

Jan. 21, 1947.

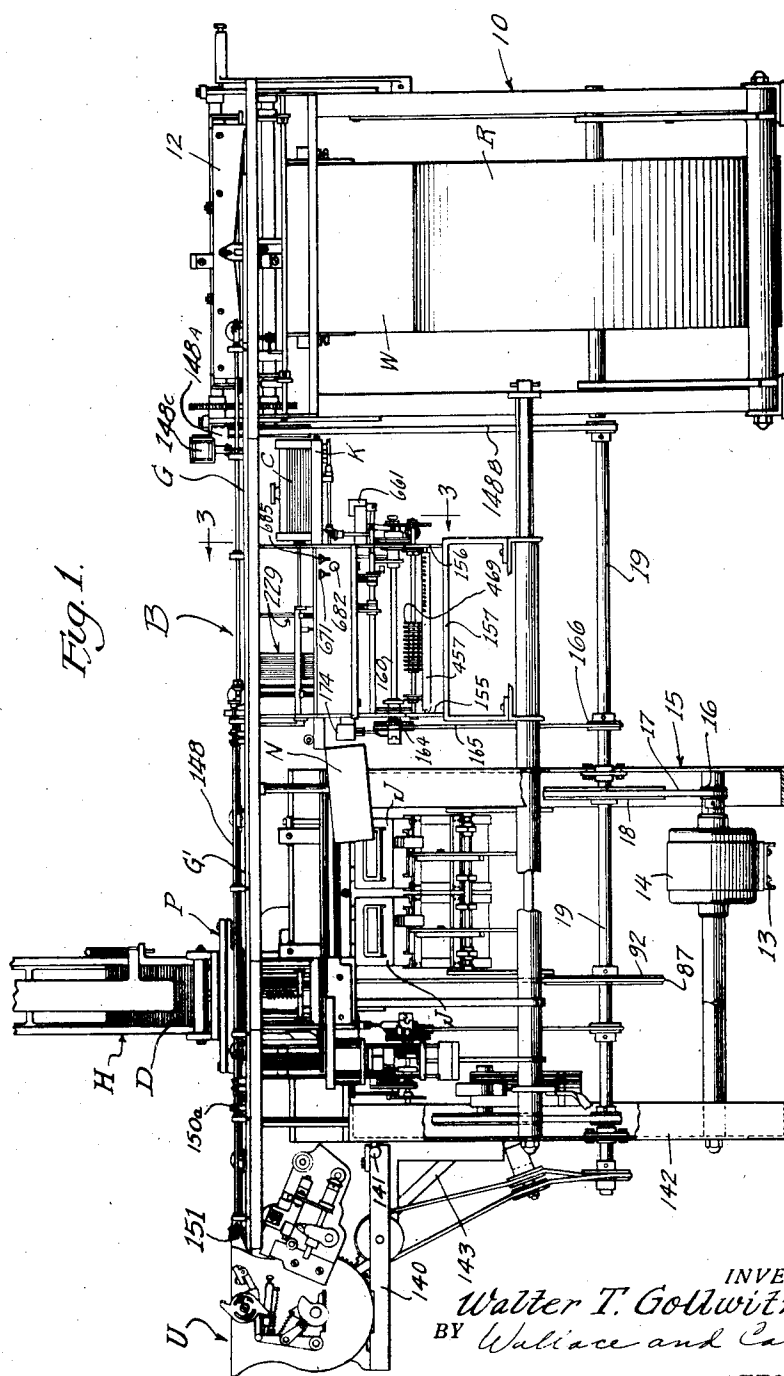
W. T. GOLLWITZER

2,414,643

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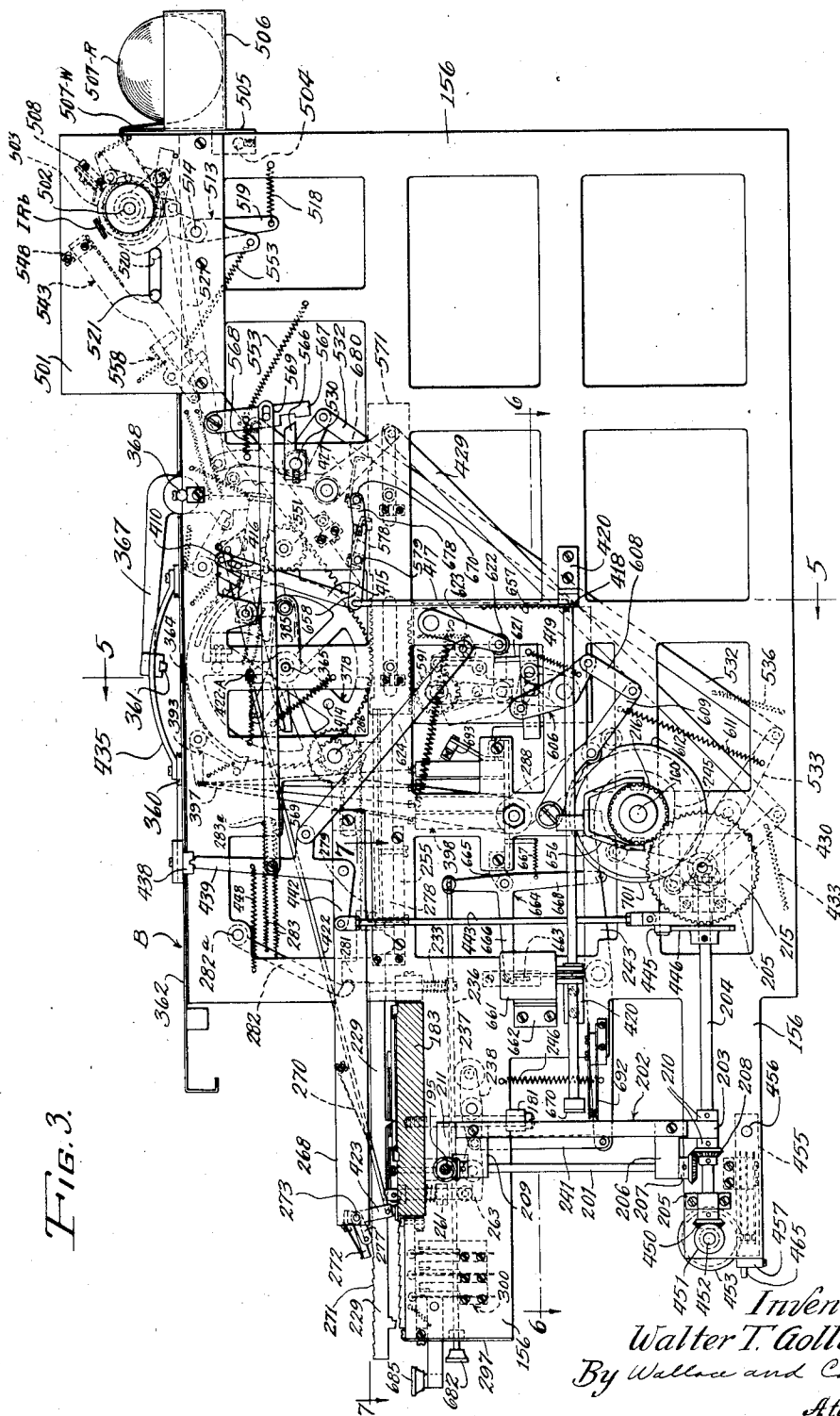
W. T. GOLLWITZER

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Inventor:
Walter T. Gollwitzer
By Wallace and Cannon
Attorneys

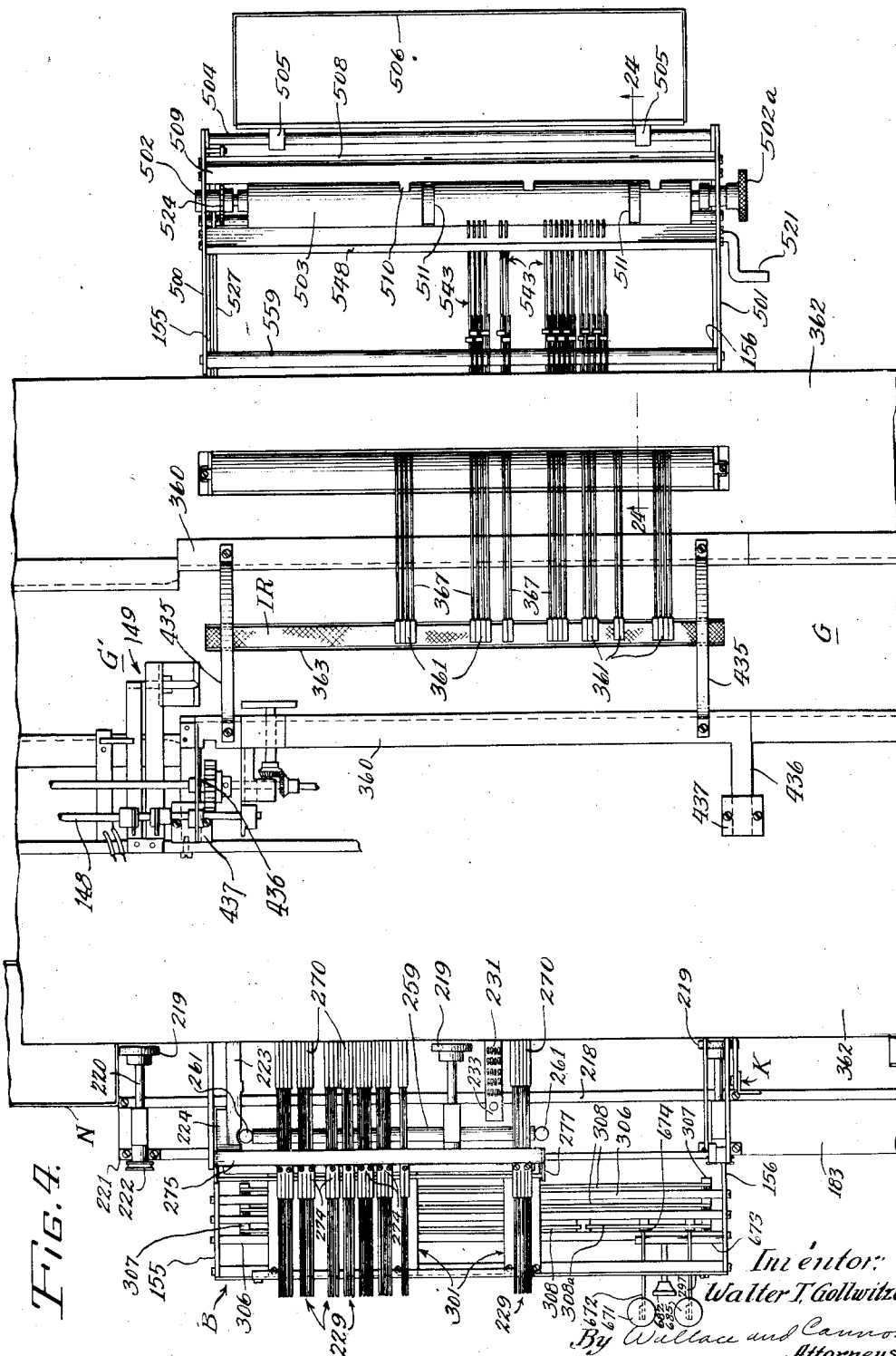
Fig. 4.

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By Wallace and Cannon
Attorneys

Walter T. Gollwitzer

ace and Cannon
Attorneys

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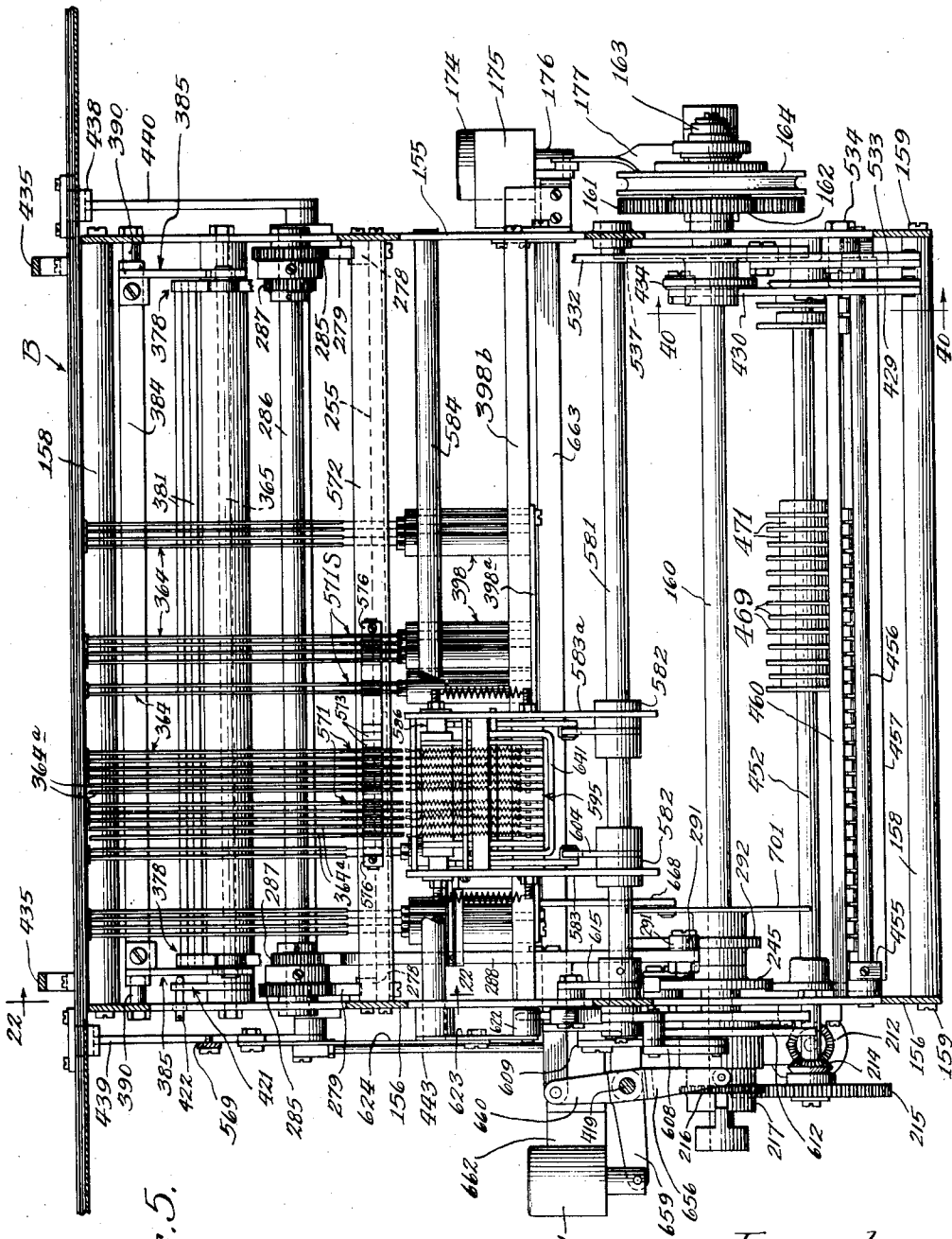


Fig. 5.

661-
6
Inventor
Walter T. Gollwitzer.
By Wallace and Cannon
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Jan. 21, 1947.

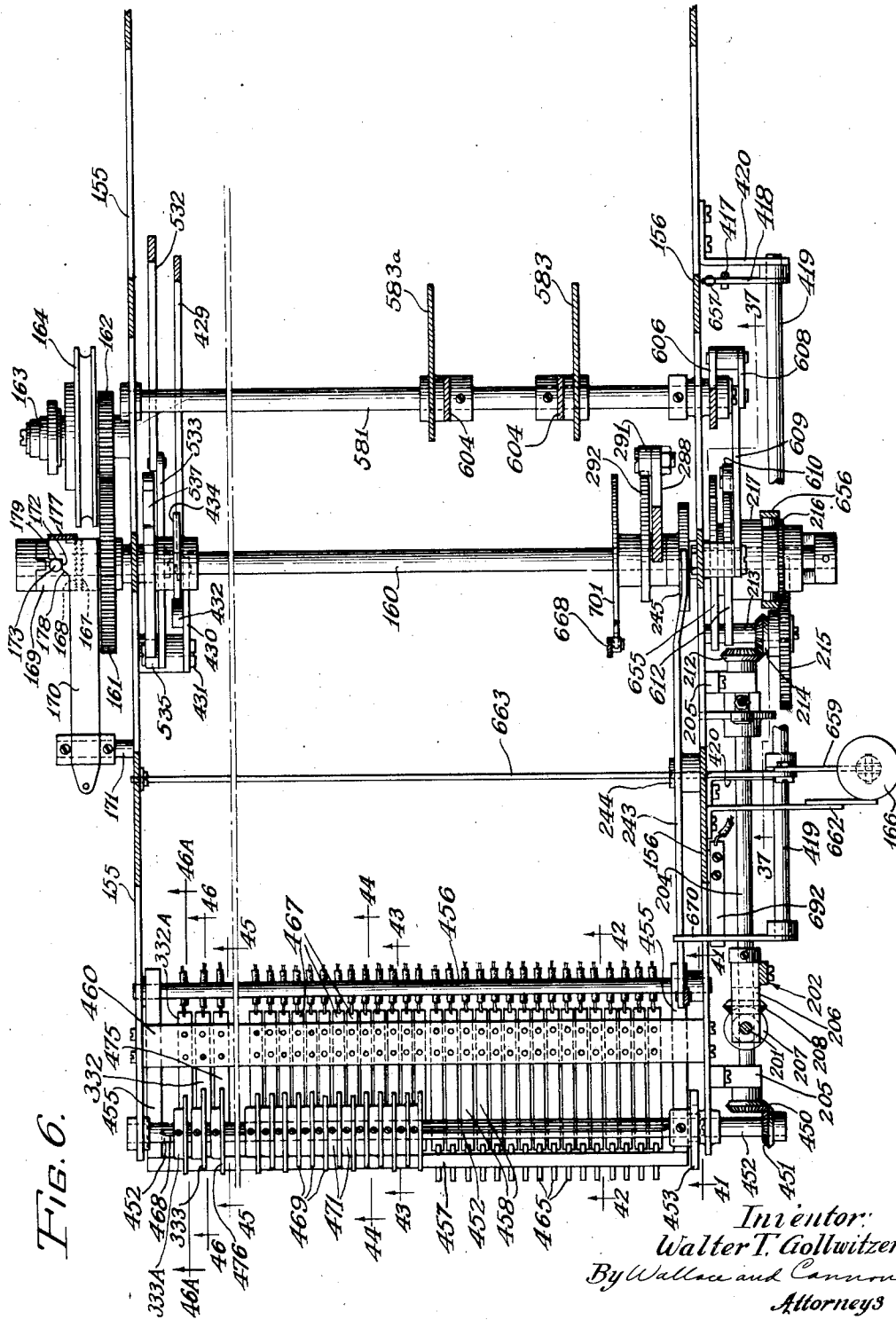
W. T. GOLLWITZER

2,414,643

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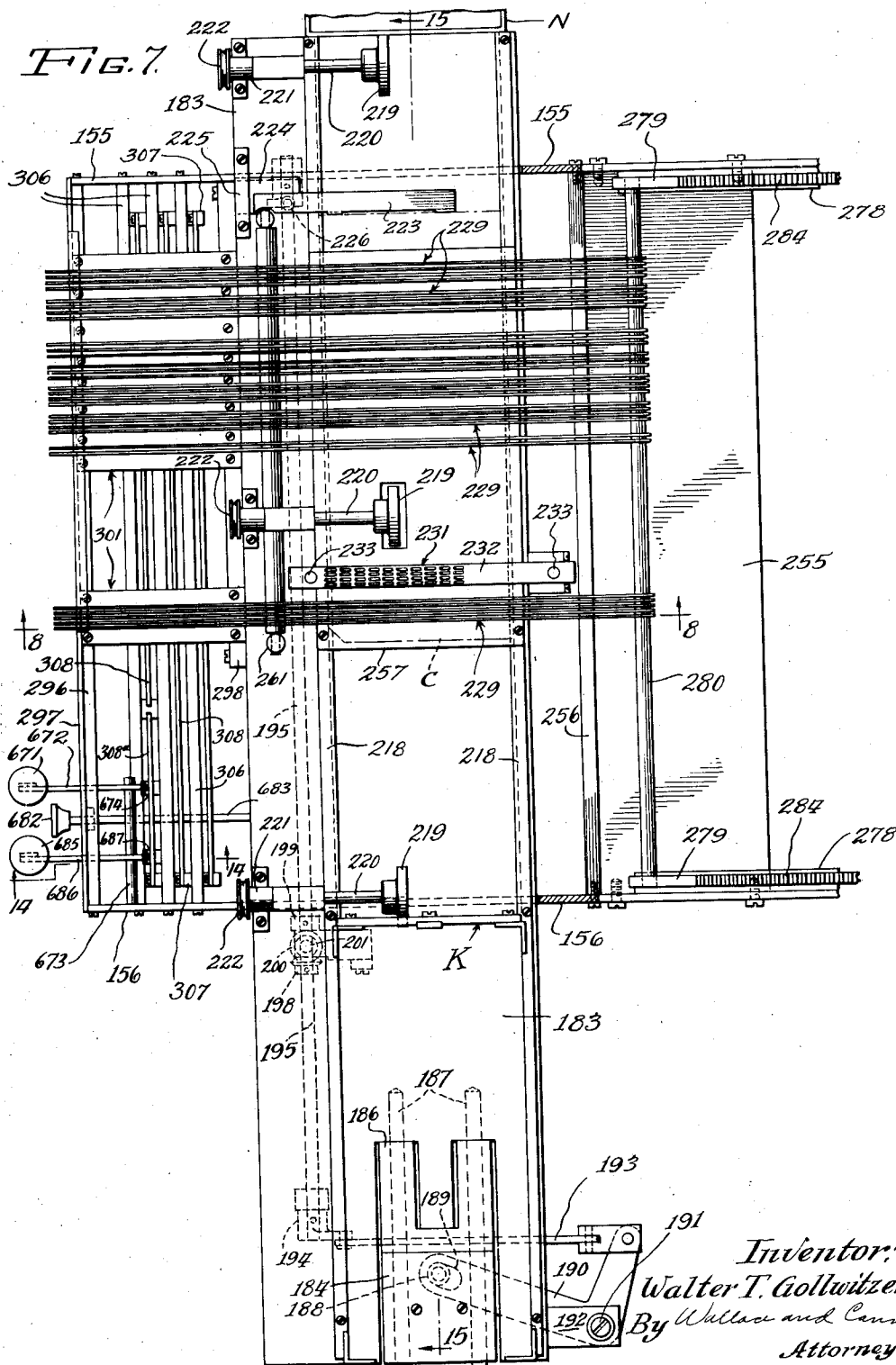
W. T. GOLLWITZER

