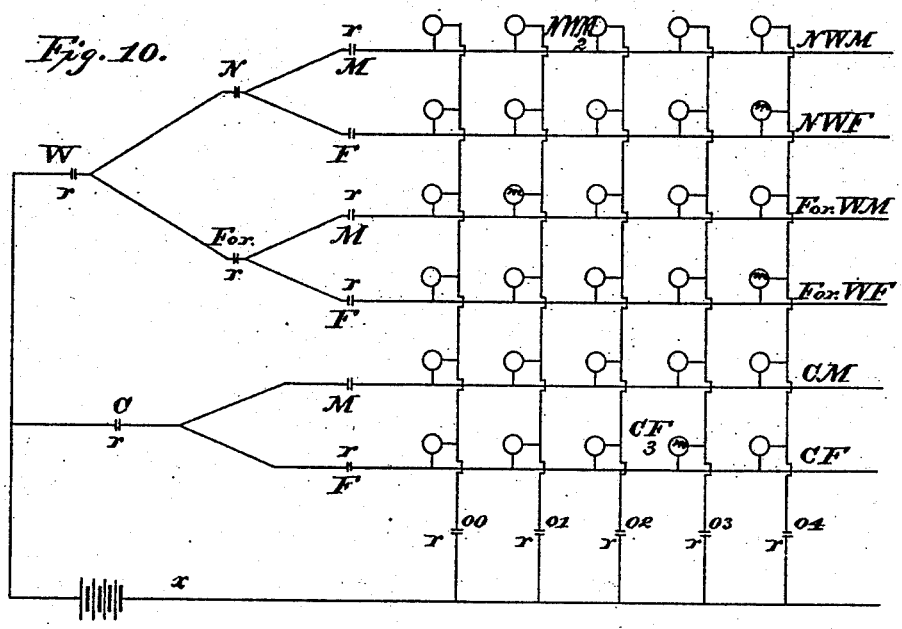


Fig. 10.



Witnesses.
Chas. R. Burr.
A. J. Stewart.

Inventor
Herman Hollerith
by Church & Church
his Attorneys.

N. PETERS, Photo-Lithographer, Washington, D. C.

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Fig. 11.

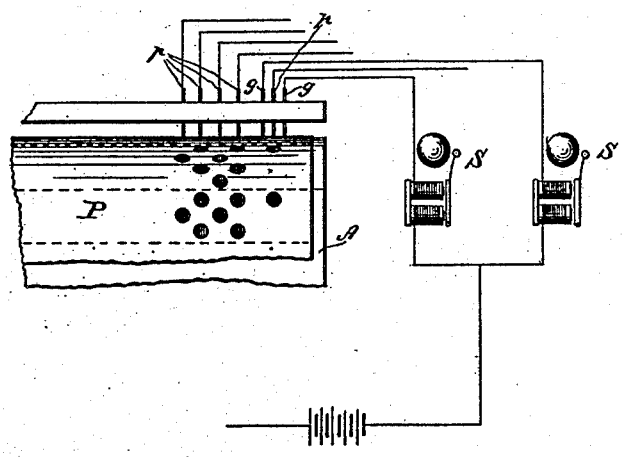
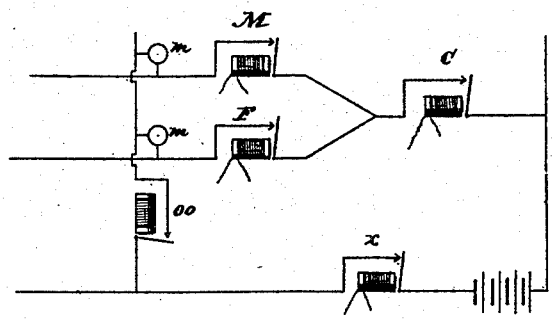


Fig. 12.



Witnesses.
Chas. R. Burr.
A. J. Stewart.

Inventor.
Herman Hollerith
by Church & Church
his Attorneys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

HERMAN HOLLERITH, OF NEW YORK, N. Y.

