

Nov. 17, 1942.

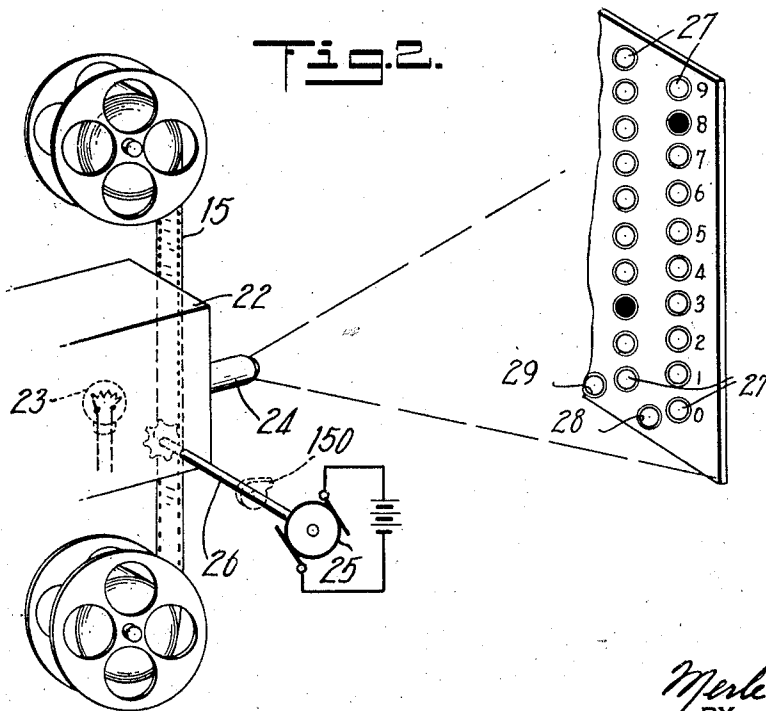
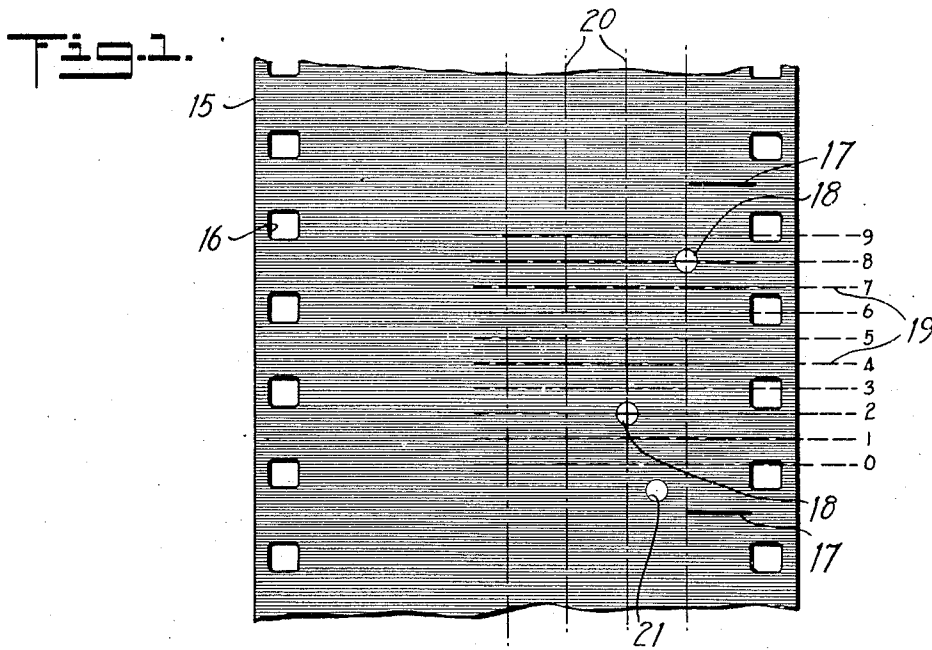
M. E. GOULD

2,302,025

ACCOUNTING MACHINE

Filed March 22, 1940

8 Sheets-Sheet 1



Nov. 17, 1942.

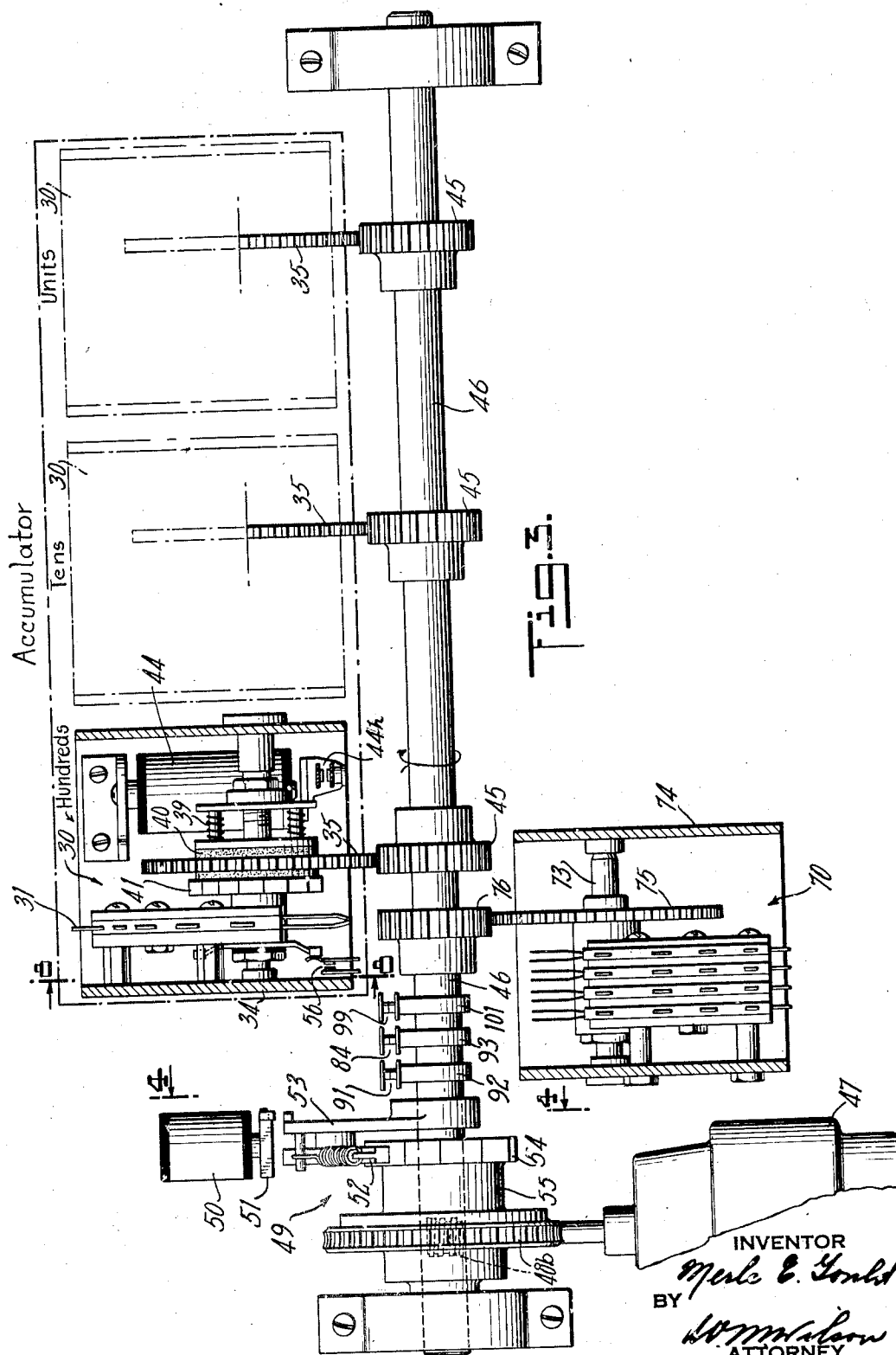
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8 Sheets-Sheet 2



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Filed March 22, 1940

8 Sheets-Sheet 3

Fig. 4.

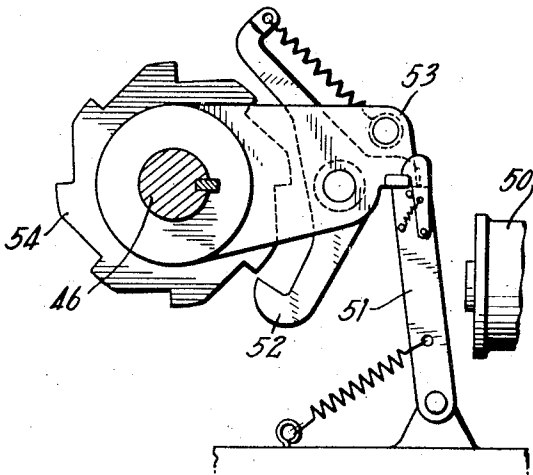


Fig. 5.

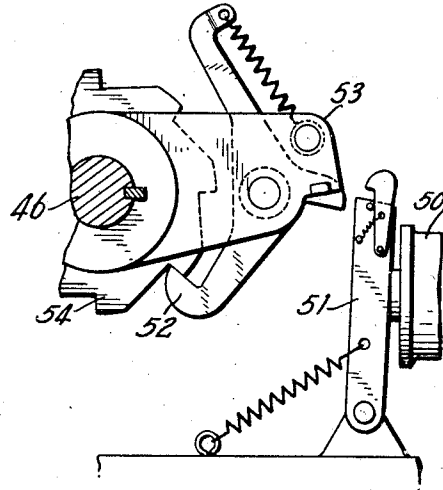


Fig. 6.

