

(No Model.)

5 Sheets—Sheet 1.

H. HOLLERITH.
ELECTRICAL CALCULATING SYSTEM.

No. 518,604.

Patented Apr. 24, 1894.

Fig. 1.

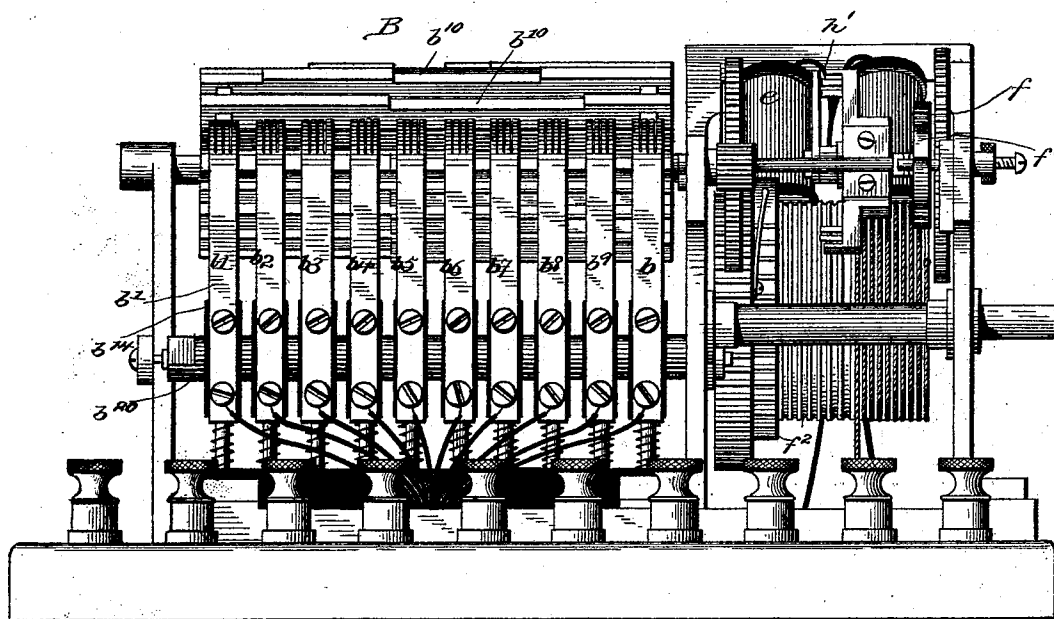
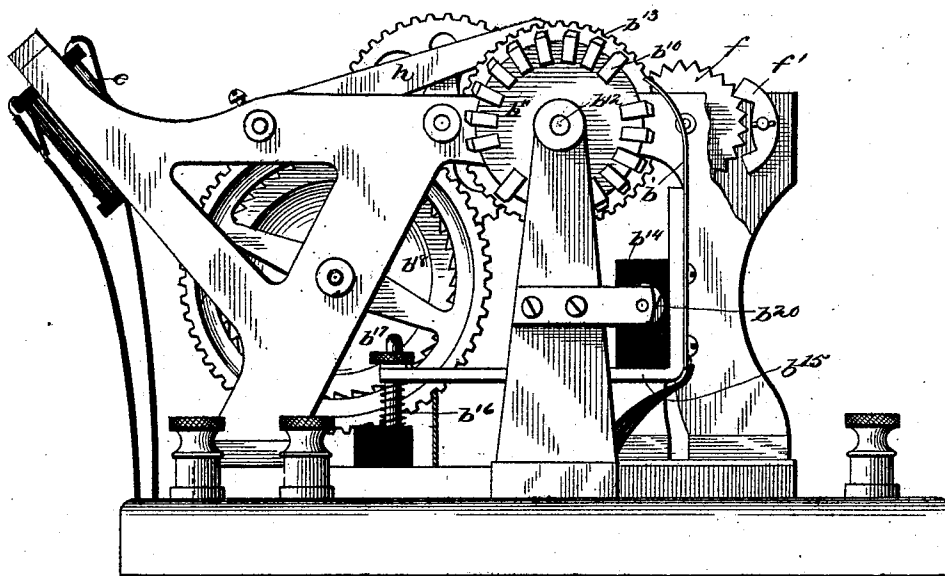


Fig. 3.



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(No Model.)