ART OF COMPILING STATISTICS.

SPECIFICATION forming part of Letters Patent No. 395,782, dated January 8, 1889.

Original application filed September 23, 1884, Serial No. 143,805. Divided and this application filed October 27, 1885. Renewed January 4, 1887. Again renewed September 8, 1888. Serial No. 284,938. (No model.)

To all whom it may concern:

Be it known that I, HERMAN HOLLERITH, of New York city, county, and State, have invented a certain new and useful Improvement in the Art of Compiling Statistics; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

My present invention has for its object to simplify and thereby facilitate the compilation of statistics wherein each of the statistical items to be recorded represents or is the product of one or more of the separate items or characteristics appertaining to each of the individuals or things respecting which the compilation is to be made; and it relates to a new and improved mode or system of effecting such a compilation and comprising the following steps or operations, viz: first, preparing a standard or templet indicating the relative position or order in which each item or characteristic of the individual or thing is to be recorded; second, forming according to such a standard or templet a separate record for each individual, wherein the separate items characteristic of or appertaining to that individual or thing, and which enter into the compilation to be made, are recorded upon a strip or tablet by means of circuit-controlling index-points bearing a fixed relation to each other, and, third, actuating a series of circuit-controlling devices, corresponding in number and position to the standard or templet, by means of the separate record strips or tablets, to interrupt, close, or otherwise vary the currents in separate circuits, including registering mechanism whereby, as each index-point or combination of index-points occurring in the individual record and representing the statistical item to be compiled is brought into position to actuate the circuit-controlling devices, the mechanism for registering such statistical item will be automatically operated, all substantially as hereinafter described.

The method herein described is applicable to the compilation of such statistics as the population statistics of a census, or the statistics of registration of births, deaths, and marriages, which are compiled by counting or adding single units as persons in the above.

Although applicable to various kinds of statistics, I will describe my invention as applied to the compilation of the population statistics of a census.

The returns of a census contain the names of individuals and various data relating to such persons, as age, sex, race, nativity, nativity of father, nativity of mother, occupation, civil condition, &c. These facts or data I will for convenience call "statistical items," from which items the various statistical tables are compiled. In such compilation the person is the unit, and the statistics are compiled according to single items or combinations of items. Thus it is required to know the number of persons returned—as whites, colored, males, females, or as carpenters, blacksmiths, &c., or as born in certain States or foreign countries. In such cases single items are counted. Again, it is required to know the number of native whites, or of native white males of given ages, or groups of ages, &c., as in what is technically known as the "age and sex" tally; or it may be required to know the numbers of persons engaged in certain occupations, classified according to sex, groups of ages, and certain nativities. In such cases persons are counted according to combinations of items. A method for compiling such statistics must be capable of counting or adding units according to single statistical items or combinations of such items. The labor and expense of such tallies, especially when counting combinations of items made by the usual methods, are very great.

For the purpose of conveying a clear idea of the manner of carrying my said invention into practice, I have illustrated in the accompanying drawings a set of mechanical and electrical appliances, the same forming the subject of a prior application, Serial No. 143,805, (renewed September 8, 1888, Serial No. 284,939,) filed September 23, 1884, and renewed January 4, 1887, Serial No. 223,414, of which this application is a division, said devices forming no part of my present invention,

other than as illustrating some of the various forms of apparatus which may be employed.

In the accompanying drawings, Figure 1 represents a transverse section of the apparatus for perforating the strip of paper used in transcribing the returns to form a record strip or tablet. Fig. 2 represents a part plan view of the same. Fig. 3 represents a tool used in connection with the above apparatus for perforating the paper. Fig. 4 represents a standard or templet used for verifying the transcription of the returns. Fig. 5 represents a transverse section of the counting apparatus. Fig. 6 represents a part plan view of the same. Fig. 7 represents an electro-mechanical counter used in connection with the counting apparatus illustrated in Figs. 5 and 6. Figs. 8, 9, and 10 are diagrams showing the arrangement of wires and electrical connections for making the various tallies. Fig. 11 is a side elevation representing a portion of one end of the drum, record-strip, contacts, and alarm-circuits. Fig. 12 is a diagrammatic view illustrating a portion of the circuit-connections, Fig. 10.