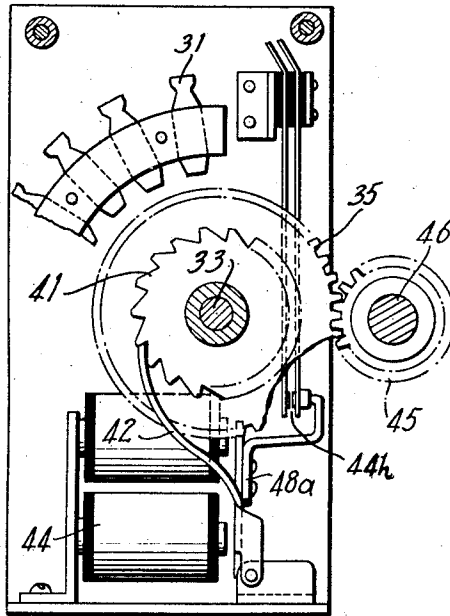
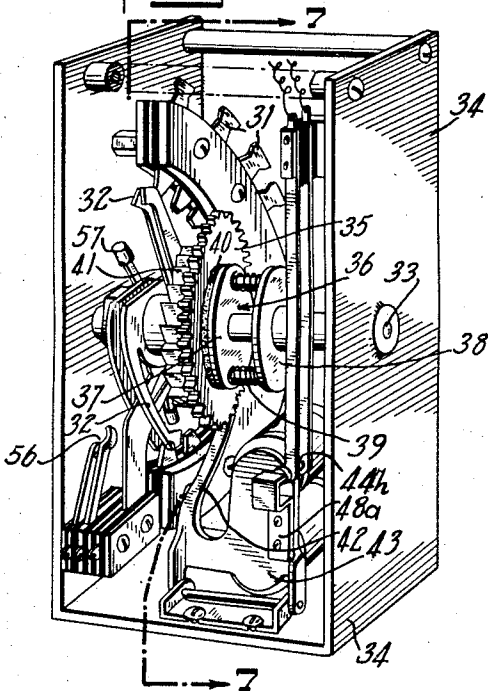


Fig. 7.

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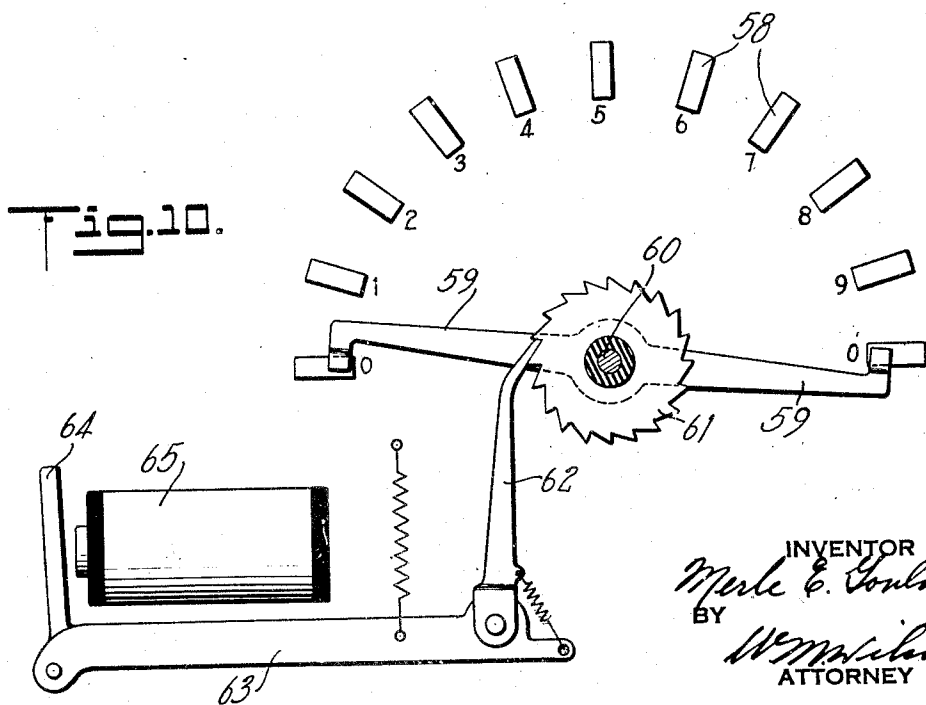
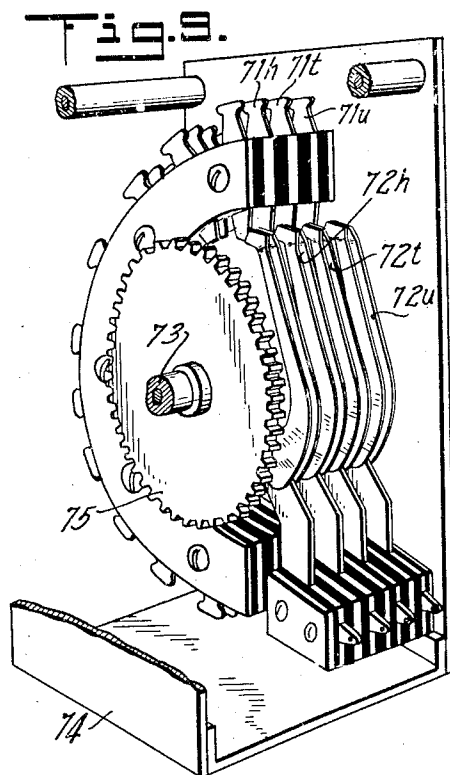
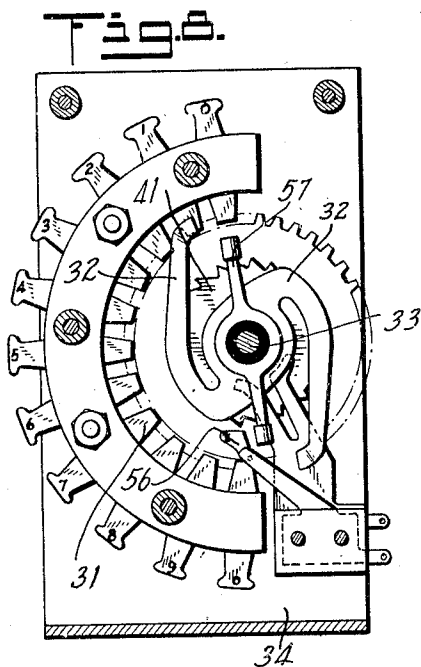
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8 Sheets-Sheet 4



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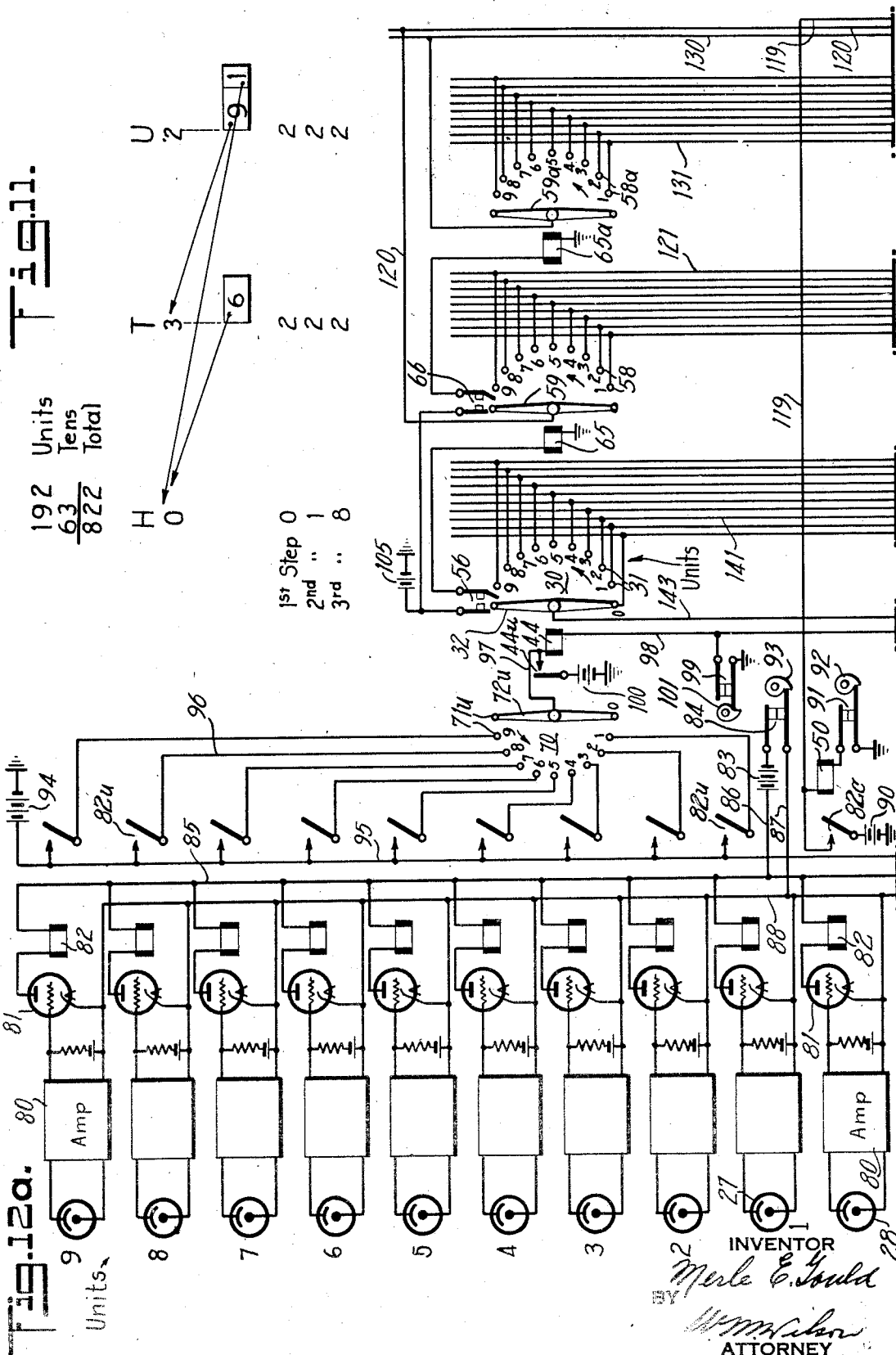
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2,302,025

