

HOLLERITH, Herman. COMPLETE SPECIFICATION. Improvements in the methods of and apparatus for compiling statistics. [London] A.D. 1889, 8th JANUARY. no 327.

FIRST EDITION, folio, pp. 7 and 5 plates on 3 sheets; disbound in a cloth folding case.

The original patent specification, and thus the first printed account, of the Hollerith electric tabulating machine, a highly significant invention in the history of computers. The Hollerith machine uses punched cards (the inspiration may have been the Jacquard loom, or more directly Babbage's analytical engine) to record and sum statistical data. It was designed in competition with other inventors to gather data from the 1890 US census of 63 million subjects and was an immense success. IN 1896 Hollerith formed the Tabulating machine company, one of the organizations later brought together to form IBM. The Hollerith machine formed the basis of IBM's 1944 Automatic sequence controlled calculator, an electromechanical computer which was heralded at the time as 'Babbage's dream come true'. But it was too late and was at once superseded by ENIAC, the first electronic computer.

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#1,500

Date of Application, 8th Jan., 1889
Specification Accepted, 16th Mar., 1889

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A.D. 1889, 8th JANUARY. N° 327.  
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COMPLETE SPECIFICATION.

Improvements in the Methods of and Apparatus for Compiling
Statistics.

I, HERMAN HOLLERITH citizen of the United States residing at New York City, in the county of New York and State of New York, United States of America, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the
5 following statement :—

This method consists, essentially ; first, in arranging a standard, template or index ; second, recording for each individual, unit, person or thing the various statistical data, to be compiled, relating to such person, unit, individual or thing, by
10 punching from or otherwise locating on sheets, strips or cards, index points according to said standard, template or index ; and, third, submitting said sheets, cards or strips successively to circuit closing devices the circuits through which are controlled by said record cards, sheets or strips and operate suitable electro-mechanical counters, or sorting boxes or both combined, all as will now be more fully described and pointed out.

15 My present invention may by slight and apparent modifications be adapted to the various kinds of statistical compilations. For purpose of illustration I will first describe my invention as adapted to the compilation of that class of statistics which consists in counting, adding or tallying single statistical units according to the various statistical items or combination of items relating to such units. Under this class
20 would come all the population statistics of a census, the statistics of the registration of births, deaths and marriages, army health statistics, *etc.* Such statistics are compiled by counting or tallying the units (persons) according to the data relating to such units. This data may be compiled in single statistical items, as age, sex, race, nativity or occupation, or it may be compiled in combinations of such items, as, for
25 example, native white males, native white females, foreign white males, foreign white females, *etc.*, such being combinations of general nativities with race and sex.

As my present invention can best be described by some practical example, I will proceed to describe its application to one particular kind of statistics and then point out generally how such methods may be modified to adapt them to any form of
30 statistics.

In figure 1 I have shown the general arrangement of a card such as would be

[Price 11d.]

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used for compiling the health statistics of the United States army. One such card is used for each admission to sick report and in a convenient part of said card is written the name of the person and the number of the corresponding record on the sick report. The name and number are intended merely to identify the card and do not in any manner affect the compilation of statistics. In place of writing the name and number any convenient system of identifying the cards may be adopted. With any convenient form of punch (an ordinary conductor's punch cutting a round hole about three-sixteenths of an inch diameter is very satisfactory) the various data relating to said person are then recorded by punching in the numbered or lettered squares according to the standard or index which has previously been arranged. Thus one of the spaces at *a* is punched according to the geographical region in which the case occurs, thus AC for Atlantic Coast, GC for Gulf Coast, NL for Northern Lakes, *etc.* At *b* one of the spaces marked A, B, C, *etc.*, is punched according as the post is in one division or another of the said region. Such divisions being arranged with reference to the topographical or geographical features of said region. The individual post is recorded, at *c*, by punching one of the spaces marked, *a, b, c, etc.* According to the given standard Fort Preble, Me, would be designated AC, A, *a*, or post, *a*, in division, A, of the Atlantic coast region. It is thus apparent that in a very small space of the card an exceedingly large number of posts may be recorded. The present standard will allow for a maximum of 1,088 posts. Should it ever be necessary to exceed this number of posts, combinations of the letters at *c* could be used, thus one post would be designed *ab*, the next *ac*, another *bc, bd*, and so on.