2,414,643

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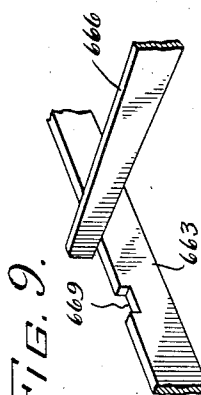
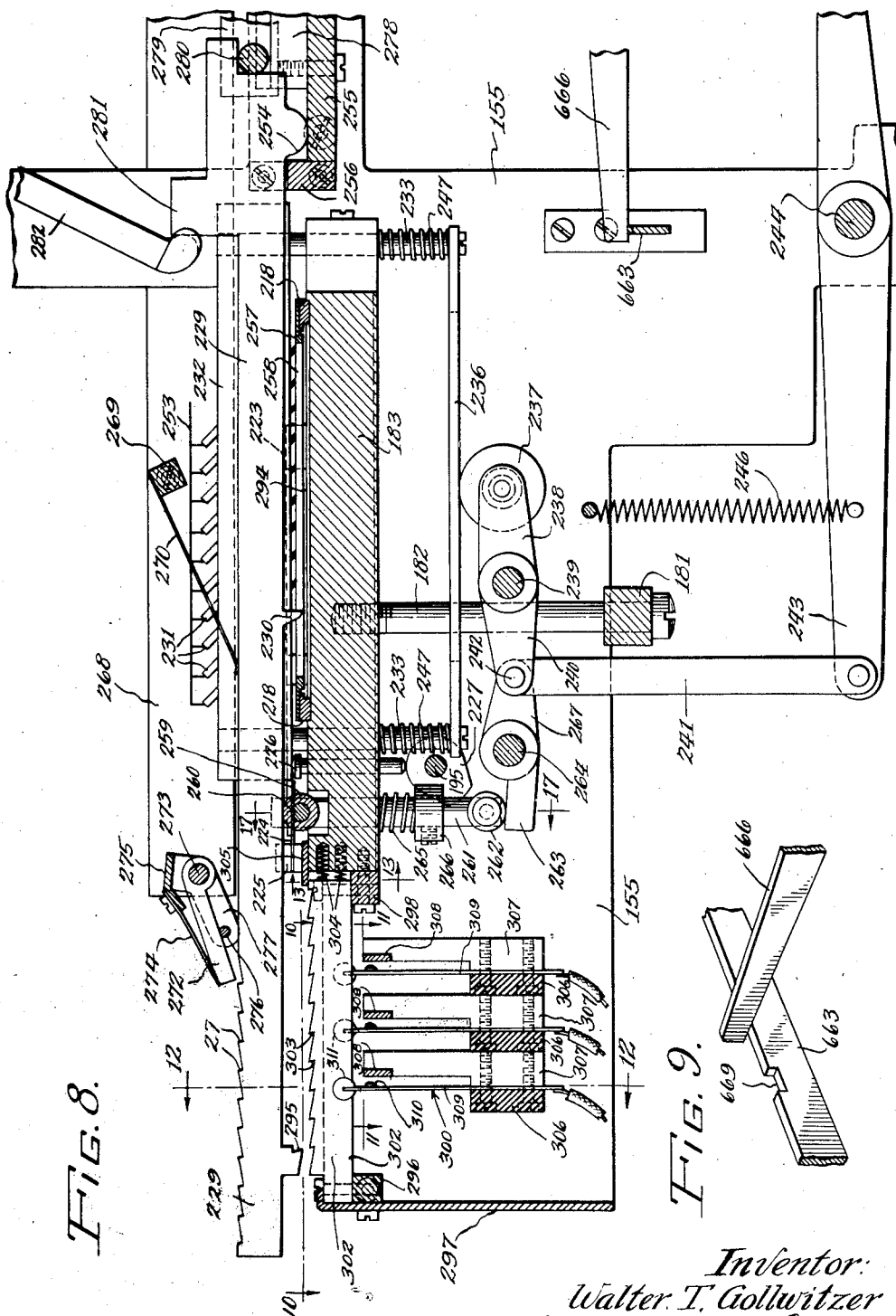
W. T. GOLLWITZER

2,414,643

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Inventor:
Walter T. Gollwitzer
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FIG. 10.

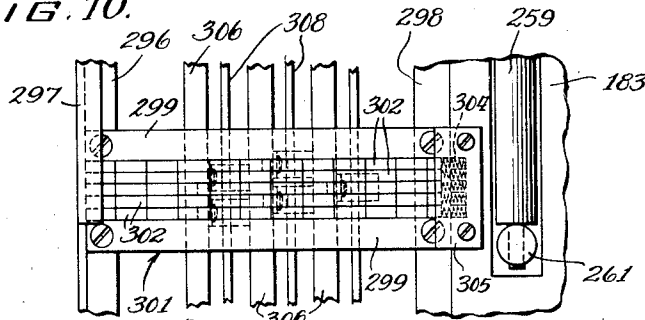


FIG. 11.

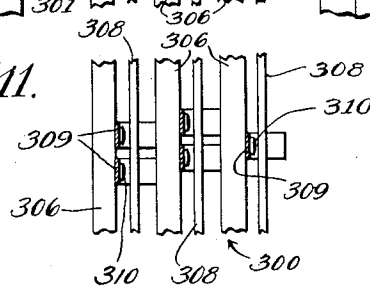


FIG. 12.

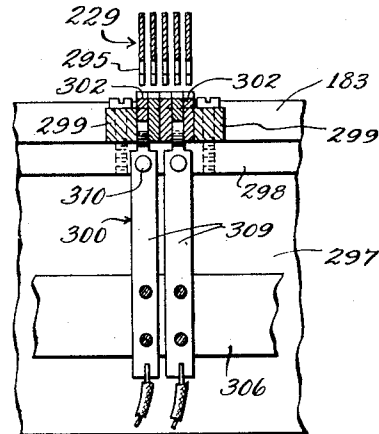


FIG. 14.

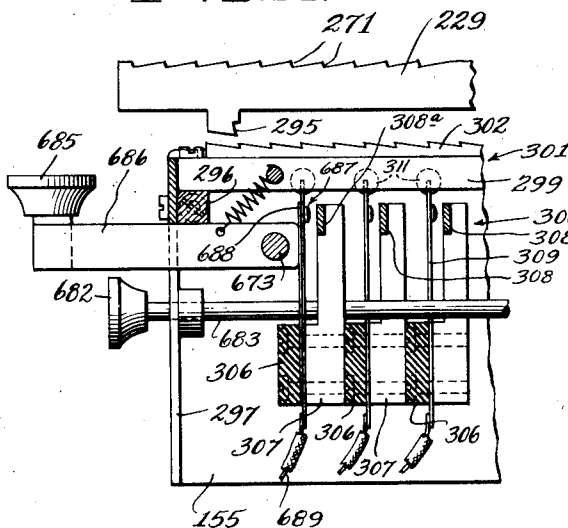
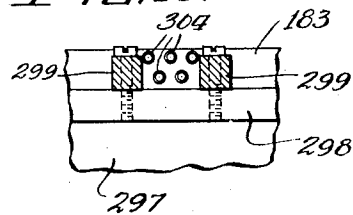


FIG. 13.



Inventor:
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2,414,643

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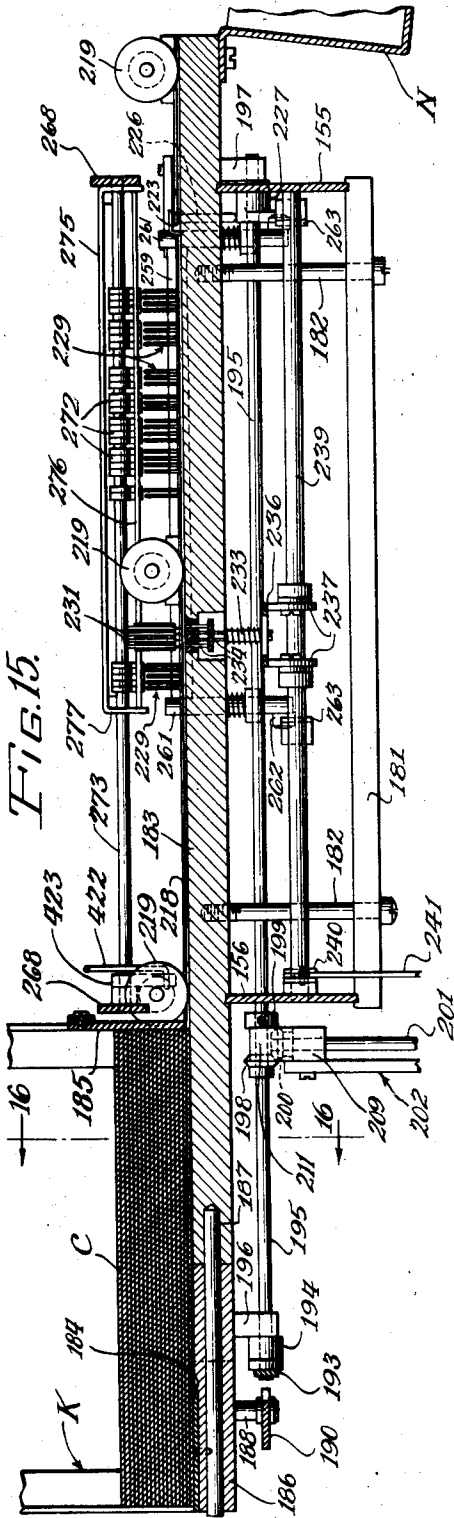


FIG. 17.

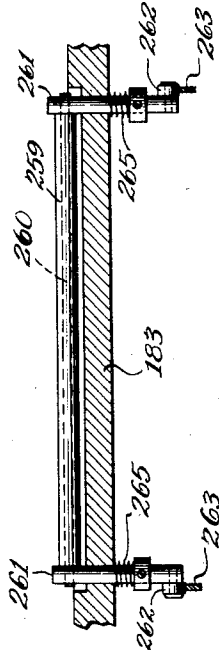
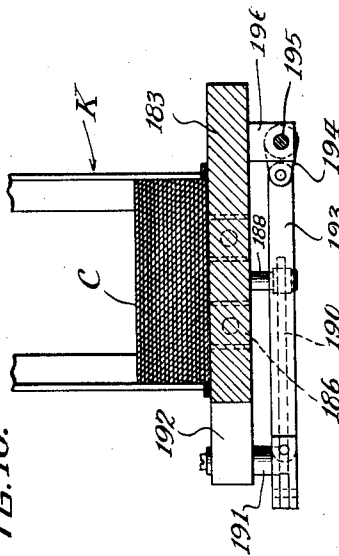


FIG. 16.



Inventor:
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By Wallace and Cannon
Attorneys

Jan. 21, 1947.

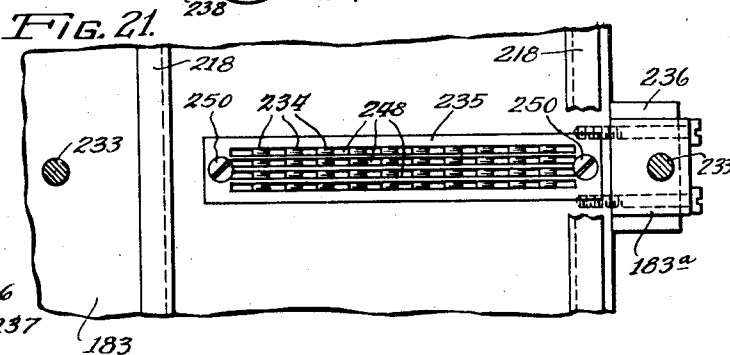
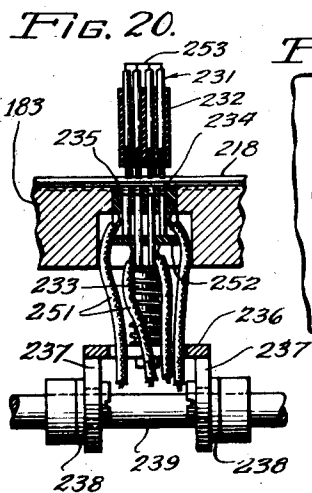
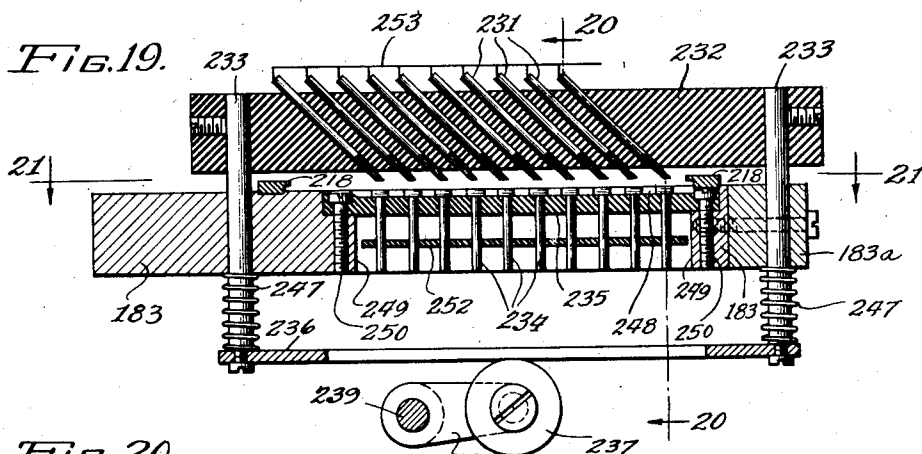
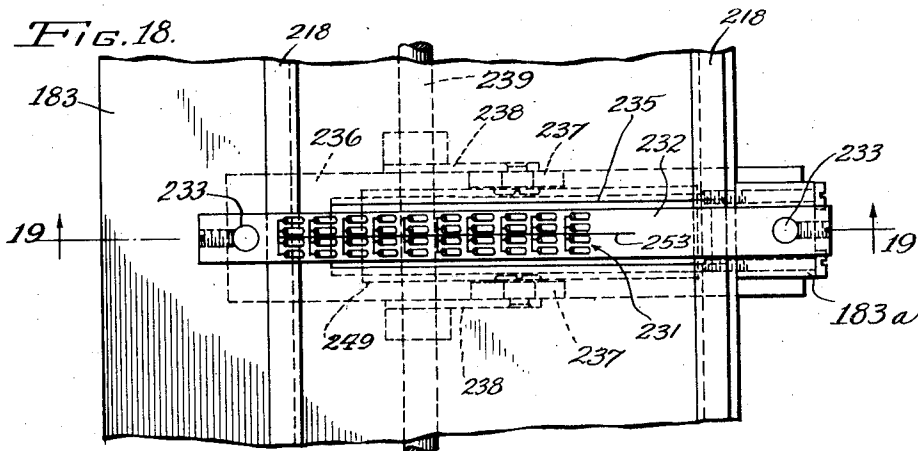
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2,414,643

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Inventor:
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By Wallace and Cannon
Attorneys

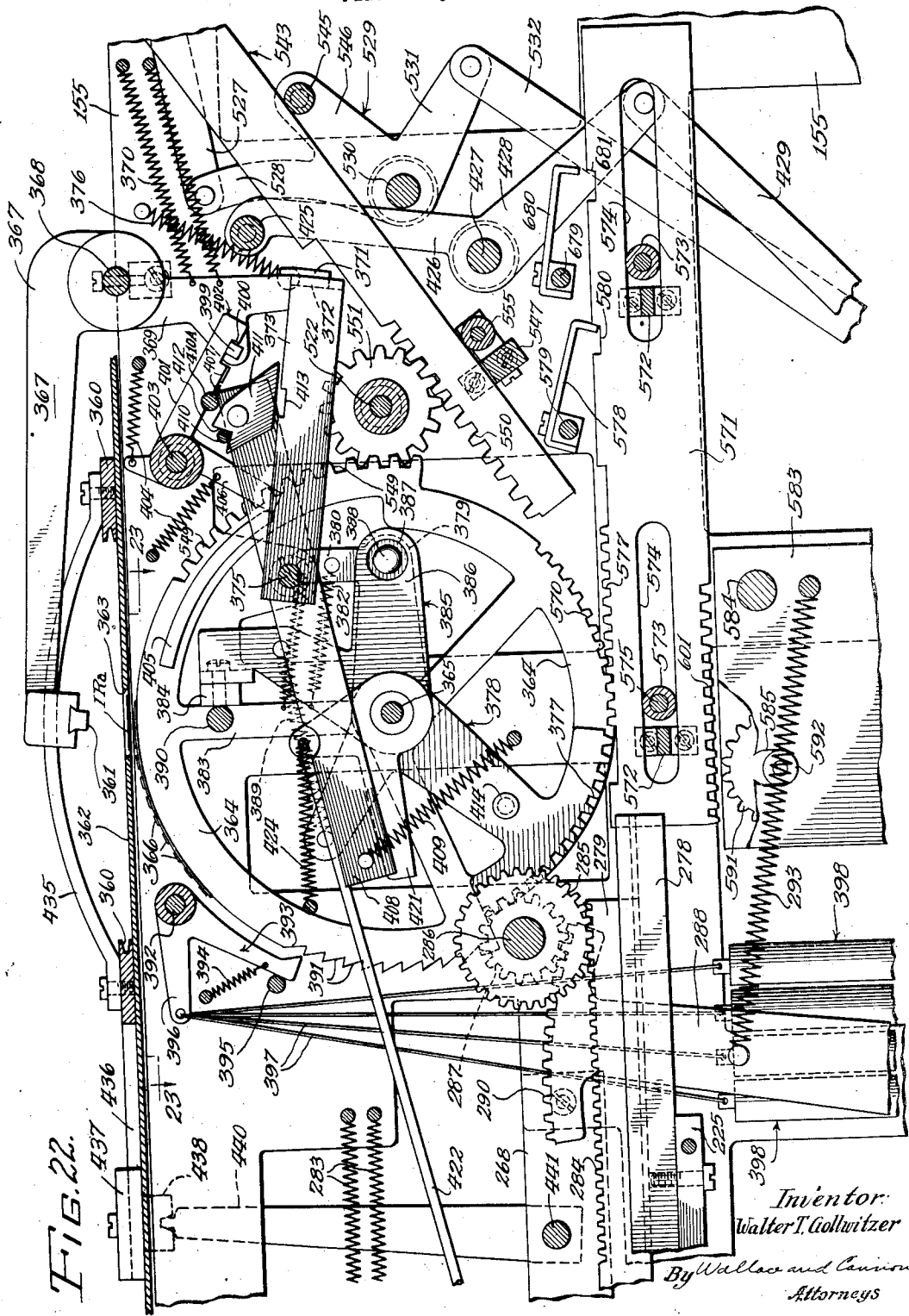
Jan. 21, 1947.

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2,414,643

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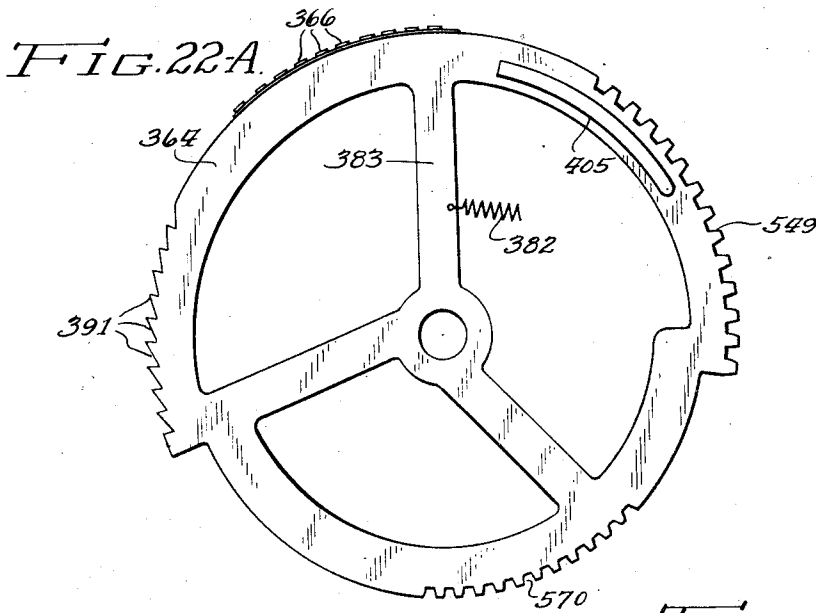


FIG. 22-B

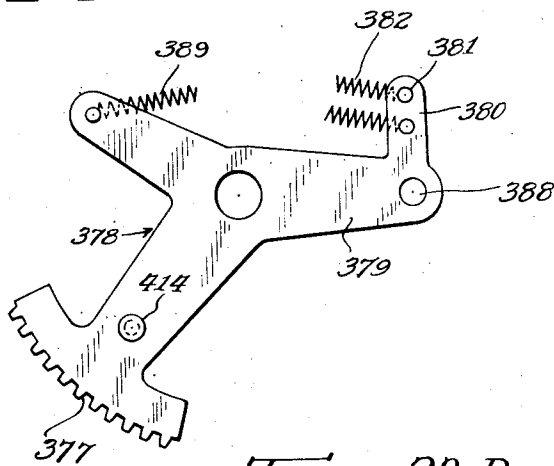


FIG. 22-C.