In the present instance the standard or templet for determining the relative position of the index-points is represented as a die-plate having a series of holes corresponding to the separate items or characteristics of the individual, and the record is in the form of a strip of paper or other non-conducting material, in which a series of holes or perforations are formed, the latter constituting the index-points referred to.

The transcription of the returns to the sheets of electrical non-conducting material can be made in various ways. I prefer to use a strip of paper, which is passed from one roller to another over a die-plate, as shown in Figs. 1 and 2. The die-plate *a* is provided with a series of holes placed staggering, extending across the width of the paper strip, as shown in plan in Fig. 2.

Above the die-plate *a* is the guide-plate *b*, provided with holes corresponding to holes in the die-plate *a'*. With a tool consisting of a plain punch provided with a suitable handle, as shown in Fig. 3, holes can be punched in the strip of paper in suitable relative positions, according to the holes in the guide-plate *b'* and die-plate *a'*. The holes are suitably lettered or numbered on the guide-plate *b*, as shown in Fig. 2. At the extreme end there is a hole marked "Persons," separated somewhat from the remainder, the object of which will hereinafter be more fully explained.

The paper strip is drawn to a certain position, when the various statistical items for a given person are recorded by punching suitable holes in a line across the strip, being guided by letters on the guide-plate. A hole is thus punched corresponding to person, then a hole according as person is a male or female, another recording whether native or foreign born, another either white or colored, &c. There are about one hundred ages to be recognized. To facilitate this two holes are used to record each age, there being two sets of ten holes each, marked from 0 to 9, respectively. Thus 00 would represent less than one year of age; 0-1, one year of age; 1-0, ten years, &c.

The occupations can be recorded by using a series of holes suitably lettered, each occupation being recorded by a combination of two holes. Thus, "ab, ac, bc," &c., would each represent a single given occupation according to a prearranged schedule. With twenty-six holes, in this way, three hundred and twenty-five combinations could be made, the number of combinations possible following the well-known mathematical law of combinations. There are thus three ways in which statistical items can be recorded—first, by single holes, (as above described for recording sex, race, &c.;) second, by combinations of two holes, each hole being in a different set, (as described above for recording ages;) third, by combinations of two holes, both holes being in the same set, (as described above for recording occupations,) or combinations of these methods can be followed.

It is necessary in case of census statistics to use combinations of holes on account of the large number of statistical items to be recognized. When the various statistical items relating to one person have been thus recorded or transcribed, the paper strip is drawn forward and the items or data relating to the next person are recorded, any suitable system of notation being used to identify each transcription. In Fig. 2 is shown a partial record for two persons, numbered 1 and 2, respectively. No. 1 is the transcription for a foreign-born white male three (0-3) years of age, while No. 2 is the transcription of a native white female thirty (3-0) years of age.

When the various items have been thus transcribed, it may be desirable or necessary to verify entirely or in part the accuracy of such transcription. For this purpose a scale of card-board, thin metal, or other suitable material may be used, arranged as shown in Fig. 4, it being lettered and numbered corresponding with the guide-plate of punching apparatus. This scale is placed across the paper strip, being located in position by the holes marked "Person" at each end. The transcription for the given person can thus be read according to the location of the holes. Any errors can now be corrected by punching holes in proper places and covering all holes wrongly punched by small seals of paper or other suitable electrically non-conducting material. When the transcription for a certain district has been made and verified, as above described, the strip is passed through a counting-machine, in which the separate items or combination of items are counted or tallied.