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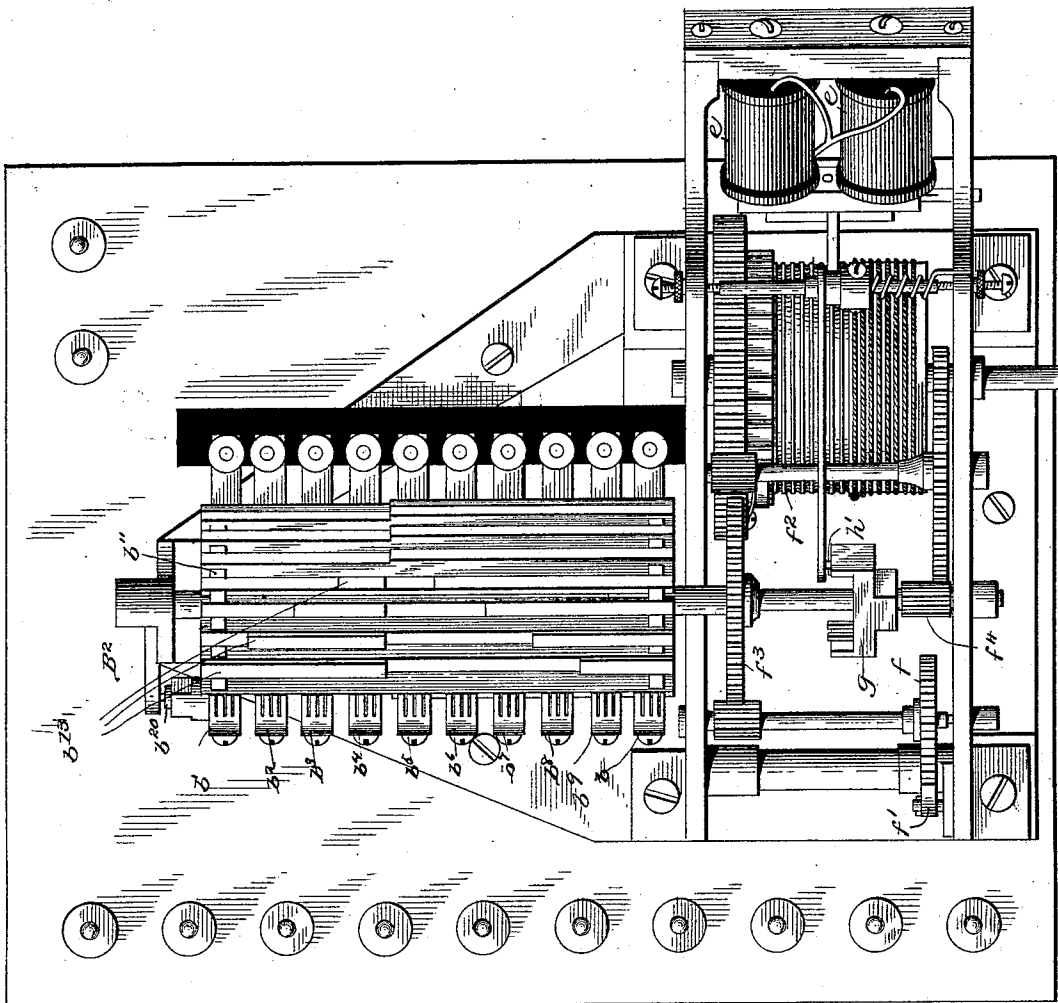


Fig. 2.

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(No Model.)

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Fig. 4.