ACCOUNTING MACHINE

Filed March 22, 1940

8 Sheets-Sheet 5



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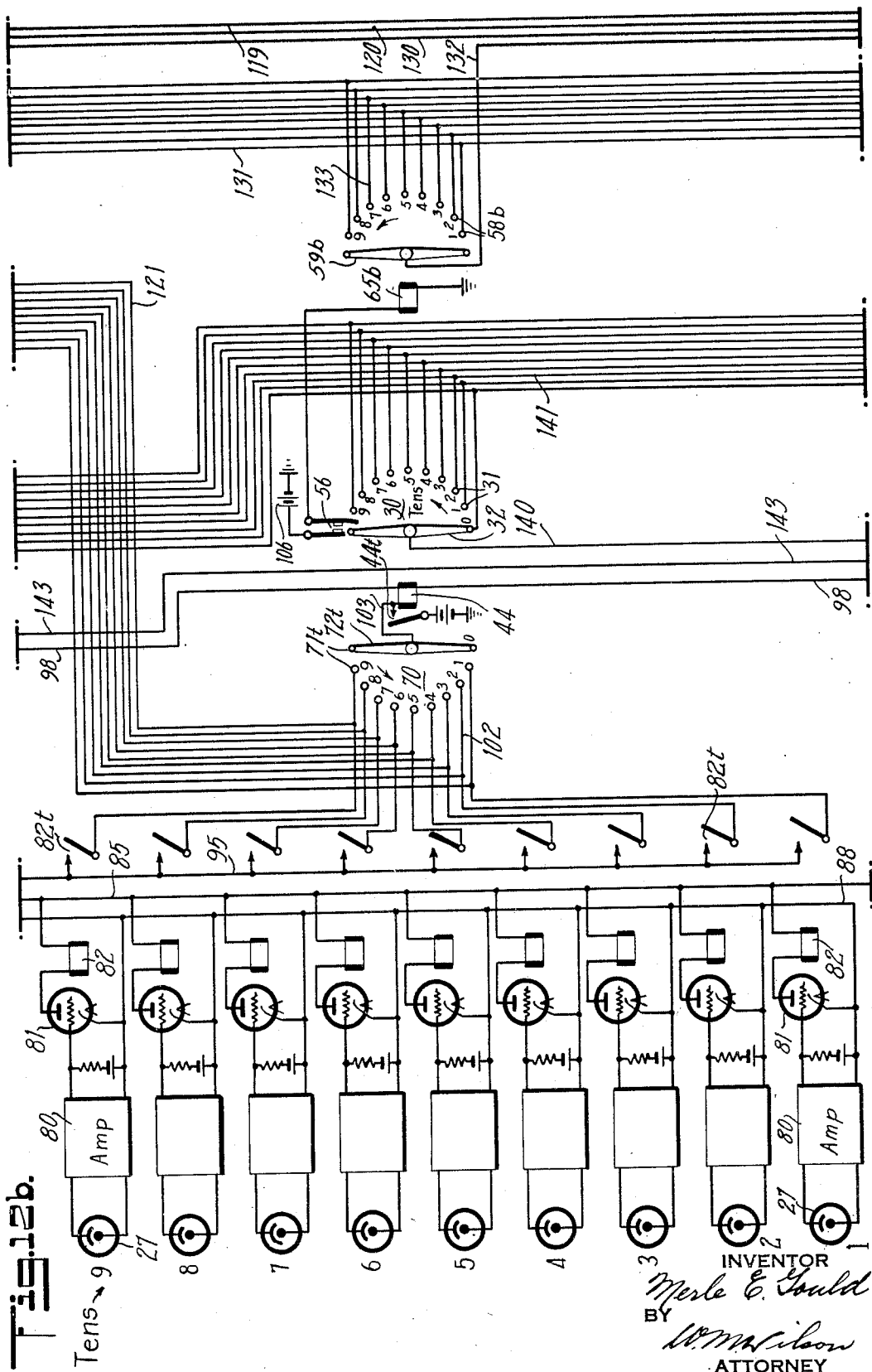
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ACCOUNTING MACHINE

Filed March 22, 1940

8 Sheets-Sheet 6



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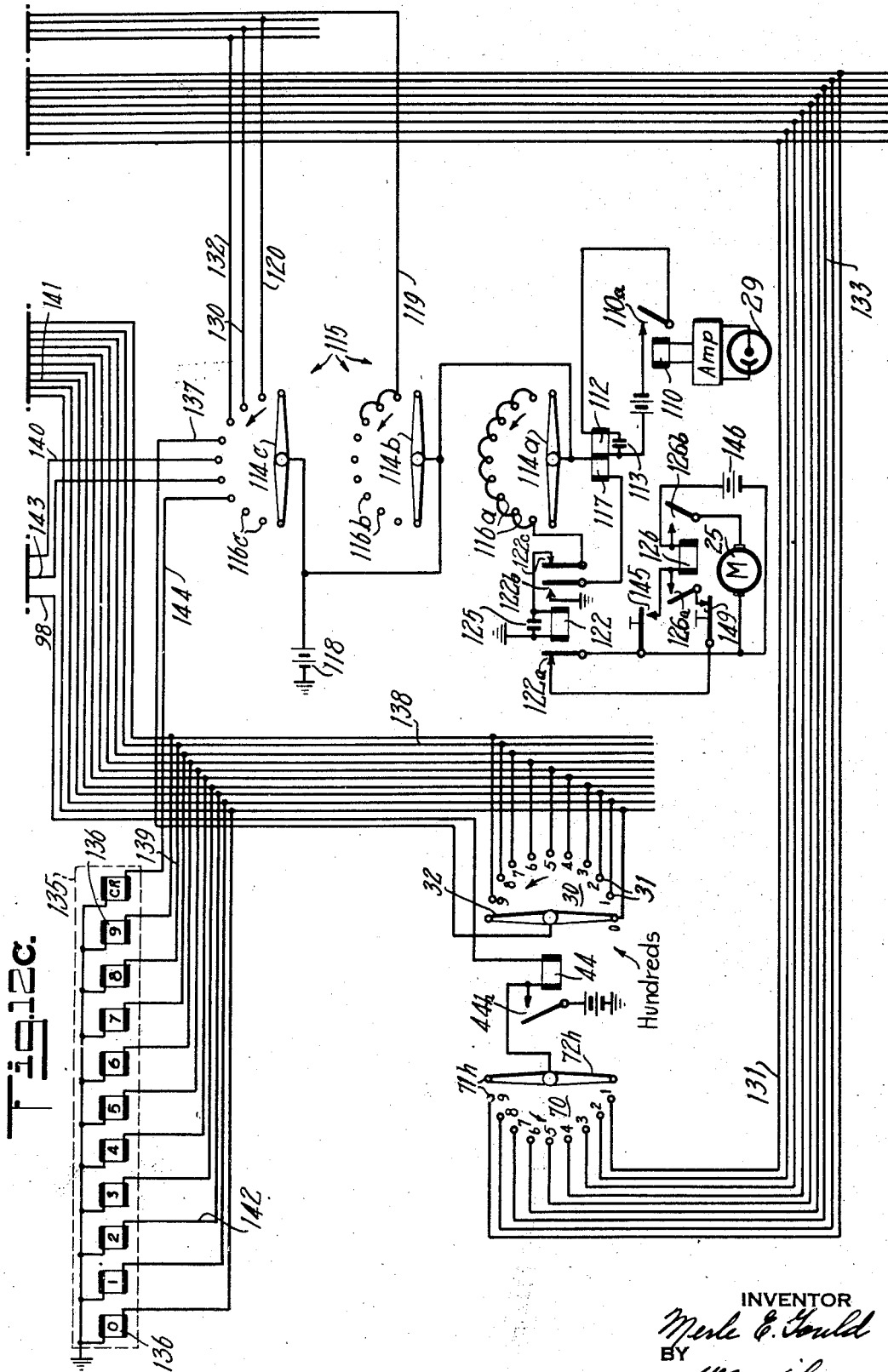
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ACCOUNTING MACHINE