At *d* we punch one of the spaces marked from 1 to 12, according to the month to which the record relates. In similar manner we record, at *e*, the rank, whether officer, non-commissioned officer or private. At *f* the arm of service as Infantry, Artillery, *etc.* At *g* the age as 15 years and under (-15), between 16 and 19 years (16), between 20 and 24 years (20), *etc.* The length of service is recorded at *h*. The years of residence at the given post are recorded at *i*. At *k* is recorded whether the given person is white, colored, Indian or of other race. At *l* is recorded whether the person was admitted to sick report during the month (DM) or during previous month (PM). At *m* record is made whether the given disease or injury was contracted in the line of service or not; at *n* whether the person was admitted to sick report from the field, from quarters or from other source. At *o* the disposition of the case is recorded, whether returned to duty cure complete (Rc) or returned to duty cure incomplete (Ri), *etc.* At *p* is recorded whether the person was treated in the field, quarters or in hospital.

The cause of admission is recorded by punching, at *q*, the class to which the disease or injury belonged as Sp, specific febrile and infectious disease; Ma, malarial diseases; GI, general injuries; SpI, special injuries, *etc.*, and, at *r*, the specific disease or injury under the given group by punching one of the numbers according to the prearranged index or standard. The number of days under treatment is recorded, at *s* and *t*, by punching at *s* according to the tens of days, and at *t* according to the units of days, thus 12 days would be recorded by punching at *s*, 1 and at *t*, 2; while 21 days would be recorded by punching 2, at *s*, and 1, at *t*.

It will thus be seen that, by properly arranging a standard, template or index a very extended record can be made on a comparatively small card.

I will now proceed to describe the construction of the apparatus which I prefer to use in connection with such punched cards to compile therefrom the desired statistical tables. This apparatus is shown in figure 2, and consists of the press or circuit closing device, A, the counters, C, and the sorting box, B. The press, A, is shown in cross-section in figure 3. The hard rubber plate, 1, is suitably supported in the frame and is provided with the holes or cups, 2, each one of which is partly filled with mercury, and connected with one of the wires, W, which latter terminate in the binding posts, D, figure 2.

A suitable box formed with the top and bottom plates, 3 and 4, is suspended above the rubber plate, 1, by the links, 5 and 6. By means of the handle, 7, the plates, 3

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and 4, can be drawn down against the tension of the spring, 8. The stops or guides, 9, are arranged on the rubber plate, 1, so that the cards hereinbefore described can be placed in such position that the cups or holes, 2, will correspond with the spaces on the card, there being one such cup and binding post for each space on said card.

5 Between the plates, 3 and 4, are a number of pins, 10, corresponding in number and arrangement with the cups, 2, and the spaces on the cards. These pins are pressed down by light spiral springs and project below the plate, 4, as shown, and are so arranged that, when the handle, 7, is pressed down, the projecting pins will enter the cups, 2, and form electric connection with the mercury in said cups. If a punched
10 record card is placed in position on the rubber plate, 1, it is apparent that a pin will enter each cup, 2, corresponding with a punched space in the card while the remainder of the pins will be pressed back.

At C, figure 2, are arranged a number of electro-mechanical counters of any desired form or construction. Each counter is so arranged that each time the circuit is closed
15 through its electro-magnet the armature will be attracted, and thus the counter register or add 1. The terminals of these magnets are connected with the binding posts, E, figure 2.