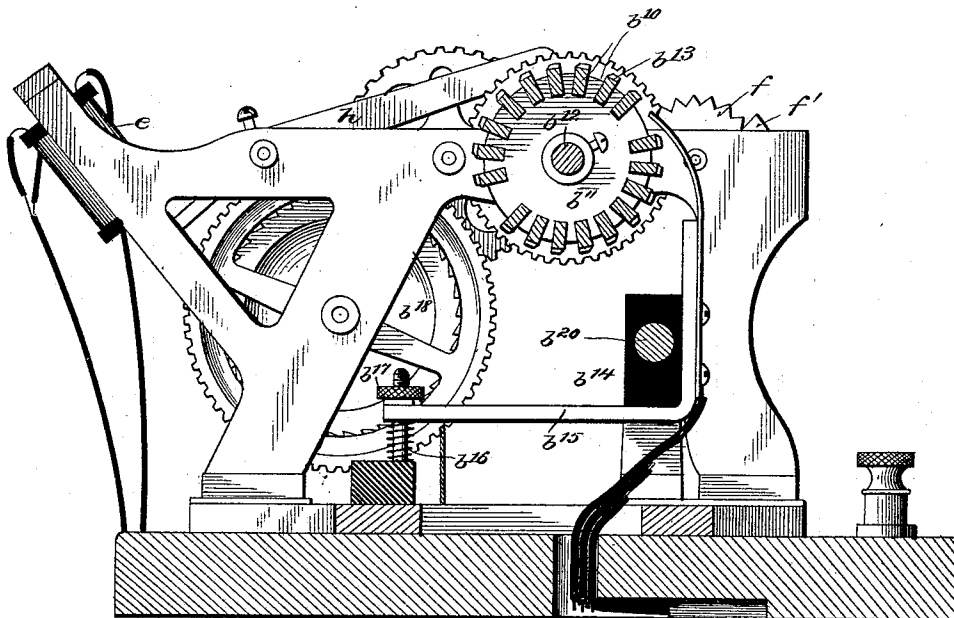
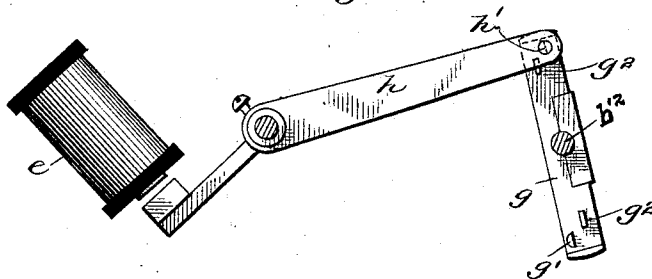


Fig. 5.



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(No Model.)

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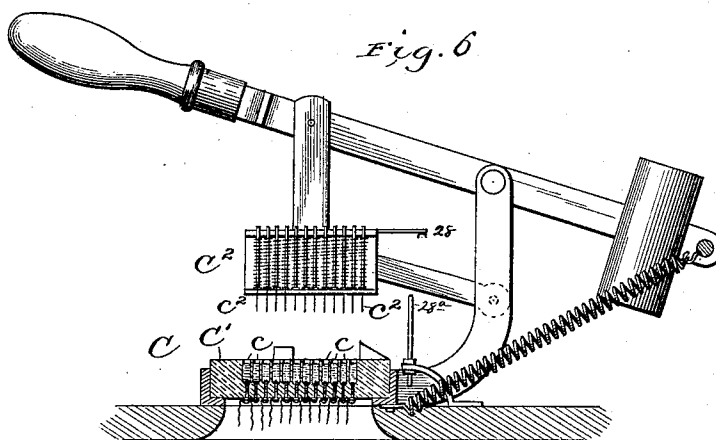
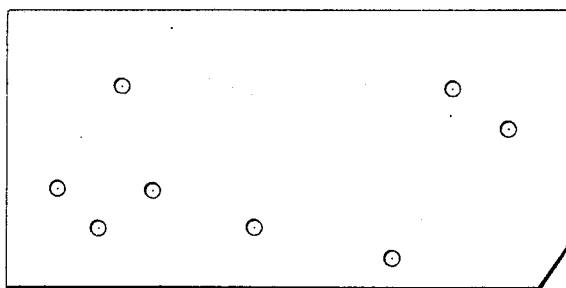


Fig. 8.