Filed March 22, 1940

8 Sheets-Sheet 7



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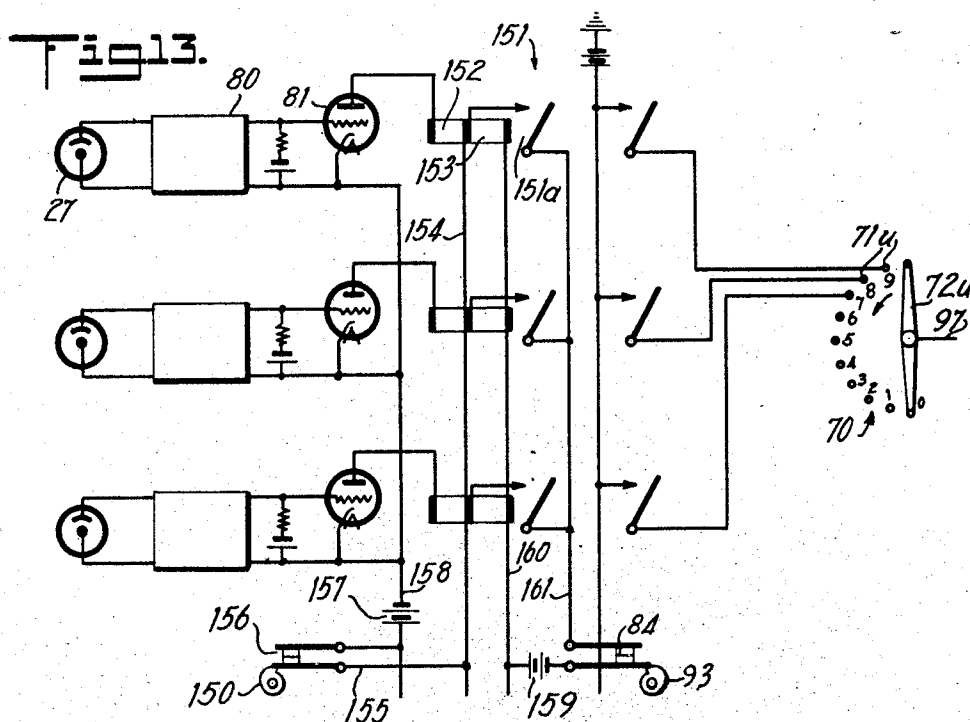
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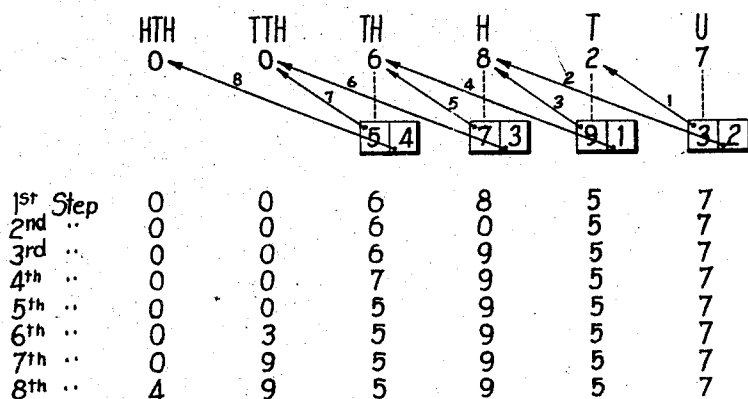
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8 Sheets-Sheet 8



237 Units
192 Tens
378 Hundreds
456 Thousands
495957 Total

Fig. 14.



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2,302,025

ACCOUNTING MACHINE

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Application March 22, 1940, Serial No. 325,407

3 Claims. (Cl. 235—61.6)

This invention relates to an accounting machine and more particularly to accounting machines controlled by individual records for controlling the operations thereof in accordance with the data designations disposed on the records.

The present invention constitutes an improvement of the machine disclosed in the copending application Serial No. 323,499 filed March 12, 1940, which has now matured into U. S. Patent No. 2,258,204, dated October 7, 1941. In the said co-pending application light sensing means comprising a light source and a plurality of photocells arranged in a spaced and coded relationship corresponding to the code of the data designations are provided to sense a photographic film having individual records formed thereon. The coded data designations on the said records are transparent areas or spots thereby permitting the light rays to illuminate and activate those cells disposed in coded positions corresponding to the coded data designations. The energization of individual solenoids is controlled by the activated cells to cause the data to be entered in a key operated adding device of known construction, the different keys of the device being operated by related solenoids. Each denominational order of the device is provided with a carry storage device for accumulating the carries from the related order to the next higher order until the end of the run of the film. At the end of the run provision is made for entering progressively the accumulated carries into the proper denominational orders of the device.

In the present invention sensing means of the type described are provided for sensing the data designations disposed on the photographic records. The sensed data is then set up and retained in suitable means until the retained data representations can be read out and entered into the data accumulating means. Each denominational order of the accumulating means is provided with a rotatable element, operating means therefor, and suitable carry storing devices for counting and storing the carries from the related order to the next higher order until a predetermined number of records are sensed. During each sensing operation start-stop means are controlled to set into operation normally inoperative actuating means, such as a driving shaft, for one cycle of operation. The data retained in the said set-up means is then read out by means of a distributor device, which is operated whenever the said shaft is set into op-

eration, to selectively render the operated driving shaft effective to control the denominational order operating means for differential times during the cycle and operating the related rotatable elements for effecting entry of the data in the accumulating means. Upon completion of each data entry operation the data retained in the said set-up means is cleared out, which clearing out operation is under control of the said driving shaft. Automatically operated means including a stepping switch are provided for effecting entries of the stored carries into the proper denominational orders upon the completion of a run of a predetermined number of records. Provision is also made whereby the stepping switch can effect recording operations of the accumulated totals after the carries have been entered into the related accumulator orders.

Accordingly, an object of the present invention resides in the provision of a record controlled machine in which the data designations of each record are sensed and stored for controlling the operations of each denominational order element of the data accumulating means at differential times during a cycle of operation of a start-stop actuating means, the latter being effective to actuate the said order elements in accordance with the stored data for effecting entries thereof in the said data accumulating means.

Another object of the present invention resides in the provision of means under control of the operated start-stop actuating means for clearing out the stored data referred to upon entry thereof in the data accumulating means.

Still another object of the invention resides in the provision of means for automatically reading out at predetermined times, under control of the record the stored carries and effecting entry thereof progressively in the related order entry control means of the accumulating means.

Still another object of the invention resides in the provision of means for automatically recording the accumulated totals progressively from period to period after effecting entry of the accumulated carries.

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 enlarged view of a fragmentary section of the photographic control element.

Fig. 2 is a diagrammatic view of the film feeding and sensing means.

Fig. 3 is a view in elevation of the start-stop actuating means and operating mechanism of the denominational order elements of the accumulating means.

Fig. 4 is a view in elevation of the start-stop clutch means, with parts broken and parts in section.

Fig. 5 is another view of the clutch detail shown in Fig. 4.

Fig. 6 is a view in elevation and perspective of one denominational order element and operating mechanism therefor.

Fig. 7 is a sectional view taken on the line 7-7 of Fig. 6.

Fig. 8 is a sectional view in elevation of the mechanism shown in Fig. 6.

Fig. 9 is a view in elevation and perspective of a distributor switch.

Fig. 10 is a simplified view of a well known type of stepping switch.

Fig. 11 is a representation of a calculating chart showing the steps involved in accumulating the data in the present invention.

Figs. 12a, 12b, and 12c taken together present a diagrammatic showing of circuits and instrumentalities of the machine.

Fig. 13 is a circuit diagram of a modified form of the controlled circuits.

Fig. 14 is a representation of a calculating chart showing the steps involved in accumulating data in a machine the capacity of which is expanded for handling calculations of greater amounts than shown in Fig. 11.

Photographic control record

Referring now to Figs. 1 and 2, the control element of the machine is shown to comprise a continuous photographic film 15 provided with the usual feed apertures 16 and consisting of individual sections or frames 17, which frames, when suitably recorded with data designations, form the individual control records.

In the use to which the invention has been applied, the film is opaque and is provided with data designations, such as the transparent areas or spots 18, which are suitably formed at predetermined index point positions on the individual frames. The differently disposed transparent areas or spots represent the values of the data by their relative positions on the individual records. In practice and according to the embodiment shown, the data designations are shown on the record in an index point relationship corresponding to the arrangement of the index perforations on the perforated record cards of the well-known Hollerith accounting system; that is, the differential positions of the spots 18 delineate the particular values of the data represented thereby. The different positions are represented by the dotted lines 19 in Fig. 1. The differently positioned spots are formed in adjacent columns on the records, which columnar positions are indicated by the dotted lines 20 in Fig. 1. In this figure it is noted, for example, that the designations or spots 18 shown represent the number "28".

Each individual record may be provided with spots in certain positions other than the data index point positions just referred to for purposes other than representing data. For example, a control designation is shown in Fig. 1 to be represented by the spot 21 which is provided in a position located below the zero index point position and between the described columnar positions. The purpose of this control designation and other control designations which may appear on the records will be understood as the description progresses.

