

Nov. 17, 1942.

A. H. DICKINSON

2,302,009

TRANSMISSION SYSTEM FOR STATISTICAL DATA

Filed March 25, 1939

7 Sheets-Sheet 1

FIG. 1.

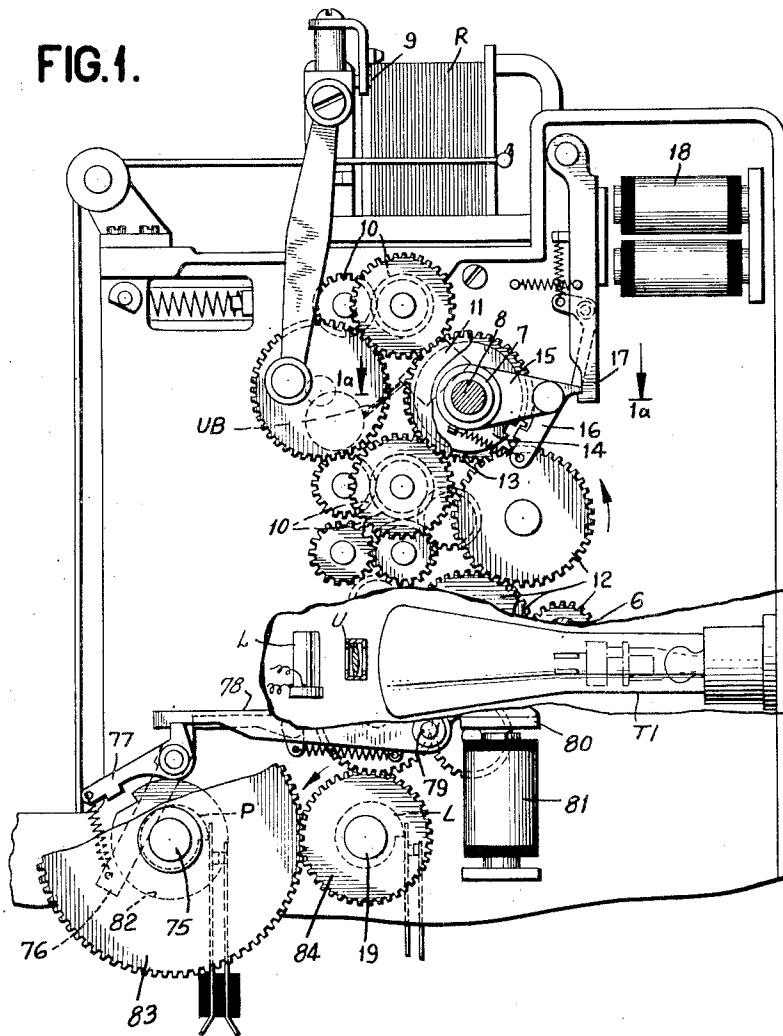
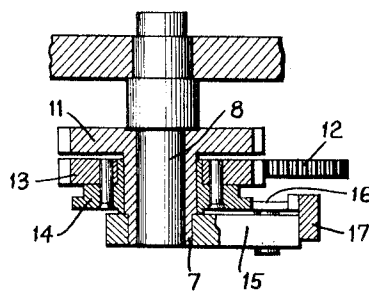


FIG. 1a.



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FIG. 6.

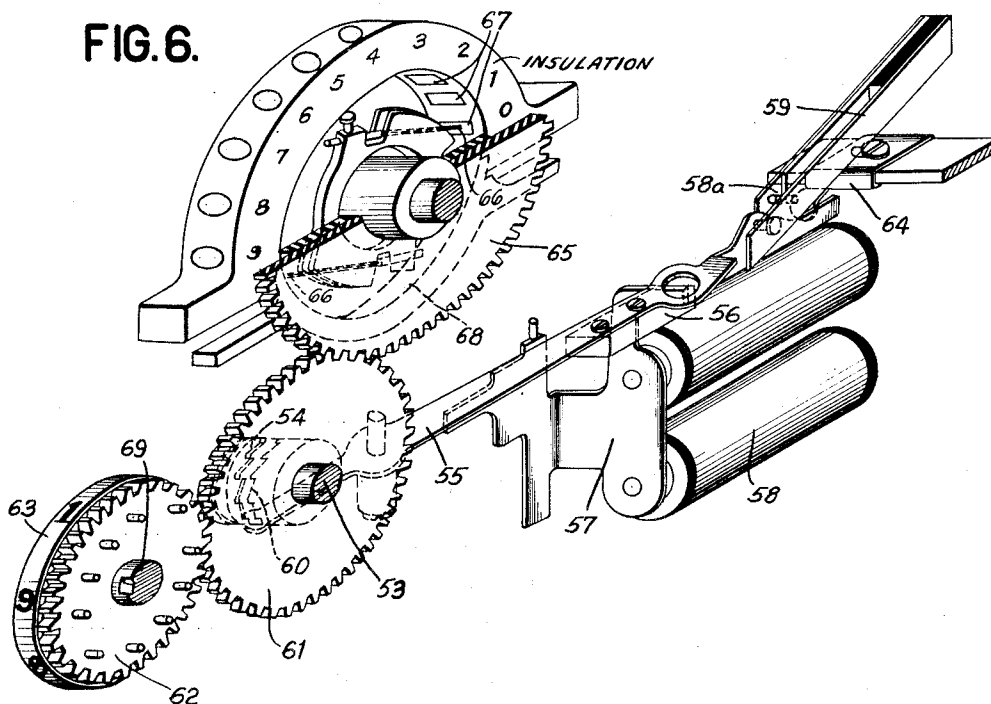
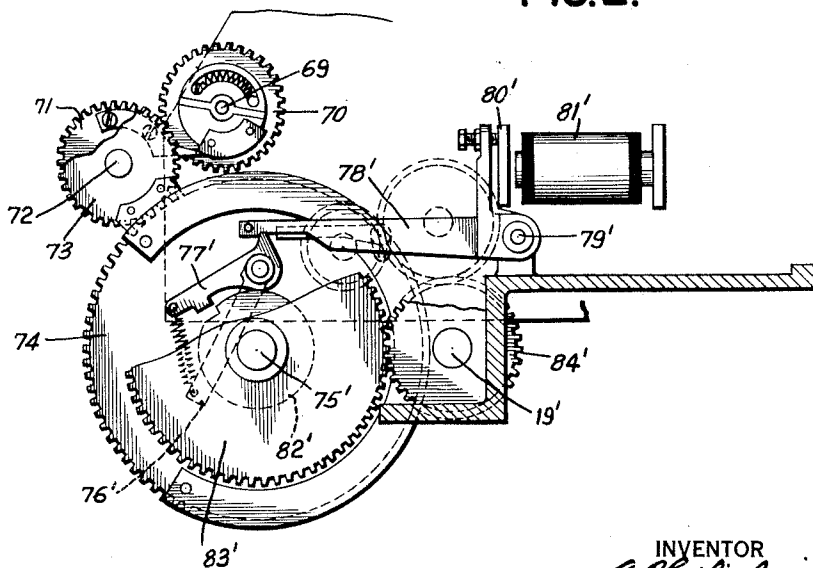


FIG. 2.



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FIG.3.

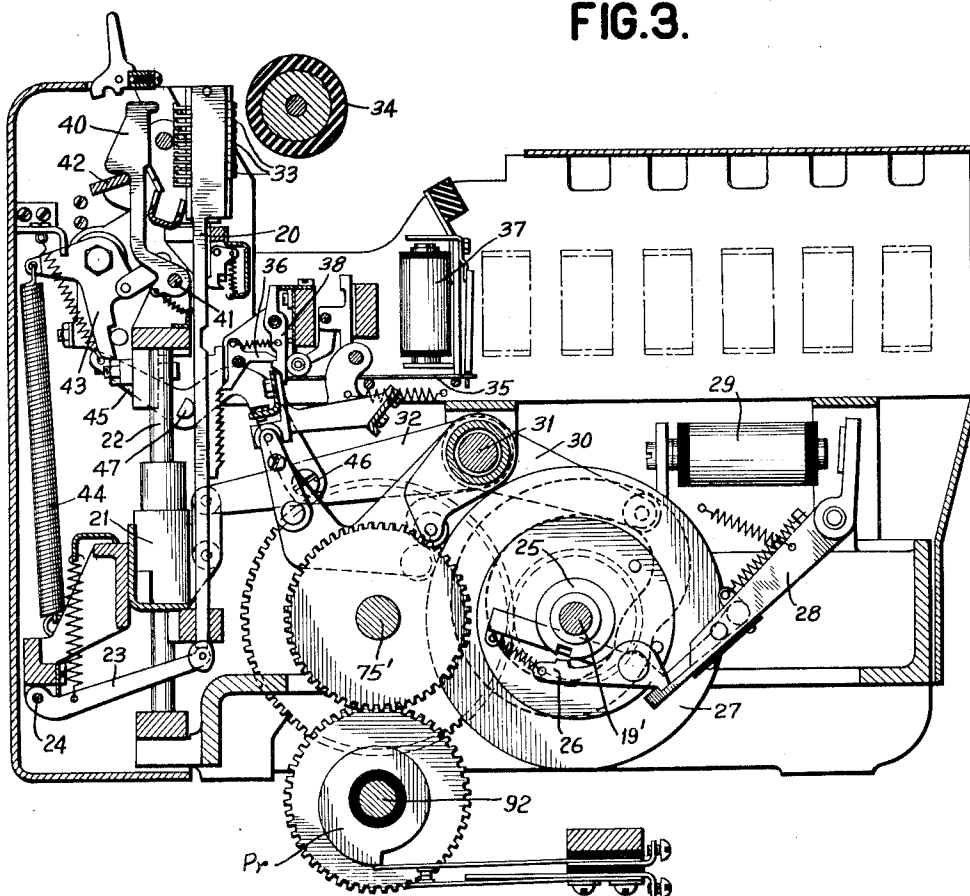
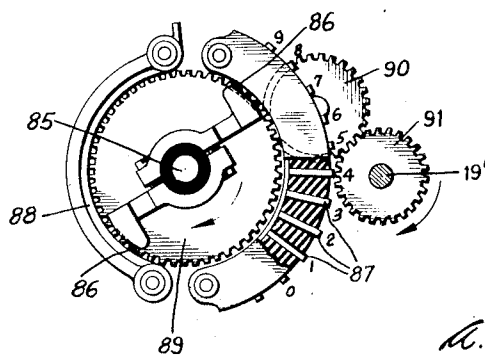


FIG.4.