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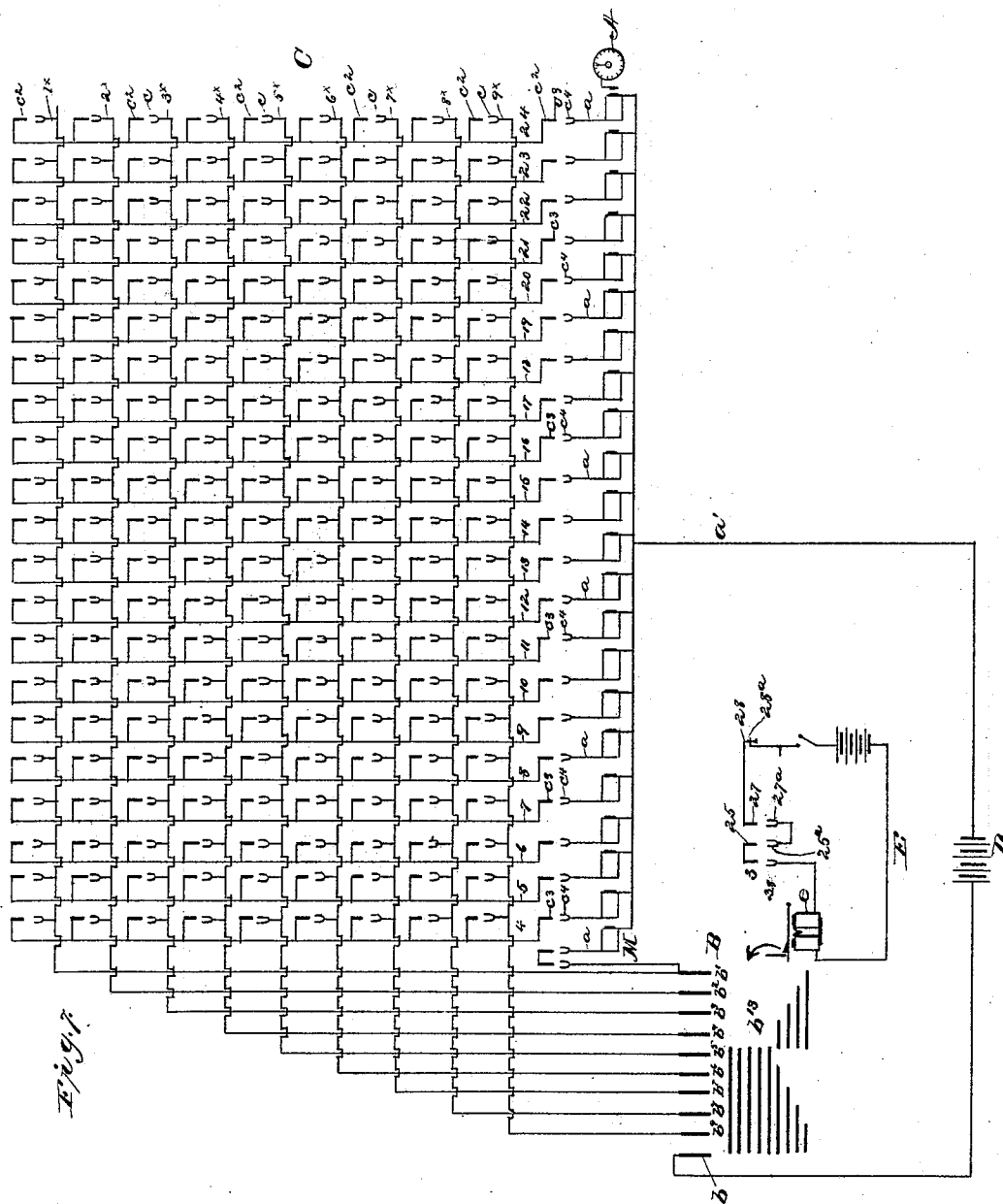
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UNITED STATES PATENT OFFICE.

HERMAN HOLLERITH, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTRICAL CALCULATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 518,604, dated April 24, 1894.

Application filed December 9, 1892. Renewed September 22, 1893. Serial No. 486,255. (No model.)

To all whom it may concern:

Be it known that I, HERMAN HOLLERITH, of Washington, District of Columbia, have invented certain new and useful Improvements in Electrical Calculating Systems; 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.

This invention relates primarily to improvements in the electrical and mechanical features of a calculating system, such as that patented to me June 24, 1890, No. 430,804, and it consists in certain new and improved forms, combinations and arrangements of the elements comprising the integrator and switching mechanism and the circuit connections, all as hereinafter fully described and pointed out.

Referring to the accompanying drawings: Figure 1 is a front elevation; Fig. 2 a top plan view; Fig. 3 an end elevation, and Fig. 4 a sectional view of my improved integrator. Fig. 5 is a detail view showing arrangement of trip mechanism. Fig. 6 is an end view partly in section of the switch mechanism. Fig. 7 is a diagrammatic view showing arrangement of contacts and circuit connections. Fig. 8 illustrates a record card prepared for application to the switch mechanism.

Similar letters and numerals of reference in the several figures indicate the same parts.

The present system includes the three principal or characteristic features of my prior patented system, to wit, a series of electrically controlled counters or registers A, each included in a separate circuit or branch; an integrator B, capable of producing in each of a series of conductors a different series of electrical impulses or interruptions; and a switch mechanism C controlling communication between the several conductors of the integrator and the several registers.

The switch mechanism is actuated to automatically set the designated circuits by means of a record card provided with perforations, disposed according to a prearranged plan, and interposed between the sections of the switch

mechanism, all substantially as explained in my before mentioned prior patent.