Record feeding means

In Fig. 2, suitable feeding means for the film 15 is shown diagrammatically and represented generally by the reference character 22. The feeding means referred to is part of and included in a conventional type of motion picture projection machine which machine comprises a source of light rays 23, a lens system 24, and a driving motor 25 connected to the projector drive shaft 26. The conventional projection machine is one in which the film is momentarily arrested opposite the lens system 24, while exposed, and in which the film is obscured by a shutter as the individual film frames are positioned successively to the lens system. Such projector machines are well known, and for this reason it is believed further detailed description of this mechanism is not necessary. For example, a suitable machine for use in conjunction with the present invention is the standard Bell and Howell film projection machine, the principles of operation of which are described in the U. S. Patent No. 1,075,407.

Record sensing means

Referring to Fig. 2, it is seen that in addition to the light source 23 and lens system 24 the record sensing means includes a plurality of light responsive means, such as the bank of photocells 27. The individual photocells are arranged in spaced and coded positions corresponding to the coded arrangement of the spots 18 on the film records; that is, the photocells are arranged in separate columns or orders, each column including as many photocells as there are index point positions in each column of the individual film record. In the present embodiment ten photocells are shown in each column to correspond to the ten index point positions for the data designations formed on the records, and are numbered accordingly, namely "9" to "0".

The bank of photocells is suitably disposed with respect to the lens system 24 of the projection machine, so that, as the film is being passed therethrough at each exposure of a frame 17, a pattern of light beams corresponding to the coded spots formed thereon will be directed to the bank of photocells, whereby the photocells in certain coded positions will be activated by the beams or rays of light passing through the coded spots. It is understood that the light rays passing through the spots 18 formed in certain coded positions will activate those photocells disposed in the corresponding coded positions in the bank of photocells. For example, the spots 18 on the frame 17 in Fig. 1 represent the number "28" and, upon exposure of said frame in the projector, the light rays passing through these spots are directed to the bank of photocells to activate those photocells disposed in the corresponding coded positions, namely, "28," which are indicated by the darkened areas.

The position or station at which the film frames are arrested momentarily (opposite the lens system 24) will be referred to as the sensing position or station. The circuits controlled by the activated photocells will be described presently.

For the sake of simplicity, only several columns of photocells are shown. However, it is un-

derstood that the number of columns of photocells provided should correspond to the number of columns of data designations provided on the film records. The photocells referred to up to now are those which are controlled by the data designations appearing on the individual records.

It is to be noted that additional photocells 28 and 29 are provided for certain control purposes which will be described later. It is only necessary to state at this time that the positions of the photocells 23 and 29 in the bank correspond to the coded positions where the control designations may appear on the film records. For example, the photocell 28 is disposed in a coded position corresponding to the coded position where the control designation 21 may appear on the film records.

Data accumulating means

Referring now to Fig. 3, it is seen that individual units comprising accumulator elements and control means therefor, which are indicated generally by the reference character 30, are provided for each denominational order of the accumulator.

In Figs. 6 to 8, each unit is shown to comprise an arcuate bank of stationary contacts 31 (each contact representing a given digital value as indicated in Fig. 8) arranged to be wiped or engaged successively by a suitable rotatable contact element consisting of a pair of oppositely curved conducting arms 32. The said arms are secured to and insulated from the spindle 33 which is journaled in opposite walls 34 of the unit casing.

The spindle 33 is rotated by a gear 35, mounted rotatably thereon, through a friction clutch indicated generally by the reference character 36. The friction clutch comprises a pair of metal disks 37 and 38, the former being slidably mounted on the spindle and the latter fixedly mounted thereon. Springs 39 urge the disk 37, which is provided with suitable resilient material 40, to engage constantly the floating gear 35. The spindle is normally held at rest by means of a toothed ratchet 41, which is secured thereto, and an engaging pawl 42, the latter being secured to armature 43, which armature is associated with a magnet 44.

Now, upon energization of magnet 44 the ratchet 41 is released permitting gear 35 and spindle 33 to be driven by the gear 45 secured to shaft 46. Obviously, the degree of displacement or rotation of the spindle 33 and conducting arms 32 depends upon the period of energization of the magnet 44 during a revolution of the drive shaft 46. It should be mentioned that the ratio of gears 35 and 45 is 2:1 so that one revolution of the drive shaft 46 produces only half a revolution of the spindle 33, in the event the magnet 44 is energized continuously during the said revolution of shaft 46. It should also be mentioned that upon energization of magnet 44, the suitably disposed contacts 44a are closed by means of the arm 48a secured to armature 43.

A main actuating means such as drive shaft 46 is provided for the accumulator whereby each accumulator element can be actuated or rotated by its associated operating mechanism whenever the actuating means is set into operation. Normally, the said actuating means is inoperative and means are provided to render it operative for one cycle of operation, which latter means will be referred to as a start-stop means for the said actuating means.

The drive shaft 46 is rotated by means of a motor 47, associated gearing 48b, and under con-

trol of a start-stop means, such as a conventional type of one revolution clutch mechanism indicated generally by the reference character 49. The clutch mechanism comprises a control magnet 50, armature 51 which is formed as a stopping member for the spring urged pawl 52 and arm 53, the said pawl being pivotally mounted on arm 53, which arm 53 is secured to the drive shaft 46 (see Figs. 4 and 5). A ratchet 54 is provided and secured to sleeve 55 which in turn is rotatably mounted on shaft 46. One of the gears of gearing 48b is also secured to the sleeve 55 as shown in Fig. 3.

Now, upon momentary energization of magnet 50 the pawl 52 and arm 53 are released by armature 51 permitting the pawl to engage the ratchet 54 (see Fig. 5), thereby causing shaft 46 to be rotated one revolution by the said motor and associated gearing. Upon completion of one revolution the armature 51 which is now in the path of the said pawl and arm effects disengagement of the pawl and ratchet, thereby preventing further rotation of the drive shaft until the control magnet 50 is again energized momentarily.

Referring again to Figs. 6, 7 and 8, it is seen that additional contacts 56 are provided in each unit for the different denominational orders of the accumulator. These contacts will be referred to as carry contacts and are suitably disposed so that one of the arms 57 is effective to close the contacts as one of the conducting arms 32 passes from the associated "9" contact to the "0" contact. The arms 57 are secured to and insulated from the spindle 33 and are positioned each time the said spindle is advanced.

It will be described later in connection with the circuit diagram how, upon each operation of the contacts 56 of an accumulator unit of one order, an associated circuit is energized to effect energization of a magnet which controls the operation of a carry counting or storing device associated with the said order.

Referring now to Fig. 10, a suitable counting device will be described, of which one or more may be provided for and associated with an accumulator unit for each denominational order, for counting the number of carry operations which are to be effected in the higher denominational orders of the accumulator at a predetermined time. The carry read-out operations will be described later herein. The counting device shown in the figure is similar to the stepping relays or switches used in present telephone systems and comprises an arcuate bank of stationary contacts 58 arranged to be engaged successively by one of the conducting arms 59, which arms are secured to and insulated from the spindle 60. It is noted that each contact represents a digital value which is indicated accordingly in the figure. The said spindle and arms are advanced step by step by means of a ratchet 61 secured to spindle 60 and a cooperating pawl 62, which is pivotally mounted on the arm 63, which arm also has attached thereto an armature 64 associated with magnet 65. The construction and operation of the stepping switch, just described, are well known, and further description thereof is deemed unnecessary. It should be mentioned that, when desired, contacts 66 (see Fig. 12a) can be provided, which are operated by the conducting arms 59 when they pass from the associated "9" contact to the "0" contact. The said contacts 66 can be provided in the counting device, similarly as contacts 56 (see Fig. 6), in the accumulator unit and operated by arms (secured to spin-

dle 60), similar to the arms 57 secured to spindle 33. The contacts 66, when employed, function as carry contacts to control the operation of the next higher counting device in a series of such devices, when the conducting arms of the counting device lower in the series pass from the associated "9" contact to the "0" contact.

Referring now to Fig. 3, it is shown also that geared to the drive shaft 46 is a distributor or switch device generally indicated by the reference character 70. In Fig. 9, the distributor is shown to comprise a plurality of arcuate banks of stationary contacts 71u, 71t, and 71h which are engaged successively by the associated conducting arms 72u, 72t and 72h respectively. The said arms are secured to, and insulated from, the spindle 73 which is mounted revolvably in the walls of the casing 74. The spindle 73 has secured thereto a gear 75, which meshes with gear 76, the latter gear being secured to shaft 46. The ratio of gears 75 and 76 is 2:1 so that one revolution of the drive shaft 46 produces a half revolution of the spindle 73 and arms 72u to 72h. The purpose of the distributor just referred to will be understood presently.

Also, with reference to Fig. 3, it should be stated that cams 92, 93 and 101 are secured to shaft 46 for controlling the operations of the associated cam contacts 91, 94, and 99, respectively. All three contacts are normally closed. Upon rotation of the shaft 46, the driven cam 92 is effective to maintain the contacts 91 in an open condition, until the said shaft is at rest at the end of one revolution. Contacts 94 remain closed during practically the entire revolution of shaft 46, and are opened momentarily near the end of each revolution of said shaft. Contacts 99 remain closed, during practically the entire revolution of shaft 46, and are opened momentarily near the end of each revolution. The timing and purpose of these contacts will be understood from the description to follow hereinafter.