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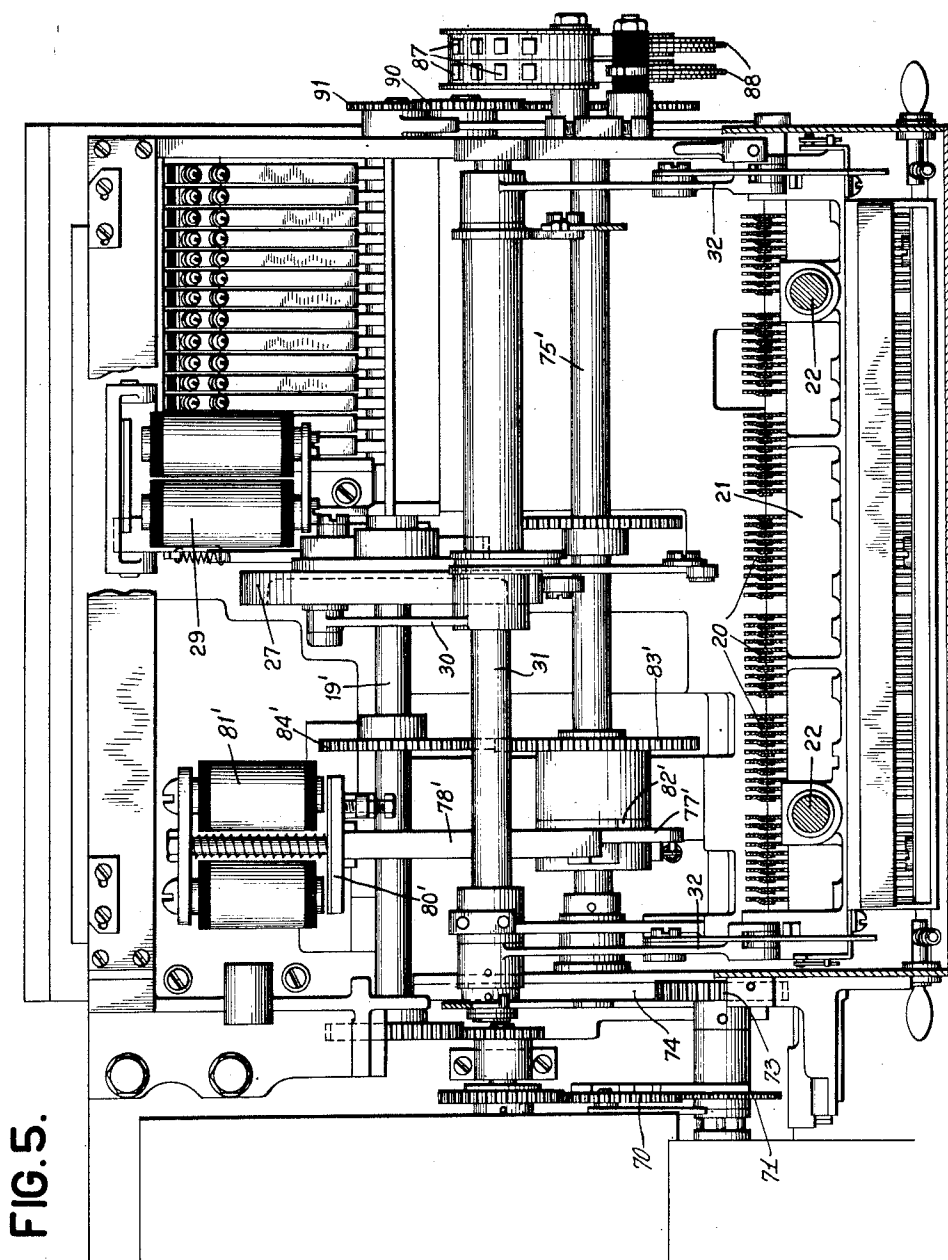
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TRANSMISSION SYSTEM FOR STATISTICAL DATA

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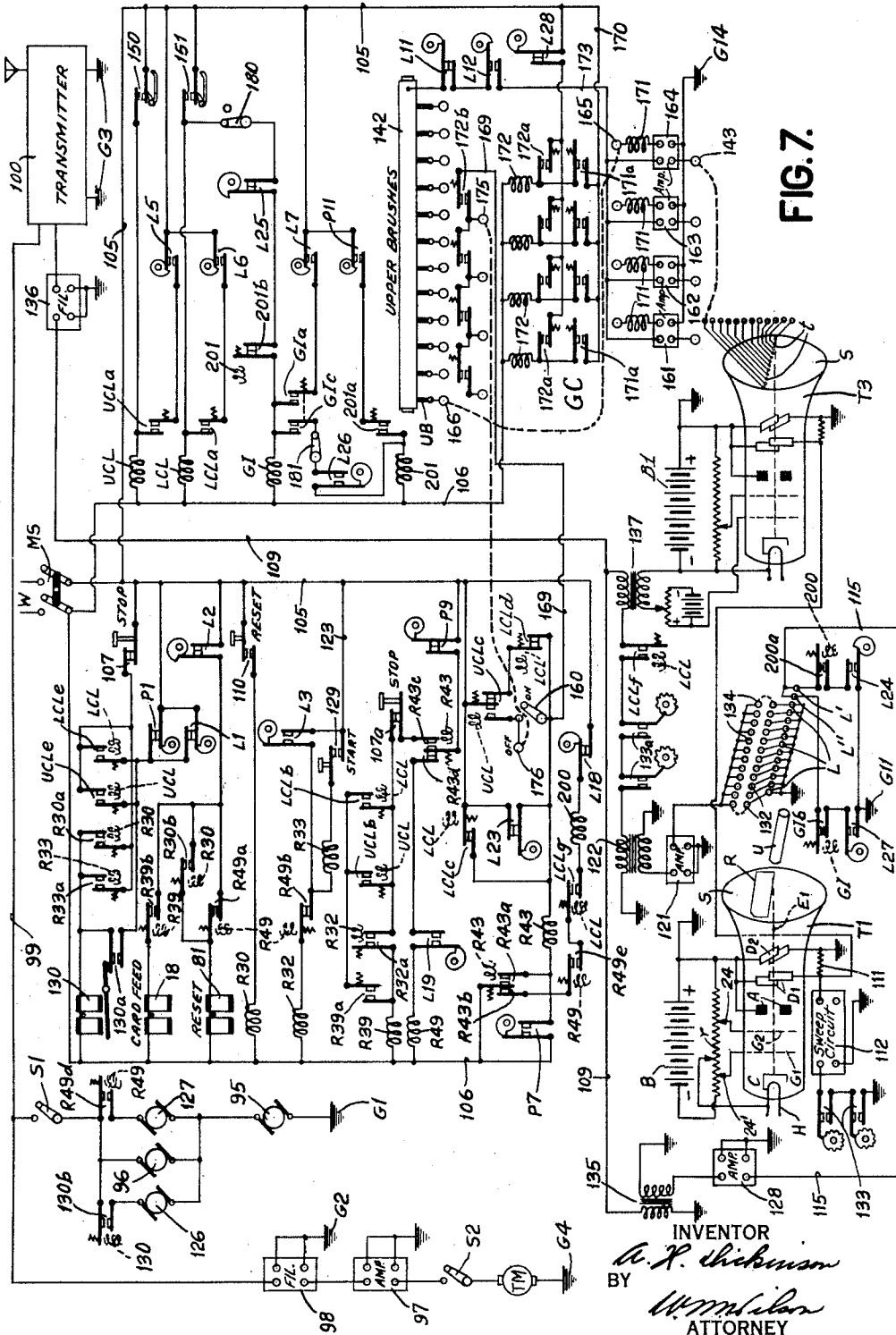


FIG. 7.

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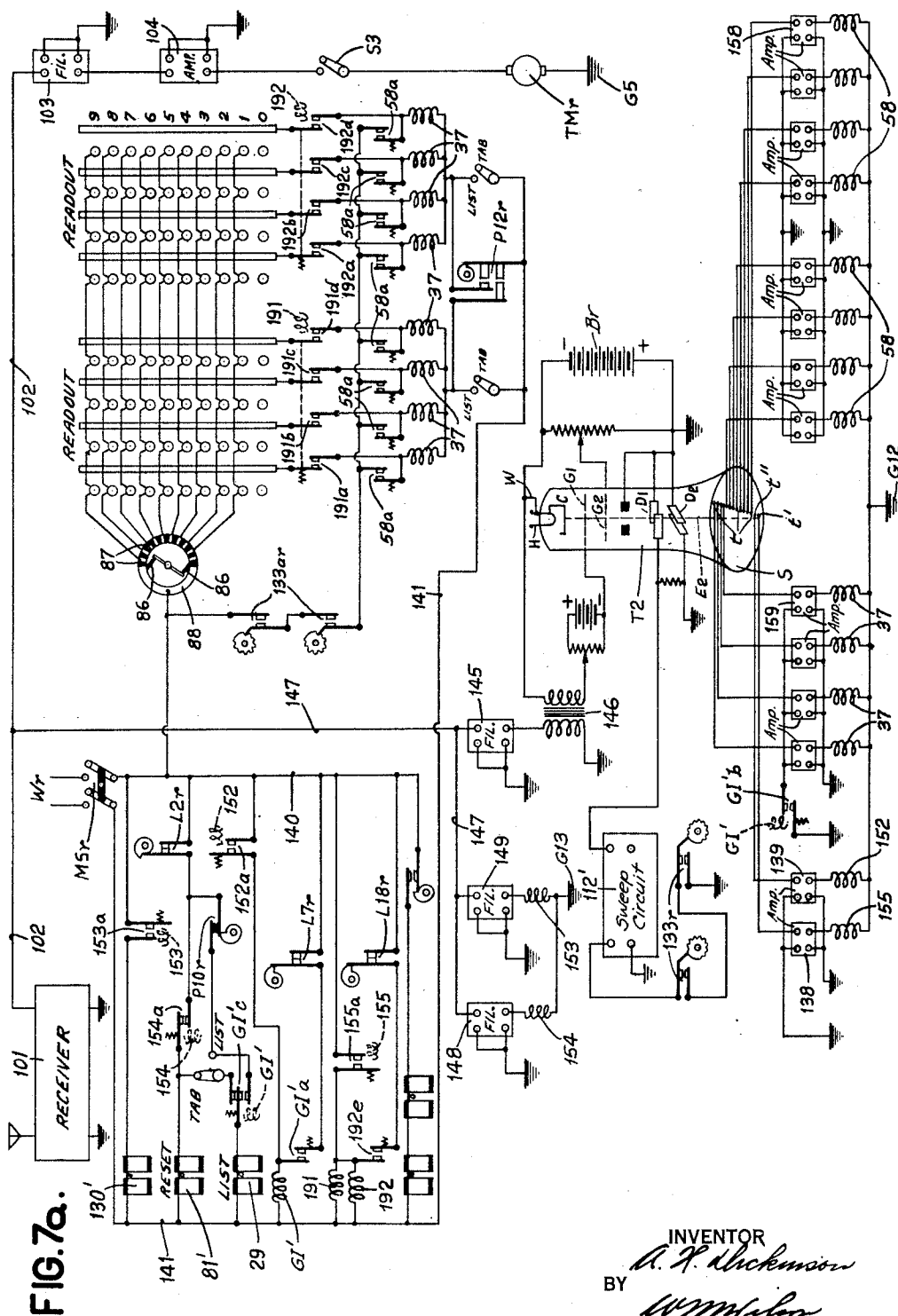
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FIG. 8.