The sorting box is formed as shown at B, figure 2, and in detail in figure 4. The box, B, is divided into a number of divisions or compartments, each one of which is
20 closed by a lid or cover, 11. This lid is secured to an arm, 12, bent at right angles as shown. The spiral spring, 13, engages the lid, 11, and tends, normally, to hold the same open. The electro-magnets, 14, are secured to the box, B, and are connected with the binding posts, F, figure 2. The armatures, 15, are pivoted as shown, and are formed with recesses or grooves, 15^a, which are adapted to engage and hold the
25 arms, 12, against the tension of the springs, 13. The spirals springs, 16, press the armatures, 15, normally upwards. It will be seen that if a circuit is closed through any magnet, 14, the corresponding armature, 15, will be attracted, thus releasing the arm, 12, and allowing the spring, 13, to open the lid, 11, until the arm, 12, strikes the stop, 17. The lid or cover, 11, will remain open until it is again closed by hand,
30 when the arm, 12, is again engaged and held by the armature, 15.

The sides of the box, B, are removable to allow easy access to the interior for purpose of removing the cards from the different compartments.

When it is desired to count the hereinbefore described record cards according to any data on said cards, the counters, C, are connected with the cups, 2, corresponding
35 to the spaces of the card which it is desired to count. This, of course, can readily be done by connecting the corresponding binding posts, D and E. Thus in the diagram, figure 5, let M and Fe represent the cups corresponding to the spaces male and female of the given card, and let *m* and *fe* represent the counters connected with the cups, M and Fe, as shown. If now a card is placed in position on the press and the
40 handle drawn down, it will be seen that the circuit is closed from the cup, M or Fe through the corresponding counter, *m* or *fe*, according as the space male or female on the card has been punched. If all the cards of a given district are thus passed successively through the press, the counter, *m*, will show the total number of males and the counter, *fe*, the total number of females in said district.

45 In case it is desired to count combinations of two or more items ordinary pony telegraph relays are used to combine the circuits as desired. In figure 6 a diagram is represented showing four cups corresponding to native, N, foreign, F, male, M, and female, Fe. The cups male and female are connected with the magnets of the relays, *m* and *fe*, respectively. The cups native and foreign are connected with the
50 contact points of the relays as shown. These relays are again connected with the counters as shown. It will be seen from an inspection of the diagram that if the card is punched for native and male, a circuit is first closed through the relays, *m*. The armatures of these relays are then attracted, and this closes a second circuit from the cup, N, through the counter N M, thus registering on said counter.

55 In this manner the counter, N M, will register the combination native male, the counter, N Fe, the combination native female, the counter, F M, the combination foreign male, and the counter F Fe, the combination foreign female. Any other

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combinations can likewise be arranged for, it simply being necessary to provide a sufficient number of relays and counters.

If it is desired to sort the cards according to data recorded on said cards, it is simply necessary to connect the magnets of the sorting box with the cups corresponding to the data according to which the cards are to be sorted. This is done by connecting 5 the binding posts, F, with the binding posts, D, (figure 2).

The diagram shown in figure 5 will serve to illustrate the operation of the sorting box, only that *m* and *fe* will now correspond to the magnets of the sorting box. If a card punched for male is placed in the press, the armature of magnet, *m*, is attracted, thus releasing the corresponding lid. As the card is taken out of the press it is 10 dropped into this open division of the sorting box and the lid then closed. This is done with the right hand, while another card is being placed in position in the press with the left hand. If all the cards are thus passed successively through the press, it will be found that the cards have been assorted according to the punched record. The accuracy of this sorting is readily verified by examining the cards to see if a 15 hole appears in the given place for all the cards. A misplaced card is thus almost immediately detected, even though among a large number of cards.

Instead of assorting the cards according to single items, the cards can be assorted directly according to combinations of two or more items, as will be readily seen from the description of the diagram, figure 6. 20

The most complicated combinations can readily be counted with comparatively few counters or relays by first assorting the cards according to the first items entering into the combinations, then reassorting each group according to the second item entering into the combination, and so on, and finally counting on a few counters the 25 last item of the combinations for each group of cards.