Operation of the machine

Referring now to Figs. 12a, 12b and 12c, arranged one below the other in the order named, the operation of the machine will be described. It is understood from the description thus far, that the term "data accumulating means" or "accumulator" refers to a plurality of the individual accumulator units, just described, and the one or more carry counting devices, and associated control means associated with each of the units for the different denominational orders of the accumulator.

In the machine illustrated in the figures, two orders of photocells and three orders of accumulator units are shown, and to simplify illustration of the invention, the machine is described as having a restricted data accumulating capacity, but it will be evident that the capacity of the machine may be enlarged to any desired capacity by employing additional units of the type described, and connected in the machine similarly as the units shown in the circuit diagram for the machine.

Assume now for the moment, that the projection machine is set into operation to feed continuously the photographic film, but as mentioned before, presenting the film frames, intermittently, to the sensing position where the coded designations appearing on the individual records, or frames, permit the rays of light to pass therethrough, momentarily, to activate only the photocells, which are disposed in the coded po-

sitions corresponding to the coded positions of the data designations. It is assumed, that the speed of operation of the projection machine is adjusted, so that the individual film frames are presented to the sensing station, at a rate, at which the data accumulating means is capable of manifesting the sensed data. By this, it is meant, that a cycle of rotation of the main drive shaft 46 must be completed in less time than a cycle of rotation of shaft 26.

It is noted, that each photocell 27 is shown connected to an amplifier unit, represented generally by the reference character 80, which may be of any well known construction suitable for photocell control circuits. Connected to the output of each amplifier unit 80 is a gaseous discharge tube 81 of a conventional type. The plate circuit of each tube includes the coil of a relay 82, a common potential source such as battery 83, and the normally closed common cam controlled contacts 84, and can be traced as follows: plate of tube 81, coil of relay 82, common conductors 85 and 86, battery 83, contacts 84, common conductors 87 and 88, and cathode of tube 81. The described control circuits are intended to operate in the following manner: the tubes 81 remain non-conductive and the associated relays 82 remain deenergized so long as the corresponding connected photocells are not subjected to and activated by the light rays passing through the transparent spots appearing on the individual film frames. However, those photocells which are illuminated by the light rays cause a suitable potential to be applied to the corresponding control grids of the associated tubes 81 to trigger the said tubes and render them conductive. The triggered tubes remain conductive and the connected relays 82 remain energized so long as the contacts 84 remain closed.

It will be understood as the description progresses, that the purpose of the tubes 81, and associated relays 82, is to set up and retain the representations of the data sensed on the records for a predetermined time. Upon effecting entry into the accumulator of the stored data, means are provided, which will be described, for clearing the stored representations, so that the data storing operations can be repeated successively for the following records.

For the present description, it is assumed, that each film frame presented to the sensing position is provided with a control spot 21 in addition to the data spots 18 to activate the photocell 28 each time a film frame is presented to the sensing position. Therefore, the associated tube 81 is rendered conductive, and corresponding relay 82 is energized to close the contacts 82c.

It is noted, to avoid confusion, that the contacts of relay 82, which is associated with and controlled by photocell 28, are designated 82c, whereas, the contacts of the individual relays 82 associated with, and controlled by the photocells 27 of the units column, are designated 82u, and the contacts of the individual relays, controlled by the photocells of the tens column, are designated 82t.

Upon closure of the said contacts 82c, a circuit is completed from grounded battery 90 to contacts 82c, coil of magnet 50, and normally closed contacts 91 to ground, energizing said magnet. Upon energization of the said magnet, the drive shaft 46 for the accumulator units is coupled, or connected, to the gearing 48b, and rotated thereby for one revolution as described hereinabove. The magnet 50 is energized only

momentarily, due to the brief period the contacts 91 remain closed. Upon rotation of the drive shaft the driven cam 92 is effective to maintain the contacts 91 in an open condition, until the said shaft is at rest at the end of one revolution.

Upon rotation of the said drive shaft, the conducting arms 72u, 72t, and 72h are advanced, in the direction indicated by the arrows, to engage successively the contacts 71u 71t and 71h, respectively, of the distributor 70. Assume now, that the film frame sensed, has disposed thereon coded spots representing the number "28", as indicated in Fig. 1. It is understood then, that the "8" photocell of the units column (Fig. 12a), and the "2" photocell of the tens column (Fig. 12b) are illuminated, and activated, by the light rays, to effect triggering of the associated tubes 81, and energization of the connected relays 82 to close the corresponding contacts 82u and 82t respectively.

It should be mentioned at this time, that the cam 93 driven by the shaft 46 is effective to maintain the contacts 84 in a closed condition, until the said conducting arms of the distributor 70 engage the associated zero contacts. Therefore, it is understood that the triggered tubes 81 remain conductive, and the associated relays 82 remain energized until the end of the revolution of shaft 46.

It will be seen that in this manner, due to the opening the contacts 84, the stored data representations are cleared after entry of the data in the accumulating means is effected.

Now it is seen, that the grounded battery 94 is connected, by means of the said closed contacts 82u and 82t, to the "8" contact 71u of the distributor, and the "2" contact 71t, respectively, so that as the conducting arms 72u and 72t are advanced, the following circuits are established in the order described. In Fig. 12a, one of the circuits can be traced from grounded battery 94 to conductor 95, the "8" contacts 82u, conductor 96, the "8" contact 71u, conducting arm 72u, conductor 97, magnet 44, conductor 98, contacts 99 to ground, energizing the said magnet. A holding circuit is then established for the magnet as follows: grounded battery 100, contacts 44u, magnet 44, conductor 98, contacts 99 to ground. The said holding circuit is maintained until the end of the revolution of shaft 46, when the cam 101 driven thereby causes the associated contacts 99 to be opened.

It is remembered, that upon energization of magnet 44, the associated conducting arms 32 are moved by shaft 46 through the friction clutch 36 described hereinabove. Near the end of each revolution of shaft 46, the contacts 99 are opened, and more specifically, the contacts are opened when the distributor arms 72u, 72t, etc. engage the "0" contacts as shown in the figures. Now, since magnet 44 of the units order is energized as the conducting arm 72u engages the "8" contact 71u, the conducting arm 32 of the units order accumulator element is advanced eight steps to wipe over eight contacts of the associated group 31, and due to the opening of contacts 99, at the said time during the revolution of shaft 46, the said arm 32 is halted opposite the "8" contact to remain in engagement therewith.

Referring now to Fig. 12b, another of the circuits established can be traced from grounded battery 94 to conductor 95, the "2" contacts 82t, conductor 102, the "2" contact of the group 71t,

conducting arm 72t, conductor 103, magnet 44 of the tens order accumulator unit, conductor 98, and contacts 99 to ground, energizing the said magnet. A holding circuit for the magnet is established through the associated contacts 44t, similarly as described above. Due to the energization of the said magnet 44, at the predetermined time mentioned during the rotation of the shaft 46, the conducting arm 32 of the tens order accumulator unit is advanced to engage the "2" contact of the associated group 31. Now it is seen, at the end of the revolution of shaft 46, that the elements or units of the accumulator indicate an entry of "28" therein.

Assume now for illustrative purposes, that the next film frame sensed has a data designation spot in the "3" index point position in the units column. It is understood then, that the magnet 44 of the units order of the accumulator (Fig. 12a) is energized as the conducting arm 72u engages the "3" contact of the group 71u to cause advancement of the conducting arm 32 to engage the "1" contact of the group 31. However, as the latter arm passes from the "9" contact to the "0" contact, the associated carry contacts 56 are closed momentarily to establish a circuit from the grounded battery 105 to contacts 56, and magnet 65 to ground, energizing the said magnet. Due to the momentary energization of magnet 65, the associated conducting arm 59 is advanced one step to engage the "1" contact of the group 58.

It is understood now, that each time the conducting arm 32 of the units order unit passes from the "9" contact to the "0" contact, the carry contacts 56 are operated to advance the conducting arm 59 of the first carry storing device one step. It is also evident now, that upon entry of sufficient amounts in the units order accumulator element to cause the conducting arm 59 of the first carry storing device to pass from its "9" contact to the "0" contact, the associated carry contacts 66 are closed, momentarily, to establish a circuit from grounded battery 105 to contacts 66, and magnet 65a to ground, energizing said magnet. The conducting arm 59a of the second carry storing device is then advanced one step. In this manner, the number of carry operations, which are to be effected at the end of the film run or any other desired predetermined time, are stored. It is understood, that the stored carries just referred to, are solely in connection with the units order unit of the accumulator. It is obvious too, that the capacity of the carry storing device of the units order can be expanded to any capacity desired by the addition of other step-by-step relays, similar to the one shown in Fig. 10, and connected in the circuit as shown in Fig. 12a.

Referring now to Fig. 12b, for the sake of simplicity, only a single carry storing device is shown, associated with the tens order accumulator unit which is operated exactly as the carry storing devices described above. Whenever, the conducting arm 32 of the tens order accumulator unit passes from the "9" contact to the "0" contact, the associated carry contacts 56 are closed, momentarily, to complete a circuit from the grounded battery 106 to the grounded magnet 65b, energizing said magnet, and causing the conducting arm 59b to be advanced one step.