My improved switch mechanism C is patented after the one described in my patent, No. 395,781, in that it is composed of a fixed bed plate C' provided with insulated contacts or terminals *c* in the form of mercury cups or equivalent contacts, and a movable platen C² carrying yielding pins or contacts *c*². The movable platen is provided with suitable guiding and supporting means, and is held normally retracted, while a lever or other actuating device is arranged for advancing the platen, to project the contacts *c*² toward and into engagement with the contacts *c*. The record card is interposed between the two sets of contacts *c*, *c*² so that as the platen is advanced only those of the movable contacts or pins *c*² standing in line with perforations in the record card will be permitted to engage contacts *c*, and thus close the circuits with which they are connected, all other contacts being held back and the circuits open by the interposition of the material of the record strip or card.

The contacts *c* are electrically connected in groups numbered 1^x to 9^x inclusive (see Fig. 7) and the contacts or pins *c*² are also connected in groups numbered 4 to 24 inclusive, there being at least nine contacts *c*² in each group so arranged and disposed that one contact of each of said groups will be opposite one contact *c* of each group 1^x—9^x. Each group of contacts 1^x—9^x is connected to one of the contacts *b*¹—*b*⁹ of the integrator B, while each group of contacts 4—24 is connected to the circuit wire or conductor *a* of one of the registers A, the opposite ends of the several register circuits being connected to a conductor *a'* containing a generator D and terminating at a contact *b* of the integrator. Instead of forming permanent connections between groups 1^x—9^x (the movable contacts of the switch) and the several register circuits *a*, the former terminate in pins or contacts *c*² carried by the movable platen and co-operate with contacts *c*⁴ in the bed plate, said contacts lying outside the record card, when in place, so as to always close the circuits whether any of the other contacts in the same group are per-

mitted to pass the card or not. This arrangement is much better than one in which the connections between the contacts upon the movable platen and the register circuits are made through more permanent though flexible conductors, as it avoids the necessity for connecting and fastening the conductors, obviates breakage of the connections, and facilitates the removal and replacement of the platen.

It is essential that the record cards should be properly located in position beneath the movable platen before the latter is depressed, as otherwise the perforations designating the values or other items pertaining to that record will not be brought into position to actuate the corresponding contacts of the switch mechanism. In my prior patent end and side gages were provided for this purpose, but experience has demonstrated that even with such aids the record cards are liable at times to be displaced or improperly located, resulting in the production of false records or at the least imperfect ones. Experience has also shown that when the circuits are completed and interrupted, that is to say, when the final closing and opening of the circuits through the generator is accomplished by the insertion and withdrawal of the pins or contacts carried by the movable platen, the sparking which takes place upon the breaking of the circuits is not only destructive of the electrodes, but it tends to reduce their capacity for accuracy and certainty, the oxide interfering greatly and at times preventing contact. To overcome these and other defects incident to my earlier system, I provide the movable platen with four additional or supplemental contacts numbered 3, 25, 27, and 28, of which the three first have to do with the proper location of the record cards on or in the switch mechanism. Contacts 3 and 25 occupy positions along one edge of the platen, opposite the side gage or gages, and just beyond the margin of the record strip when in position; while contact 27 is located at one end just beyond the end of the record card opposite the end gage. As thus arranged if the record card is properly located it will not interfere with the descent of any of the contacts, but if shifted out of proper position, it will lie in the path of one or more of the contacts and prevent further advance on the part of the contact thus engaged. These three contacts 3, 24 and 27 are located in the same circuit, and all three must be in contact with the opposite electrodes or contacts 3^a 25^a and 27^a to close the circuit, hence if any one is held back the circuit will remain open and the apparatus inactive, as said contacts are located in what may be termed a master or starting circuit, which, in the present instance, includes the devices for setting in motion the integrator through which the several operating circuits extend. The contact 28 is also carried by the movable platen and co-operates with a contact 28^a on the base; it, too, is located in the

master circuit and is adjusted to effect the final closing and first opening of the circuit in which it is located, so that all the sparking in that circuit will occur at this one point where it can be most easily controlled and its injurious effects provided against. In the present instance the contacts 28, 28^a are located in the circuit including the card positioning contacts 3, 25, 27, and the trip or starting mechanism of the integrator, but it might, with the same effect, be located at any point in the line between the generator and switch mechanisms for relieving and protecting the contacts thereof.