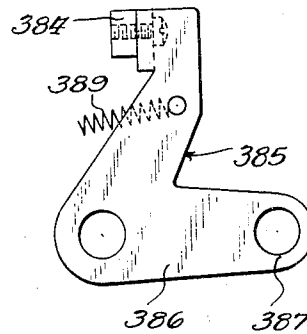
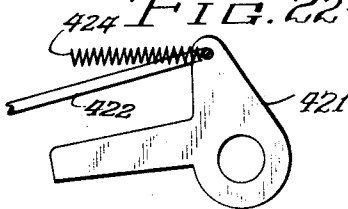


FIG. 22-D.



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FIG. 22E.

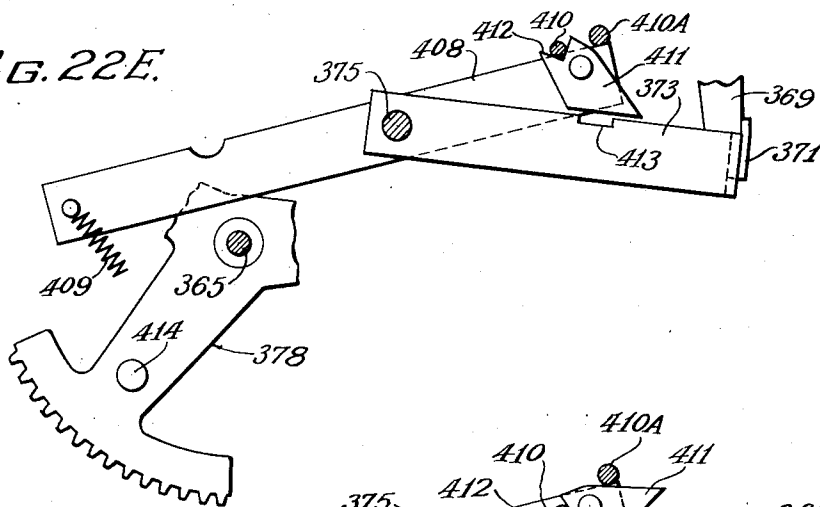


FIG. 22F.

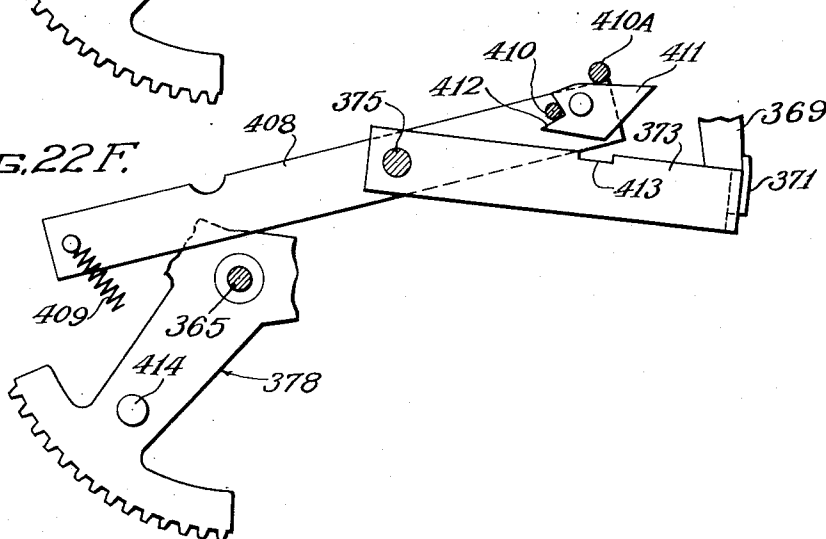
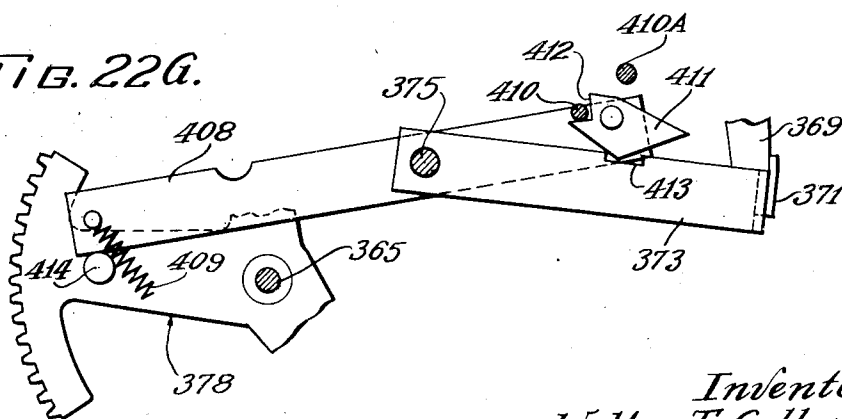


FIG. 22G.



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Attorneys

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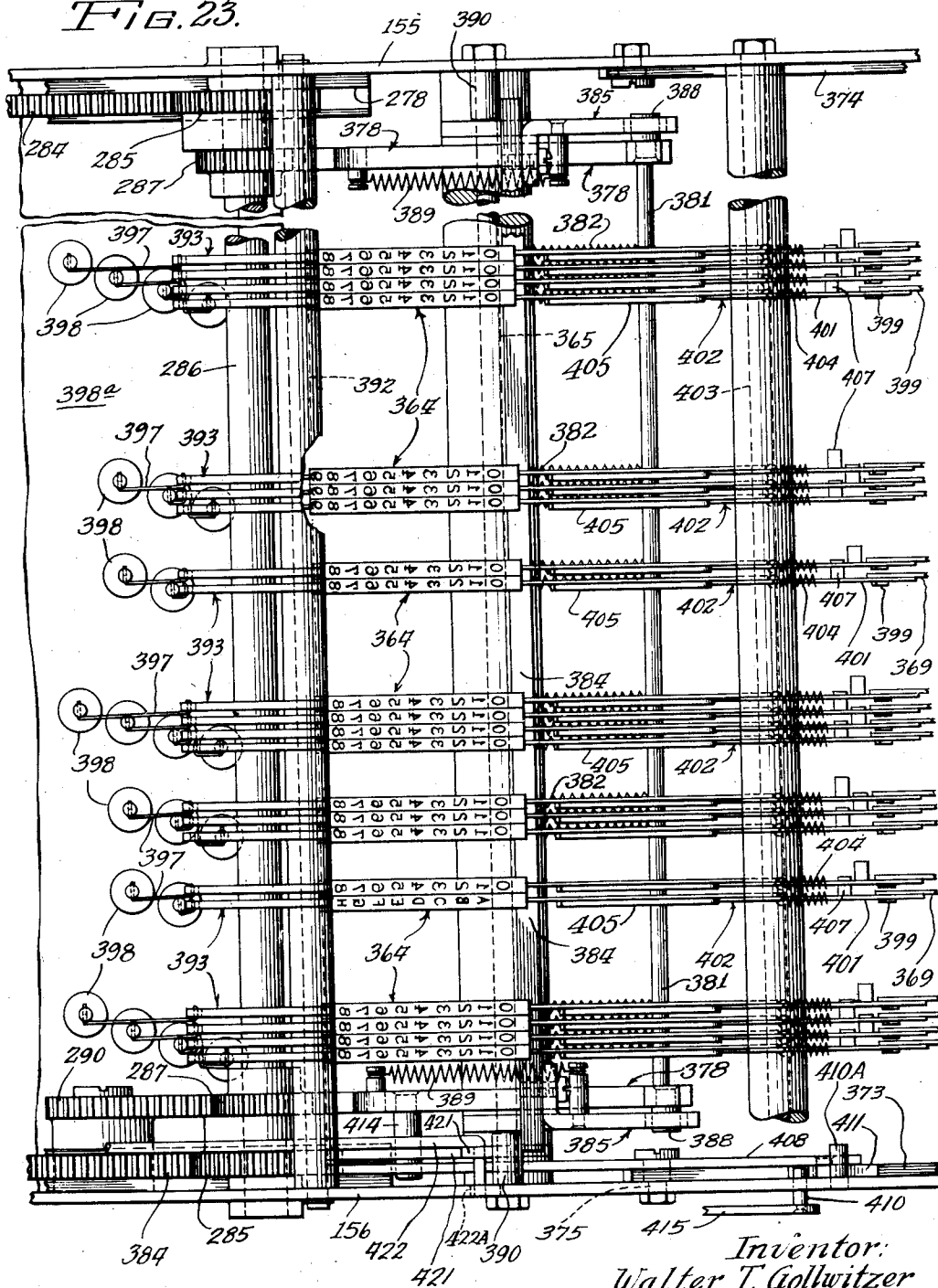
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FIG. 23.



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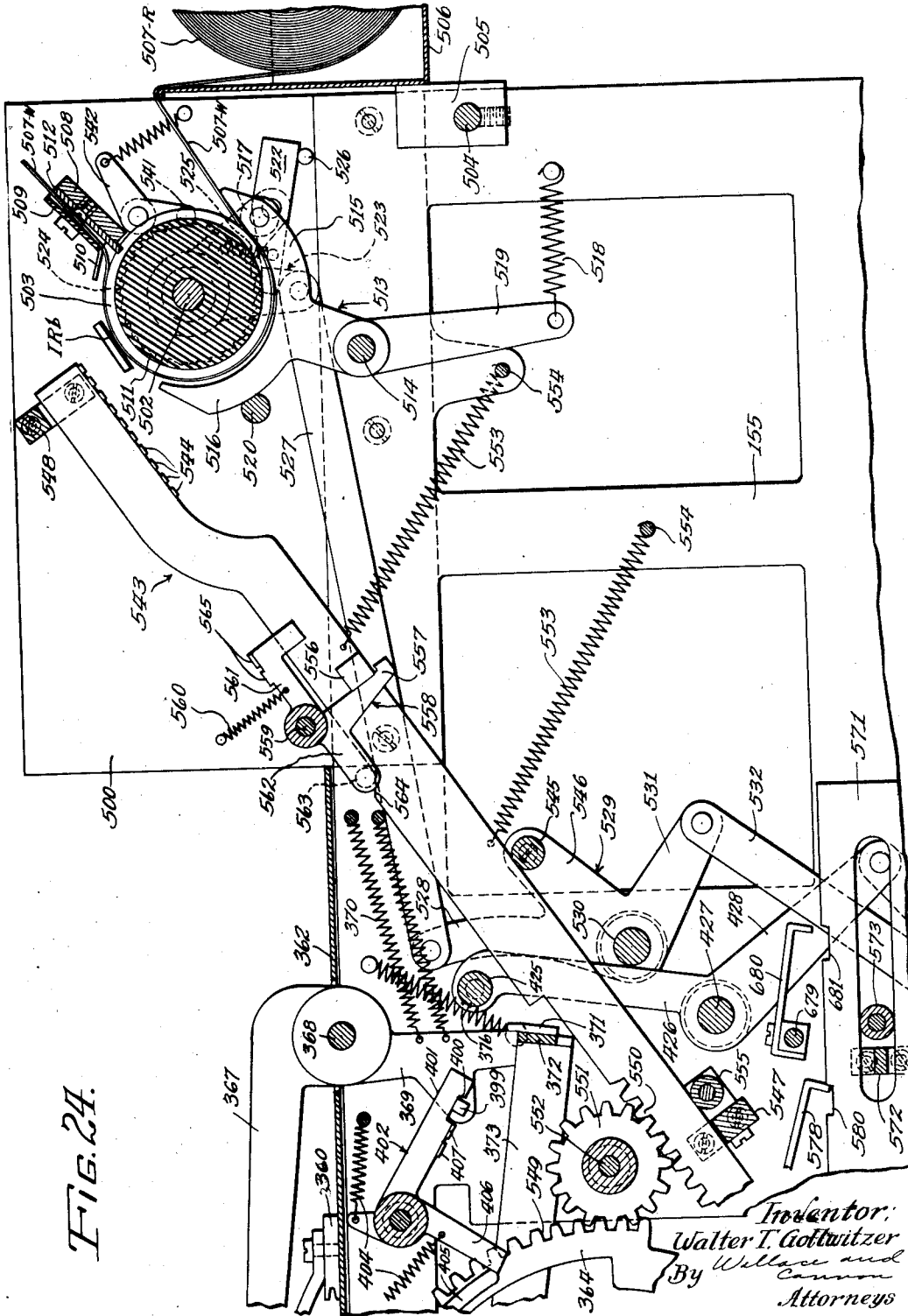
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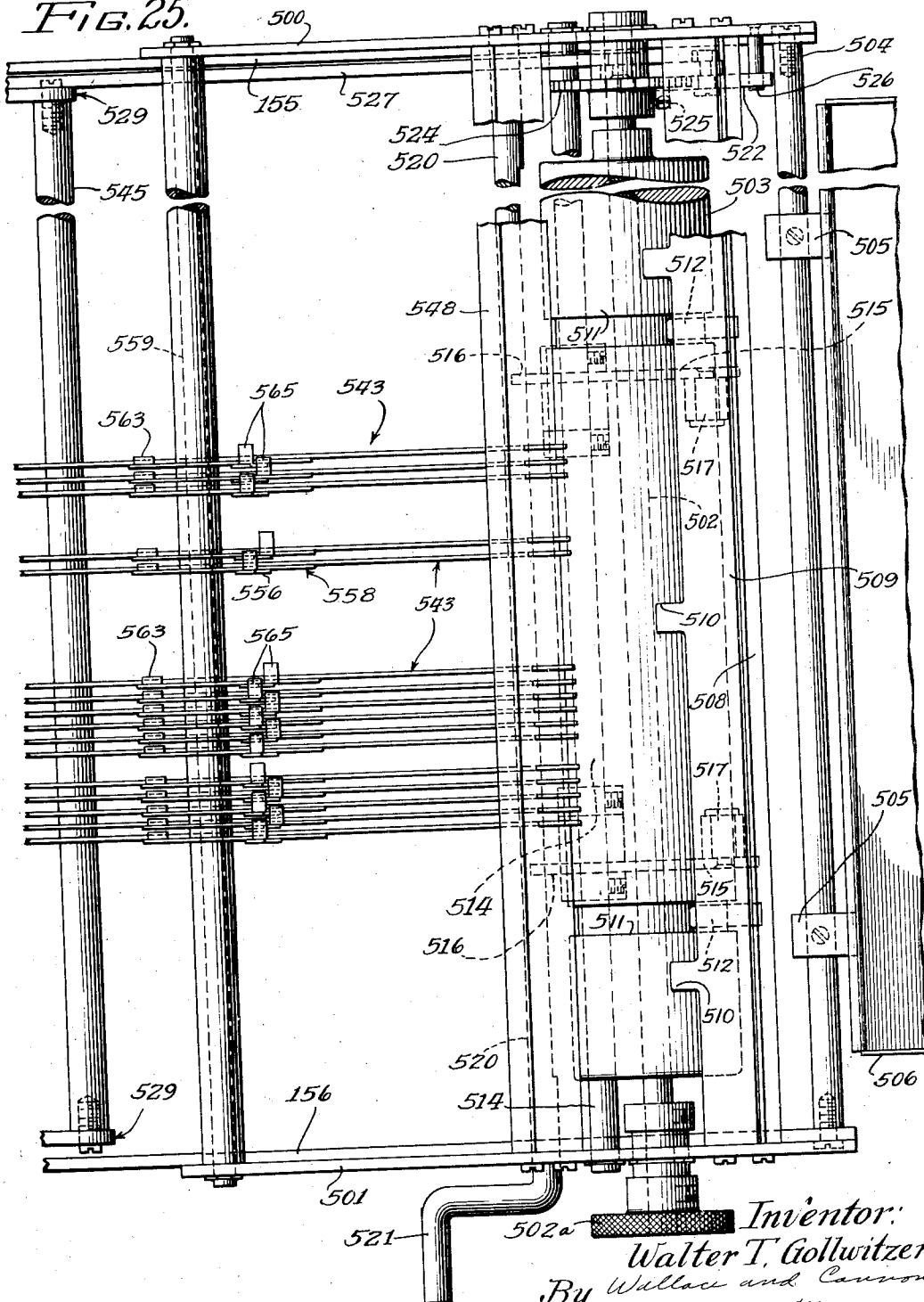
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FIG. 25.



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FIG. 27.

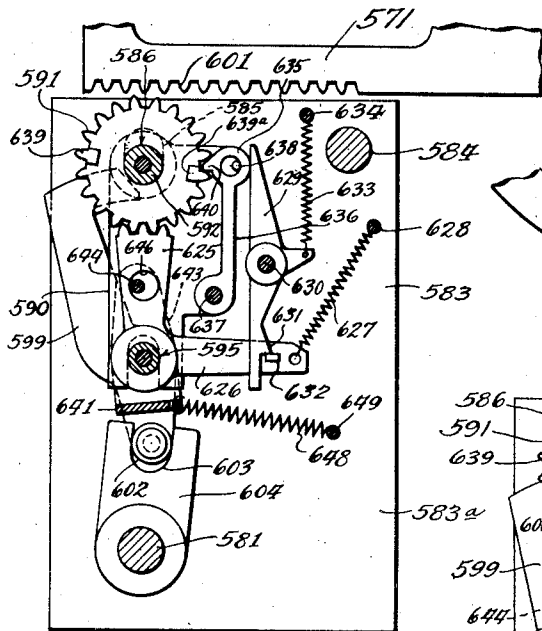
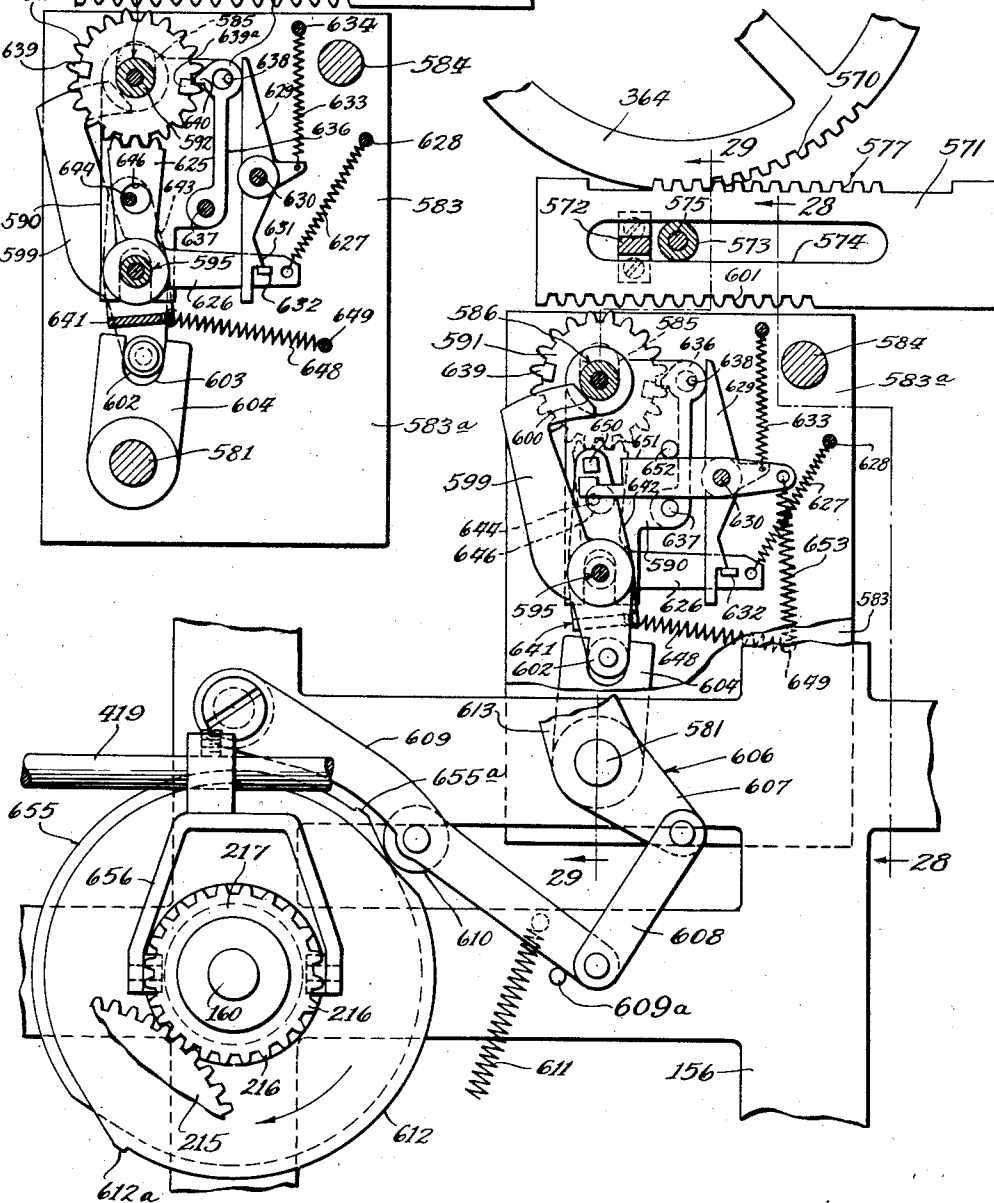


FIG. 26.