It will be seen that while passing the cards through the press once, certain data may be counted, or two or more different kinds or groups of data may be counted, while at the same time the cards are being sorted according to some other data. Two or more operations being thus carried on at the same time.

It will also be noticed that, if desired, groups of data can be counted on single 30 counters by simply connecting several of the binding posts, D, according to the desired groups, with single binding posts at E.

Under certain conditions, it may be desirable to replace the separate cards just described by a continuous strip. This is especially desirable when a very large number of units or persons, with comparatively few items to each unit or person, 35 are to be considered. For this purpose I use a strip of manilla or other paper of suitable width, and punch the record for each individual in a straight line across this strip. A line of such a punched record strip thus corresponds to a single punched record card before described.

In figure 7 I have represented part of such a record strip. The first record 40 represents a native, white, female; the second a foreign, white, male; the third, a native, colored, male, *etc.* To count these records either singly or in combinations we use a machine substantially as shown in figure 8 in place of the press, A, shown in figure 2. The cups, 2, of the press, A, (figure 3) are replaced by the levers, 80, ending in the fine spring points or pins, 82. These levers are insulated from each 45 other and are connected with the counters in the same manner as the cups, 2, (figure 3) all as hereinbefore described. Below the points, 82, is the metal drum or cylinder, 81, which thus replaces the metal plates, 3 and 4, of figure 3. The points, 82, are held against the drum, 81, by the spiral springs, 83. The paper strip is passed between the points, 82, and the drum, 81. It will be seen, for example, that each time the 50 punch record for male comes under the corresponding pointer, 82, the circuit will be closed through the corresponding counter and thus register one, the operation being thus in all respects substantially the same as for the press hereinbefore described.

If it is desired to use a strip of paper, and the record is given in such detail that we are unable to bring the punch record within the limits of width of paper 55 strip, the record can be punched in two or more lines across the paper strip, provided in one row a single hole is punched for each record as shown at G, figure 9. In this

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strip the record for each person is represented in three lines across the strip. The hole, G, is punched for each unit or person and no other hole is punched in this row. The points, 82, (figure 8) are arranged in three lines to correspond with the centers of the record spaces shown in figure 9. In the row, G, however, there is but a single
 5 pin, 82, in a corresponding position. The pin, 82, is connected in circuit with a relay which controls the return or ground circuit from all the other pins. It is apparent that when, and only when, the circuit through G is closed, all the points, 82, are in their proper relative positions and the relay thus closing the ground circuits the proper counters will register. In other words, though each punch record hole passes
 10 successively under three pins, it will only be able to record on the counters when under the proper pin.

In compiling statistics of manufacture, agriculture or other similar statistics, it is necessary to add, instead of the single units as hereinbefore described, aggregate amounts. For this purpose I arrange certain modifications of the apparatus herein-
 15 before described.

The cards used for such purpose are arranged as shown in figure 10. Nine horizontal rows of punch spaces, numbered consecutively from 1 to 9, are arranged across the card, and are divided vertically into divisions corresponding to the subjects treated. Thus in figure 10 the first division is used for recording the amount paid in
 20 wages, the second for recording the value of materials, *etc.* Each division is subdivided into spaces, one for each digit which may enter into the numbers to be recorded. Thus in the card illustrated, each division is divided into six spaces, the first for hundred thousands, the next for ten thousands, the third for thousands, next hundreds, tens, and finally units. To record any number we punch in the proper spaces
 25 from 1 to 9 according to the number to be recorded. Thus in figure 10 the small circles would indicate where the card would be punched to record \$54,892 wages and \$145,035 materials.

The press, A, shown in figure 2 is modified by replacing the metal plates, 3 and 4, figure 3, by similar plates of hard rubber or other non-conducting material, and by
 30 adding an integrating device as will now be described.