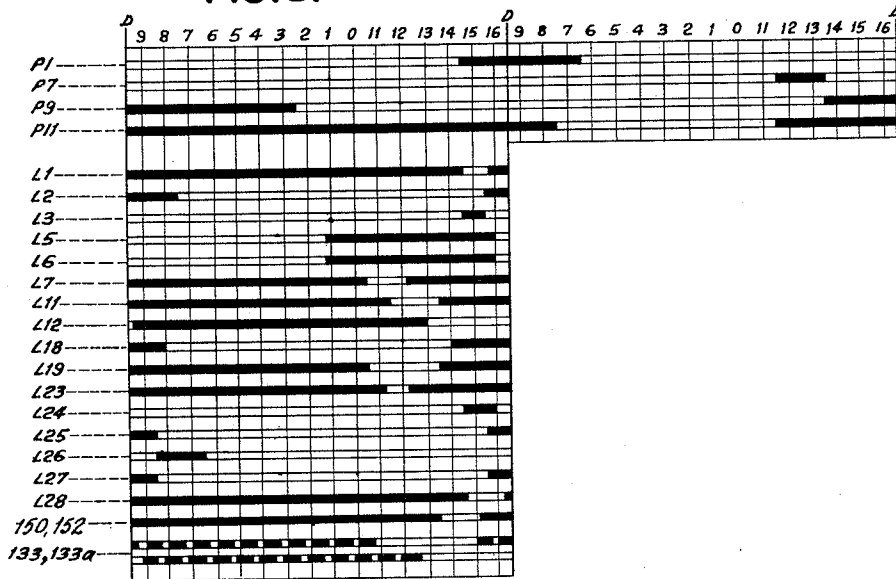


FIG. 8a.

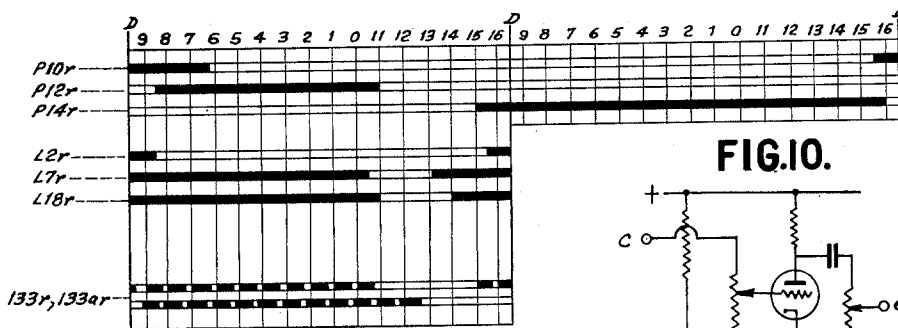


FIG. 9.

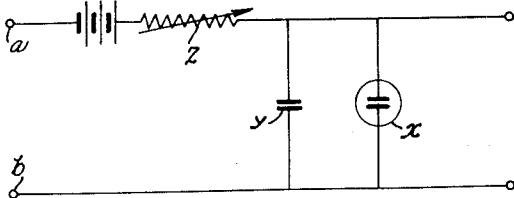


FIG. 10.

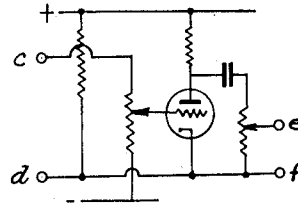
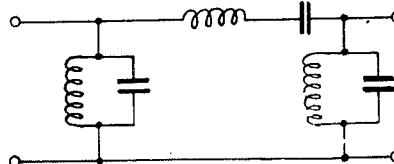


FIG. 11.



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TRANSMISSION SYSTEM FOR STATISTICAL DATA

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Application March 25, 1939, Serial No. 264,264

9 Claims. (Cl. 235—61.7)

This invention relates to transmission systems for statistical data and, more particularly, to systems of the type wherein data accumulating and recording units are provided at a secondary station to be operated in accordance with data transmitted from a primary station.

It is the general object of the instant invention to provide novel means for transmitting concurrently a plurality of orders of statistical data to a distant point over a single transmission system.

A more specific object of the invention resides in the provision for columnar separation of a plurality of columns of data to be transmitted by causing a cathode ray tube to scan such columns successively to effect concurrent transmission of data therein having the same numerical magnitude.

Another object is to provide means for effecting digit value separation of data on a record card in accordance with differential time while attaining columnar separation by causing a cathode ray tube beam to scan the columns of the card successively in a given digit value position during a predetermined time interval.

Still another object is to form a succession of impulses which are created by a sensing device and which by their time difference during the predetermined brief interval required to sense a given index point position in all the data columns of a record card represent such data columns, to transmit these impulses during the brief time interval, and to separate these impulses at a receiving station for controlling the operation of corresponding columns of the data accounting elements of an accounting machine.

A further object is the provision of means whereby impulses created by a sensing device during the sensing of one index point position of all the data columns of a record card are employed to modulate a carrier wave for transmission purposes, the impulse upon reaching a distant station being separated from the carrier wave and operated through an electronic distributor to effect operation of data accounting elements at that distant station.

A still further object is to provide record card control of the operations of a distantly located accounting machine in their proper sequence by employing a cathode ray tube at the controlling station to scan the card so as to create impulses and distribute the same for transmission and a synchronously operating cathode ray tube at the distant station for distributing the impulses to the various units of the accounting machine.

Another object of the instant invention is to

provide novel automatic group control means at the transmitter for comparing corresponding control columns of successive record cards for control indicia therein and to control, in accordance with such agreement or lack of agreement, an accounting machine at a distant point in its accumulating, total taking, and resetting operations.

It is within the contemplation of the invention to provide in cooperation with a record feeding means an improved form of record sensing means comprising a cathode ray tube for sensing all columns of the record in succession once during each successive index point of time in the cycle of the record feeding means, resulting in the creation of data impulses having slight time differences to represent the columns to which they are related and the impression of those impulses on a single carrier medium for transmission purposes.

It is further contemplated to provide a record analyzing means comprising a cathode ray beam and individual light responsive means for each column of the record actuated by the beam upon contacting data representations in related columns of the record to generate pulses and impress the same on a common carrier medium for the purpose of transmitting them to a distant point to operate data accounting elements in accordance with the data representations on the record.

In the usual record controlled accounting machines of the well known Hollerith type, the general circuit pattern comprises a single circuit extending to an analyzing unit where the record card, by its passage therethrough and the data indications it bears, causes a number of parallel circuits to be completed to the automatic group control, accumulating and recording units, the parallel circuits thereupon combining over a single circuit for the return to the source of power supply. According to the present invention, however, a plurality of potential impulses are made available by a single sensing device, and impulses representing the same digit values are transmitted simultaneously, for all practical purposes, over a single carrier medium to a point where the original plurality of electrical characteristics is reestablished as distinct impulses for the control of accumulating and recording units. The fact that a single carrier medium rather than parallel circuits is utilized becomes particularly advantageous where the accumulating and recording units of an accounting machine are remotely located with respect to

its record feeding and analyzing unit. It is to be appreciated, however, that the present invention is equally applicable to an accounting machine of the usual compact structure.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is an outside view of the card feeding and cathode ray sensing mechanism showing the card feed and reset clutch, all of which mechanism is located at the transmitting station.

Fig. 1a is a section taken at 1a of Fig. 1 in the direction indicated by the arrows.

Fig. 2 is a detail view of the controlling devices of the accumulator resetting mechanism at the receiving station.

Fig. 3 is a central section of the printing mechanism at the receiver.

Fig. 4 is a detail of an impulse emitting commutator associated with the printing mechanism.

Fig. 5 is a sectional plan view showing the main driving and operating mechanism for the printing unit.

Fig. 6 is a view of one order of the accumulator.

Fig. 7 is a representative diagram of the circuits associated with the transmitter.

Fig. 7a is a diagram of the circuits at the receiver.

Fig. 8 is a timing chart of the circuit closing devices utilized in the circuits at the transmitter.

Fig. 8a is a timing chart of the circuit closing devices employed in the receiver circuits.

Fig. 9 is an illustration of a sweep circuit.

Fig. 10 illustrates an amplifier tube and associated circuits.

Fig. 11 shows the circuit connections of one form of filter.

The machine to which the features of the present invention are applied is similar to that shown in the U. S. Patent No. 1,976,617 issued to C. D. Lake and G. F. Daly on October 9, 1934. That patent illustrates and explains in more extensive detail the manner of organization and the mode of operation of the various units of a well known type of accounting machine. In the present application, these units will be explained in only as much detail as will be necessary to point out the manner in which the objects of the present invention may be realized.

Before setting forth the general operation of the machine, the various mechanical units will be described and their relationship pointed out thereafter.

Card feeding mechanism

The card feeding mechanism shown in Fig. 1 is identical with that shown and described in the aforementioned patent, except that provision is made in the form of a clutching device for interrupting the card feeding operations without stopping the main drive shaft. As is customary in machines of this type, a pair of sensing stations are provided. The upper station is provided with the usual brushes UB, whereas at the lower station a cathode ray tube scanning device T—1 is provided and cooperates with a plurality of light sensitive devices L. The tube T—1 and the devices L are suitably supported in position at the lower sensing station by the side frames of the feeding mechanism.

In the feeding operation, a stack of record cards R are successively advanced by a picker 9 to pairs of feed rollers 10 which serve to advance the cards past the upper and lower sensing station.

The shafts upon which rollers 10 are mounted are provided with gears at their extremities, arranged as shown in Fig. 1, for operation by a main driving gear 11 which is freely mounted upon a shaft 8 and which has connection with an arm 15 through a sleeve 7 (Fig. 1a). Arm 15 carries a spring-pressed clutching dog 16 normally held in the position shown by an armature latch 17 which is adapted to be controlled by clutch magnet 18. Between gear 11 and arm 15 are located gear 13 and clutch driving disc 14 freely rotatable upon the sleeve 7. Gear 13 has connection generally designated 12 with pulley shaft 6 which is in operation as long as the main driving motor is operating. Energization of magnet 18 causes dog 16 to be tripped into engagement with disc 14, and the card feeding mechanism thereupon causes the records R to be advanced past the sensing stations. Card feeding operations continue as long as magnet 18 remains energized.