This counting-machine can be constructed in various ways. The construction which I prefer consists, essentially, of a metallic drum

or cylinder, A, Fig. 5, over which the strip of paper is passed from a roller, C, to a roller, C′, around suitable guide-rollers, B B′. Above the metallic drum A, extending across the machine, is the bar D, Figs. 5 and 6, supported by lugs from pins at each end, one of which pins, *e*, is provided with a screw-thread engaging with screw-thread in corresponding lug, and is connected with wheel E, by means of which the bar D can be given a slight lateral motion. Passing through the bar D and suitably insulated from each other are the metallic pins or pointers *p*. These pins are arranged in relative positions corresponding to the centers of the holes in the die-plate *a*, Fig. 1. The pointers or pins *p* press against the drum A, and, together with the drum A and metallic brush *d*, can each be made part of an electric circuit. In an electric circuit with each pointer can be placed an electro-magnet, the armature of which is attached to a lever operating any suitable mechanical counter—such, for example, as is used for registering the revolutions of a steam-engine, as shown in Fig. 7 at M^2. If the paper is now drawn through the counting-machine, the circuit through any given pointer *p* is closed and broken each time a hole in the paper strip passes under the pointer, the armature of the magnet being attracted when the circuit is closed and withdrawn by the spring of the counter when the circuit is broken, thus registering one for each hole. In this way, when the strip corresponding to any given district has been drawn through the apparatus, counters arranged as above described will show the numbers of males, of females, &c., reported in each district. In this work a difficulty might be experienced, as the paper strip is liable to move or shift gradually from one side to the other of the drum A while being drawn through the apparatus. To allow for this two pointers, *g g*, are placed at each end of the bar D, Fig. 6. These pointers are so placed that when the bar D is in proper position relative to the holes in the paper strip the pointers *g g* will constantly be over paper just to either side of the holes corresponding to persons. Each pointer *g g*, together with the drum A, is put in circuit with a suitable bell, S, as shown in Fig. 11. Should the paper shift to either side the circuit would close through one of the pointers, ringing the corresponding bell. The bar D can be then shifted to one side or the other by means of the wheel E, according to which bell rings.

By the above method of course only items recorded by single holes can be counted. The count items recorded by combinations of two holes, each hole being in a different set, as in recording age, as above described, the arrangement shown in Fig. 8 is followed, in which 0′ 1′ 2′, &c., represent wires connected with corresponding pointers of first set of holes or tens of age, while 0 1 2 3 represent points connected with corresponding pointers of second set or units of age. The electro-magnets *m* of the counters are placed as shown by the small circles. The wire marked 0′ is connected with magnets 00 01 02, &c., while wire marked 10 is connected with magnets 00 10 20 30, &c., as shown. If, now, a hole in paper strip comes under the pointer 1′ and another hole at the same time comes under pointer 2, the circuit would be closed through electro-magnet 12 and corresponding counter would register. Should a hole, however, come under pointer 2′ and another under pointer 1 the circuit would be closed through magnet 21, and its corresponding counter would register. In this way a counter can be arranged for each age.

The method followed when counting combinations of two holes, both holes being the same set, is shown in Fig. 9. Five wires, *a b c d e*, are represented, each wire being connected with a corresponding pointer. Electro-magnets *ab ac ad*, &c., are shown, one for each combination, connected with the corresponding pointers. From an inspection of the drawings it will be seen that should the two holes come under pointers *a* and *b* the circuit would be closed through the electro-magnet *ab* and corresponding counter, and only this counter would register, for the direct circuit through any other magnet would remain open. Should the holes come under *a* and *c* the circuit would be closed through the magnet *ac*, &c.

It will be seen that by the above methods any combination of two holes can be counted or tallied. In statistical work, however, it is often desirable to tally by combinations of more than two holes or items—as, for instance, in the age and sex tally. Here we must combine age with race, sex, and nativity. Thus in the tenth census of the United States single ages were tallied under the following six classes: first, native white males; second, native white females; third, foreign white males; fourth, foreign white females; fifth, colored males; sixth, colored females. For such purposes I use secondary circuits for the electro-magnets of the counters, which circuits are controlled by the electro-magnets of ordinary telegraph-relays or other suitable apparatus in circuit with the pointer *p* of the counting-machine.