In order, to describe briefly the readout operations, whereby the stored carries are entered successively, or progressively, in the proper orders of the accumulator, assume that, at the end of a predetermined run of the film, the amount 192

has been entered in the units order of the accumulator and the amount 63 in the tens order. With reference now to Fig. 11, it is seen that the total of the entered amounts equals 822. However, at the end of the said run before the carry readout operations are initiated, the accumulator elements 30 indicate an amount of 032. In the counting devices, associated with the units order accumulator element, 19 carries have been stored, and at this particular time, the conducting arm 59 of the first carry storing device is positioned to engage the associated "9" contact, and the conducting arm 59a of the second carry storing device is positioned to engage the associated "1" contact. In the counting device, associated with the tens order accumulator element, the conducting arm 59b of the carry storing device is positioned to engage the associated "6" contact.

It will be understood from the description to follow, that during the first step of the carry readout operations, the entries made into the first counting device, or lower order device, associated with the units order accumulator element, are transferred to, or entered into, the tens accumulator element; during the second step, the entries made into the second counting device, or next higher order device, associated with the units order accumulator element, are entered into the hundreds accumulator element; and during the third step, the entries made into the counting device, associated with the tens order accumulator element, are entered into the hundreds accumulator element. It will then be seen, that at the end of the carry readout operations, the different orders of the accumulator elements are positioned to indicate the true amount of the data designations sensed on the photographic film (see Fig. 11).

In order, to effect the carry readout operations automatically, assume that, the last film frame sensed is provided with a control spot, in addition to the data spots 18 and control spot 21 (see Fig. 1), which is effective to activate the photocell 29 (see Fig. 2), in addition to the photocells 27 and 28. Referring now to Fig. 12c, it is seen, that activation of the said photocell effects energization of a relay 110, and closure of the associated contacts 110a, to complete a circuit to a magnet winding 112, energizing said magnet. A condenser 113, which is charged upon closure of contacts 110a, is connected across the terminals of the said winding, maintaining the winding energized, for a predetermined time after contacts 110a open, depending upon the chosen capacity of the condenser 113 and the resistance of winding 112 through which the said condenser discharges. The purpose of the described arrangement is to prevent advancement, or movement of the associated conducting arms 114a, 114b, and 114c until the drive shaft 46 for the accumulator units is at rest, and obviously, after the last film frame has passed photocell 29. The stepping switch, generally indicated by the reference character 115, is similar in design and operation to the carry counting device, shown in Fig. 10, and described hereinabove. Thus, as long as the winding 112 is energized, the conducting arms 114a and 114c are not advanced. Three arcuate banks of stationary contacts 116a, 116b, and 116c are provided, and are engaged successively by the associated arms 114a, 114b, and 114c respectively. Separate magnet windings 112 and 117 are provided to advance the said arms, step by step, upon each deenergization of the magnet winding. Upon deenergization of the

magnet winding 112 or 117, the said arms are advanced one step to engage the first contacts of the associated banks.

The following circuits are then established: the first to be considered extends from grounded battery 118 to conducting arm 114b, the first associated contact of the group 116b, conductor 119, magnet 50, and contacts 91 to ground energizing said magnet. Upon energization of the said magnet, the drive shaft 46 is released for rotation of one revolution. The second circuit to be considered includes grounded battery 118 conducting arm 114c, the first contact of the associated group 116c, conductor 120, conducting arm 59, the "9" contact of the bank 58, conductor 121, the "9" contact of the bank 71t, conducting arm 72t (upon engagement of said arm with the said contact), conductor 103, magnet 44 of the tens order, conductor 98 and contacts 99 to ground, energizing said magnet, and establishing the holding circuit therefor, through the associated contacts 44t which was traced before.

The conducting arm 32 and the tens accumulator element is advanced nine steps, thus being positioned from the "3" contact to the "2" contact. As the said arm 32 passes from the "9" contact to the "0" contact, the associated carry contacts 56 are operated to energize, momentarily, magnet 65b, and advance the conducting arm 59b one step from the "6" contact to the "7" contact. The individual accumulator elements now indicate an amount of 022 (see Fig. 11).

Another of the circuits established, and just referred to, comprises a homing circuit for the stepping switch 115, and includes the grounded battery 118, conducting arm 114a, the first contact of the associated bank 116a, normally closed contacts 122c of relay 122, and coil of relay 122 to ground, energizing said relay to close the contacts 122b and open the contacts 122a and 122c. Closure of the said contacts 122b connects ground to the winding 117 to cause the battery 118 to energize the second winding 117 of the stepping magnet. Due to condenser 125, the said relay and magnet remain energized for a predetermined time, which is sufficient for the shaft 46 to complete its rotation of one revolution. Upon deenergization of the winding 117, the associated conducting arms 114a, 114b and 114c are advanced one step to engage the second contacts in the associated banks. The homing circuit described functions periodically until the said arms are positioned in their home positions as shown in Fig. 12c.

Opening of contacts 122a breaks a holding circuit for relay 126, which relay controls the operation of the projector motor 25. The motor control circuits will be described presently.

Upon advancement of the said conducting arms 114a to 114c to engage the second contacts of the associated banks, the following circuits are completed which constitute the second step in the carry readout operations: from grounded battery 118 to conducting arm 114b, and the second contact of the bank 116b to energize the magnet 50 momentarily, and effect release of the shaft 46 for another revolution of rotation. This circuit is traced hereinabove, and need not be repeated at this time. For the chosen illustration which is being described, the second, third and fourth contacts of the bank 116b are connected to the conductor 119, so that during the first three operations of the stepping switch 115, the circuit referred to, is established to cause the shaft 46 to be released as described. An-

other circuit can be traced from grounded battery 118 to conducting arm 114c, the second contact of bank 116c, conductor 130, brush arm 59a, contact "1" of the bank 58a, conductor 131, contact "1" of the bank 71h, conducting arm 72h, magnet 44 of the tens order, conductor 98 and contacts 99 to ground, energizing said magnet. The conducting arm 32 of the hundreds accumulator element is then advanced from the "0" contact to the "1" contact.

The operations just described comprise the second step in the carry readout operations referred to, and at this time, the individual accumulator elements now indicate an amount of 122.

Upon further advancement of the conducting arms 114a to 114c, the third step of the carry readout operations is performed. A circuit is established from the grounded battery 118 to the conducting arm 114c, the third contact of the bank 116c, conductor 132, conducting arm 59b, the "7" contact of the bank 58b, conductor 133, the "7" contact of the bank 71h, conducting arm 72h, magnet 44 associated with the hundreds accumulator element, conductor 98, and contacts 99 to ground, energizing said magnet, and establishing a holding circuit (a similar holding circuit is traced hereinabove) through the associated contacts 44h. Due to the energization of the said magnet 44, the associated arms 32 are advanced from the "1" contact to the "8" contact; therefore, at this time, the accumulator elements 30 indicate the amount 822, which is the true amount of the items entered into the accumulator. This completes the description of the carry readout operations for the chosen illustration. It is evident from this description, how additional readout operations are to be effected in the event it is desired to handle amounts of a higher value than the one chosen for the present description.

Recording the accumulated data

Now, as the progressive advancement of the conducting arms 114a to 114c continues, due to the described homing circuit, provision has been made to print the amount standing in the described accumulator. The recording or printing unit is shown diagrammatically, and represented generally by the reference character 135. Individual solenoids 136 are shown to be included in the recording unit, and are associated in a well-known manner with the keybars of a conventional typewriter, so that upon energization of any one solenoid, let us say the "5" solenoid, the "5" keybar of the typewriter is depressed to effect actuation of the "5" typebar, and record the number "5." Such control of conventional typewriters is so well known, that it is deemed unnecessary to described this mechanism further in detail. Reference can be made to the U. S. Patent No. 2,066,786, wherein detailed description of the structural details of a preferred type of solenoid controlled "Electromatic" typewriter is set forth.

The first circuit established to effect the recording of the accumulated data is as follows: grounded battery 118 to conducting arm 114c, the fourth contact of the bank 116c, conductor 137, conducting arm 32 of the hundreds accumulator element, the "8" contact of the associated bank 31, conductors 138 and 139 to the "8" solenoid of the typewriter unit, and ground, energizing said solenoid, and effecting the printing of the "8" character on a suitable record sheet.

Upon advancement of the conducting arms 114a to 114c to engage the next associated contacts of the respective banks, a circuit is completed from the grounded battery 118 to conducting arm 114c, the fifth contact of the bank 116c, conductor 140, conducting arm 32 of the tens accumulator element, the "2" contact of the associated bank 31, conductors 141 and 142, the "2" solenoid of the unit 135 to ground, energizing said solenoid to effect printing of the "2" character.

The next circuit completed during the recording operations is as follows: grounded battery 118, conducting arm 114c, the sixth contact of the bank 116c, conductor 143, conducting arm 32 of the units accumulator element, the "2" contact of the associated bank 31, conductors 141 and 142 to the "2" solenoid of the unit 135 to ground, energizing said solenoid to effect printing of the "2" character.

Upon completion of the recording of the amount, set up in the individual accumulator elements, a circuit is completed from grounded battery to the conducting arm 114c, the seventh contact of the bank 116c, conductor 144 to the carriage return solenoid CR of the unit 135 to ground, energizing said solenoid to effect return of the carriage and record sheet, and advancement of the record sheet in the said unit. Now, the record sheet in the typewriter is in proper position to receive further recordings of the amounts, to be read out of the said accumulator.