In the actual sensing operations, the upper brushes act in the usual manner to complete circuits through the holes in the cards for controlling purposes. The cathode ray tube, which replaces the customary lower brushes, is acted upon by a controlling sweep circuit as explained hereinafter in such a manner that an electron beam, active within the tube during its operation, is caused to sweep horizontally across a fluorescent screen S in timed relation with the feeding of the cards. The fluorescence of the screen when acted upon by the beam causes an increased amount of light to pass through the holes in the card as they appear at the lower sensing station so as to actuate a group of photo-cells L placed on the opposite side of a convex lens system U. Screen S is preferably of low retentivity so as to permit the maximum amount of light to pass therethrough, and the convex lenses serve to concentrate this light on the photo-cells which are preferably quite small so that a great number of them may be placed side by side without requiring too much space. These cells may be of the photo-voltaic type and they operate in the conventional manner such as to produce an electromotive force when there is an increase in the light directed thereto. The cards have the usual vertical columns of digit positions and one photo-cell is provided for each data column. Arrangement is made for the electron beam to traverse like digit positions during each sweep, i. e. the "9's" are read during one sweep, the "8's" during the next, etc. The controlling circuits for this operation will be taken up later.

During total taking cycles of operation to be explained later, magnet 18 is deenergized and thus card feeding will not take place during such cycles.

Printing mechanism

The printing mechanism is shown in Fig. 3 where type bars 20 are carried by cross-head 21 which is slidable vertically on rods 22. Spring-pressed arms 23 pivoted to the cross-head at 24 have their free ends butting the lower extremity of the type bars so that, as the cross-head moves upwardly, the type bars are urged in the same direction. The reciprocating movement of the cross-head is controlled from shaft 19 corresponding to shaft 19 of Fig. 1, the latter being

continually driven from the main operating shaft 6 at the transmitter and the former being driven from a corresponding shaft (not shown) at the receiver which is kept in synchronism in a manner to be described hereinafter. Shaft 19' has secured thereto a clutch driving element 25 notched to cooperate with a clutching dog 26 carried by and pivoted to listing cam 27. Clutch releasing arm 28 cooperates with dog 26 to hold the parts in the position shown when magnet 29 is deenergized. Energization of magnet 29 causes arm 28 to rock in a counterclockwise direction releasing dog 26 for engagement with element 25 whereupon the listing cam rotates with shaft 19' and, through follower arm 30, effects the rocking of shaft 31.

Secured to shaft 31 are arms 32 whose free ends have link connection to the cross-head 21 causing the latter to be reciprocated once for each revolution of the listing cam. As the type bars move upwardly, the type elements 33 successively pass the printing position opposite platen 34 and ratchet teeth 35 successively pass the toe of the stop pawl 36. Energization of printing magnet 37 effects the tripping of latch 38, permitting stop pawl 36 to engage one of the ratchet teeth 35 and thus positioning the corresponding type element opposite the platen.

Associated with each type bar 20 is a spring-pressed printing hammer 40 pivoted at 41. The hammer normally rests against an operating ball 42 also pivoted at 41, the ball being operatively connected to a tripping member 43 which is biased in a counterclockwise direction by a spring 44. The lower extremity of one arm of member 43 is in latching cooperation with an arm 45 pivoted at 46 to the cross-head operating lever 32. As the lever 32 is rocked in a clockwise direction to elevate the cross-head 21 and the type bar 20, the pivot 46 is moved upwardly therewith and causes the tripping member 43 to be rocked clockwise against the action of spring 44. The connection between the ball 42 and the member 43 is such that the ball is rocked counterclockwise away from the type elements 33. As the lever 32 reaches its utmost extremity of travel, a pin 47 carried by arm 45 brings about the release of the tripping member 43 so that the latter is rocked rapidly in a counterclockwise direction by the action of spring 44. The hammer ball 42 is concurrently rocked in a clockwise direction against the hammers 40 causing the latter to strike the type elements 33 which are in a printing position to effect printing therefrom.

Accumulating mechanism

The adding mechanism is identical to that shown and described in patent referred to and the description thereof will accordingly be limited to a brief explanation of its manner of operation. The accumulator drive shaft 53 (Fig. 6) is geared directly to the pulley shaft at the receiver (not shown) which corresponds to, and is kept in synchronism with, shaft 6 at the transmitter (Fig. 1). The manner in which the transmitter and receiver shafts respectively are kept in synchronism will be described later. It will be understood that these shafts are operated in phase by a pre-adjustment of the receiver driving mechanism with respect to the transmitter driving mechanism so that, for example, a ratchet tooth on a drive clutch for the receiver will have the same phase relationship as a ratchet tooth on the corresponding drive clutch for the transmitter. The angular relationship between the teeth on the

clutch ratchets and the armatures of the synchronous motors TM and TMr is initially established by timing marks on the respective elements. The ratchets have a tooth for each possible angular position at which they may be pulled into synchronous speed. Thus, if the engaging pawls of the clutches are tripped slightly ahead of the tooth in which they are to engage, a slight variance in the tripping time will not render any detrimental effect in view of the fact that they are engaged at the same instant by the driving faces of the next ratchet teeth. Shaft 53 is thus kept in operation as long as the driving motor at the receiver is functioning and the driving ratio is such that this shaft makes one revolution for each record feeding cycle at the transmitter. A clutch element 54, slidably mounted on shaft 53 but keyed for rotation therewith, is provided for each denominational order of the accumulator. The element 54 is provided with a groove in which fits the short arm of a lever 55 pivoted as shown and having a block 56 normally held as in Fig. 6 by armature latch 57 of an adding magnet 58. A leaf spring 59 bears against the extremity of the longer arm of lever 55 and moves the same in a counterclockwise direction upon release of block 56 by armature 57. This movement brings clutching member 54 into engagement with co-operating teeth 60 which are integral with a gear 61 loosely mounted on shaft 53. Gear 61, when thus coupled to shaft 53, causes the rotation of a gear 62 meshing therewith and consequently the displacement of accumulator index wheel 63. The rearward extremity of member 55 is adapted to be engaged by a finger 64 toward the end of the cycle for the purpose of disengaging the clutch element 54 from teeth 60 and relatching block 56 on armature 57.

Briefly summarizing the adding operation, it is noted that magnet 58 may be energized at various points in the cycle of the machine depending upon the location of a digit indication in a column of the record card being sensed by the cathode ray tube T1 at the lower sensing station. This energization may occur in response to a digit indication in any of the index point positions from 9 to 1 inclusive. Should a digit indication be in the "9" index point position, clutch element 54 is tripped nine steps before finger 64 is operated to declutch it. Similarly, a digit indication in the "1" index point position causes the clutch element 54 to be tripped one step before it is declutched by the finger 64. The digit indications are customarily in the form of holes in the card. Each step of clutching arrangement corresponds to a tenth of a revolution in the accumulator index wheel 63 so that a "9" hole moves the wheel $\frac{9}{10}$ of a revolution and a "1" hole moves it $\frac{1}{10}$ of a revolution. Energization of adding magnet 58 also causes the closing of a pair of so-called accumulator-list contacts 58a associated therewith to establish circuits to the print magnets on listing cycles which will be described later in connection with the circuit diagram.

Read-out mechanism

Also driven by gear 61 is a gear 65. Since the ratio of gears 65 and 62 is 2:1, the former will turn through a half revolution for each revolution of the latter. Carried by and insulated from gear 65 is a pair of electrically connected brushes 66, one of which cooperates successively with the conducting segments 67 while the other cooperates with an arcuate conducting strip 68.

The relationship of the parts is such that, when

the index wheel 63 is in its zero position, one of the brushes 66 is in contact with the zero segment 67 and the other brush is in contact with the strip 68, thus forming an electrical connection between the two. If the wheel 63 is displaced to indicate, say, "8," then one of the brushes 66 will be in contact with the "8" segment 67 and the other brush will be in contact with the arcuate strip 68.

The positioning of the brushes 66 provides a convenient electrical read-out mechanism for controlling total printing operation and the electrical circuits involved in these functions will be more fully explained with reference to the circuit diagram.

Accumulator resetting mechanism

The shaft 69 (Fig. 6) upon which the index wheels 63 of an accumulator are loosely mounted is slotted for cooperation with spring-pressed pawls (not shown) pivoted upon and carried by the individual index-wheels in such manner that counterclockwise rotation of shaft 69 causes the index wheels 63 to become engaged and driven forwardly to the zero position during a single revolution of shaft 69.

Referring to Fig. 2, shaft 69 carries a gear 70 at its extremity which is in engagement with gear 71 mounted upon reset shaft 72. Gear 71, of which there is one for each accumulator, is coupled to the resetting shaft 72 in the well known manner more fully explained in the patent above referred to. At the extremity of shaft 72 is a gear 73 (see also Fig. 5) which is adapted to be driven by an intermittent gear 74 which is secured to shaft 75' which corresponds to shaft 75 shown in Fig. 1. Also fixed to shaft 75' is an arm 76' which carries a spring-pressed clutch dog 77' normally held in the position shown in Fig. 2 by a latching arm 78' supported by armature shaft 79' of magnet armature 80'.

Energization of magnet 81' causes dog 77' to be released for engagement with clutch driving element 82'. Element 82' is integral with a gear 83' which meshes with a gear 84', secured upon the constantly running shaft 19'. With this arrangement, drive element 82' is in constant rotation and whenever it is desired to effect resetting of the accumulators, magnet 81 is energized to provide a connection between the element 82' and the resetting shaft 72. Resetting is usually an accompaniment of total taking and, by virtue of the intermittent gear connection between 73 and 74, occurs during the latter part of a total taking cycle after the totals have been printed.

Although there are no accumulators at the transmitter, a reset clutch is provided as shown in Fig. 1 for operating the P cams which are mounted on shaft 75 and have circuit controlling contacts associated therewith. This clutch mechanism is similar to that just described for the accumulators at the receiver and corresponding parts at the transmitter are given the same reference characters without the primes. The clutch is engaged during a total taking cycle to cause the P cams to operate their associated contacts to control the machine during a printing cycle at the receiver. It will be noted in the timing chart (Figs. 8 and 8a) that the P and Pr cams are two-cycle cams. This is for the reason that the drive ratio between the cam shaft and the drive shaft is such that these cams make only one revolution for two revolutions of the drive shaft. It is understood that the purpose of such a gear ration is to provide sufficient time for a total printing cycle

to occur. If the printing is accompanied by a resetting operation at the receiver, then both reset clutches function in unison as will be better understood upon explanation of the wiring diagram. It should be mentioned that proper speed and phase relationship of shafts 75 and 75' are maintained, since the drive shafts 19 and 19' at the transmitter and receiver, respectively, are operated in exact speed and phase relationship. The reset magnets 81 and 81' are energized at the same time in the cycle, under control of the related cam contacts, to cause driving engagement of the related clutch mechanisms 77 and 82, and 77' and 82', respectively, at the same time.