For an age and sex tally the arrangement is shown in Fig. 10. The electro-magnets *m* of the counters are arranged in circuits, as shown, these circuits being broken by relays *r*, which are connected in circuits with corresponding pointers *p* of the counting apparatus. Relays W and C are connected with pointers corresponding to white and colored, respectively, relays N and For., with pointers corresponding to native and foreign born, and relays M and F with pointers corresponding to male and female, while relays 00 01 02, &c., one for each age, are connected with the pointers representing the ages in same way as the magnets shown in Fig. 8. Let us suppose the record corresponding to a native

white male of two years of age passes under the pointer *p*. Relays W N M and 02 would then close the circuit through magnet *n w m* 2, and the corresponding counter would register. If the record corresponding to a colored female of three years of age passes under the points *p*, the relays C F and 03 would then close the circuit through magnet C F 3, thereby registering one on the proper counter. In this way, by suitable arrangements of magnets in circuits, which are broken by relays operated by circuits through points *p*, any desirable combinations of statistical items can be counted or tallied.

Various modifications of the above methods of carrying out my invention may be used. Thus, instead of punching the strip of paper, a perforated strip may be used in which all but the required perforations could be covered by pasting over them strips of paper; or the record strip or tablet might, instead of closing the circuit, open it or be made to actuate circuit-controlling devices independent of the roller, as by causing a movable electrode to approach and recede from an opposite electrode, all of which modifications are illustrated in my application, Serial No. 240,629, filed June 8, 1887. Again, instead of a single hole representing a single item, it could be used to represent a combination of items. Thus one hole might represent native white males, another white females, &c.

It may sometimes be desirable to count groups of single items—as groups of ages or groups of occupation, &c. This can of course be done by placing a single magnet in several circuits.

If, on account of the large number of items to be recorded, a strip of paper too wide to be conveniently handled would be required when using a single row of holes, two or more rows of holes could be used in all lines except that corresponding to person and the pointers of the counting-machine arranged correspondingly. A relay placed in the circuit shown in Fig. 10 at *x* (see also Fig. 12) could be controlled by the hole corresponding to persons in such manner that the circuit through the electro-magnets *m* could only be closed when the holes were under their corresponding pointers.

The counters could of course be constructed in many different ways, as will be readily understood.

It is evident that by modifications of the apparatus hereinbefore described cards or sheets of electrically non-conducting material, suitably perforated, could be used instead of the strip of paper, as described. In such case the drum A would be replaced by a flat plate, which would be made to press against a series of pointers connected with counters in the same manner as hereinbefore described. This card would be placed in position over these pointers and plate, then pressed against the pointers, in which case the circuits would be closed through proper magnets and the corresponding counters would register.

For an illustration of the foregoing modifications see application Serial No. 240,629.

Instead of employing perforations in a non-conducting strip as index-points for locating the items on the record strip or tablet and actuating the circuit-controlling devices, sections of conducting material may be applied to such a strip; or depressions or protuberant portions may be formed in or upon the record-strip and caused to engage and actuate the circuit-controlling devices.

What I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described improvement in the art of compiling statistics, which consists in, first, forming or arranging a standard or templet indicating the relative position in which each item or characteristic of the individual is to be recorded; secondly, forming a record of each individual or thing by locating index-points upon a strip or tablet, said index-points representing the characteristics of the individual and bearing a determinate relation to each other and to the standard, and, finally, submitting said separate records successively to the action of circuit-controlling devices for operating the registering devices representing the statistical items to be compiled, whereby each statistical item or combination of items when contained in the record of any individual is accurately registered.

2. The herein-described method of compiling statistics, which consists in recording separate statistical items pertaining to the individual by holes or combinations of holes punched in sheets of electrically non-conducting material, and bearing a specific relation to each other and to a standard, and then counting or tallying such statistical items separately or in combination by means of mechanical counters operated by electro-magnets the circuits through which are controlled by the perforated sheets, substantially as and for the purpose set forth.

HERMAN HOLLERITH.

Witnesses:
J. HOLDSWORTH GORDON,
DUDLEY T. HASSAN.