In figure 11, 30 and 40 represent the upper and lower plates of hard rubber. The pins, 31, are constructed and arranged with spiral springs as before described. The metal bushings, 32, are screwed into the upper hard rubber plate as shown. The spiral springs surrounding the pins, 31, are in contact with the bushings, 32, thus forming a
 35 metal circuit from the pin, 31, to the bushing, 32. It will be seen, that the pins, 31, are insulated from each other, but that they can be connected together in any desired groups by wires passed under or around the bushings, 32. In connection with the card just described the bushings, 32, are connected together in rows across the card as shown in the diagram figure 12, each series being connected with a counter, C.
 40 The cups, 2, are constructed and arranged as before described. There being one such cup for each pin, 31. In the present instance, however, the cups are connected in rows corresponding to the horizontal lines of the card, as shown in figure 12. The connections of the bushings being thus at right angles to the connections of the cups. Each row of cups terminates in a spring contact point as shown at 41, figures 12
 45 and 13. These contact points are arranged alongside of the metal cylinder, 42, which is provided with nine projecting ribs, 43, as shown. The cylinder, 42, is adapted to be rotated and the projecting ribs, 43, are of different lengths so arranged that in one rotation of the cylinder the first point will make one contact, the next two, the next three, *etc.*, until the last, which will make nine contacts. A circuit is completed from
 50 the metal cylinder, 42, through a suitable battery to the counters, C. The cylinder, 42, is normally in the position shown in figure 13, in which none of the points are in contact with it.

If a punched record card, as just described, is now placed in the press, and the handle brought down, it will be seen that no circuit will be closed, but if, while the
 55 handle is held down, the cylinder, 42, will be rotated, it will be seen that the circuit will be closed through the given counter from one to nine times according to the location of the corresponding punched record hole in the card. If a number of such

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record cards are successively treated in this manner, it will be seen that each counter will show the sum of all the digits in the given column from which, by a simple addition, the sum total of the various items can readily be obtained.

It is, of course, apparent that many modifications of the devices hereinbefore described can be arranged without departing from the spirit of my invention. Thus indentations or depressions may be formed in the card to effect through intermediate mechanism the desired control of the circuit closing devices. Again, if desired, cards or strips can be used in which all the spaces are punched and the record made by pasting small seals over, or otherwise suitably covering certain of the holes corresponding to the given record. Such a modification is illustrated in figure 14. Many other modifications can readily be made by those skilled in the art to which my invention relates.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is :

1. The herein described improvement in the art of compiling statistics, which consists in first forming or arranging a standard or template 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.

3. The combination with perforated sheets of electrically non-conducting material, said perforations representing statistical items, of electro-magnets and mechanical counters in circuits controlled by said perforated sheets ; substantially as and for the purpose specified.

4. The combination with a series of electro-magnets and the series of mechanical counters actuated thereby, said electro-magnets being arranged in circuits controlled by relays, of a perforated sheet of electrically non-conducting material, said perforations representing statistical items controlling the circuit through the electro-magnets of the relays above referred to, substantially as and for the purpose described.

5. In a system such as described for automatically compiling and recording statistics, the combination with a series of electric circuits, a series of electro-magnets connected thereto, a recording mechanism for each electro-magnet, and a series of circuit breakers controlling the flow of electricity in the before-mentioned circuits, of a movable record strip provided with means such as described for actuating the circuit breakers, whereby each item or combination of items represented upon said record strip are automatically distributed and recorded ; substantially as described.

6. The improvement in the art of compiling statistics, which consists in first assigning to each item entering into the proposed series of compilations one or more designated points or spaces ; secondly, forming a complete record of each individual or subject upon a single card by applying a circuit controlling index point or points to each space appropriated to or indicative of each separate item in the given series which pertains to the individual or subject ; and finally feeding said cards

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successively to an apparatus operated by the index points on each card to designate the particular division to which it belongs, and depositing each card in a place or receptacle corresponding to the division thus indicated ; substantially as described.