Circuit controlling devices

In Fig. 4 is shown a so-called emitter which cooperates with the read-out devices of the accumulator for total printing operations. Carried by a stud 85 coaxially with the shaft 75' is a pair of electrically connected brushes 86, one of which contacts with conducting segments 87 while the other wipes over a common arcuate conducting strip 88. The brushes 86 are carried by a gear 89 driven through an idler 90 from a gear 91 carried by constantly running shaft 19'. The emitter used for controlling total printing operations is timed so that a brush 86 successively contacts with each of the segments 87 as the corresponding type elements 33 of Fig. 3 approach printing position opposite platen 34.

A plurality of cam-controlled contacts, operable only during printing and reset cycles, are provided at the receiver, these contacts being prefixed with the letter "P" but bearing the subscript "r" to distinguish them from the P cams already referred to at the transmitter. The Pr cams are mounted on a shaft 92 driven from shaft 75'. Similar cam controlled devices prefixed with the letter "L" are carried by or may be driven from shaft 19 at the transmitter and shaft 19' at the receiver and these are in constant operation as long as the driving motors are functioning. The contacts associated with the constantly running cams at the receiver are provided with a subscript "r" to distinguish them from the L-cam contacts at the transmitter.

The usual circuit breakers 133 and 133r are provided at the transmitter and receiver respectively and are timed to make at the beginning of each index point in the machine cycle and break before the end thereof to control circuits to the accumulators and print magnets as will be explained later. Additional sets of contacts 133a, 133ar are provided at the transmitter and receiver respectively to aid the usual circuit breaker contacts in effecting the control circuits above referred to.

All the cam contact devices are indicated in the timing diagrams (Figs. 8, 8a) where their relative timing may be observed.

General explanation of the circuit diagram

The wiring diagram of the electric circuits is shown in Fig. 7 and 7a wherein the various cam contact devices are diagrammatically shown and suitably labeled L, Lr or P, Pr as just explained. The exact timing of these contact devices is shown in Figs. 8, 8a to which reference may be made for the actual time in the cycle of operation during which they function. Due to the presence of numerous interlocking relays in the circuits both at the transmitter and receiver, it has not been advisable in all instances to show relay magnets

and their associated contacts in close proximity to one another.

For purposes of clarity in the wiring arrangement the relay contact points are shown in the circuits which they control and their relay magnets are repeated adjacent thereto. Furthermore, the contacts are designated with the same reference numeral as their controlling magnet, followed by a lower case letter.

Synchronizing means.—The driving motors at the transmitter and receiver may be operated in synchronism by any well known means, a preferred method being that illustrated in the U. S. Patent No. 1,505,158, issued to De Loss K. Martin on August 19, 1924. This method will now be explained briefly in connection with Figs. 7 and 7a and if more detailed description is desired, reference may be made to the above Martin patent. The obvious purpose of maintaining the driving mechanism at each station in synchronism is to assimilate most nearly the condition of an accounting machine having the usual compact structure in which the various units are driven from a common, constantly running drive shaft.

At the transmitter (Fig. 7) a pair of alternators 95 and 96 are provided to supply electrical power at two different frequencies. The frequency set up by alternator 95 becomes the carrier frequency of the system whereas the frequency established by alternator 96 is utilized purely as a synchronizing frequency. Upon the closing of switch S1, a circuit is completed from ground G1, alternator 95, alternator 96, switch S1 now closed, either through filter 98 to ground G2 or via conductor 99 through transmitter 100 to ground G3. Filter 98 is comprised of suitably tuned elements which may be inductance, capacitance, or resistance. Filters are generally classed as high pass, low pass and band pass filters, filter 98 being of the low pass type and designed to permit the synchronizing frequency but not the carrier frequency to pass therethrough.

For purposes of illustration, Fig. 11 shows a representative circuit arrangement of that type of filter known in the art as a band pass filter. It consists of high pass and low pass sections comprising inductance and capacitance suitably tuned so that the desired range or band of frequencies in the input circuit is non-attenuated in the output circuit, while remaining input frequencies are attenuated and do not appear in the output. The synchronizing frequency which appears at the output of the filter is fed to the input of an amplifier 97, then upon closing of switch S2, the output circuit of amplifier 97 affords a power supply through switch S2, motor TM, to ground G4. Motor TM is a synchronous motor and is thereby driven at synchronous speed in accordance with the controlling frequency of the alternator 96. It is noted that both the synchronizing frequency and the carrier frequency are impressed upon the transmitter and that the output of the transmitter is in turn impressed upon the aerial and transmitted therefrom as radiant energy in the well known manner.

Fig. 10 illustrates an example of a form of amplifier and its associated circuits. A three element tube is shown having an input circuit with terminals c and d and an output circuit having terminals e and f. A voltage divider is employed to provide the customary negative bias on the grid element normally to prevent current flow through the tube. However, the reception of impulses by the input circuit has the effect of reducing the negative bias on the grid element of the tube to

permit current to flow in the output circuit through whatever load may be connected to terminals e and f.

It will be understood that wherever an amplifier such as 97 is shown hereinafter, the power supply is included in the diagrammatic outline representation of the amplifier and its connected surface. Furthermore, it will be appreciated that the representative showing includes as many stages of amplification as are necessary to provide sufficient power to operate whatever load may be connected to its output.

When the receiving device 101 receives this radiant energy from the transmitter, it is demodulated and its output circuit includes a signal having a frequency corresponding to the synchronizing frequency mentioned above. Receiver 101 is shown diagrammatically in box form but is understood to include the fundamental sections which comprise the radio frequency amplifier, a detector or demodulator, and an amplifier for the output of the detector, and that such amplification is provided as will be necessary to produce an output current of sufficient strength to operate the various relays and magnets of the accumulators and print unit.

In the present system it will be noted that at the transmitter a current having a given frequency is provided for synchronizing purposes. This current is amplified at the transmitter to drive the motor TM at a fixed speed. The same current is also utilized to modulate the transmitter from which it is sent to the receiver as radiant energy in the well known manner. The radiant energy is demodulated by the receiver, the output of which includes a current having the synchronizing frequency. The latter current is separated from the total output of the receiver and is amplified to drive the synchronous motor TMr at the same fixed speed as TM. It will be appreciated in this method of synchronizing that, although the power employed for driving the motors at the transmitter and receiver respectively is supplied locally, a current of predetermined frequency is utilized commonly at both transmitter and receiver for controlling the respective local sources of power.

The feed mechanism is driven by motor TM through shaft 6 and accumulators and print mechanism by motor TMr, through shafts 6', 53 and 19 as previously mentioned. Since motors TM and TMr are kept at constant speed by current of the same frequency, the shafts at the receiver are constantly operated in a synchronous relationship closely approximating the condition normally attained by actual mechanical connection between these parts in the usual tabulating machine structure.

Generation of impulses.—A preferred type of cathode ray tube is illustrated schematically in the wiring diagrams (Figs. 7, 7a). Three such tubes are employed in the system and are designated T-1, T-2, and T-3. Tube T-1 is located in the card feeding and analyzing unit as previously mentioned and tube T-2 is located at the receiving station and is arranged to operate in step with tube T-1. Tube T-3 cooperates with the tube T-1 at the transmitting station for automatic group control purposes as will be described later herein. These tubes are highly evacuated vessels containing means for generating an electron beam in a manner familiar to those skilled in the electronic art. The cathode C is heated by the heater H which is connected to suitable battery supply (not shown). The first anode A acceler-

ates the electrons of the beam E which passes between the electrostatic deflecting plates D1 and D2 and on to the opposite end of the vessel to impinge on a fluorescent screen S in the case of tube T-1 and on targets *t* in the case of tubes T-2 and T-3.

The high voltage direct current potential source B (see tube T-1) supplies the operating potentials for the various electrodes. A variable resistance *r* is connected across the battery B. The high voltage anode A is connected to the positive side of the variable resistance which point is connected to ground. The grid G2 is connected to a suitable intermediate potential by means of tap 24. The control grid G1 is negatively biased with respect to the cathode C by connection to a suitable point 24' along the variable resistance *r*. Deflecting plates D1 and D2 are connected on one side directly to high potential ground to assume the same potential as anode A. Plates D1 have their other connection leading through a high resistance 111 to ground so that they have the same static potential as anode A, an operating expedient commonly employed in this type of circuit arrangement.

Tubes T-2 and T-3 are provided with a plurality of spaced metallic plates or targets *t* within the tube at its larger end S. These plates have individual connections thereto which extend through the tube and have individual circuits leading therefrom which control various machine operations to be described hereinafter. Tube T-1, on the other hand, has no such targets, the beam E1 being played upon the screen S to produce a fluorescent effect. The light from this fluorescence falls upon the record cards as they are fed in succession thereto by the card feeding mechanism previously described. In the event that the light beam encounters a hole in the record card, it passes through the card and the lens system U, and then strikes upon a related one of the light sensitive photo-cells L to cause the latter to generate an impulse.

In the preferred embodiment shown in the drawings, the beam E1 is caused to sweep across the full horizontal length of the card, plus a slight distance more, and to return to the starting point within one-half of an index point of a card feeding cycle. In other words the beam scans all of the columns of the record card at one time in like digit positions. For example, all the "9" holes of a card are read concurrently within one sweep of the beam and all the "8" holes are read with next sweep of the beam. Provision is made for a greater sweep than the length of the card in order that photo-cells L' and L'' may be operated. These cells serve in special control functions, as will appear later, L' being instrumental in sending a control signal to the receiver for total printing operations and L'' being employed in effecting a group indication cycle. It will be noted that L' and L'' are actuated upon each sweep of the beam. However, it will later become apparent that other conditions must be present before these cells may become effective. In order that the beam will have horizontal deflection imparted to it by the horizontal deflecting plates D1 a simple sweep circuit is connected to these plates so that the proper variances in potential to effect the desired sweep of the beam are automatically applied. The sweep circuit generally designated 112 is shown only diagrammatically in Fig. 7 since any one of numerous different well known types are applicable. A preferred disclosure is shown on page 59 of a text book by John F. Rider

entitled "The Cathode Ray Tube at Work" published in 1935. It will be noted that this sweep circuit is not continuously operating but is rendered effective only during the active index points of card feed cycles under the control of the customary circuit breaker contacts 133 at the transmitting station and 133r at the receiving station (see timing charts Figs. 8 and 8a).

An illustration of a sweep circuit is shown in Fig. 9 which, in its simplest form, includes a gaseous discharge tube X, a condenser Y, and a resistance Z connected with a suitable source of supply and an external circuit through terminals *a* and *b*. With this arrangement, current flows through resistance Z building up a charge of the condenser Y until the break down point of tube X is reached, whereby the condenser discharges through the tube. The building up time of the condenser being much greater than the discharge time, a so-called saw tooth current wave is produced. The circuit breaker contacts 133 or 133r are arranged to control the closure of the sweep circuit in timed relation with the feeding of the cards. The sweep circuit in turn controls the cathode ray tube to which it is connected to change the potential on the horizontal deflecting plates so that the electron beam is caused to sweep across the cards. The timing of the sweep circuit itself, obviously, depends upon the selection of the capacitance and resistance which control this circuit.