Inventor:
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FIG. 28

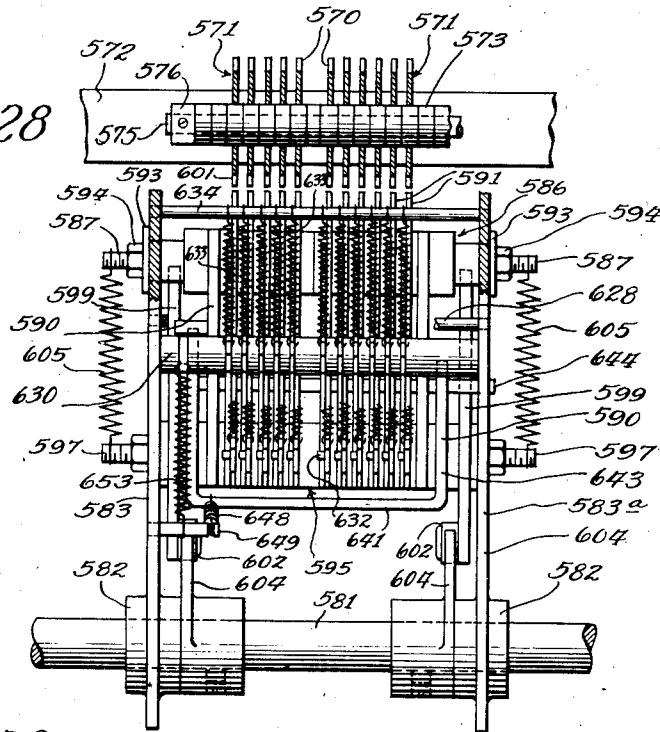


FIG. 29

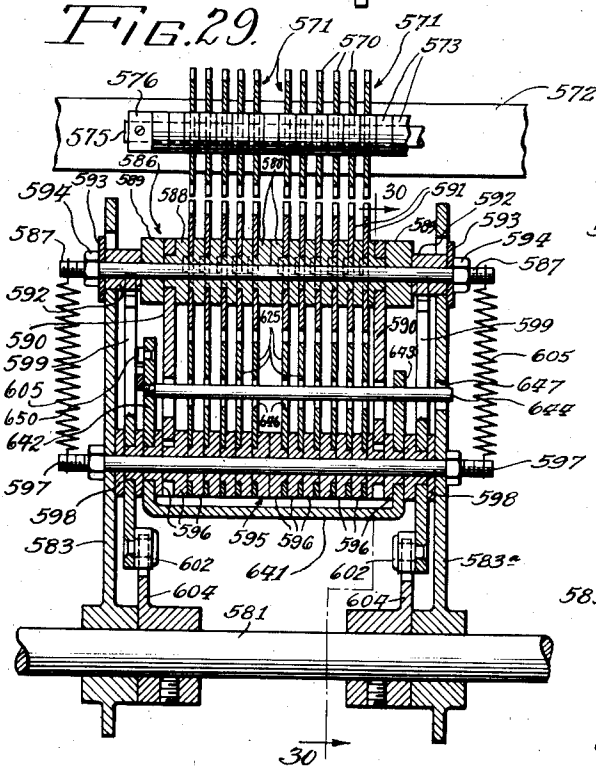
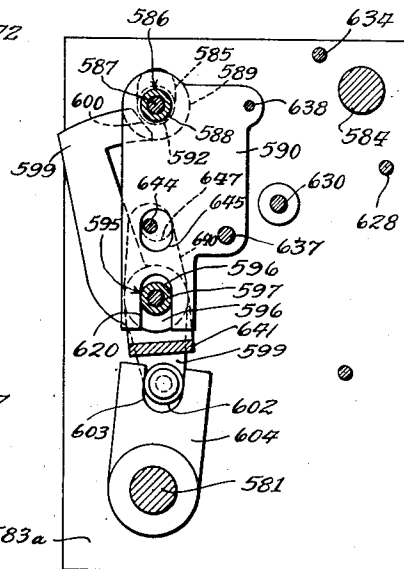


FIG. 30



Inventor:
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FIG. 31.

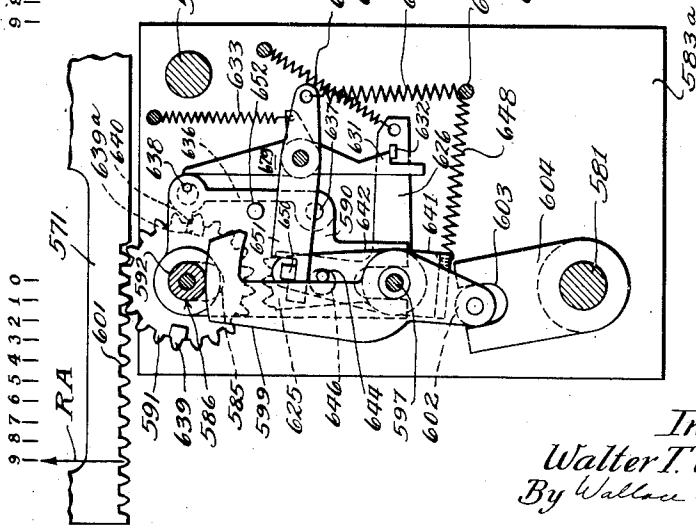


FIG. 32.

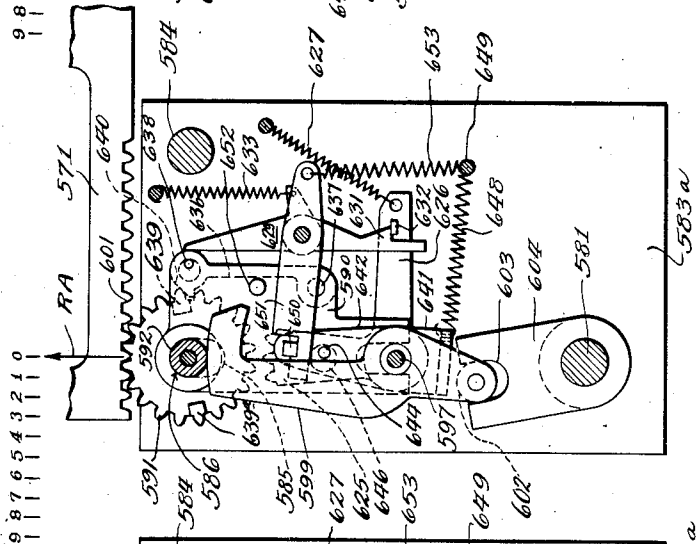
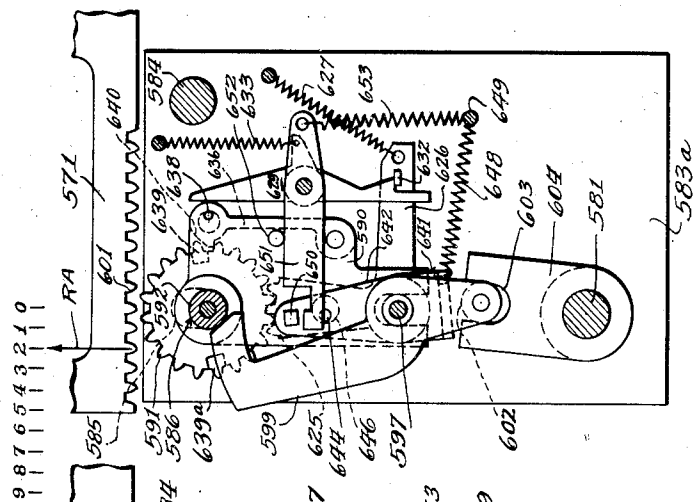


FIG. 33.



Inventor:
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FIG. 36.

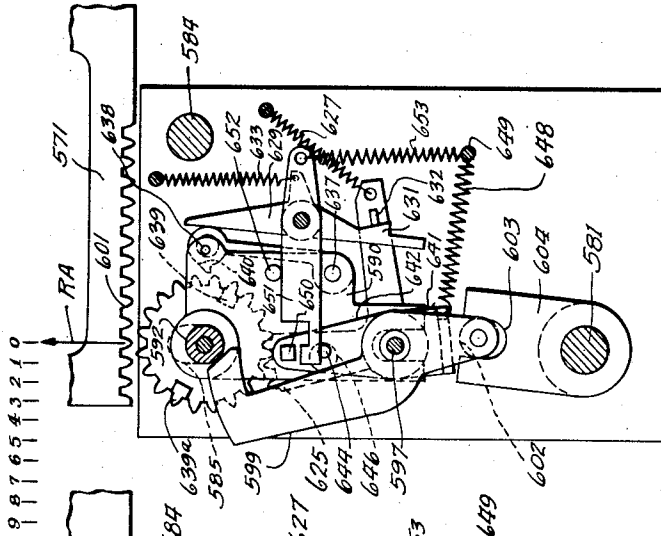


FIG. 35.

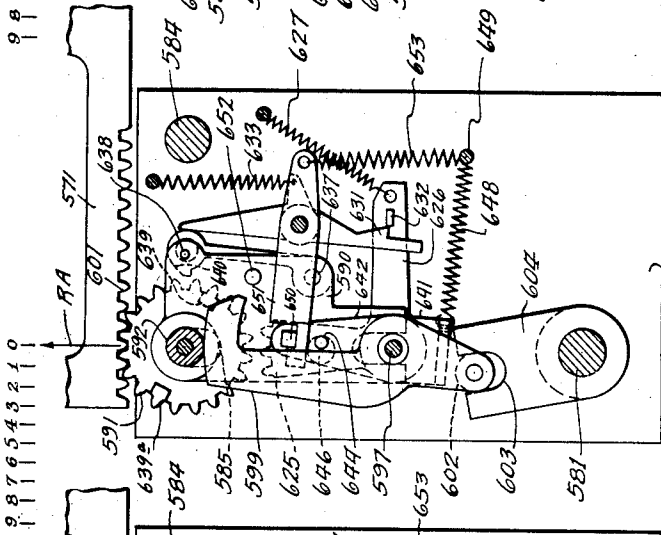
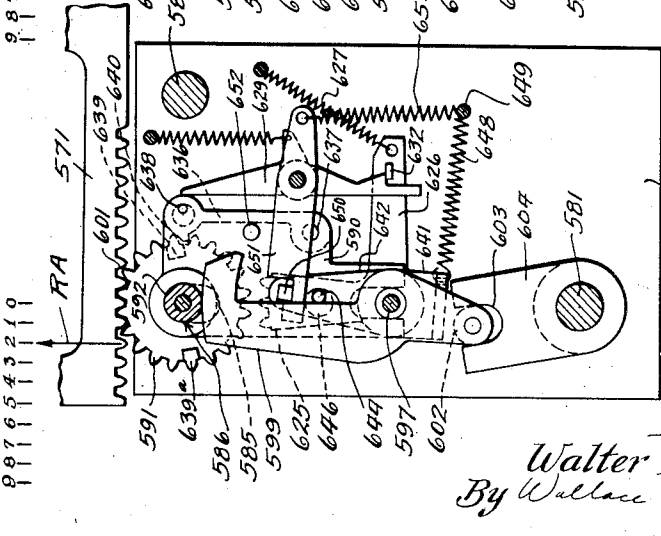


FIG. 34.



Inventor:
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By Wallace and Cunniff
Attorneys

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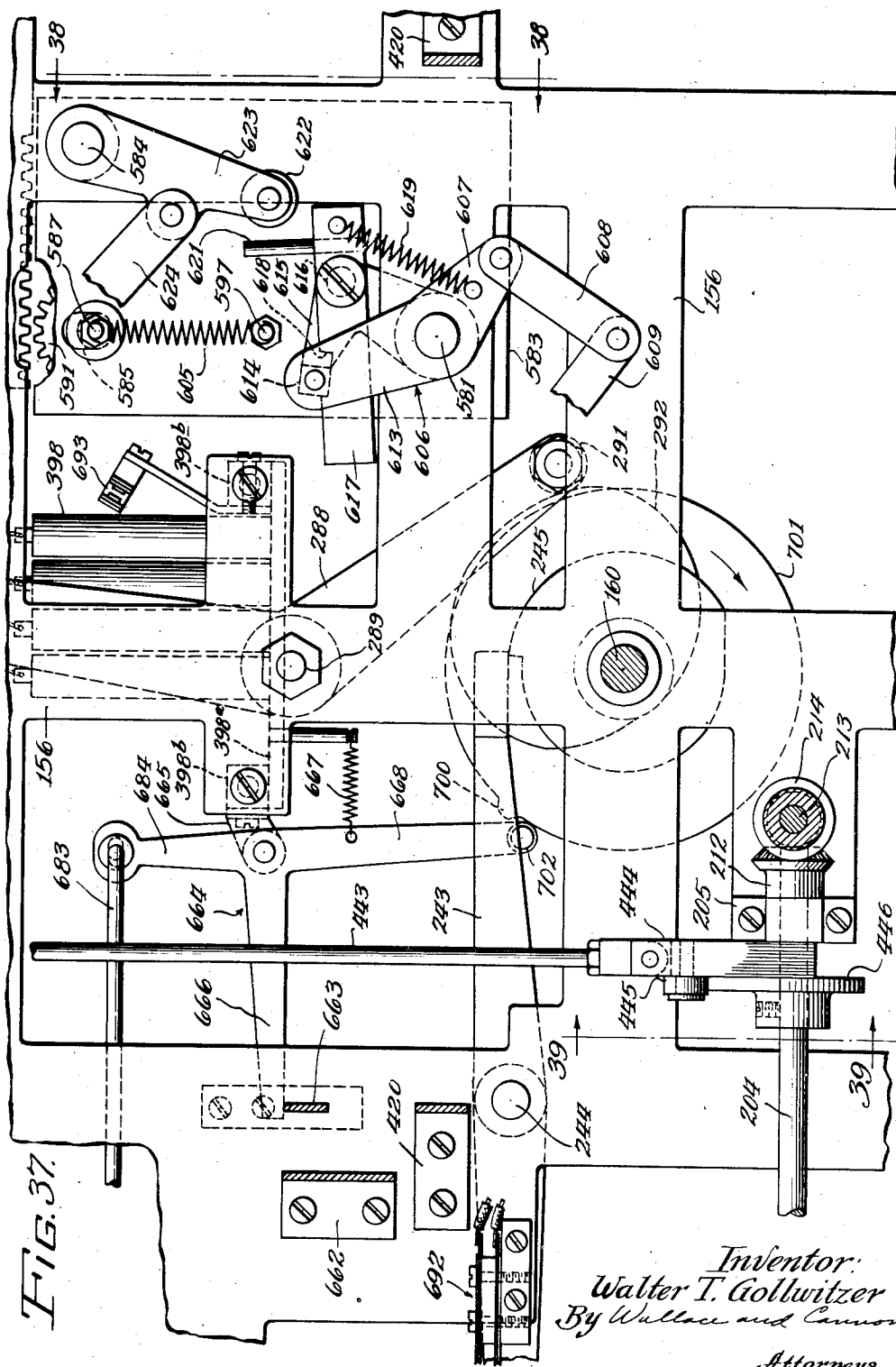
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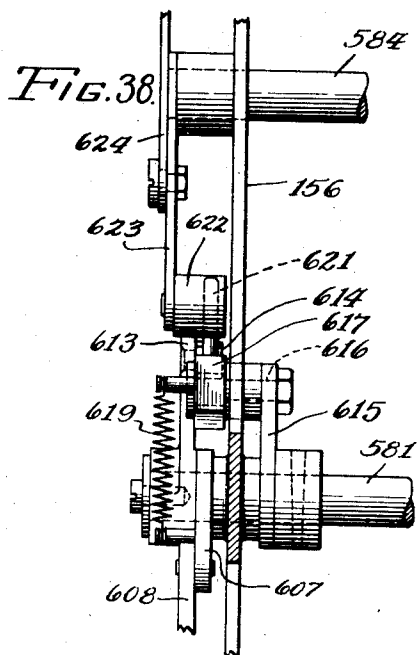
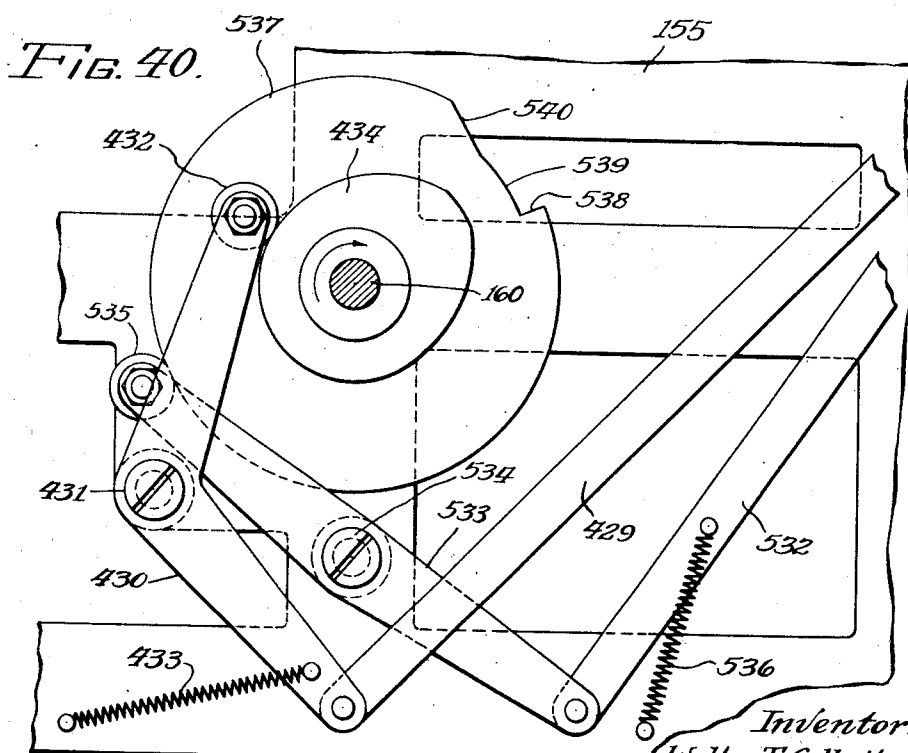
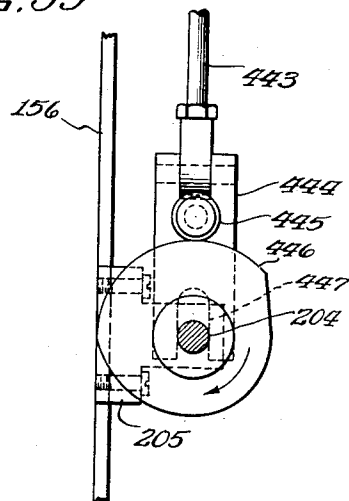


FIG. 39



Inventor:
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Attorneys

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FIG. 41.

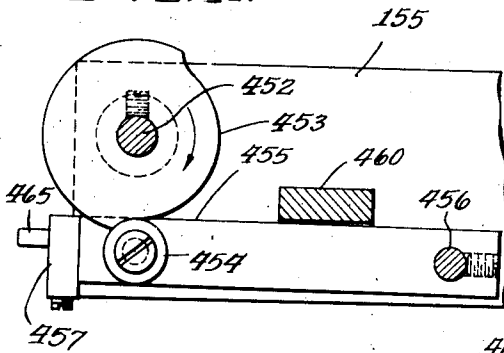


FIG. 42.

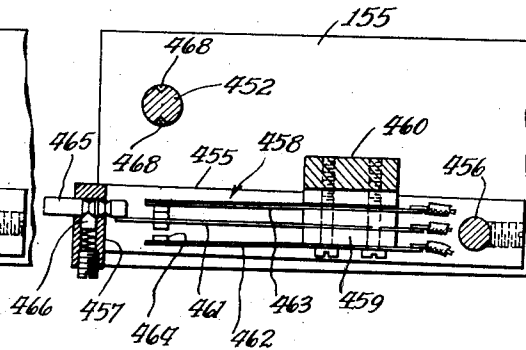


FIG. 43.

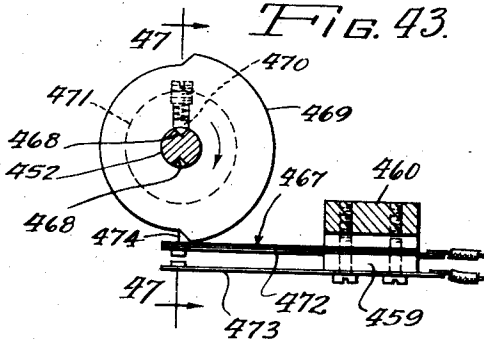


FIG. 44.