5 7. The hereinbefore described improved system for compiling statistical matters, consisting essentially in the combination with a series of circuits and operating electro-magnets and a series of pins controlling said circuits, of a series of separate record cards, each card bearing circuit controlling index points indicative of items characteristic of an individual or subject.

10 8. The combination, to form a system for compiling statistical matters, as hereinbefore described, of a series of separate cards, each card bearing a series of index points representing the items or characteristics of one individual or subject ; an apparatus provided with a series of circuit controlling devices corresponding and co-operating with the index points on the cards, a system of electro-magnets connected to said pins or circuit controlling devices, and a series of operating electro-magnets
15 forming part of said system ; substantially as described.

9. In a system such as described, the combination with a record card or strip, circuit controlling devices and a system of circuits connected thereto, of operating magnets controlled by said circuits and a series of boxes provided with lids controlled by said operating magnets ; substantially as described.

20 10. In a system such as described, the combination with separate record cards, circuit controlling devices co-operating with index points on the cards, a system of circuits, one or more boxes or receptacles for cards, a movable lid or section controlling the entrance to each box or receptacle and actuating devices for the movable lid or section, said devices being controlled by the index points on the record cards to
25 designate the proper receptacle for each card ; substantially as described.

30 11. In a system such as described, the combination with the perforated record cards, and a system of circuits controlled thereby, a bed plate and platen between which the cards are successively fed, a series of yielding pins mounted upon the platen and a corresponding series of mercury cups in the bed plate ; substantially as described.

12. The combination with a perforated record card, of a circuit closing device controlled by said record card, electro-mechanical counters in circuit with said circuit closing device and an integrating device, substantially as described.

35 13. The combination with a perforated record card, of contact points adapted to form electric circuits through the perforations of said record card, electro-mechanical counters in circuit with said contact points and an integrating device adapted to transmit one or more electrical impulses to said counters according to the value of said record punch marks.

Dated this 8th day of January 1889.

40

W. P. THOMPSON & BOULT,
Agents.

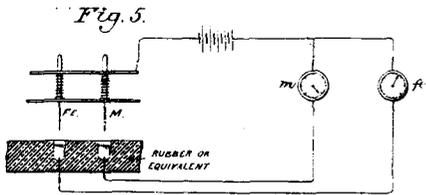


Fig. 5.

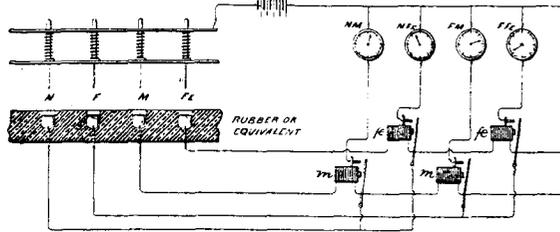


Fig. 6.

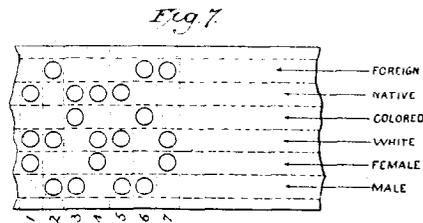


Fig. 7.

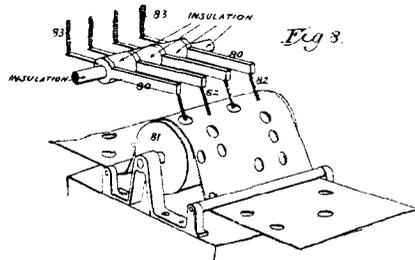


Fig. 8.

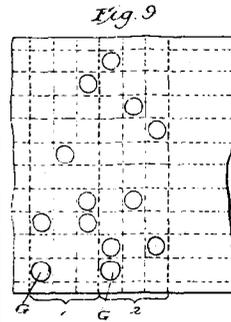


Fig. 9.

Fig. 10.

WAGES					MATERIAL				
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

Fig. 10.

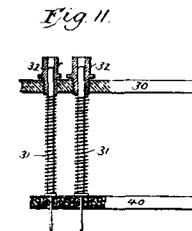


Fig. 11.