The integrator.—The integrator is an apparatus for producing in each of a series of conductors leading to groups 1^x—9^x a different number of electrical impulses of such form, duration and character as to affect the registering devices to advance them as many steps or units as there are electrical impulses sent over the particular circuit at the time including the particular register. In the present example the contacts *b'*—*b*⁹ representing terminals of the groups of contacts 1^x—9^x are arranged to be engaged intermittently by a series of contacts or bars *b*¹⁰ on a cylinder B², a contact *b* constituting the opposite terminal of the circuit or circuits co-operating with said contacts to alternately close and open the circuit through the generator. The contacts *b*¹³, of which two or more sets are arranged upon the one cylinder, for convenience, comprise a series of bars of conducting material secured in heads *b*¹¹ and mounted upon a shaft *b*¹² supported in bearings. The bars or strips are each provided with protuberant portions or sections *b*¹³ forming the contacts, and they are so arranged and disposed that at least six of the contacts will bear at the same time upon the contacts *b'*—*b*⁹, thus producing a more uniform action or resistance to the rotation of the cylinders. The contacts *b*¹³ are so arranged and disposed upon the cylinder that during a complete movement thereof, *i. e.*, a complete or partial rotation, contact *b'* will be engaged by but one of said contacts *b*¹³, contact *b*² by two contacts, *b*³ by three and so on throughout the series, the last contact *b*⁹ being engaged by nine contacts *b*¹³. To equalize the resistance to rotation the contacts *b*¹³ are so arranged that the first five will engage contacts *b*⁵ to *b*⁹ inclusive; after this fifth contact the series on the left diminish in length, and, at the same time, a new series of gradually increasing length is begun on the right. Thus as *b*⁵ passes off having completed its series, *b*⁴ begins to contact, and as *b*⁷ drops off during the next period of advance, *b*³ comes on and so on as one is dropped, having completed its series, another takes its place.

The ultimate effect produced by one complete movement of the integrator is the same as in my prior patent, No. 430,804, that is to say, the current entering through contact *b*¹³ is transmitted, intermittently, through the

contacts $b'-b^9$, and each of said last named contacts receives a different number of electrical impulses, the series including from 1 to 9. If, now, any of the circuits through the switch mechanism are closed through the registers, the latter will be advanced as many points as there are pulsations produced in its circuit; and the number of pulsations is governed by the record card which places any one of the contacts $b'-b^9$ in communication with any one of the registers.

The contacts $b'-b^9$ are conveniently mounted and adjusted as follows: Upon a shaft b^{20} are pivotally supported a series of insulating blocks or sections b^{14} , to each of which is secured a lever b^{15} carrying a metallic strip or brush whose end is in position to be engaged by the contacts on the cylinder B^2 . The rear end of the lever b^{15} is upheld by a spring b^{16} against an adjusting nut b^{17} traversing a bolt b^{18} mounted in or upon an insulated support. By turning the screw or nut the lever is depressed, to advance the brush, the spring serving to hold the lever against the adjusting member, and causing it to follow the latter as the same is retracted. The cylinder B^2 stands normally with the contacts $b'-b^9$ opposite the space between contiguous strips or contacts b^{11} , the circuits through the switch and registers being thereby opened, and before the integrator is started into action the switch mechanism is operated to close the appropriate circuits through the registers, remaining in this position until the integrator completes its movement and is again arrested. The sparking resulting from the alternate closing and opening of the circuits, all takes place between the contacts of the integrator, which, being movable one upon the other, are thus kept free from oxide and in operative order.

It is desirable that the integrator should be put in action as soon as the desired circuit connections shall have been made in or by the switch mechanism, and to accomplish this result, automatically, I have supplied it with a detent or starting and stopping mechanism and placed the latter under the control or in connection with the switch mechanism, so that when the switch is operated to set the circuits the integrator will be at once set in action.

An actuating or master circuit E supplied with current from a generator and including an actuating electro-magnet e is provided with a contact maker whose movement is controlled by the platen of the switch or some part connected therewith, so that when the platen is actuated to close the switch circuits the actuating or master circuit will be affected in a manner to cause the release and advance of the integrator cylinder. In the present example contact 28 is arranged to perform this office, and it may operate either in conjunction with or independent of the gage contacts 3, 25, and 27. It will be remembered that contact 28 is arranged to close with

its opposite contact 28^a after all the other contacts have closed, consequently the actuating circuit will not become operative to start the integrator until after the register circuits have first been closed through the switch; nor will the actuating circuit be closed unless the cord is properly placed, owing to the arrangement of the card gages 3, 24 and 27 in the actuating circuit.