The provision for an extended sweep of the beam beyond the length of the card is so that other photo cells may be actuated for certain control operations of the system to be described presently. The rate of travel of the sweeping beam is sufficiently great in comparison with the speed of card feeding that the beam may be easily made to operate within the desired time intervals. Impulses set up by the photo-electric cells upon which the beam plays are then sent to the transmitting device and from there to the receiving station to make entries into and control the operation of the accumulating and printing mechanism at the receiving station.

Initial reset cycle.—At the lower right portion of Fig. 7 is located the usual group control mechanism generally designated GC and, as is usual in tabulating machines, it is first necessary to set up the group control holding relay magnet R43 (just above tube T-1) before the card feeding mechanism previously described can be set in operation. This is effected by depression of the reset key to close contacts 110, thereby completing a circuit from right-hand side of the line 105, contacts 110, relay coil R30, to left-hand side of the line 106. The lines 105 and 106 are connected through a main switch MS to a suitable source of supply W which provides the electrical energy for energizing the transmitter circuits such as the one just described. Energization of magnet R30 closes its contacts R30a in the upper part of Fig. 7 which will thereupon complete a circuit from right side of line 105, stop key contacts 107, contacts R30a now closed, main drive clutch magnets 130, to line 106. Magnets 130, upon becoming energized, cause a coupling of the drive motor to the pulley shaft 6, mentioned above, and, incidentally, also causes the closing of contacts 130a which provide a holding circuit for magnets 130 through cam contacts L1 to line 105. Cam contacts L1 open toward the end of each cycle, and at such time, the circuit is maintained through either contacts UCL or LCL which are in series with stop

key contacts 107. The manner in which one or more of these contacts in the holding circuit may be opened to interrupt the same will be explained hereinafter.

The relay magnet R30, energized by depression of the reset key, closes a second pair of contact points R30b to complete a circuit from line 105, cam contacts L2, contacts R30b, reset magnet 81, to line 106. As explained in the mechanical description, energization of magnet 81 causes a cycle of operation of the P cam contacts at the transmitter to control various circuits of the system. Contacts P7 (at the lower part of Fig. 7), for example, close to energize the group control relay magnet R43 from line 106, cam contacts P7, relay magnet R43, contacts LCLc or L23, to line 105. Contacts R43a close to provide a shunt circuit around contacts P7 to hold relay magnet R43 energized. The manner in which the group control mechanism GC functions in the system will be described later.

Prior to the closing of cam contacts P7 to energize magnet R43 in the manner just described, however, relay magnet R49 is energized by a circuit from line 106, relay magnet R49, cam contacts L19, relay contacts R43d, cam contacts P9, to line 105. Contacts R49d close upon energization of magnet R49 to bring an alternator 127 into a circuit associated with the carrier for transmitting a control signal of a characteristic frequency to the receiver as follows: ground G1, carrier frequency alternator 95, alternator 127, relay contacts R49d now closed, switch S1, via conductor 99, input of transmitter 100 to ground G3. The output of the said transmitter is impressed upon the associated grounded aerial in the well known manner for radiating the energy waves, which waves, in turn, are impressed upon the grounded aerial of receiver 101. The usual demodulation and amplification of the waves take place within the receiver 101, the output of which is impressed upon conductor 102, via conductor 147 to the input of filter 148. The output of filter 148 includes relay magnet 154 and common ground G13. Contacts 154a close when magnet 154 is energized to complete a circuit for energizing the reset magnet 81' from line 141, reset magnet 81', contacts 154a now closed, cam contacts L2r to line 140. Lines 140 and 141 are connected to a suitable source of supply Wr through the main switch MSr. The energization of magnet 81' causes the resetting of the accumulators, to clear out any old amounts which may be standing therein and prepare the accumulators for new entries. The main clutch 130', of course, must be energized to drive the adding wheels through the reset just described. Referring to the upper left portion of Fig. 7, contacts 130b close upon energization of the main clutch 130, so that an alternator 126 supplies power at a characteristic frequency. The circuits involved are the same as those previously traced for alternator 127 as far as the receiver 101 (Fig. 7a). The output of receiver 101 is traceable through conductors 102 and 147 to the input of filter 149, the output circuit of this filter including relay magnet 153, and ground G13. Relay contacts 153a close to energize the main clutch 130'. Briefly, then, upon depression of the reset key both main clutches and both reset magnets are energized concurrently to cause the operation of the P cams at the transmitter and the operation of the Pr cams and the reset of the accumulators at the receiver. Immediately following the reset cycle, the feeding of

record cards may be initiated upon depression of the start key.

Starting circuit.—With relay magnet R43 energized and the accumulators cleared, depression of the start key to close contacts 129 completes a circuit from line 105, conductor 123, contacts 129, relay magnet R33, relay contacts R49b, relay magnet R32 to line 106. The contacts R49b will be in their normal deenergized position because when magnet R43 is energized, the circuit to magnet R49 is broken. Relay contacts R33a are in parallel with the previously mentioned contacts R30a and complete the following circuit through the main clutch magnet 130: from line 105, stop key contacts 107, relay contacts R33a now closed, main clutch magnet 130, to line 106. The energization of magnet 130 is again accompanied by the energization of the main clutch magnet 130' at the receiver by means of the previously described circuit energized from alternator 126.

Relay magnet R32 is provided with a pair of contacts R32a which are adapted upon closure to complete a circuit to the card feed control relay magnet R39. This circuit is traceable from line 106, relay magnet R39, contacts R32a now closed, stop key contacts 107a (operable concurrently with the contacts 107), contacts R43c of the group control relay magnet R43 which are now closed, cam contacts P9, to line 105. The above circuit, it will be observed, can only be completed when the group control relay magnet R43 is energized. Magnet R39 closes its contact points R39b which are wired in series with card feed clutch magnet 18 to energize the latter so that records commence to feed. Contacts R39a also close to provide a holding circuit for magnet R39 first through upper card lever relay contacts UCLb and then also through lower card lever relay contacts LCLb which close as the first record card reaches the lower brushes.

Card lever circuits.—As the record cards are advanced past the analyzing brushes UB of the upper sensing station, the usual upper card lever contacts 150 are closed to complete a circuit from line 105, contacts 150, magnet UCL, to line 106. Magnet UCL controls a number of contacts which are disposed in various circuits for controlling purposes. One of these contacts, for example UCLc pointed out above as being in the holding circuit for the main clutch 130, helps interrupt this circuit if cards fail to feed past the upper brushes. Deenergization of main clutch 130 is always accompanied by deenergization of main clutch 130' at the receiver, because contacts 130b (Fig. 7) open to break the previously described control circuit to the receiver from alternator 126. Since the card lever contacts 150 open between successive cards, a holding circuit is provided through contacts UCLa and cam contacts L5 which serve to maintain magnet UCL energized during the interval when contacts 150 are open. In a similar manner, the lower card lever contacts 151, suitably located at the lower sensing station so as to be operated by a card as it arrives at that station, cause energization of lower card lever relay LCL and the contact points LCLa cooperate with cam contacts L5 to provide a similar holding circuit.

Listing circuits.—The circuit for the listing magnet 29 (Fig. 7a) is completed from line 140, cam contacts L2r, cam contacts P10r, TAB—LIST switch set to the list position, upper and center straps of relay contacts G1'c, listing magnet 29, to line 141. Through this circuit magnet 29 is en-

energized during each cycle of operation of the machine and the printing mechanism will function accordingly.

As the record cards advance past cathode ray tube T—1 at the lower sensing station of the transmitter, circuits are provided for communicating the descriptive data analyzed at this station through accumulator list contacts 58a to the printing magnets 37 at the receiver which control the stopping of the type bars as already explained in operation of the printing mechanism given hereinbefore. The list contacts 58a are closed upon energization of the adding magnets as the latter receive impulses set up by the tube T—1 and the light sensitive cells L at the transmitter. The adding circuit will be explained later. The closing of a pair of accumulator list contacts 58a completes a circuit to a print magnet 37 as follows: from line 140, circuit breaker contacts 133a now closed, the particular contacts 58a which are also now closed, the print magnet 37 in series therewith, LIST—TAB switch set to LIST, to line 141. Print magnet 37 upon energization stops the upward movement of the type bar it controls to effect the listing of the digit analyzed on the record card at the transmitter.

Adding circuits.—The circuits for adding into the accumulators are completed simultaneously with the listing circuits just described when all the list control switches are set for listing. When the switches are set to the other position, no listing occurs but adding into the accumulator takes place as data entries are read from each card passing the lower sensing station at the transmitter. An adding circuit is completed during a sweep of the beam E1 upon encountering a hole in the card in any live column as previously described. The beam is under the control of its sweep circuit which in turn is controlled by the circuit breaker contacts 133. Provision is made for plugging up the desired columns for reading out the data, and unless the columns are plugged properly no circuit for any particular column is completed even when a hole in that column is encountered by light rays produced by the electron beam due to the fluorescence of screen S. Representative circuits involved in an adding operation are traceable from the actuated photo-cell L, plugboard jack 132, plug wire to jack 134, to the input of amplifier 121, the output of the amplifier being connected to the input of transformer 122. By virtue of the transformer action, a circuit is completed from the output of the transformer when circuit breaker contacts 133a are closed, through contacts LCL/ now closed, through the primary winding of transformer 137, conductor 109, to the input of filter 136, and from the output of filter 136 to the input of transmitter 100. Transmission occurs in the manner previously described to the input of receiver 101, and from the output of the receiver via conductors 102 and 147 to the input of filter 145, and from the output of the filter to the input of transformer 146. The output circuit of transformer 146 controls the bias on the grid element G1 of the tube T2 which is immediately reduced upon reception of the impulse so as to permit the electron beam E2 to extend to the targets t. The circuit through the tube is from negative battery Br, wire w, through connection with heater H to cathode C, electron beam E2, through the particular one of the targets t which is related to the data column of the card being sensed to the input of amplifier 158 and from the output of the ampli-

fier through adding magnet 58 for this column to common ground G12. The circuit just traced energizes the adding magnet 58 for one order of the accumulator to turn its adding wheel in a manner previously described to effect addition. It will be noted that tube T—2 has a sweep circuit 112 controlled by contacts 133r which are timed with contacts 133 at the transmitter. The beam however, does not reach the targets t until a pulse arrives to reinforce the input circuit, change the bias on the grid, and thus effect current flow through the tube.