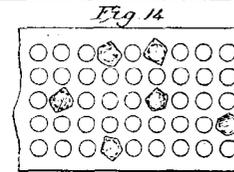


Fig. 14.

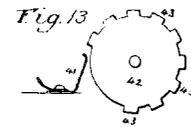


Fig. 13.

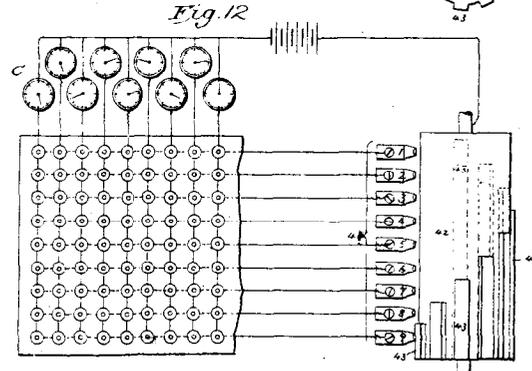


Fig. 12.

Fig. 1.

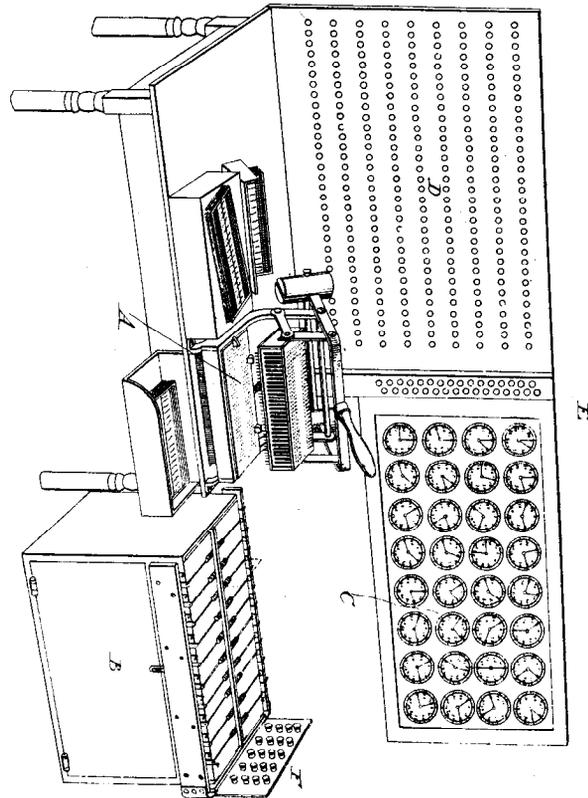