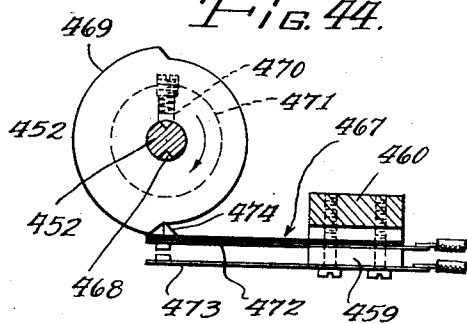


FIG. 45.

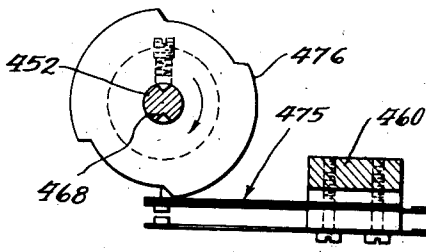


FIG. 46.

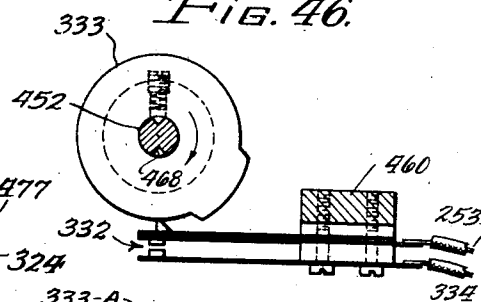


FIG. 47.

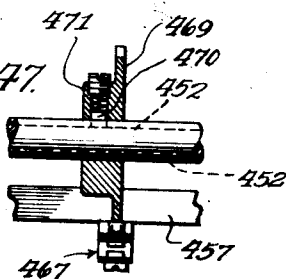
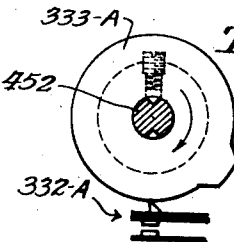


FIG. 46A.



Inventor:
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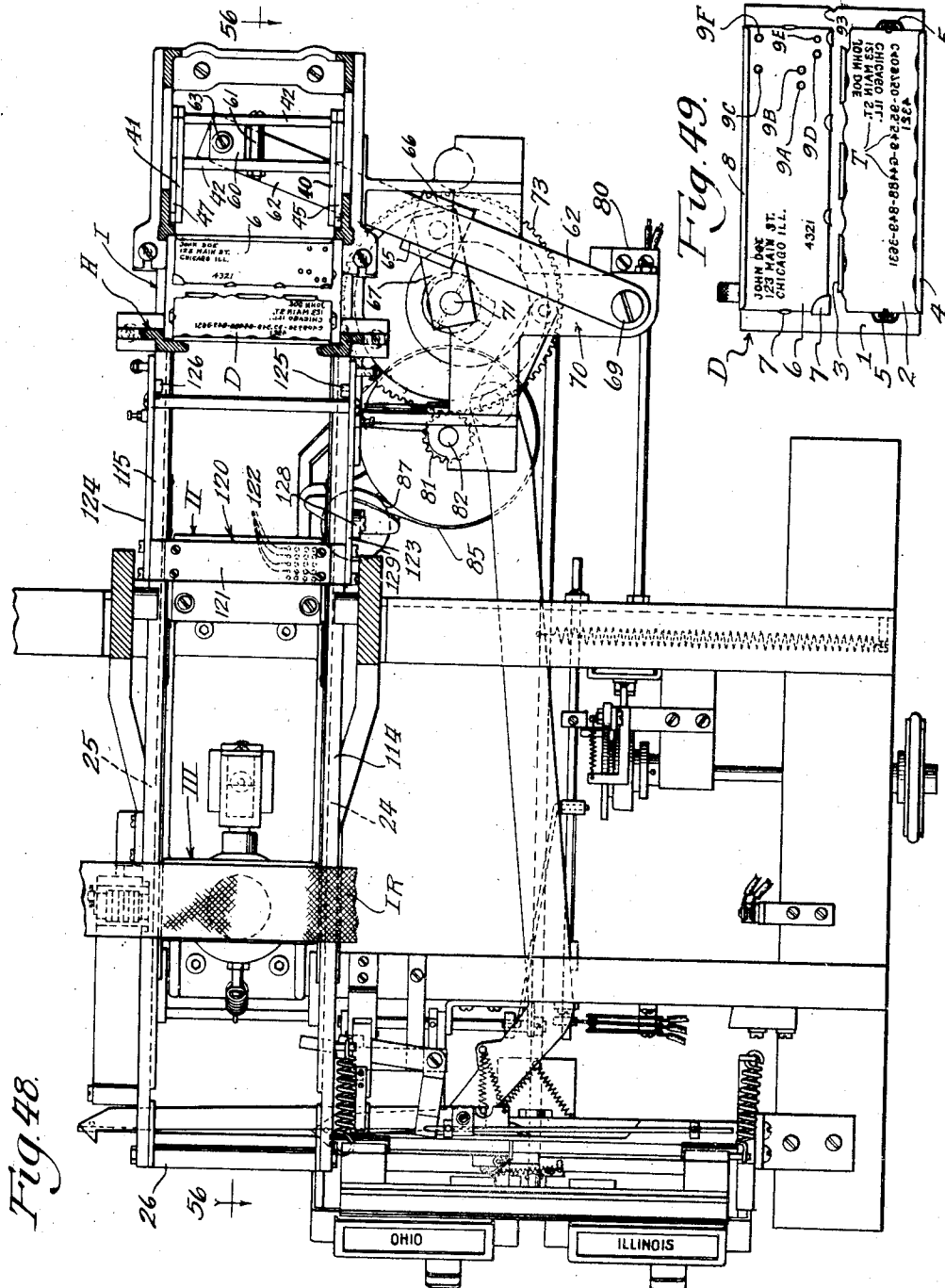


Fig. 48.

Fig. 49.

INVENTOR
Walter T. Gollwitzer.
BY Wallace and
Cannon
ATTORNEYS

Jan. 21, 1947.

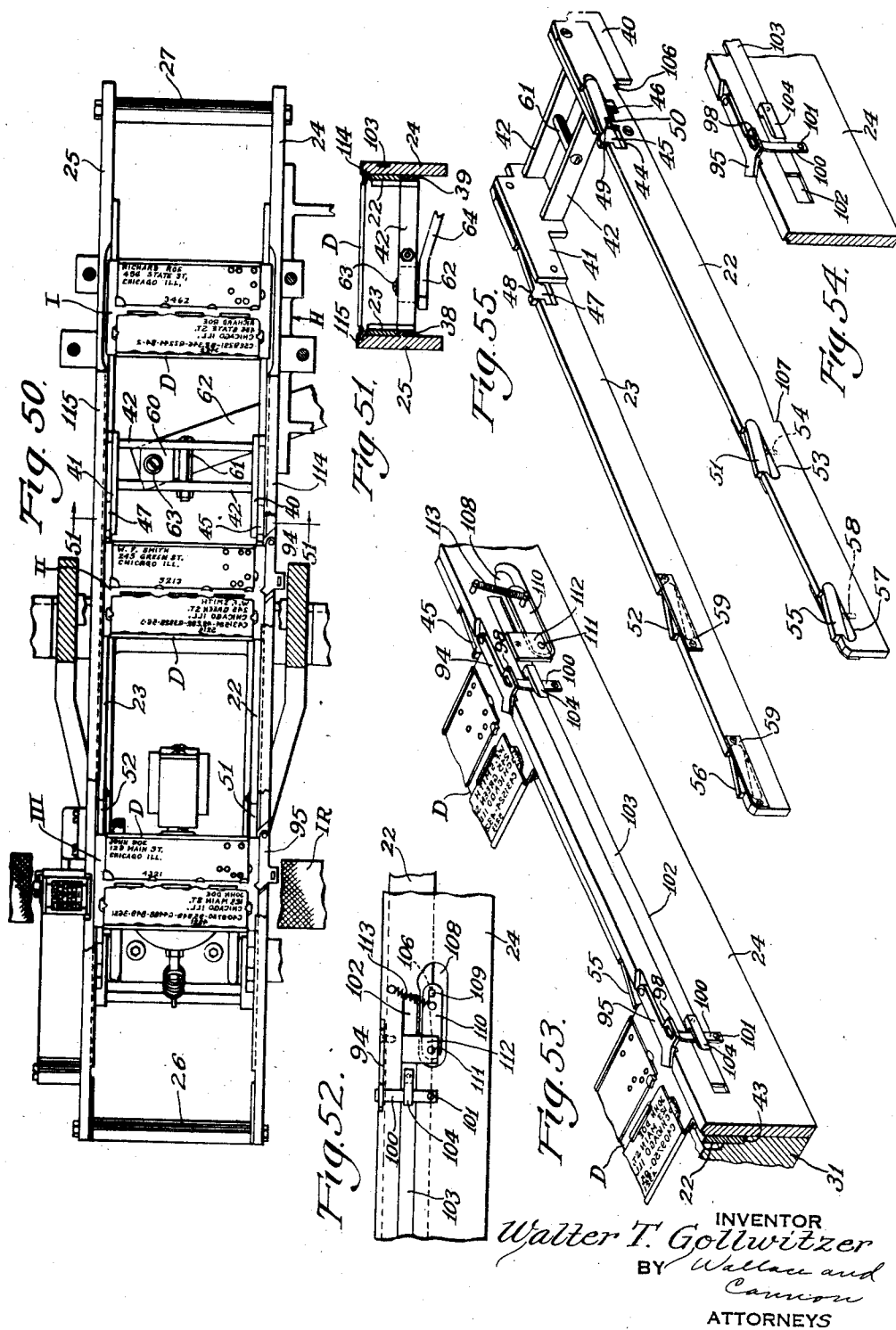
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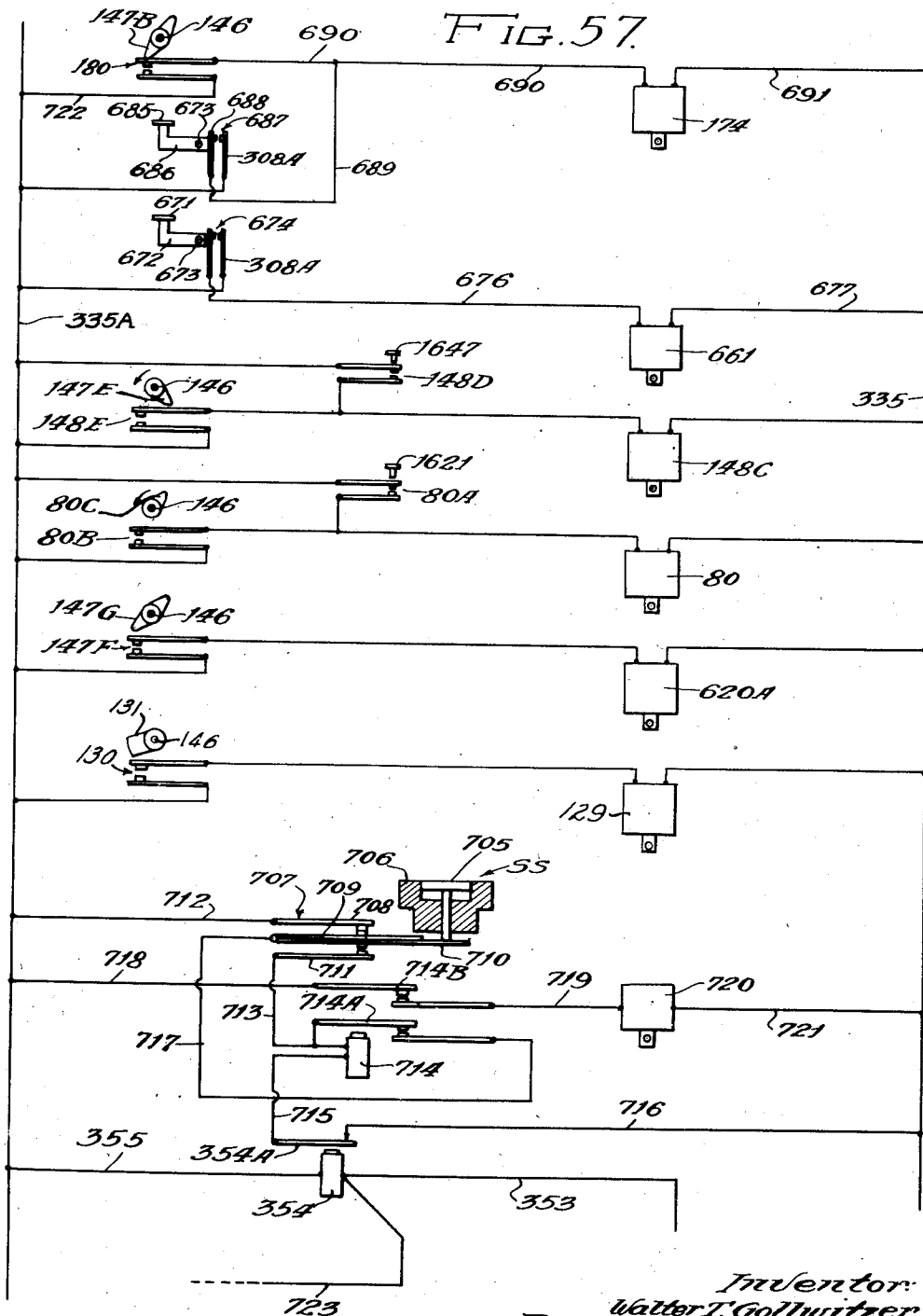
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Inventor:
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By: Wallace and Cannon
Attorneys.

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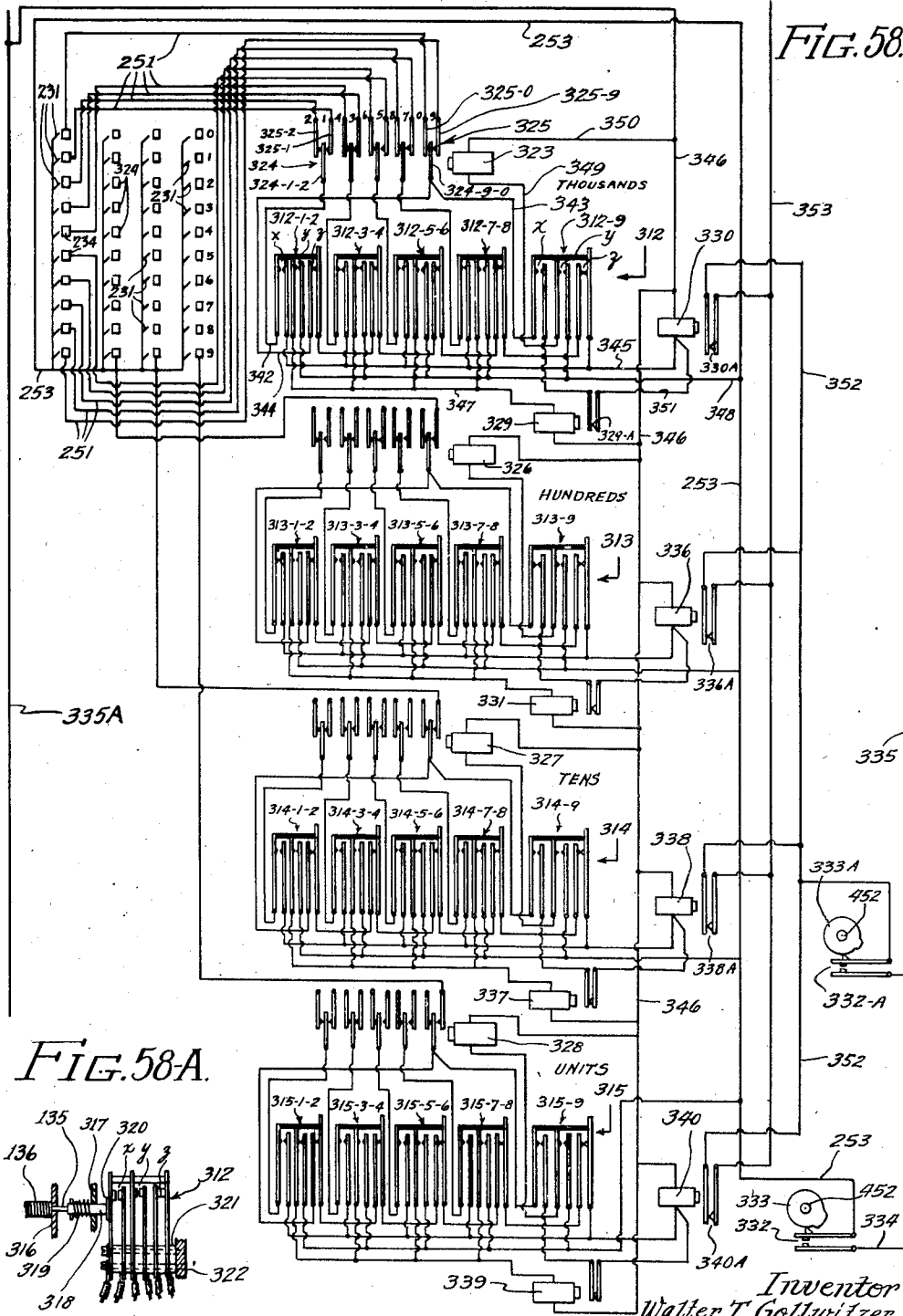


FIG. 58.

FIG. 58A.

Inventor
Walter T. Gollwitzer
By Wallace and Cannon
Attorneys.

Jan. 21, 1947.

W. T. GOLLWITZER

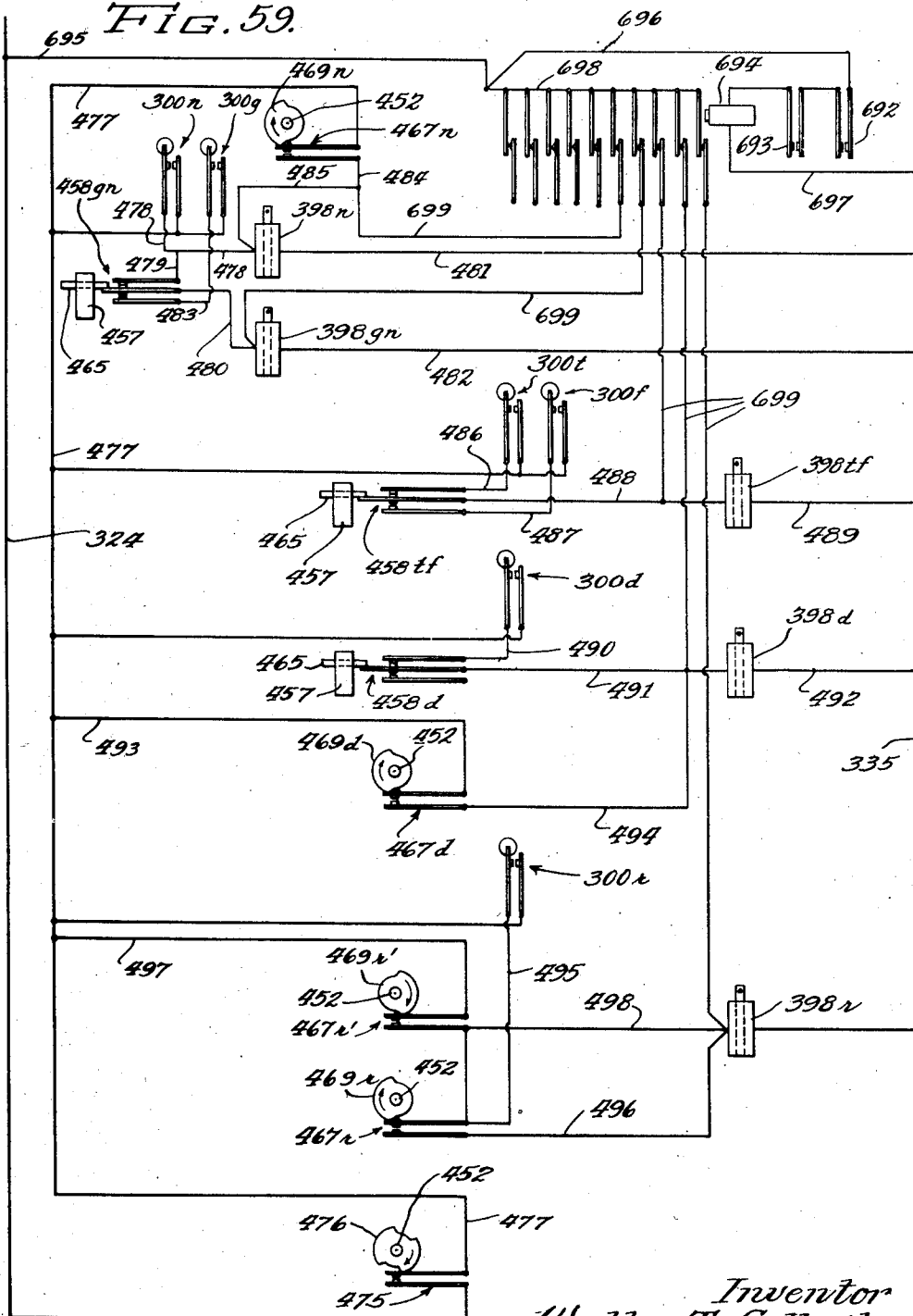
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FIG. 59.



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By Wallace and Cannon
Attorneys

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FIG. 62.

[illegible]

5

JOHN DOE
123 MAIN ST.
CHICAGO ILL.

C409750-95.549-64488-849-3631

ACCOUNT NO. 4321

NOV. 15, 1937

COM.