Any appropriate form of motor and detent for the integrator cylinder may be employed, and I have illustrated, as an example, a train of gearing governed by a scape wheel f and pallet f' and driven by a weight suspended by a cord from a drum f^2 . Gears f^3, f^4 of the gear train are in this example secured to the shaft b^{12} of the integrator cylinder. The detent mechanism is, also, connected to shaft b^{12} , and comprises a cross head g provided with two sets of pins or stops g' located at different distances from the center and one in advance of the other. An armature lever h pivoted in the frame and provided with a retracting spring, bears at or near its outer end a stop or shoulder h' standing normally in the path of the rear and outermost pin g' of each set, and movable, under the influence of the electro magnet e , into the path of the inner and forward pin g^2 . The electro-magnet e is included in the actuating or master circuit and when energized it draws the armature lever toward it thus withdrawing the stop h' from in front of the rear pin g' and permitting the motor to advance the integrator cylinder until the inner and foremost pin g^2 of the next set makes contact with stop h' and thus arrests the motion of the train and cylinder. By this time the register for the card in the switch has been completed, and the platen is raised for the removal of said card and the insertion of another. The raising of the platen opens the actuating or master circuit, and the armature lever being released is thrown back into position to again engage the rearmost and outer pin g' thus permitting the cylinder to advance the distance between the two pins, but no farther. The intervals or spaces between adjacent series of contact bars b^{11} may be made somewhat wider than between the individual bars of the series, to accommodate the extra motion of the cylinder when the stop passes from the front to the rear pin, it being understood that at such time the contacts $b'-b^9$ are removed from the bars or contacts on the cylinder and no current is passing.

Other or equivalent forms of motor and detent mechanism can readily be applied in lieu of that shown, the principle involved in my invention contemplating the use of an adequate motor for propelling the integrator and starting and stopping means controlled by the switch mechanism.

Before illustrating the working of the system it may be noted that the number of registers and groups of contacts c^2 employed at one time or in effecting a given series of com-

putations may be increased or diminished at will, and that the series shown are adapted to be sub-divided into any desired number or series. Thus the groups 4, 5 and 6 may represent the hundreds, tens and units of one table, while the groups 7, 8, 9 and 10 may represent the thousands, hundreds, tens and units of another, according to a prearranged plan of division carried out in the punching of the record cards or strips; it being understood that the record card or strip, whether containing representations of one or more distinct series of computations, is to be of such dimensions as to cover the switch plate.

Assuming for convenience of description that groups 4, 5 and 6 only are to be employed, and that the perforations in the record card indicate 562. When the record card is placed in position in the switch, all of the contacts c^2 will be covered except the one in group 5^x, opposite contact in group 4; one in group 6^x opposite contact in group 5; and one in group 2^x opposite contact in group 6. The record card being properly placed the platen of the switch is depressed, with the result of closing the circuits between contact b^5 and register magnet of group 4; between contact b^6 and register magnet of group 5; and between contact b^2 and register magnet of group 6; at the same time the gage contacts 3, 25 and 27 will be closed in actuating circuit. No current will however flow over any of the circuits named until, by a further movement of the platen, the actuating or master circuit is closed at 28. As soon as this takes place the defent is shifted and the integrator is set in motion; during its excursion contact b^5 will be engaged five times, contact b^6 six times and contact b^2 twice, thus producing in the electro-magnet of group 4 five electrical pulsations, in group 5 six, and in group 6 two, thus adding 5 on the hundreds register, 6 on the tens register and 2 on the units register.

It is frequently of advantage to preserve a record of the number of cards or strips which pass through the switch mechanism. A separate register and electro-magnet M is employed for this purpose, and is placed in connection with contact b' of the integrator through connected contact points 1, 2, on the platen co-operating with opposite contacts on the bed plate. This register does not record the number of times the platen of the switch is depressed, for that operation by itself is insufficient to affect the register; but it registers the total number of movements of the integrator and is actuated from the switch, hence it registers the total number of registrations or computations effected through the instrumentality of the integrator.

Having thus described my invention, what I claim as new is—

1. In a system, such as described, provided with an integrator and a switch mechanism controlling the circuits operated upon by the integrator, the combination therewith of actuating devices governing the movements of

the integrator, said actuating devices being controlled in their application by the movements of the switch-mechanism, whereby the circuit connections are established and the integrator put in action by or from the switch mechanism; substantially as described.