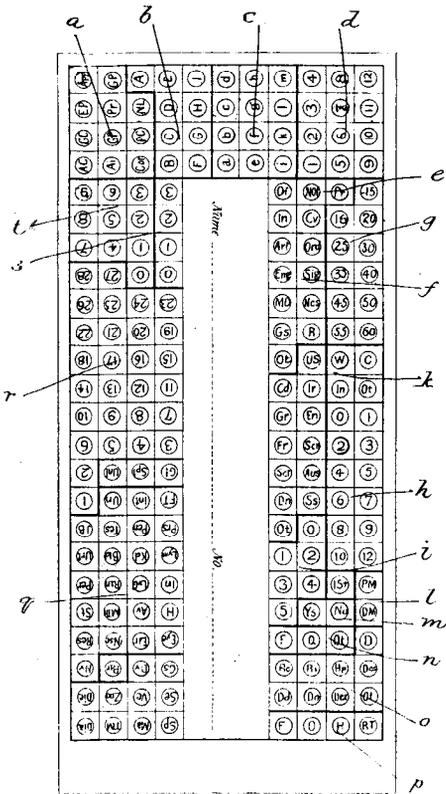
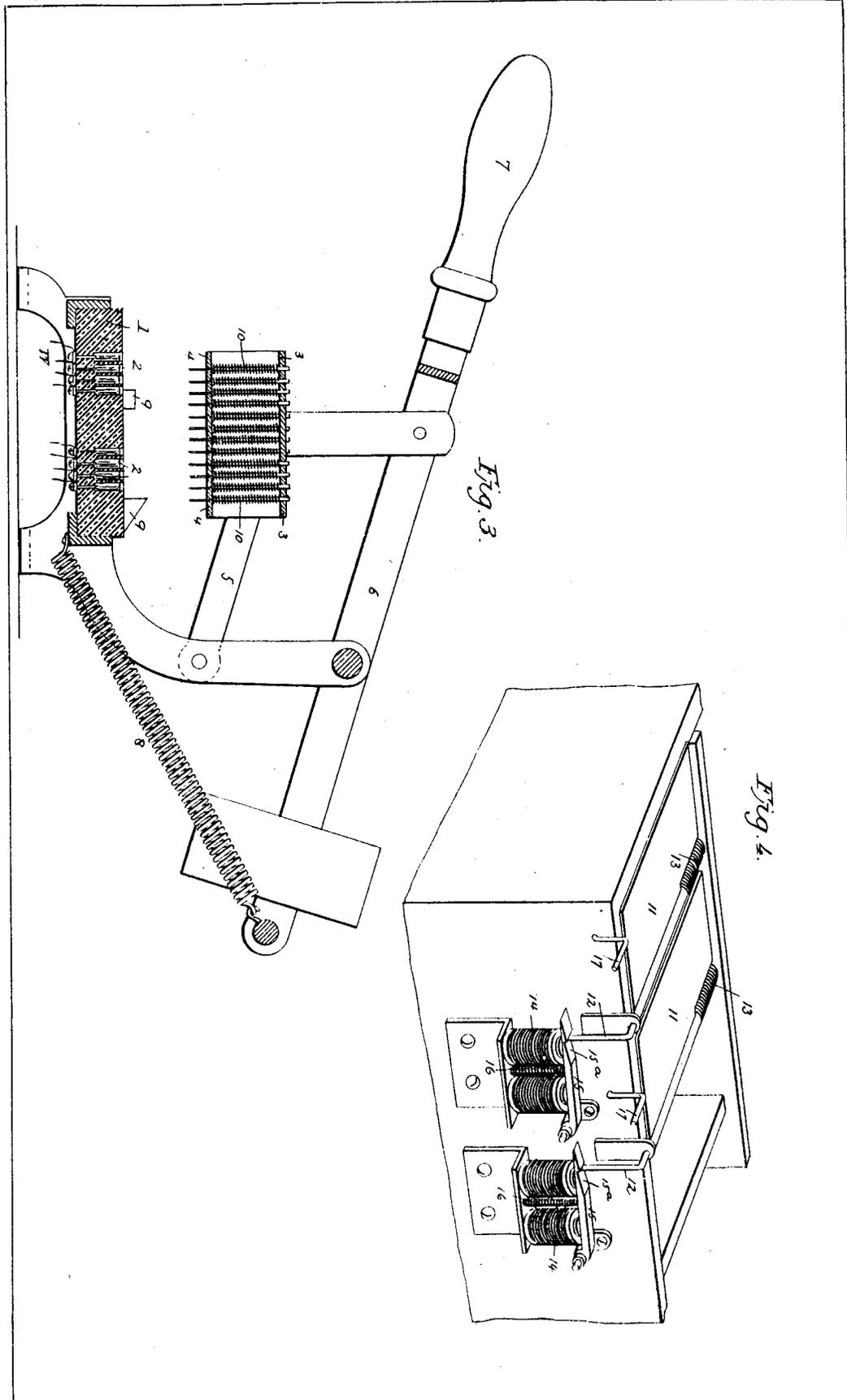


Fig. 2.

[This Drawing is a full-size reproduction of the Original.]



[This Drawing is a reproduction of the Original on a reduced scale]