Upon return of the conducting arms 114a to 114c of the stepping switch 115, to the normal home position (indicated in Fig. 12c), the relay becomes deenergized, to position the associated contacts in the normal positions shown in the said figure.

Now, the control circuits for the projector motor 25 are conditioned, so that, upon operation of the start key 145, a circuit is completed from one terminal of the battery 146 through the closed contacts of the start key and coil of relay 126 to the other terminal of the said battery, thereby permitting a holding circuit to be established. The holding circuit is as follows: one terminal of the battery 146 to contacts 122a, normally closed contacts of a stop key 149, contacts 126a, coil of relay 126 to the other terminal of the said battery. The projector motor is then connected to the said battery, by means of contacts 126b, and the said motor is operated, until the said contacts 122a, or the contacts of the stop key 149 are opened, to break the described holding circuit for relay 126.

Since the automatic resetting of the accumulating elements and carry storing devices form no part of the present invention, such structure is not disclosed herein. For the purposes of the present invention, it is assumed that the said elements and devices are reset manually.

Modification

Referring now to Fig. 13, the modification of the control circuits, to be explained, will be readily understood, in view of the detailed description set forth hereinabove. In the present modification, it will be shown, that the conventional shutter mechanism included in the projector, referred to above, can be deleted, and be replaced by simplified mechanism for controlling the conductivity of the tubes 81. In this modification, it will be seen, that it is immaterial, whether the individual film frames are fed continuously past the lens system 24, or fed inter-

mittently thereto. It will be assumed for this description, that the conventional projector intermittent motion mechanism is used for feeding the film therein.

Now, as the film frames are presented to the lens system 24, the light rays passing through the spots 18 are projected upon the bank of photocells 27 to activate certain of the cells, in accordance with the data designations sensed. Due to the increased potentials impressed upon the corresponding tubes 81, these tubes are rendered conductive to energize the associated relays 151.

Relays 151 are provided with two windings or coils, one being a pick-up coil 152 and the other a holding coil 153. Whenever a tube 81 is rendered conductive, the pick-up coil of the associated relay is energized as follows: plate of tube 81 to pick-up coil 152, common conductors 154 and 155, contacts 156, battery 157, common conductor 158 to the cathode of tube 81. A holding circuit is then established for the said relay, which can be traced from battery 159, common conductor 160, holding coil 153, contacts 151a, common conductor 161, and contacts 84 to the said battery. The cam 93 (secured to shaft 46) permits the contacts 84 to be opened only after the conducting arms 72u, 72t, etc., of the distributor 70 engaged successively the associated contacts of the banks 71u, 71t, etc. The holding circuit, just described, is then maintained, until the end of the revolution of shaft 46, so that proper entries can be made into the associated accumulator elements, exactly as described hereinabove.

A cam 150 is provided to control the operation of contacts 156. The said cam is secured to the projector drive 26, and is effective to maintain the said contacts in an open condition at all times, except those times when the film frames are directly opposite the lens system. When the film frames are positioned properly, at the sensing station or position, the contacts 156 are closed, momentarily, to permit the activated cells 27 to render the associated tubes 81 conductive as described. At all other times, as the film frames are moved to, or from, the sensing position, the contacts 156 are open; thus, it is seen that the tubes 81 cannot be triggered falsely to effect erroneous entry in the accumulator elements.

Now in closing, refer to Fig. 14, it was mentioned hereinabove, that it is evident that larger amounts can be handled by the accounting mechanism, described herein, than the amount chosen for illustration purposes. In order to describe briefly, the readout operations involved for such larger amounts, assume (1) that the accumulator, for the following example, has six orders and that the four lowest orders are provided with multi-order carry storage devices as shown in Fig. 12a, and (2) that at the end of a predetermined film run that the amount 237 has been registered, or entered in the units order of the accumulator, the amount 192 in the tens order, the amount 378 in the hundreds order, and the amount 456 in the thousands order. The total of these is 495957. However, at the end of the said run the different orders of the accumulator indicate 006827.

The first step in the readout operation is to enter the number, or amount, standing in the lower order carry counting device, associated with the units accumulator element, into the tens accumulator element. At the end of this first step, the accumulator indicates the amount 006857.

The steps are indicated by the numbered arrows in the figure.

During the second step, the amount standing in the next higher order carry counting device associated with the units accumulator element is entered into the hundreds accumulator element. At the end of the second step, the accumulator indicates the amount 006057. It is noted, that the conducting arm of the hundreds accumulator element passes from the "9" contact to the "0" contact of the associated bank, and thus effects an entry into the lower order counting device associated therewith. In this event, the said counting device now registers "8" instead of "7".

During the third step, the entries made into the lower order counting device, associated with the tens accumulator element, is entered into the hundreds accumulator element. At the end of this operation the accumulator indicates 006957.

During the fourth step, the entries made in the next higher order counting device, associated with the tens accumulator element, is entered into the thousands accumulator element. At the end of this operation, the accumulator recording is 007957.

During the fifth step, the entries made in the lower order counting device, associated with the hundreds accumulator element, is entered into the thousands accumulator element. At the end of this operation, the accumulator reading is 005957. It is noted, during this operation, the conducting arms of the thousands accumulator elements pass from the "9" contact to the "0" contact of the associated bank to effect an entry in the lower order counting device associated therewith. The said counting device then registers "6" instead of "5".

During the sixth step, the entries made in the higher order counting device, associated with the hundreds accumulator element, is entered in the ten-thousands accumulator element. At the end of this operation, the accumulator reading is 035957.

During the seventh step, the entries made in the lower order counting device of the thousands accumulator element is entered in the hundred-thousands accumulator element. At the end of this operation the accumulator reading is 095957.

Finally, during the eighth step, the entries made in the higher order counting device of the thousands accumulator element is entered in the hundred-thousands accumulator element. At the end of this operation the accumulator reading is 495957, which is the true total reading of the different items entered into the different accumulator orders.

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. An accounting machine controlled by records bearing data designations at predetermined index point positions comprising means for feeding the records, means for sensing the data designations on the records, said sensing means comprising a plurality of light responsive means disposed in a spaced and coded relation, an indi-

vidual light responsive means disposed at a position to correspond to each index point position on the records and means including a source of light rays for illuminating the records and activating only those light responsive means by the light rays modified by the data designations which are disposed at those positions corresponding to the index point positions of the designations, individual gaseous discharge devices, one for each light responsive means, said devices connected to and rendered conductive by the related activated light responsive means, means controlled by the conductive discharge devices to set up and retain representations of the data sensed, data accumulating means and entry control means therefor, a rotatable shaft having one revolution clutch means for normally preventing rotation thereof, means under control of the sensing means for effecting operation of the said clutch means, each time the data designations are sensed on each record, to cause the clutch means to release the shaft and permit the latter to be rotated one revolution, the said entry control means including means which are connected to and operated by the said shaft, means including distributor means to read out the data representations retained by the said setup means, said distributor means including rotatable means which are rotated by the said shaft, upon release of the latter, to effect the reading out of the data representations during the rotation of said shaft, means jointly controlled by the said distributor and set up means for selectively rendering the said entry control means effective, at differential times during the cycle, to control the data accumulating means and effect entries of the data in the latter, and means operated by said shaft for rendering the said conductive discharge devices non-conductive upon entries of the data in the said accumulating means.

2. In an accounting machine controlled by records bearing data and control designations and having means for sensing the said data and control designations, data accumulating means having a plurality of denominational order entry control means, means under control of the sensing means for controlling the said entry control means and effecting entries of the data sensed, carry storing devices, for each denominational order of the accumulating means and controlled by the related orders of the accumulating means for counting and storing the carries of each said denominational order as required during the data entry operations in the accumulating means, readout means for each carry storing device hav-

ing means for connecting the readout means of each carry storing device related to a denominational order of the accumulating means to the entry control means of the next higher denominational orders of the accumulating means, in combination with control means for rendering each readout means effective to read out the stored carries to control the operations of the entry control means of the next higher order of the accumulating means and effecting entries therein, said control means including means for effecting the readout operations from the carry storing devices for each related denominational order of the accumulating means progressively and automatically, and additional means under control of the sensing means, upon sensing a control designation, for initiating the operations of the said control means.

3. In an accounting machine controlled by records bearing data and control designations and having means for sensing the said data and control designations, data accumulating means having a plurality of denominational order entry control means, means under control of the sensing means for controlling the said entry control means and effecting entries of the data sensed, carry storing devices for each denominational order of the accumulating means and controlled by the related orders of the accumulating means for counting and storing the carries of each said denominational order as required during the data entry operations in the accumulating means, readout means for each carry storing device having means for connecting the readout means of each carry storing device related to a denominational order of the accumulating means to the entry control means of the next higher denominational orders of the accumulating means, in combination with stepping relay control means for rendering each readout means effective progressively to read out the stored carries to control the operations of the entry control means of the next higher orders of the accumulating means and effecting entries therein, means for controlling the operations of the stepping relay control means for effecting the readout operations from the carry storing devices for each related denominational order of the accumulating means automatically, and additional means under control of the sensing means, upon sensing a control designation, for initiating the progressive and automatic operations of the said stepping relay control means.

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