2. In a system, such as described, the combination of an integrator provided with a movable section or part arranged to operate upon or through a series of circuit connections, to produce in each circuit a different number of electrical impulses; a motor for driving the movable section of the integrator; a series of registers; a switch mechanism controlling the circuit connections between the registers and integrator, including movable and fixed contacts and a perforated record card or strip; and a master or actuating circuit controlled from the switch mechanism and provided with starting devices for inaugurating the movement of the integrator; substantially as described.

3. In a system, such as described and in combination with the integrators, the registering devices, and a switch mechanism operated by a record card or strip to set the circuit connections between the integrator and registers, a motor for advancing the movable section of the integrator, and a stopping and starting mechanism controlled by an electro-magnet in a master circuit; substantially as described.

4. In a system, such as described, and in combination with the integrator, and the switch mechanism provided with movable contacts for setting the circuits leading from the integrator, actuating devices controlling the movements of the integrator, a master circuit including an electro-magnet operating upon said actuating devices, and a switch or movable contact in said master circuit operated to close said circuit and start the integrator after the switch mechanism has set the circuit connections, substantially as described.

5. In a system, such as described, the combination of the integrator provided with a movable section; a switch mechanism controlling the circuit connections with said integrator and provided with a movable platen or section carrying a series of contacts or contact actuating devices; a motor for the integrator; a master circuit containing devices for controlling the motion of the integrator; and a contact carried or actuated by the movable section of the switch and operating to close the master circuit and start the integrator after the circuit connections have been established through or by means of the switch mechanism; substantially as described.

6. In a system, such as described, the combination with electrically operated registering devices, an integrator, and a switch mechanism intermediate the registers and integrator and controlling the circuit connections between the series of contact breakers of the integrator and the several registers through

the medium of a perforated record-card or strip, of a motor device controlled by the switch mechanism and operating to throw the integrator into action; substantially as described.

7. In a switching mechanism, such as described, the combination with the bed plate and its contacts, the movable platen carrying the series of groups of contacts, and the perforated record card or strip, of the register circuits or conductors connected to their respective groups of contacts through contacts carried by the platen and engaging contacts on the bed plate, the latter forming terminals of said registering circuits; substantially as described.

8. In a switch mechanism, such as described, the combination with the bed plate provided with a series of groups of contacts, a movable platen provided with a second series of groups of contacts, a perforated record-card or strip for controlling connection between the opposite groups of contacts, gages for locating two sides of the record card, and contact gages carried by the platen and co-operating with contacts on the bed plate beyond the edges of the record-card, said contact gages being arranged in a circuit controlling the operating circuits through the switch, and operating to arrest or prevent the passage of a current when the record card is not properly positioned, substantially as described.

9. In a system, such as described, the combination with an integrator, a switch mechanism provided with two series of groups of contacts, of which one series of groups is movable relatively to the other; circuit connections between one series of groups of contacts and the contacts of the integrator on the one side, and between the other series of groups and the registers on the other; and a perforated record card interposed between and determining connection between the contacts, of a master circuit including devices for starting the integrator; and gage contacts carried by the movable sections of the switch and controlling the master circuit; substantially as described.

10. In a system, such as described, the combination of the integrator; the registers; the switch mechanism intermediate the registers and integrator; the record-card; the master circuit controlling the integrator; the gage-contacts; and the circuit closer for the master circuit.

11. In a system, such as described, the combination with integrator; registers; switch mechanism operated by record-card; and motor for integrator controlled by master circuit; of the card counter or register located in a circuit controlled by the switch mechanism and receiving its electrical impulses from the unit contact of the integrator through which the circuit is completed; substantially as described.

12. In an integrating apparatus, such as described, the combination with the series of fixed independent contacts or brushes, of the movable section provided with graduated series of contacts bearing successively on an equal number of the fixed contacts but engaging each of the latter a different number of times, whereby the same number of fixed contacts will be caused to engage the contacts of the movable series each time contact is established between the two series, and, at the same time, each of the fixed contacts will be caused to engage in the aggregate a different number of the movable contacts thus equalizing the frictional resistance and producing a graduated series of electrical impulses, substantially as described.

13. In an integrating apparatus, such as described, the combination with the fixed and movable contacts, of a motor or propelling device acting continuously upon the movable section of the integrator, an arm provided with two stop pins located in different planes, a detent lying normally in the path of one of said stop pins and movable into the path of the other stop pin, and an electro-magnet controlling the movement of said detent; substantially as described.

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