NET BILL
INCLUDING TAX

18.12

DISTRICT-LEDGER NUMBER

95-549

1

JOHN DOE
123 MAIN ST.
CHICAGO ILL.

C409750-95.549-64488-849-3631

ACCOUNT NO. 4321

NOV. 15, 1937

COMMERCIAL

METER READING DATES	METER READINGS PRESENT	FOR EXPLANATION OF RATE SEE REVERSE SIDE.	KILOWATT HOURS PRESENT	GROSS BILL INCLUDING TAX	NET BILL	INCLUDING TAX
OCT 17	7618	C3	250	20.13	18.12	
SEP 17	7192		426			

NET BILL PAYABLE ON OR BEFORE

PRECEDING

TOTAL KILOWATT HOURS

Inventor:
Walter T. Collwitzer
By Wallace and Cannon
Attorneys

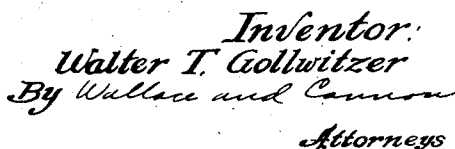
Fig. 63.

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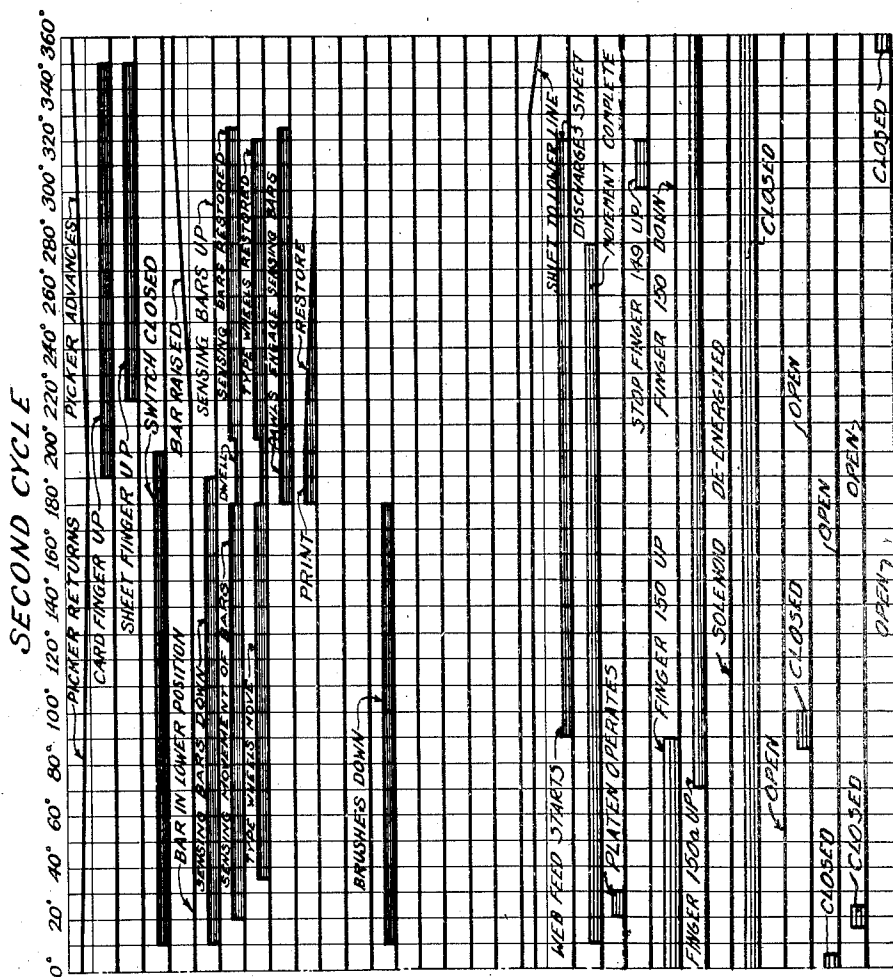
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FIG. 64.



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FIG. 65.

TOTAL TAKING CYCLE

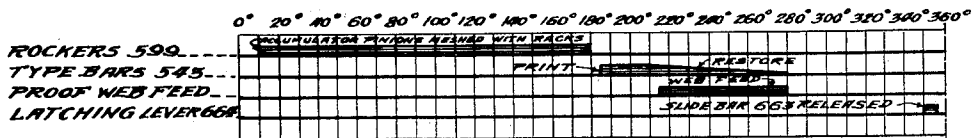
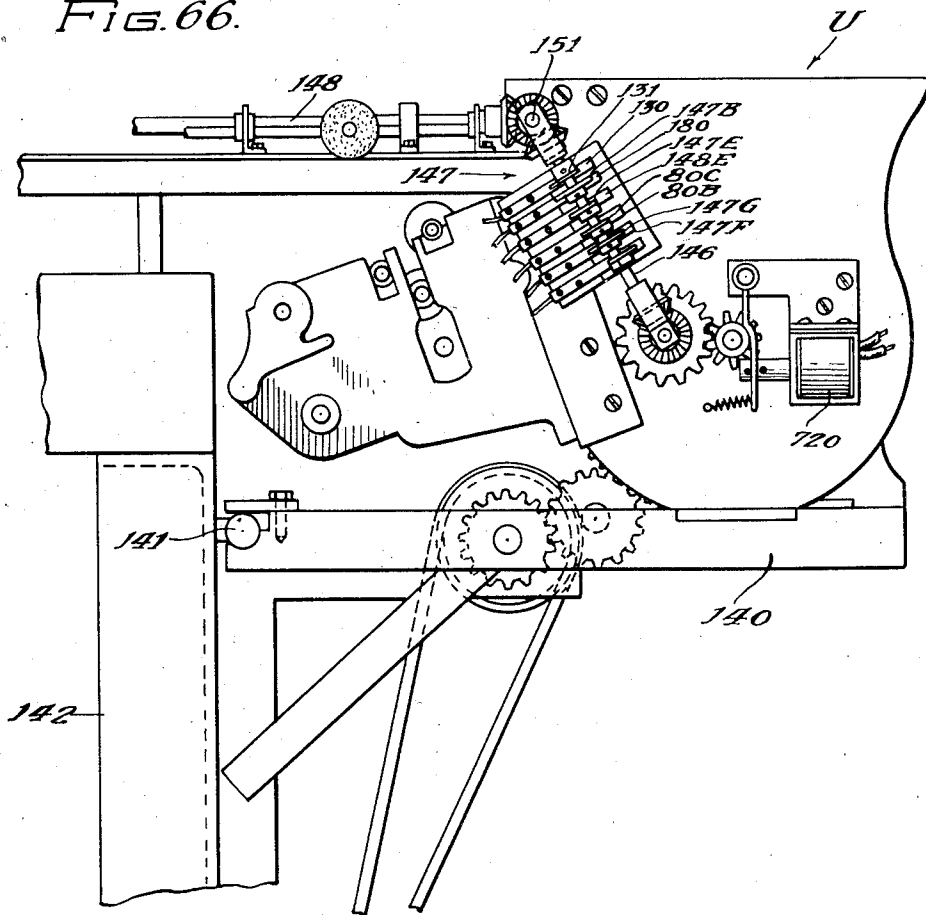


FIG. 66.



Inventor:
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By: Wallace and Cannon
Attorneys.

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2,414,643

PRINTING AND ADDING MACHINE

Filed July 29, 1940

35 Sheets-Sheet 35

FIG. 67 (FIRST CYCLE)

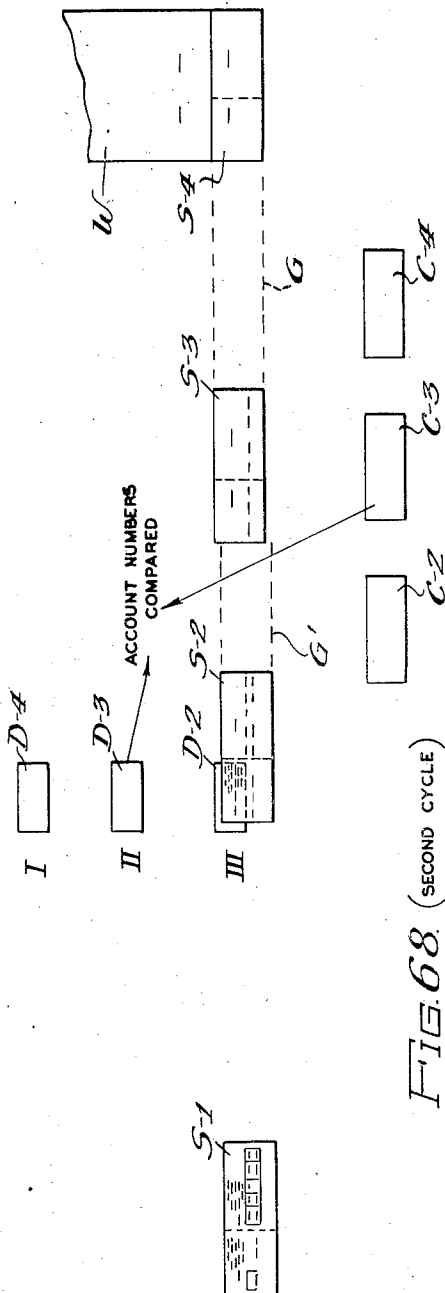
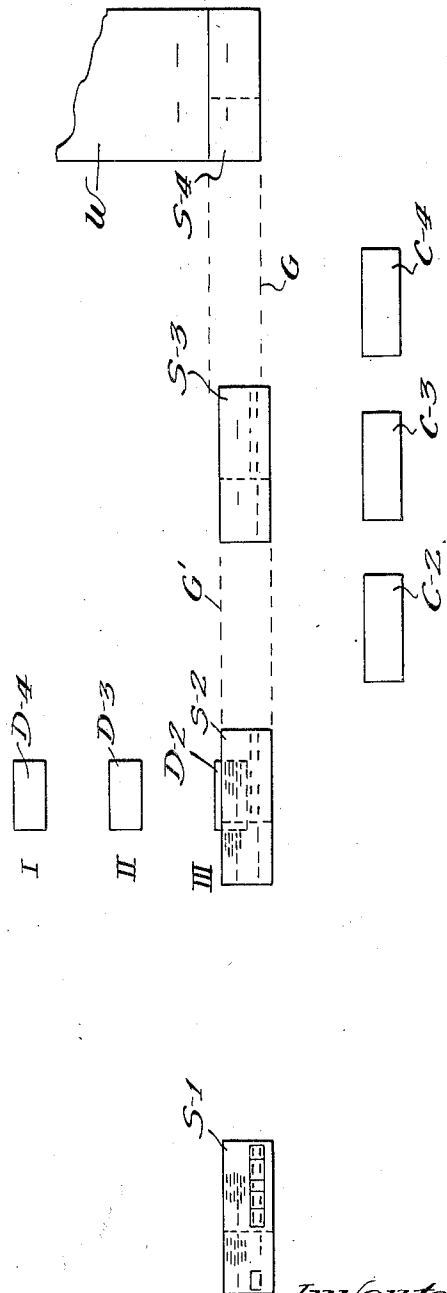


FIG. 68 (SECOND CYCLE)



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UNITED STATES PATENT OFFICE

2,414,643

PRINTING AND ADDING MACHINE

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17 Claims. (Cl. 235—61.7)

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This invention relates to printing machines of the kind wherein certain more or less unvarying data, such as, for example, names and addresses, and certain varying data, such as, for example, the monetary charges to be made from month to month to the customers of a public utility or the like, are printed on bill sheets or the like.

A machine of the general character to which this invention pertains is disclosed in my United States Letters Patent No. 2,083,061, patented June 8, 1937. Suitable devices are passed seriatim through such a machine to have more or less unvarying data, such as names and addresses, printed therefrom and control devices, such as so-called record cards, are also passed seriatim through such a machine and varying data, for example, the charge to be made to the customers of a public utility or the like, are printed under control of such devices.

However, in the machine disclosed in the aforesaid patent, in those instances where a plurality of lines of variable data were to be printed, a printing station was provided in the machine for each line of variable data to be printed; electrical circuits were established in the machine that included therein selected of the devices in a series thereof passed through the machine; representations of data on devices in a series thereof were sensed electrically to effect set-up of operative parts in the machine, such as printing members from which impressions were made in the course of operation of the machine; and, the devices in the respective series thereof passed through the machine were required to be synchronically advanced through a plurality of interrelated stations in the machine in order to effect desired printing and other operations of the machine. Now while machines of the aforesaid character are in most instances entirely suitable, there are instances where a greater degree of flexibility is required, especially insofar as set-up and arrangement of the machine and the like are concerned, than is afforded by machines of the aforesaid character and, also, instances are encountered where devices included in a series thereof cannot be included in electrical circuits that are required to be established in the course of operation of the machine, as where the devices are made of a nonconductive material. Furthermore, in many instances, it is advantageous to sense representations afforded on devices, included in a series thereof passed through a machine of the aforesaid character, mechanically rather than electrically.

In view of the foregoing and for other and

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kindred reasons, which will be apparent from the following description, it is among the objects of my invention to enable a plurality of lines of variable data or the like to be printed at a common printing station in a machine of the aforesaid character; to control the establishment of electrical circuits, in the course of operation of such a machine, by devices included in a series thereof passed through the machine rather than to include such devices in such circuits under selective circumstances; to mechanically sense representations of data afforded on devices in a series thereof passed through the machine; and to avoid passing devices included in separate series thereof through a plurality of interrelated stations in the course of passage of the devices through the machine.

Other and further objects of this invention are to afford a plurality of variably settable printing members at a printing station in a machine of the aforesaid character and to control the set-up of such members by sensing means responsive to representations of data afforded on respective devices included in a series thereof sequentially passed through the machine; to enable the same or different sensing means or members to effect set-up of particular printing members in successive operations of the variably settable printing members; to effect such cyclic operation in the machine that predetermined sensing members will control set-up of certain printing members in predetermined cycles of operation of such members while other sensing members will effect such set-up in other predetermined cycles of operation; and to enable the variably settable printing members to be selectively placed under control of the various sensing members and thereby enable variable data represented on various devices, in a series thereof passed through the machine, to be printed in a selected order without regard to the order in which such data are represented on the devices.

Further objects are to print more or less unvarying data, such as names and addresses or the like, directly from printing and control or like devices, passed seriatim through a printing machine, onto bill sheets or the like in association with variable data, such as the monetary charges to be made from month to month to customers of a public utility or the like, printed on such sheets or the like under control of record cards or like devices passed seriatim through the machine independently of the passage of the printing and control or like devices through the machine; to pass separated bill sheets or the

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like through the machine and to so control the passage thereof through the machine and also to so arrange and operate the machine that data printed on each bill sheet or the like at different printing stations in the machine and from or under control of devices sequentially passed through the machine in independent series will be interrelated so as to thereby avoid printing more or less unvarying data on a bill sheet or the like bearing varying data that in no way pertain to such more or less unvarying data; and to compare devices passed seriatim through the machine in independent series and to interrupt operation of the machine when devices in such series which should correspond with each other do not so correspond.

Still further objects are to compare identification indicia on the respective devices in a series thereof passed through the machine with supposedly corresponding indicia on the respective devices in another series thereof passed through the machine and to interrupt operation of the machine after a predetermined operation thereof when supposedly corresponding identification indicia on devices in the two different series do not correspond; to enable identification indicia represented in code on the devices in one of two independent series of devices passed through the machine to be compared with identification indicia represented in digital count on the devices in the other series thereof; and to enable predetermined controlled operations of the machine to be effected after operation of the machine has been so interrupted whereby all of the data to be printed from or under one of the two supposedly corresponding devices may be printed on a bill sheet or the like.

Yet other objects are to afford a printing station in the machine whereat parallel or otherwise separated lines of data may be printed on a bill sheet or the like in different printing operations; to feed a bill sheet or the like into predetermined relation with printing means at such printing station and to thereafter make an impression thereon from said printing means; to thereafter shift the bill sheet relative to the printing means whereby an impression may be made at a new position thereon in the next printing operation of said printing means; to so operate the printing means that selected data will be printed thereby in one printing operation thereof and also so that the same or but part of the same data or different data will be printed thereby in the succeeding printing operation thereof whereby selected data may be printed on the main body and one or more stubs of a public utility bill or the like at predetermined positions thereon.

An additional object is to enable a first sensing member to control the simultaneous setting up of first and second printing members for printing an item at two different places in one line upon a record sheet, to thereafter render the first sensing member ineffective and render a second sensing member effective to set up the first printing member for printing another item in a second line upon said record sheet, and to suppress the operation of the second printing member while the second line of items is being printed.

My novel printing apparatus is adapted for use in a machine of the type shown in my co-pending application Ser. No. 221,841, filed July 28, 1938, now Patent No. 2,296,277, patented September 22, 1942, and is particularly designed to be employed in lieu of the multiplying apparatus in such a

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machine in instances where the work is in the nature of straight billing or listing rather than the ascertainment of the results of computations. In public utility billing, for example, it is often desirable to derive numerical items from each of a series of record cards or the like and to print the items so derived from each card in a plurality of lines upon a bill sheet or the like, at a single printing station in the machine, and also, to enter certain of the items derived from each record card into an accumulator, and to furthermore enter said certain items into a tabulator and also to print selected items upon a proof sheet, and so to do is yet another object of this invention.

It is a still further object of this invention to expeditiously accomplish the foregoing results in a printing machine which also embodies means for directly printing from printing and control or like devices, respectively corresponding to record cards or the like, onto bill sheets or the like that receive the numerical data derived from the record cards or the like.

Other and further objects of the present invention will be apparent from the following description and claims and will be understood by reference to the accompanying drawings which, by way of illustration, show a preferred embodiment and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a front elevational view of my novel printing machine;

Fig. 2 is a plan view of the machine shown in Fig. 1;

Fig. 3 is a side elevation, taken substantially on the line 3—3 on Fig. 2, of the variable data printing and accumulating apparatus;

Fig. 4 is a plan view of the apparatus shown in Fig. 3;

Fig. 5 is a vertical sectional view taken along the line 5—5 on Fig. 3;

Figs. 6 and 7 are plan sectional views taken respectively on the lines 6—6 and 7—7 on Fig. 3;

Fig. 8 is a vertical sectional view taken on the line 8—8 on Fig. 7;

Fig. 9 is a perspective detail view of a latching mechanism employed in total taking operations of the apparatus shown in Fig. 3;

Figs. 10 and 11 are plan sectional views taken on the lines 10—10 and 11—11, respectively, on Fig. 8;

Figs. 12 and 13 are vertical sectional views taken on the lines 12—12 and 13—13, respectively, on Fig. 8;

Figs. 14 and 15 are transverse sectional views taken on the lines 14—14 and 15—15, respectively, on Fig. 7;

Fig. 16 is a transverse sectional view taken on the line 16—16 on Fig. 15;

Fig. 17 is a transverse sectional view taken substantially on the line 17—17 on Fig. 8;

Fig. 18 is a plan detail view of certain sensing brushes shown in Fig. 7;

Fig. 19 is a vertical sectional view taken along the line 19—19 on Fig. 18;

Fig. 20 is a transverse sectional view taken substantially on the line 20—20 on Fig. 19;

Fig. 21 is a plan sectional view taken along the line 21—21 on Fig. 19;

Fig. 22 is a vertical sectional view taken on the line 22—22 on Fig. 5;

Figs. 22A to 22D are elevational detail views of certain of the parts shown in Fig. 22;

Figs. 22E, 22F and 22G are elevational detail views illustrating various stages in the operation of certain parts shown in Fig. 22;

Fig. 23 is a plan sectional view taken on the line 23—23 on Fig. 22;

Fig. 24 is a vertical sectional view taken on the line 24—24 on Fig. 4;

Fig. 25 is a plan view of the structure shown in Fig. 24;

Fig. 26 is a side elevational view of a portion of the apparatus shown in Fig. 3, with some of the parts broken away to show the accumulator mechanism;

Fig. 27 is a vertical sectional detail view of the accumulator;

Figs. 28 and 29 are transverse sectional views taken respectively on the lines 28—28 and 29—29 on Fig. 26;

Fig. 30 is a transverse sectional view taken on the line 30—30 on Fig. 29;

Figs. 31 to 36, inclusive, are elevational detail views showing typical entry-effecting operations of the accumulator;

Fig. 37 is a vertical sectional view taken on the line 37—37 on Fig. 6;

Figs. 38 and 39 are vertical sectional detail views taken on the lines 38—38 and 39—39, respectively, on Fig. 37;

Fig. 40 is a sectional detail view taken on the line 40—40 on Fig. 5;

Figs. 41 to 46, inclusive, and 46A, are sectional detail views taken along the lines 41—41, 42—42, 43—43, 44—44, 45—45, 46—46 and 46A—46A, respectively, on Fig. 6;

Fig. 47 is a sectional detail view taken on the line 47—47 on Fig. 43;

Fig. 48 is a plan sectional view showing the printing and control device feeding mechanism;

Fig. 49 is an elevation of a typical printing and control device which may be utilized in the present machine;

Fig. 50 is a fragmentary plan section similar to Fig. 48;

Fig. 51 is a transverse sectional view taken on the line 51—51 on Fig. 50;

Fig. 52 is an elevational detail view of a part of the printing and control device feeding mechanism;

Figs. 53, 54 and 55 are perspective detail views of the printing and control device feeding mechanism;

Fig. 56 is a vertical section taken on the line 56—56 on Fig. 48;

Figs. 57, 58 and 59 constitute a wiring diagram of the machine of the present invention;

Fig. 58A is an enlarged detail view of one of the switch assemblies;

Fig. 60 is an elevation of a typical record card that may be utilized in the present machine;

Fig. 61 is an elevation of a typical sheet printed in the present machine;

Fig. 62 is a chart of the code employed in representing certain numerical values in the printing and control device shown in Fig. 49;

Figs. 63, 64 and 65 are timing charts pertaining to the variable printing and accumulating apparatus;

Fig. 66 is a fragmental rear elevational view of the rotary printing unit showing the main con-

trol cam shaft and its relationship to the rotary printing unit and the sheet feed mechanism; and

Figs. 67 and 68 are diagrammatic flow charts illustrating the progress of the sheets, the printing devices and the data cards through the machine in the first and second cycles of operation respectively of the variable printing unit.