Group control.—When the group control switch 160 (Fig. 7) is set to the "on" position, cards are allowed to continue to feed as long as the control indicia on successive cards passing the upper and lower sensing stations remain the same. The principle is the same as that shown in Patent No. 1,976,617 previously referred to. Representative circuits involved in group control are traceable from the actuated photocell L related to the column in which a perforation representing control data appeared, jack 132, plug wire to jack 134, input of amplifier 121, and from the output of the amplifier to the input of transformer 122. The output of the transformer is connected through contacts 133a now closed, contacts LCL/ now closed, primary winding of transformer 137, conductor 109, to the grounded input of filter 136. The output of transformer 137 is connected to the input of tube T—3 and is arranged to bring about a reduction of the negative bias on the grid of the tube to cause it to pass current in the same manner as previously described for tube T—2 at the receiver. Assuming the machine to be properly plugged for control, the output circuit of the tube is from negative battery B1, cathode connection of tube T—3, electron beam to the target t corresponding to the control column on the card, plug wire to jack 143, input of amplifier 164, to ground G14. The output circuit of amplifier 164 comprises wire 173, cam contacts L12 and L11, contact roll 142, upper brush UB in corresponding column, jack 166, plug wire to jack 165, and control magnet 171. It will be noted that the circuit just traced depends upon the fact that the hole in the record card at the upper and lower sensing stations is the same in the particular column on which the control is operating. Energization of the particular magnet 171 by the circuit just traced causes the closing of its 171a contact points which are in series with one of the control magnets 172 and provide a circuit to energize the latter from line 106, magnet 172, contacts 171a, common conductor 170 to line 105. Contacts 172a close when magnet 172 becomes energized to provide a holding circuit through cam contacts L28, and contacts 172b also close to complete a circuit for maintaining the group control relay magnet R43 energized when contacts L28 open. The latter circuit is traceable from line 106, relay contacts R43a, relay magnet R43, conductor 169, contacts 172b now closed, jack 175, plug wire to jack 176, through left and center strap of contacts UCLc now closed, to line 105. This circuit is not set up upon the occurrence of a group change and the relay magnet R43 is deenergized on the next cycle when L28 breaks, the card feeding mechanism continuing under its momentum to the end of the cycle where it is latched up by the card feed clutch 18. The operations just described are well known in the tabulating art and are described in detail in the previously mentioned Patent No. 1,976,617.

Total printing and reset cycle

After the opening of relay contacts R43c (Fig. 7) upon the occurrence of a group control change, relay contacts R43d close to complete a circuit from line 106, relay magnet R49, cam contacts L19, contacts R43d now closed, cam contacts P9, to line 105. Energization of relay magnet R49 closes its contact points R49a which are in series with the reset clutch magnet 81. The circuit which energizes magnet 81 is traceable from line 106, magnet 81, relay contacts R49a now closed, cam contacts L2 to line 105. Relay contacts 49d also close to render alternator 127 effective to energize the circuit for operating reset clutch magnet 81' at the receiver concurrently with the energization of magnet 81 at the transmitter in a manner already described under the heading of "Initial reset cycle." Upon energization of the reset magnets 81, 81' the P and Pr cams start to turn and the first operation to take place is the printing of the totals standing in the accumulators at the receiver. This is brought about as follows: at the start of the cycle a circuit is completed from line 106, relay contacts R43b, relay contacts R49e now closed, contacts LCLg now closed since there is a card at the lower sensing station, relay magnet 200, cam contacts L18, to line 105. Energization of relay magnet 200 causes its contact points 200a to close, thereby to complete a circuit to the receiver from ground G11, cam contacts L24 now closed, contacts 200a, control cell L', conductor 115, to the input of amplifier 128, and from the output of the amplifier to the input of transformer 135. The output of the transformer is connected via conductor 109 to the input of filter 136, and the output of filter 136 is connected to the input of transmitter 100. Transmission occurs to receiver 101 in the previously described manner and then via conductors 102 and 147 to the input of filter 145. The output of filter 145 is connected to the primary winding of transformer 146, the output of the transformer being influenced by the transformer action as described hereinbefore to cause the tube to pass current to target t' and to the input of amplifier 138, the output circuit of amplifier 138, relay magnet 155 and common ground G12. Filter 145 is tuned to prevent the synchronizing frequency from interfering with the adding and total taking circuits at the receiver, and thus acts similarly to filter 136 (Fig. 7) which is arranged in conjunction with the transmitter connections so as to prevent all frequencies appearing on line 99 from interfering with those appearing on line 109. Energization of magnet 155 by the circuit just traced completes an obvious circuit for energizing total print control magnets 191, 192 which are then maintained energized through contacts 192e and cam contacts L18r. Contacts 191a—d and 192a—d connect the readout mechanism of the accumulators with the print magnets 37, the latter becoming energized at differential times under the control of the total print emitter as its brushes 86 sweep the segments 87, in a manner already described, to stop the type bars in accordance with the totals standing in the accumulators and thus effect printing of these totals.

The total printing operation is followed by a resetting of the accumulators to clear the same in preparation for new entries to be made therein from the following group of record cards. This is so well known in the art that further description here is deemed unnecessary.

Automatic resumption of card feeding

Cam contacts L3 are provided to energize the start relay magnet R32 near the end of the resetting cycle of operations to pick up and energize the card feed clutch magnet 18. The circuits involved in the starting of the machine have been already traced in detail and the operations controlled thereby will proceed in the same manner as above.

Group indication cycle.—On the first tabulating cycle after a reset, if certain machine switches are properly thrown, a group indication is effected in the following manner: the GI magnet (Fig. 7) is energized by a circuit from line 106, relay magnet GI, contacts 201b, contacts L25, switch 180 in the position shown for group indication, lower card lever contacts 152, to line 105. Relay magnet GI is held energized through its contacts GIa and cam contacts L7. Shortly after the energization of magnet GI, cam contacts L26 make (see timing chart Fig. 8) to complete a circuit for energizing the control magnet 201. The circuit is traceable from line 106, magnet 201, contacts L26, now closed, switch 181 in the position shown for group indication, contacts GIc now closed, contacts GIa also now closed, cam contacts L7, to line 105. Magnet 201 is maintained energized through its contact points 201a which now close and cam contacts P11. Energization of magnet 201 causes normally closed contacts 201b to open in order to prevent the energization of magnet GI on subsequent tabulating cycles prior to the next group change.

Magnet GI, when energized, causes contact GIb to close and circuits are completed when contacts L27 close from ground G11, through contacts L27, contacts GIb, control cell L'', conductor 115 to the input of amplifier 128. The circuits from the output of amplifier 128 to receiver 101 and through conductors 102 and 147 are the same as previously traced to the input of filter 145 and from filter 145 through the primary of transformer 146. The transformer action of 146 reduces the bias of the grid G1 to cause the tube to pass current from negative battery Br, wire w, cathode connection c, target t'', to the input of amplifier 139. The output of this amplifier extends through relay magnet 152 to the common ground G12. Energization of magnet 152 closes its contacts 152a to complete an obvious circuit for energizing the group indication relay magnet GI' at the receiver. Contacts GI'a close to provide a holding circuit for magnet GI' through cam contacts L7r. Contacts GI'b also close and complete a ground circuit for the amplifier 159 to prepare a print magnet 37 connected thereto for energization by the pulses received from tube T—2. This circuit is the same as that traced for the adding circuit down to a target t and then to the input of amplifier 159, and from the output of the amplifier through magnet 37 to ground G12. Energization of print magnet 37 effects the usual group indication, this circuit being completed only on the first card cycle after a reset because of the fact that magnet GI at the transmitter is deenergized when L7 breaks and contacts GI'b open to cut off the ground circuit of the amplifiers 159.

It is understood that the list clutch magnet 29 is energized for this cycle to set the printing mechanism in operation to print the group indication just referred to. The specific circuit is traceable from line 141, list clutch magnet 29, center and lower strap of contacts GI'c now

closed, cam contacts P10r, cam contacts L2r, to line 140.

Summary of operation

It has been described how a cathode ray tube replaces the customary analyzing brushes at the lower sensing station of a Hollerith type tabulating machine and is controlled by a sweep circuit which causes the cathode ray beam to sweep the complete length of the card and back during the time the card is being fed one-half an index point position. Any data perforation encountered by the beam allows the beam to pass and act on a photo cell related to the particular column in which the hole occurs to set up a pulse. This pulse is sent to a transmitting device where it is impressed on a carrier wave and sent to a receiving station. The pulse upon arrival at the receiving station is taken off the carrier wave and sent to the input circuit of another cathode ray tube which is controlled by a sweep circuit in step with the sweep circuit of the tube at the transmitting station. The incoming pulse changes the grid bias of the tube at the receiving station and allows the beam to reach a particular target to complete a circuit leading therefrom to an adding magnet and/or a list magnet.

A third tube is provided to cooperate in a similar manner with the first tube at the transmitter for the purpose of effecting automatic group control. Control circuits are maintained as long as holes in successive cards remain the same in the columns on which the machine is controlling. A failure of any one of these circuits causes the halting of the card feed and, if the switches are so set, an automatic total and reset cycle is initiated as is customary in Hollerith machines. Control pulses are set up by the cathode ray tube and two special control cells at the lower sensing station and control currents of characteristic frequencies are generated by several alternators to provide for all the control operations of the machine in their proper sequence and to connect the units of the machine at the receiving station and at the transmitting station in a manner which assimilates actual mechanical connection.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a remotely controlled accounting machine system employing record cards having digit representations differentially located thereon in accordance with the denominational order and magnitude of said digits; a primary station including therein a cathode ray tube, means for feeding record cards past said tube, control means for causing the ray of the tube to scan each record card repeatedly in timed relation with the record feeding means, each individual scanning operation covering all digit representations of equal value, and said scanning operations being repeated once for each different digit value, data detecting means comprising a fluorescent element for producing a light trace of the ray during each individual scanning movement and light sensitive devices selectively actuated by the light from said

trace upon detection of the like digit representations during said scanning movement for generating differentially timed current pulses in accordance with the location of said digit representations on the record card to distinguish the different denominational orders of the like digits, and means to transmit said pulses; and a secondary station including therein means to receive said pulses, a cathode ray tube and control means for the ray of said tube operating in synchronism with the control means at the primary station, denominational order data accounting elements with individual operating means therefor, a plurality of conductors located so as to be impinged upon by the ray of the second mentioned tube as said ray is operated by its control means, circuit connections from said conductors to said operating means, and means controlled by the receiving means in accordance with the received pulses for causing the second mentioned tube to pass current through said conductors to control the energization of the aforesaid operating means in accordance with the differential timing of said pulses to cause the data accounting elements to manifest the digits in their proper denominational order, the magnitudes of said digits being determined by the differential operation of said accounting elements dependent upon the particular scanning movement of the ray in which said digits are detected.

2. In a remotely controlled accounting machine system employing record cards having digit representations differentially located thereon, in accordance with the denominational order and magnitude of said digits; a primary station including therein a cathode ray tube, means for feeding record cards with data representations past said tube, a plurality of light sensitive devices adjacent said tube and aligned with certain portions of each record card as the latter passes the tube, control means for causing the cathode ray to sweep a predetermined distance across the face of each record card repeatedly in timed relation with the record feeding means, each complete sweep of the ray covering all representations of equal values and said sweeping operation being repeated once for each different digit value, an element placed between the source of the ray and the card for changing said ray from an invisible electron beam into a light beam, said light beam upon encountering a digit representation in a portion of the record card causing actuation of the device aligned with that portion to generate a timed impulse for said representation to distinguish by its timing the denominational order of the digit which it represents, and means to transmit said impulse; and a secondary station including therein means to receive said impulse, a cathode ray tube with control means constructed to operate in step with the control means at the primary station, denominational order data accounting elements with individual operating means therefor, a plurality of conductors located so as to be impinged upon by the ray of the second mentioned tube as said ray is operated by its control means, circuit connections from said conductors to said operating means, and means controlled by the receiving means upon reception of the impulse for causing the second mentioned cathode ray tube to pass current through a selected one of said conductors in accordance with the timing of the impulse to control the energization of the connected operating means to cause the related accounting element of the particular denominational order to manifest the digit repre-

sented by the timed impulse, the magnitude of the manifested digit being dependent upon the particular sweeping movement in which the timed impulse is established.

3. In a statistical system controlled by a record medium having columns of denominational index points with the same digit points of different columns forming rows extending across the record medium; a first station including therein means to feed said record medium past a sensing station, an electronic sweep device at said sensing station for sensing data representations at certain digit points on the record medium; control means including a sweep circuit for controlling the sweep of said device across the record medium in timed relation with the feeding means, one row being traversed during one sweep movement, an element responsive to the flow of electrons in the device for producing a light beam corresponding thereto, light sensitive units located on the opposite side of the record medium from the device and selectively rendered operative during one sweep of the beam in accordance with the sensing of data representations to generate differentially timed impulses representing the proper columnar relationship of the data, and means to transmit said impulses; and a second station including therein means to receive said impulses, an electronic sweep device, means responsive to said impulses for causing a flow of electrons in said device, control means including a sweep circuit operating in synchronism with that of the first mentioned device, a plurality of conductive targets located so as to be impinged upon by said electronic ray of the second mentioned sweep device, data receiving elements with individual operating means therefor, and circuit connections between said operating means and the targets of the second mentioned device for causing selective energization of said operating means in accordance with the differential times of operation of said second mentioned device by the aforesaid impulses to enter equal values in related ones of said receiving elements in their proper columnar relationship, during each sweep of the devices, thereby determining the magnitude of the manifested data in accordance with the particular sweeping operation in which the impulses are established.

4. In a statistical system controlled by a record medium having columns of denominational index points with like digit points of different columns forming rows extending across the record medium; a first station including means to feed said record medium past a sensing station, a cathode ray tube at said sensing station for sensing data representations at certain digit points on the record medium, control means including a sweep circuit for causing the ray to sweep in a predetermined path, each sweep of the ray covering a different row of digit points of the record, a fluorescent screen located between the source of the ray and the record medium for transforming the ray of the tube into a light ray, a plurality of light responsive units each related to one of the columns of the record medium and located so as to be selectively operated by the ray as it senses the data representations of a row of the record medium for setting up impulses at a differential time for each of the data representations in said row thereby distinguishing the different denominational orders to which said representations are related, and means to transmit said impulses; and a second station including therein means to receive said

impulses, a cathode ray tube normally in an inoperative condition and means responsive to said impulses for rendering the tube operative, control means including a sweep circuit for said tube operating in synchronism with that of the first mentioned tube, a plurality of conductive targets located so as to be impinged upon by said ray during each operation of the ray by the second mentioned control means, data recording elements and individual operating means therefor, and circuit connections between the conductive target and the individual operating means for selectively energizing said operating means at differential times in accordance with the differential times of setting up of the impulses by the light responsive units at the first station to operate the recording elements in the related denominational orders to manifest the data, the extent of operation of each of said recording elements being dependent upon which of the different sweeps of the cathode rays causes the establishing of the energizing impulses for said elements.

5. In a statistical system controlled by a record medium having columns of denominational index points with like digit points of different columns in rows extending across the record medium; a first station including therein means to feed said record medium past a sensing station, a cathode ray tube at said sensing station for analyzing said record medium for data representations in certain digit points thereof, means for causing the cathode ray to sweep across the rows of digit points in succession, one sweep for each row, a fluorescent screen between the record medium and the source of the ray for producing a light beam corresponding to said ray, a plurality of light responsive elements, one for each column of the record medium, arranged to selectively cooperate with said tube upon contact of the light beam with data representations in related columns to generate differentially timed impulses representing different denominational orders of said data, and means to transmit said impulses; and a second station including therein means to receive said impulses, a cathode ray tube normally biased to cut-off, means responsive to the impulses to cause operation of the tube for each of said impulses, means to impart a sweep to the cathode ray of the second tube corresponding to the sweep of the cathode ray of the first mentioned tube, a plurality of conductive targets located so as to be impinged upon in succession by the cathode ray of the second mentioned tube during its sweep, data recording devices having individual operating means therefor, and circuit connections between the conductive targets and said operating means selected under the control of the cathode ray of the second mentioned tube in accordance with the differential times the impulses are received from the first mentioned tube to energize the operating means to cause the recording devices of the related denominational orders to record the data, the extent of operation of each of the said recording devices being dependent upon the particular sweep of the rays which establishes the energizing impulses for said device.

6. In a statistical system controlled by a record medium having columns of denominational index points with like digit points of different columns forming rows extending across the record medium; a first station including therein means to move said record medium past a sens-

ing station, a cathode ray tube at said sensing station for sense data representations at certain digit points on the record medium while in motion, control means including a sweep circuit for effecting a movement of the cathode ray across the record medium to sense the rows of points successively, one sweep for each row, means intermediate the source of the ray and the record medium for changing the ray into a light beam, a plurality of light responsive devices individually related to predetermined columns of index points of the record medium, said devices cooperating with the tube upon contact of the light beam corresponding to the cathode ray with the data representations on the record medium to generate impulses to represent different denominational orders of said data, and means to transmit said impulses; and a second station including therein means to receive said impulses, a cathode ray tube normally biased to cut-off, control means including a sweep circuit for the latter tube constructed to function in definite timed relation with the sweep circuit of the first mentioned tube, means responsive to the impulses for rendering the second mentioned tube operative at successive intervals in accordance with the timing of said impulses, a plurality of conductive targets located so as to successively intersect the cathode ray of the second mentioned tube during each sweeping movement, data accounting elements with individual operating means for said elements, circuit connections between the conductive targets and said operating means selected for operation under the control of said second mentioned tube in accordance with the differential timing of the impulses to operate said elements of the related denominational orders to indicate the data sensed on the record medium, the extent of operation of each of said elements being dependent upon the particular sweep during which the energizing impulse for each related element is established.

7. In a statistical system controlled by a record medium having columns of denominational index points with the same digit points of different columns forming rows extending across the record medium; a first station including therein means to feed said record medium past a sensing station, a cathode ray tube at said sensing station for sensing data representations at certain digit points on the record medium while being fed in motion by the feeding means, control means including a sweep circuit controlling the position of the cathode ray of the tube and causing said ray to sweep across the record medium horizontally to sense the rows of points successively so as to detect like digit values of all denominations at differential times within one index point of movement of the record medium feeding means, means intermediate the source of the ray and the record medium for transforming the ray into a light beam, a plurality of light responsive cells, each related to one of said denominational columns of index points of the record medium, also situated at the sensing station and adapted to be selectively operated upon contact of the light beam corresponding to the cathode ray with the data representations of the record medium to generate impulses to represent the data, the denominational orders of digits of equal values being distinguished by their differential timing, and means to transmit said impulses; and a second station including therein means to receive said impulses, a cathode ray tube and control means including a sweep circuit for deflecting the ray

of the second mentioned tube in definite time relation with the sweep circuit of the first mentioned tube, means responsive to the said impulses for causing the said tube to be triggered off upon reception of each of said impulses, a plurality of conductive targets located so as to intersect the ray of the second mentioned tube in succession during the sweep of said ray, data accounting elements with individual operating means for said elements, and circuit connections between said conductive targets and said operating means selected for operation under the control of the ray of said second mentioned tube in accordance with the differential timing of the impulses to operate each of said elements to a differential extent dependent upon which of the sweeps of the cathode rays establishes each energizing impulse for said elements.

8. In a record controlled statistical system, cyclically operated means to feed records having columns of data representations in succession past an analyzing section of the system, means at that section including an electronic sweep device and a group of analyzing brushes for analyzing corresponding columns of successive records simultaneously for data representations thereon during a cycle of the feeding means, stop means normally capable of stopping the feeding means at the end of the cycle, means cooperating with the sweep device and effective upon analysis of a data representation thereby in one of the columns of the record to emit a current signal, and a second electronic sweep device, means cooperating with the latter for operating it in a predetermined timed relationship with the first mentioned electronic sweep device, a plurality of conductive targets located so as to be impinged upon in succession by the electrons of the said second electronic sweep device, individual circuit connections from the analyzing brushes to the targets of the second electronic sweep device, means responsive to said signal for rendering the second electronic sweep device operative, thereby causing one of the said circuit connections to be energized whenever data representations are detected at the same instant in corresponding record columns by the analyzing brushes and the first mentioned electronic sweep device, and means under control of the energized circuit connection for controlling the said stop means whereby the latter is rendered incapable of stopping the feeding means at the end of said cycle.

9. In a record controlled accounting machine system, cyclically operated means to feed record cards having columns of data representations in succession past an analyzing section of the system, said section comprising a first station provided with a plurality of analyzing brushes and a second station having a cathode ray tube scanning device for analyzing corresponding columns of successive cards simultaneously for data representations thereon during a cycle of the feeding means, stop means normally capable of stopping the feeding means at the end of the cycle, means intermediate the source of the ray and the cards for causing the ray to produce light, light responsive devices cooperating with the said cathode ray tube and selectively operated upon analysis of a data representative in one of the columns of the card at the second station to generate a current impulse, a second cathode ray tube, a plurality of conductive targets, control means for causing the ray of the second tube to scan the targets in succession in synchronism with the scanning of the data representations by the tube

at the second station, normally open individual circuits connecting each of said targets and analyzing brushes, one of said circuits being partially completed by the data representation according to its location in the corresponding column of the card being analyzed by said analyzing brush at the first station, means responsive to said impulse for rendering the ray of the said second cathode ray tube effective to wholly complete and cause energization of the said partially

5 completed circuit whenever data representations are detected at the same instance in corresponding record columns by the analyzing brushes and the first mentioned cathode ray tube, and means under control of the energized circuit for controlling the said stop means whereby the latter is rendered incapable of stopping the feeding means at the end of the said cycle.

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