GENERAL DESCRIPTION OF BASIC MACHINE

My novel apparatus can be advantageously used in a machine such as is shown in Figs. 1 and 2. The machine there illustrated is similar in construction to that disclosed in my aforesaid co-pending application, Serial No. 221,841, now Patent No. 2,296,277, patented September 22, 1942, and while the machine is fully described in said co-pending application certain aspects are first described herein to facilitate explanation of the present invention.

A sheet representative of those which may be produced in a machine embodying the present invention is shown in Fig. 61, and as there illustrated this sheet S bears (1) constantly recurring data, consisting of a form F, which in the present instance includes various headings such as "Net bill payable on or before," the meter reading dates at the beginning and end of the billing period, and kindred data imparting characteristics to the sheet, which in this instance is a public utility bill, the partition dividing lines appearing on the sheet S also being a part of the form F; (2) changing data A, specifically characterizing the bill and, in the present instance, this is an address comprising a name, street and number, city and state, account number, and various other designations for classification purposes; (3) variable data V which include the meter readings, consumption quantity, and consumption charges; and (4) other analogous data such as an invoice date E. The date E is the first datum, in the machine as illustrated, to be printed; next the variable data V are printed; and thereafter the address and associated data A are printed; and finally the form F is printed on the bill.

In the present machine, the address, or changing data A, are printed on the bill directly from a printing and control device, such as the device D, Fig. 49, and the variable data V are printed under control of a control device such as a record card C, Fig. 60. The printing and control devices D and record cards C are advanced concurrently through the machine and are matched against or compared with each other according to customers' account numbers, in the illustrated form of the invention, but it is obvious that identification indicia other than account numbers might be utilized for matching or comparison purposes. By referring to Fig. 61 it can be seen that the changing data A are printed in duplicate on the bill or sheet S, and that the variable data V are printed in two superposed lines on the sheet. The printing machine is, in the nomenclature of the art, operated in duplicate so as to print the data A upon both body and stub of the sheet S, and preferably, when each impression of such data is made from a device D onto a sheet S, a line of variable data is concurrently printed upon the next subsequently fed sheet S under control of the record card C corresponding to the next subsequent printing and control device D.

The printing and control device D shown in Fig. 49, which is typical of such devices, includes a carrier or frame I having, in this instance, a

metallic plate 2 removably retained thereon by fixed retaining devices 3, a bead 4 at the lower edge of the frame, and yieldable or depressible retaining tongues 5. When one or the other of the tongues 5 is depressed, the plate 2 may be slid endwise from the retaining devices 3 and the bead 4. Type characters T are embossed in the metallic plate 2 so as to appear in relief on one face thereof and in intaglio on the opposite face, impressions of changing data such as the address and associated data A, Fig. 60, being made from the relief faces of the type characters T when the printing and control device D is fed into printing relation with the platen P, Figs. 1 and 2, in the machine.

The printing and control device shown in Fig. 49 also bears an identification card 6 on which an impression is made from the type characters T so that the data that may be printed from these type characters may be read easily, thus facilitating handling of the device D. The card 6 is removably retained on the frame 1 above the plate 2 thereon by suitable retaining devices 7 and a bead 8 at the top of the frame. The card 6 and underlying portion of the frame 1 are adapted to have perforations formed therein so as to afford identification indicia which in the present instance are representative of the account number of the customer whose address has been embossed in the plate 2, these perforations being formed in accordance with the five-unit code illustrated in Fig. 62, in denominationally arranged columns extending transversely of the card 6. Thus, referring specifically to the device D illustrated in Fig. 49, the perforation 9A represents the digit 4, the perforations 9B and 9C the digit 3, the perforation 9D the digit 2, and the perforations 9E and 9F the digit 1, these digits constituting the account number 4321. The perforations in the control card 6 and the underlying portion of the frame 1 may be conveniently produced in a machine such as that disclosed in my co-pending application Serial No. 210,897, filed May 31, 1938, now Patent No. 2,265,229, patented December 9, 1941.

When data represented by perforations in the card 6 need be changed, all that need be done is to remove this card 6 and substitute another unperforated card therefor and this new unperforated card may then be perforated to afford representations of the data that are to be substituted for that which has been previously incorporated in the device D. It may be that in so doing the frame 1 will also be perforated and this will be done in all instances where the newly formed perforations are located differently than the supplanted perforations, the supplanted and unused perforations, in such instances, being covered and rendered ineffective by unperforated portions on the new card 6.

The bill or sheet S is severed from a web W, Figs. 1 and 2, that is withdrawn from a roll R which is rotatably supported in the stand 10, which, in the machine as shown in Fig. 1, is positioned at the right-hand end of the machine. The web W is led from the roll R to suitable web withdrawing devices, such as are shown and described in detail in my co-pending application Serial No. 239,562, filed November 3, 1938, now Patent No. 2,288,350, patented June 30, 1942. During passage of the web through the aforesaid withdrawing devices the date E is printed in duplicate thereon in the present machine but, as will be explained, such data could be printed along with the form F if so desired. The man-

ner in which printing of data as the date E is done is described in Letters Patent 2,132,411. Subsequently a portion of the web bearing this and any concurrently made impressions is extended beyond a severing device including the knife 12, and upon operation of this device the bill sheet S is severed from the web to be deposited in the sheet guideway G, Figs. 1 and 2.

Once the sheet is deposited in the guideway G it is under control of the sheet feeding and stopping devices shown and described in detail in my co-pending application Serial No. 268,182, filed April 17, 1939, now Patent No. 2,211,772, patented August 20, 1940. These devices serve first to position the sheet in association with printing means included in the variable data printing apparatus B, to which this invention primarily pertains, movement of the sheet being interrupted while impressions are made thereon in such apparatus, these impressions normally being the two lines of variable data V, Fig. 61. The printing means in the apparatus B are set up under control of a control device such as the record card C, Fig. 60, that is positioned at a sensing station in the printer B, such card having been withdrawn from the magazine K and fed to the sensing station by means which will be described more fully hereinafter. Concurrently with the advance of the card C to the sensing station in the printing apparatus B, a printing and control device D is withdrawn from the magazine H by means to be described presently and is fed into a detecting position intermediate the magazine H and the platen P. While the card C is being sensed to set up the printing means in the apparatus B for printing the first line of variable data V upon the sheet S, the account number represented on this card is compared with the account number represented on the identification card 6 of the printing and control device D in detecting position. In the event of non-matching of the two account numbers, only one line of the variable data V is printed, and further automatic operation of the machine is suspended until this condition is rectified, but if the account numbers are in agreement, automatic operation continues.

After the data V have been printed, the sheet bearing these data is advanced into association with the platen P whereat an impression is made directly from the type characters T on the printing and control device D corresponding to the card C under control of which the data V on the sheet S were printed, the device D having, in the meantime, advanced from detecting position into printing position below the platen P. In this operation the changeable data A, comprising the address and associated identification data, are printed on the sheet S from the embossed type characters on the printing and control device at printing position through an ink ribbon IR, Fig. 48. In this connection it will be noted by referring to Fig. 2 that the sheet guideway G, along which the sheets as S are advanced from the web severing means to the variable printer in the apparatus B, is not in alignment with that portion of the guideway designated G' along which the sheets move from the apparatus B to the platen P. When the sheet S is at the variable printer the bottom line of data V is printed first, and the sheet is then shifted laterally, or toward the bottom of Fig. 2, to enable the top line of data V to be printed thereupon. The sheet S is not returned to its initial position by the shifting means, but is ad-

mitted directly to the guideway G', the latter being offset sufficiently with respect to the guideway G so that the sheet registers with the guideway G' when it has been shifted as aforesaid.

When the data A have been printed upon the sheet S, the sheet feeding and stopping devices operate to feed the sheet S into the printing unit U illustrated at the left-hand end of the machine, as it is viewed in Fig. 1, and upon passing through this printing unit the form F is printed on the sheet or bill S and then the sheet passes into a suitable sheet collector (not shown).

It is advantageous to drive the various mechanisms employed in a machine, such as illustrated in Fig. 1, from a common source of power and to this end a bracket 13, Fig. 1, is provided which supports a motor 14 from the frame 15 of that part of my novel printing machine through which the printing devices D are sequentially fed. In the present instance a pulley 16 on the shaft of the motor 14 has a belt 17 directed thereabout, this belt also passing about a pulley 18 on the main drive shaft 19 that is journaled in the frame 15. Various pulleys are provided at spaced intervals along the main drive shaft 19, and the various mechanisms in the machine have belts leading therefrom to these pulleys so that these mechanisms are driven from the main drive shaft 19 and the motor 14.

At the start of operation of the machine a plurality of printing and control devices D is introduced into the magazine H from which the devices are withdrawn one at a time to be passed through the machine in a step-by-step manner into and through detecting and printing positions therein. After passing through these positions, the printing and control devices pass into a printing and control device collecting mechanism such as is illustrated and described in my co-pending application, Serial No. 403,272, filed July 21, 1941, now issued as Patent No. 2,390,583, patented December 11, 1945, this mechanism operating to direct the devices into one or the other of the drawers J in which such devices are stored when not in use and from which they are removed when they are introduced into the magazine H.

In the present machine the lowermost printing and control device in the magazine H is removed therefrom and is fed through positions or stations in the printing and control device guideway, in one of which stations the identifying indicia such as the perforations 9, Fig. 49, on the device are sensed to effect operation of means for comparing the identification of the printing and control device with a similar identification represented on a card C in the printing apparatus B, as will be explained in greater detail hereinafter, and in another of which stations impressions are made directly from the type characters T provided on the printing and control device, this station being referred to as the printing position of the machine. Included in the means which withdraw the printing and control devices from the machine and move these devices through the aforesaid stations are means which positively retain the devices in position in the stations into which they are moved to have operations performed thereon or therefrom.

The magazine H is supported at the rear side of the frame 15 and projects upwardly therefrom. The lowermost of the printing and control devices D in this magazine is withdrawn therefrom by the reciprocal carrier bars 22 and 23, Figs. 50 to 55, inclusive. These carrier bars are disposed between the side plates 24 and 25 which

are spaced apart by spacer bars 26 and 27 located at the front and rear ends, respectively, of the side plates 24 and 25 and these side plates are rigidly supported in the frame 15 on girders 28 and 29, Fig. 56. A casting 30, carried by these girders, has an anvil 31 provided thereon, the printing and control devices resting on this anvil at the time impressions are made directly therefrom by the platen P. An impression operation of the platen P is effected each time fluid under pressure is admitted into the cylinder 32 in the casting 30 from the pipe 33' that leads from an intermittently operated pump. When fluid under pressure is admitted into the cylinder 32 the piston 33 is forced downwardly to force the bar 34, that extends between arms 35 of the platen frame 36, downwardly. This causes the platen frame 36 to so rock about its pivotal mountings as 37 that the platen P carried thereby is forced into printing relation with the printing device D resting on the anvil 31. A platen of this character and such hydraulic operating means therefor are described in detail in my co-pending application, Serial No. 416,548, filed October 25, 1941.

The carrier bars 22 and 23 are supported for reciprocal movement over the inner faces of the side plates 24 and 25 by strips 38 and 39, Figs. 51 and 56, the carrier bars merely resting on the upper edges of these strips. A plate 40, Figs. 55 and 56, is fastened to the inner side of the carrier bar 22 at the rear end thereof and a similar plate 41 is fastened to the inner face of the carrier bar 23 at the rear end thereof. Bars 42 are secured to, as by being welded thereto, and extended between the plates 41 and 42 and serve to maintain the rear ends of the carrier bars 22 and 23 in permanently spaced relation, this spaced relation being such that the carrier bars are held in a tight sliding fit against the inner faces of the side plates 24 and 25, respectively. The anvil 31 is recessed, as at 43, Fig. 53, at its sides and below the top surface thereof, on which the printing devices D rest when impressions are being made therefrom. The forward ends of the carrier bars 22 and 23 rest in these recesses as 43 and in this way the forward ends of the carrier bars are supported for reciprocal movement over the inner faces of the side plates 24 and 25 and at the same time are maintained in properly spaced relation.

In the present machine the lowermost of the printing and control devices D (or printing devices D as these devices are sometimes referred to hereinafter for convenience) is withdrawn from station or position I thereof, Figs. 48, 50 and 56, in the magazine H and first comes to rest in what will be referred to hereinafter as the sensing position or station, this position or station being indicated at II. In the course of movement of the printing devices through the machine they also come to rest in printing position above the anvil 31, which position or station is indicated at III. After passing from station III over anvil 31 the printing devices pass into the printing device collecting means. It will thus be apparent that the printing and control devices come to rest in two different positions or stations after movement thereof from the magazine H.

Suitable means are provided for engagement with the printing devices to effect advancing thereof from station I into and through stations II and III and for retaining the devices in a fixed position when in stations II and III. Thus, a slot 44, Fig. 55, is provided in the carrier bar 22 near

the rear end thereof, and a pawl 45 mounted in this slot is acted on by a spring 46 which urges the forward end of the pawl upwardly so that this end of the pawl normally extends above the top edge of the carrier bar 22. A pawl 47 is similarly mounted in the carrier bar 23, the pawls 45 and 47 being in transverse alignment. The pawls 45 and 47 serve to withdraw the lowermost printing device D, in station I in the magazine H, from this station and advance such device to station II. These pawls are free to pivot downwardly during the rearward movement of the carrier bars so that they will pass below the lowermost printing device in the magazine and then spring up behind this device into position to engage the rear edge of such lowermost printing device when the carrier bars 22 and 23 start to move forwardly. In order to facilitate movement of the pawls underneath the lowermost printing device during rearward movement of the carrier bars these pawls are beveled as indicated at 48, this serving as a cam surface to insure depression of the pawls against the action of the springs as 46.

The pawls 45 and 47 are so mounted in the slots as 44 that they are capable of movement longitudinally of the bars. Then, as an incident to the first part of the forward movement of the carrier bars, at which time the pawls are engaging the lowermost of the printing devices in the magazine H, these pawls are forced rearwardly of the carrier bars in the slots as 44. Such rearward movement causes the notches as 49, Fig. 55, in the lower edges of the pawls 45 and 47 to be moved from alignment with the projections as 50 on the lower edges of the slots as 44, and that part of each of the pawls immediately forward of these notches thereupon rests on these abutments during the forward movement of the carrier bars. By reason of such seating of the pawls on these abutments the downward force exerted by the printing devices D in the magazine H does not disengage the pawls from the lowermost printing device which is, therefore, fully fed out of the magazine from position I to position II by the pawls 45 and 47. When, however, the pawls move rearwardly with the carrier bars, the beveled edges 48 engage the lowermost printing device in the magazine H as an incident to such rearward movement and prior to the time the pawls are cammed downwardly, they are moved slightly forwardly in the slots as 44 to thereby align the notches as 49 with the abutments as 50 so that during the rearward movement of the carrier bars, the pawls may be cammed down against the action of the springs as 46 and at this time the abutments 50 pass into the recesses 49.

Another pair of pawls 51 and 52 are respectively mounted in slots as 53 in the carrier bars 22 and 23 and are acted on by springs as 54 to have the forward ends thereof projected above the top edge of the carrier bars. These pawls are spaced forwardly of the pawls 45 and 47 in an amount sufficient so that when the carrier bars come to rest in their forwardmost positions these pawls will dispose a printing device in position III above the anvil 31. It will be understood that during the rearward movement of the carrier bars, the pawls 51 and 52 are forced downwardly against the action of the springs as 54 during the time they pass under the printing device in position II and that these springs re-position the pawls in device engaging position as soon as the pawls pass beyond a device in position II in the rearward movement of the carrier bars.

Still other pawls 55 and 56 are mounted in slots as 57 in the carrier bars 22 and 23 and are acted on by spring 58 to be urged upwardly. The pawls 55 and 56 are respectively spaced forwardly of the pawls 51 and 52 in but a relatively short amount and in the forward or at rest position of the carrier bars, these pawls are located in a position slightly forward of the printing device in position III. Hence as soon as the carrier bars start to move rearwardly, the pawls 55 and 56 are pivoted downwardly as they pass under the printing device disposed in position III, and in the course of such rearward movement and prior to the time it is completed the pawls 55 and 56 are disposed well to the rear of the rearwardmost edge of the printing device in position III. However, in the course of forward movement of carrier bars 22 and 23 the pawls 55 and 56 move into engagement with the rearwardmost edge of the printing device in position III, which is above the anvil 31, Fig. 56, and carry this printing and control device to the printing and control device discharge chute.

The just described pawls are retained in the aforesaid slots by plates as 59, Fig. 55, that are mounted on the inner faces of the carrier bars in alignment with the slots in which the pawls are mounted, and these plates serve to prevent inward movement of the pawls. Outward movement of the pawls is prevented by reason of the fact that the carrier bars 22 and 23 are mounted for sliding movement over and against the inner faces of the side plates 24 and 25 and the pawls engage the inner faces of these side plates to be retained in the slots in which they are mounted.

Reference has been made to reciprocation of the carrier bars 22 and 23 and this movement is imparted to the carrier bars in the following manner: A block 60, Figs. 48 and 56, is mounted between the bars 42 for reciprocal movement between the plate 41 and a spacing pin 61 that extends between the bars 42. The free end of an arm 62 extends beneath the block 60 and affords a support for said block, the block being pivotally connected to the arm as indicated at 63. As best shown in Fig. 56, the end of the arm 62, to which the block 60 is pivotally connected, is offset upwardly, this offset portion being interconnected by an inclined portion 64 in the arm. That portion of the main extent of the arm 62 adjacent the inclined portion 64 is reciprocally mounted in a recess 65, Figs. 48 and 56, in a block 66 pivotally mounted on an arm 67. The end of the arm 62 opposite that at which the block 60 is pivotally connected is pivotally mounted as indicated at 69 on a bracket 70, Figs. 48 and 56.

The block 66, the arm 67 and the pivotal connection therebetween afford a scotch yoke connection for the arm 62, the arm 67 being fast to a vertical shaft 71, Fig. 56. The shaft 71 is journaled in a vertical bearing 72 that is carried by the bracket 70. A gear 73 is rotatably mounted on the shaft 71 and includes a hub 74 having clutch teeth 75 thereon. A sleeve 76 is slidably but non-rotatably mounted on the shaft 71 and includes clutch teeth 77 which are urged toward the clutch teeth 75 by springs acting between the sleeve 76 and a collar 78 mounted on the shaft 71, the sleeve 76 being connected to the collar 78 for rotation therewith. Reference may be had to my Patent No. 2,265,133, patented December 9, 1941, for details of construction.

The clutch teeth 75 and 77 and the sleeve 76 are part of a one-revolution clutch such as is

disclosed in my copending application Serial No. 239,561, filed November 8, 1938, now Patent No. 2,265,133, patented December 9, 1941, and which is of substantially the same construction as the one-revolution clutch described hereinafter under the heading "Drive for variable printer and accumulator." A pin (not shown) on the sleeve 76 cooperates with a cam surface (not shown) on an arm 79 to hold the clutch teeth 77 separated from the clutch teeth 75. A suitable electrically operated means such as the solenoid 80, Fig. 48, is provided for causing the arm 79 and the cam surface thereon to be retracted from cooperation with the pin on the sleeve 76 to thereby enable the clutch teeth 77 to engage the clutch teeth 75 at predetermined times in the operation of the machine, and in this manner the gear 73 is connected to the shaft 71. After the solenoid 80 has been energized to enable engagement of the clutch teeth, the pin on the sleeve 76 acts to again dispose the cam surface on the arm 79 in position to be engaged by this pin near the end of a revolution so that as the pin moves over the cam surface the clutch teeth 77 are separated from the clutch teeth 75 to interrupt rotation of the shaft 71 at the end of a complete revolution thereof.

The gear 73 meshes with a pinion 81, Figs. 48 and 56, rotatably mounted on a rod 82 that is driven into a socket in the bracket 70; the cross member 83, Fig. 56, being fixedly attached to the lower end of this rod. A pulley 85 is also rotatable on the rod 82 and is fixedly connected to the pinion 81, the pulley 85 being mounted below the pinion, and said pulley and pinion are supported in operative position by suitable means such as a collar secured to the rod 82.

A belt 87, Figs. 1 and 56, is passed about the pulley 83 and over guide pulleys 88 and 89 that are secured in position at the point of interconnection of the cross member 83 with the rod 82. From the guide pulleys 88 and 89 the belt 87 passes to a pulley 92, Fig. 1, fast on the main drive shaft 19. Thus whenever the main drive shaft 19 is rotating, the pinion 81 and the gear 73 are rotated so that when the aforesaid solenoid is energized to cause the clutch teeth 77 to engage the clutch teeth 75, as described above, the arm 67 is caused to make a complete revolution whereupon, through the connection of the arm 62 with the block 66, a reciprocatory movement is imparted to the end of the arm 62 to which the block 60 is pivoted and thereupon reciprocatory movement is imparted to the carrier bars 22 and 23 to advance the printing and control devices through the guideway therefor.

While each printing and control device D is in position II a detecting means cooperates therewith to effect set-up of the means for comparing the identification number perforated in such device with a similar identification number perforated in a card as C, Fig. 60, at the variable printer B, Fig. 1, and it is therefore advantageous to accurately locate the printing and control device when it is in position II and this detecting means is to cooperate therewith. Furthermore, when each printing device is in position III above the anvil 31 and impressions are being made therefrom it is desirable to firmly hold the printing device in position for so to do enables accurate location of the impression made therefrom and this also enables a clear-cut impression to be produced.

By referring to Fig. 49 it will be seen that a

notch 93 is provided in one side edge of each printing and control device D, this notch being accurately positioned with respect to the identification area 6 and printing plate 2 on the particular printing and control device. Inasmuch as notches as 93 are accurately located with respect to other parts on the printing and control devices it is possible, by locating means in the machine adapted to cooperate with these notches accurately with respect to parts in the machine adapted to cooperate with the printing devices, to insure that the machine parts will cooperate with the printing and control device parts in an accurate manner. The means in the machine adapted to cooperate with the notches 93 in the printing devices D are, in the present instance, pawls 94 and 95, Fig. 53, the pawl 94 being positioned to cooperate with the notch in the printing devices at the station II and the pawl 95 being positioned to cooperate with the notch in the printing devices at the station III.

The pawls 94 and 95 are pivotally mounted on the upper edge of the side plate 24. In order to insure seating of these pawls in the notches in which they are adapted to seat, these pawls are urged toward the edges of the printing devices by applying spring pressure thereon. However, these pawls are arranged in such a manner that the pressure exerted thereon may be varied so that appreciable pressure will be effective on these pawls only at the time the pawls are to be operative and at all other times, and especially when the printing devices are moving past these pawls, but very light pressure is applied thereon so that objectionable wear on the printing devices is avoided. Each pawl 94 and 95 includes an ear 98 having an opening therein, and the free upper end of a leaf spring 100 is passed through this opening. The lower end of each leaf spring is firmly connected to the outer face of the side plate 24 as by a screw 101.

A groove 102 is provided in the outer face of the side plate 24 and a slide 103 is mounted in this groove, said slide passing behind each leaf spring 100 and these springs serve to retain the slide in the groove. A lug as 104 is fast on the slide in position to cooperate with each spring 100, each lug 104 including an overhanging portion which may pass over the outer face of the adjacent spring. The forward edge of the overhanging portion of each lug 104 is beveled to insure passage of the overhanging portion of this lug over the outer face of the adjacent spring 100 upon reciprocation of the slide 103.

By referring to Fig. 55, it will be seen that a notch 106 is provided in the lower edge of the carrier bar 22 and that another notch 107 is provided in the lower edge of this bar forwardly of the notch 106. These notches are arranged to define oppositely facing shoulders, the shoulder defined by the rear notch 106 facing forwardly and the shoulder defined by the front notch 107 facing rearwardly. An opening 108 is provided in the side plate 24 and a pin 109, Fig. 52, projects through this opening to be engageable in the notches 106 and 107. The pin 109 is fast in a finger 110, pivoted at 111 to the lower end of a plate 112 secured to the slide 103. A spring 113 extends between spring anchors respectively located on the side plate 24 and the finger 110 and acts on this finger to urge the pin 109 into engagement with the lower edge of the carrier bar 22.

In the latter part of the rearward movement of the carrier bar 22 the shoulder thereon defined

by the notch 107 engages the pin 109 and through the finger 110 and plate 112 moves the slide 103 rearwardly, and thereupon the lugs as 104 assume the position shown in Fig. 54. This disposes the beveled edges on these lugs in alignment with, but free of, the springs 100. Hence, the fulcrum for each spring 100 is the screw 101 wherefore the extent of each spring between its fulcrum and the point where it applies its effective pressure is relatively elongated and by reason of this each spring exerts but very little pressure on the pawl to which it is connected. Hence, after the carrier bars attain their rearwardmost position and start to move forwardly to advance the printing devices in the manner above described, both the pawls 94 and 95 exert but very little pressure on the edges of the printing devices moving past them.

However, just before the carrier bars attain their forwardmost position, the pin 109 enters the notch 106 and engages the shoulder thereof whereby, as the carrier bars complete their forward movement, the shoulder of the notch 106 acts through the pin 109, finger 110 and plate 112 to move the slide 103 forwardly. In this movement the slide 103 moves the lugs 104 over the outer faces of the springs 100 with the result that the springs fulcrum on the lugs rather than on the screws 101. This change in the point of fulcruming of the spring decreases the effective length and thereby substantially increases the effective pressure thereof and at the time this is effected the pawls 94 and 95 are moving into the notches as 93 in the printing devices in stations II and III. Therefore, effective pressure is applied on the pawls to positively seat these pawls in the notches wherefore the printing devices in stations II and III are accurately located and the printing devices are firmly held in position. The slide 103 is moved rearwardly so as to withdraw the lugs 104 from association with the springs 100 prior to the time the printing devices start to move forwardly in the next advancing thereof and hence the effective pressure applied on the pawls is relieved prior to the time the printing devices are to be moved relative thereto.

During the time the printing devices are being carried along by the carrier bars 22 and 23, they are held down on these carrier bars by thin strips 114 and 115, Fig. 51, respectively fastened to the upper edges of the side plates 24 and 25, these thin strips projecting inwardly beyond the inner faces of these side plates and defining the upper surfaces of the printing device guideway.

When printing and control devices D are withdrawn from the magazine H and come to rest in position II, Figs. 48, 50 and 56, in the course of the step by step advancing movement thereof through the printing device guideway, these devices are in a position for cooperation with the detector mechanism which ascertains the value of the account number or other identifying designation represented thereon. The detector to which reference has just been made is generally indicated at 120 in Figs. 48 and 56 and comprises a block 121 from the bottom of which several columns of spring-pressed sensing pins 122 protrude. When a printing and control device D is in position II, the columns of sensing pins 122 are aligned with the columns in the card 6, Fig. 49, in which perforations may be formed according to the code shown in Fig. 62, and there are as many columns of sensing pins 122 as there are to be active columns on the cards 6. In the present

instance where the identifying (account) numbers are confined to not more than four orders, only four columns of sensing pins 122 are provided (see Fig. 43) for cooperation with the perforations in the cards 6 representative of such number. Inasmuch as a five unit-code is employed to represent the digits of the identifying number, as shown in Fig. 62, five sensing pins 122 are provided in each column or order thereof, so that an individual sensing pin is aligned with each index point position on a card as 6 where a perforation may be located, when the printing and control device D is in position II.

The block 121 is mounted between a pair of arms 123 and 124, Fig. 48, which are provided with knife edges 125 and 126, Figs. 48 and 56, near their rear ends which seat in substantially V-shaped notches respectively formed in the side plates 24 and 25 of the printing device guideway. Springs as 127 act on the arms 123 and 124 and normally urge the head 121 carrying the sensing pins 122 upwardly out of its operative position. A link 128 is pivotally connected to the arm 123, and the lower end of the link 128 is connected to the armature of a solenoid 129, Figs. 48 and 56, so that when the solenoid 129 is energized, the link 128 is moved downwardly to thereby bring the sensing pins 122 into cooperating relation with the card 6 on the printing and control device D disposed at position II. The solenoid 129 is controlled by a normally open switch 130 that is closed at the proper time in the machine cycle, as will hereinafter be explained, so as to effect sensing cooperation of the sensing means 120 with the printing and control device that is located at station II. In the course of such downward movement those sensing pins 122 which do not move into alignment with perforations in the card 6 come to rest on the face of this card and are forced upwardly against the action of their retaining springs in the head 121. Those pins, however, which move through perforations in the card 6 come into cooperation with the devices which bring about setting up of switches included in the number comparison means to be described hereinafter.

The devices with which sensing pins 122 so cooperate include push pins 133, Fig. 56, mounted in a block 134 carried by the casting 30. There are as many columns of push pins 133 as there are columns of sensing pins 122 and each push pin 133 is respectively aligned with a sensing pin 122. Thus, when a sensing pin 122 passes through a perforation in a card 6 on a printing and control device at position II, it moves into engagement with a push pin 133 and pushes the aligned push pin 133 downwardly. Connection between the push pins 133 of the detecting device 120 and the aforesaid switches of the number comparison means is established through Bowden cables 135 for so to do affords the required flexibility in the mounting of the various parts of my machine in operative association with each other for, as will be understood, varied lengths of Bowden cables may be employed and inasmuch as these cables are flexible they may be directed as required.

In the present instance, the ends of the Bowden cables 135 that are to receive movement are respectively aligned with the push pins 133, these ends of the cables being maintained in proper relation with these push pins by having the casings 136 of the cables secured in a supporting plate 137 carried by the block 134. The Bowden cables 135 are slightly longer than the distance between the push pins 133 that impart movement

thereto and the devices in the number comparison means receiving movement from these cables, and therefore each push pin 133 is provided with a head, as shown in Fig. 56, so that when the push pins are in their normal at rest position with the Bowden cables effective thereon these pins are firmly seated against the bottom of the block 134 in which the push pins are mounted.

The variable printing apparatus to which this invention primarily pertains is particularly, though not necessarily, adapted for use in the machine shown in the accompanying drawings and when so used the apparatus as a whole is operated in timed relation with other operative parts in the machine. Moreover, the various operative parts in the variable printing apparatus are operated in timed relation with each other, such timed relation of these parts being correlated with the timing of other devices in the machine. The timing of the operation of the various operative devices in the machine, as well as the timing of the various operating parts in such operative devices, is under control of means associated with the form printing unit U. Thus, while the present invention primarily pertains to the variable printing apparatus and while this apparatus may be used in other ways than in the particular machine shown in the accompanying drawings, the form printing unit U and its operative functions are described herein for so to do will facilitate describing the operation of the variable printing apparatus, both in so far as the operative parts included therein are concerned and in so far as the operation of the variable printing apparatus is related to the operation of other operative devices in the machine is concerned.

While constantly recurring data, such as the form F on the sheets S, Fig. 61, may be printed on the sheets in a wide variety of ways, in the present instance I have employed a well-known printing unit, one form of which is indicated at U, Figs. 1, 2, and 66. Reference may be made to, for example, U. S. Letters Patent 816,311; 970,411; 990,207; 1,031,311; 1,094,065; 1,148,940; and 1,647,560 for a disclosure of the full details of a printing unit such as the unit U.

The unit U is mounted on bars as 140, Figs. 1, and 66, in a fixed position longitudinally of these bars. The bars as 140 are mounted on a rod 141 that is carried by the upright 142 of the frame 15, and the printing unit U is prevented from pivoting about the rod 141 by a brace 143 that depends from the frame thereof and which engages the adjacent end of the frame 15.

The printing means of the printing unit U includes a rotatable drum 144, Fig. 2, which has suitable printing means, such as electroplates, secured on the periphery thereof. Such printing means may be located on the periphery of the drum 144 as required and in the present instance are located on the periphery of the drum in such positions that when sheets are admitted into the bite between this drum and its cooperating platen roller 145, the form F will be printed on the bills or sheets S at the proper and required positions thereon. This, of course, entails locating the printing members on the periphery of the drum in such locations that as the drum starts from its at rest position and a sheet starts to pass thereto from a given position, the leading edge of the sheet will engage the bite between the drum 144 and the platen roller 145 at a time when the leading printing means on the drum is spaced from the bite in the same amount as the portion of the

sheet that is to receive an impression from such means, all of the foregoing being standard practice in the art and for further description reference may be made to U. S. Letters Patent 816,311 or 990,207.

It is to be noted that, of the various operative mechanisms provided in the machine, the only one which is constantly operated when the machine is in operation is the printing unit U and, more specifically, the drum 144 and its associated mechanisms in this unit. This drum rotates at a constant given speed which is selected according to the productive capacity desired of the machine, the printing unit 11 being of such a character that it is operative to print upon a sheet as S in every other revolution of the drum 144, and the speed of rotation of the drum 144 is in most instances such that the drum will make a complete revolution each time the platen P is to be operated to make an impression. For example, if it should be desired that fifty sheets, such as the bills S, Fig. 61, each bearing duplicate impressions of changeable data A, are to be produced per minute, then the drum 144 is rotated at a speed of 100 revolutions per minute. By way of further example, if four impressions were made on each sheet and the drum speed were 100 revolutions per minute, then the productive capacity would be twenty-five sheets per minute. From the foregoing it will be apparent that the productive capacity of the machine in so far as the number of sheets produced is concerned, is based upon the speed of rotation of the drum 144, and it is therefore, advantageous to operate this drum at as high a speed as possible consistent with the production of satisfactory work in the machine as a whole.

In order to insure that sheets will pass through the machine and have operations performed thereon in such a way that sheets will be produced consistent with the type of work being performed, that is, consecutive, duplicate, triplicate, and so forth, the various mechanisms in the machine are timed to operate in accordance with the speed of rotation of the drum 144 and, in order that this may be effected, the devices which control operation of the various mechanisms in the machine are placed under control of the drum 144 and mechanisms associated therewith. Since, in the present machine, the various operative mechanisms receive power through suitable controls, and more specifically clutches, provided in each of the mechanisms, and since these clutches are electrically controlled, by means of solenoids, it is possible to associate the regulating means, for the controls or clutches of the mechanisms to be timed relative to the printing unit U, directly on the printing unit U, these regulating means, in the present instance, being in the form of switches for controlling the closing of the circuit to the solenoids of the clutches. To this end a timing shaft 146, Figs. 2 and 66, is journaled in suitable bearings provided on the outer face of the form printing unit U. This shaft is adapted to be coupled through suitable gearing to the shaft on which the drum 144 is fast, for rotation therewith. Cam discs as 147 are fast on the shaft 146 to be rotatable therewith and these cam discs operate the switches that control operation of various operative mechanisms in the machine.

In the present instance where the machine is set for printing two lines of variable data V, Fig. 61, and printing the changeable data A at two places on the sheet S, as has been explained hereinabove, the gear ratio between the drum 144 and

the timing shaft 146 is two-to-one, so that the shaft 146 and the various cam discs 147 fast thereon make one revolution for each two revolutions of the drum 144. Thus the timing shaft 146 makes one revolution for each operating or printing cycle of the printing unit U, or in other words, for each sheet or bill S that is to be produced on the machine, and hence in a complete revolution of the timing shaft 146, the cam discs 147 of the timing shaft 146, and the stop finger mechanism driven by the shaft 146, may be effective to control and properly time the operations of the various mechanisms that are to be operative in producing a particular bill or sheet S. In order to insure that there will be a definite timed relation between the operation of the form printing unit U and the various other operating mechanisms in the machine, an arrangement is provided such that the angular relation between the shaft 146 and the drum 144 will always be the same at the beginning and at the end of every complete rotation of shaft 146, which is to say, such that there will exist a predetermined angular relation between the lobe or lobes on each cam disc as 147, and a given point on the drum 144 at the beginning of each and every 360 degrees of rotation of shaft 146. This may be accomplished by providing a uniform engagement clutch such as is shown, for example, in my co-pending application, Serial No. 239,563, filed November 3, 1938, now Patent No. 2,265,134, patented December 9, 1941, which functions in such a manner that the shaft 146 is always connected in an identical manner to the shaft on which the drum 144 is mounted. The main timing shaft 146 is thus connected in every instance in the proper timed or angular relation to the printing unit U, thereby to insure that the timing cams 147 will cause proper timed operation of the various mechanisms that are to be controlled by such timing shaft, and in addition, the timing shaft 146 is connected in a one-to-one relation by means including a cross shaft 151, Figs. 2 and 66, so as to drive a stop finger cam shaft 148 that is extended along the sheet guideway sections G and G'. Thus the cam means on the stop finger cam shaft 148 serves to operate sheet advancing means including the stop fingers 149, 150 and 150a in the timed sequence or relation shown in Fig. 64 so as to thereby cause controlled movements of the sheets along the sheet guideway in timed relation to the operations of the mechanisms that are governed by the timing shaft 146 and timing cams 147. The manner in which the just described switch arrangement functions to bring about the properly timed operation of the various mechanisms in the machine is described in detail hereinafter. Thus the web feeding and severing unit includes a one-revolution control clutch 148A, the driving element of which is constantly driven from the main drive shaft 19 by means including a belt 148B, and this clutch has a control solenoid 148C which serves when energized to cause engagement of the clutch. The clutch 148A, as shown in my aforesaid Patent No. 2,288,350, serves to drive the web feeding and severing mechanism through a single cycle of operation each time the solenoid 148C is energized, and this is accomplished by one of the cams 147 each time the control shaft 146 is rotated through a complete revolution.

While the machine disclosed in the accompanying drawings includes other devices which enter into the production of printed sheets, such as the bill S, Fig. 61, it is believed that the foregoing description is sufficient to enable under-

standing of the relationship between the various operative devices in the machine and the variable data printing apparatus B to which this invention primarily pertains and which will now be described, particularly since reference may be had to my co-pending application, Serial No. 221,841, now Patent No. 2,296,277, patented September 22, 1942, for a full description of the other units in the machine. The specific timing of the units of the present machine is set forth hereinafter.

VARIABLE DATA PRINTING AND ACCUMULATING APPARATUS

The variable data printing and accumulating apparatus generally designated B, Figs. 1, 2 and 3, is adapted, in the present instance, to be operated under control of record cards C, Fig. 60. These cards are of a well-known type in which the data are represented by perforations formed in the card in accordance with the conventional single-hole notation. Thus, the card C is divided into a number of data columns extending transversely of the card starting from the line L beneath the printed heading as A', Fig. 60, this heading including the name and address of the customer for whose account the record card is prepared. The first row of index point positions extending lengthwise or horizontally of the card C below the line L, in the several card columns, is allocated to the digital value of zero; the next row beneath the line L pertains to the digit 1; and so on, to the last row of index point positions, situated just above the bottom edge of the card C as viewed in Fig. 60, which row pertains to the digit 9.

Perforations may be made in the aforesaid rows in any of a plurality of card columns that extend transversely across the card. When it is desired to represent a digit in any particular card column, a perforation is made in the card at the index point in that column in the row allocated to the desired digit, this being standard practice in the art and hence not explained herein in greater detail.

The card columns are generally grouped together to accommodate numerical entries of more than one order, as for example in the case of the group of columns on the card C designated "Dist.," which comprises two columns that are perforated, in the present instance, to represent the district number 95. Similarly, other perforations are present in the appropriate card columns to represent the ledger number 549, account number 4321, preceding meter reading 7192, present meter reading 7618, total kilowatt-hours of consumption 426, first rate step quantity 250, gross bill (\$) 20.13, and net bill (\$) 18.12. The rate designation (C3 in the present instance) consists of an alphabetical character in combination with a numerical character. The numerical character may be any digit from 1 to 9 or 0, and is represented in the appropriate card column in the same manner as are digits in other columns. The alphabetical character is selected from nine available letters, for example, A, B, C, D, E, F, G, H and J, that may be respectively represented in the appropriate card column by perforations in the index point positions allocated to the digits 1 to 9. Preferably, a perforation in the zero position of such column denotes a blank or blanking character. An interpretation of the gross bill and net bill is usually printed on the card C along with the account number, meter reading dates, and invoice date, as at Z. For a reason which will appear hereinafter, the ciphers, as in the first step quan-

tity 250 and gross bill 20.13, are perforated in the card C as at X and Y in the zero row, instead of being represented by the mere absence of perforations in the corresponding columns.

In general, the printing apparatus B comprises card feeding and card analyzing means; means for comparing the account number on each card C with that represented on the corresponding printing and control device D that is being advanced concurrently therewith through the machine; means under control of the number comparison means for interrupting automatic operation of the machine in the event the account numbers do not match; the variable printing mechanism proper, which interprets the variable data represented on the card C that is sensed by the card analyzing means, and which prints such data upon the corresponding sheet S one line at a time; a line shifting mechanism which moves the sheet S transversely from alignment with the guideway G and into alignment with the guideway G', Fig. 2, after the first line of variable data V has been printed upon the sheet S, to thereby enable a second line of such data to be printed on the sheet; a selective control means including cam-operated switches for governing the operative interrelation between the card analyzing means and the variable printer as each line of variable data is printed, to enable the data derived from each card C, Fig. 60, to be transposed in the desired manner upon the sheet S, Fig. 61; a proof printer operable to produce a list of certain items of variable data printed upon the various sheets S under control of the cards C; and an accumulator which is operable to keep a running total of certain of the items printed by the proof printer.

As shown in Figs. 1 and 3, the supporting framework of the printing apparatus B includes side frames 155 and 156 which, at their lower ends, are secured to a bracket 157 that may be adjustably secured to the frame of the machine in which the present apparatus is included. In order to positively reinforce the side frames 155 and 156, spacing sleeves as 158, Fig. 5, are disposed therebetween at suitable positions and bolts as 159 are freely passed through the side frames 155 and 156 and are threaded into tapped openings in the ends of these spacing sleeves. The various operative devices of the printing apparatus B, which have been briefly referred to hereinabove, are supported by the side frames 155 and 156 and are operated in timed relation with the printing machine as a whole, as will be explained.

Drive for variable printer and accumulator

The variable data printing and accumulating apparatus constituting the present invention is adapted to be operated in a plurality of printing cycles during each variable data printing operation of the machine. In each such cycle of operation a single line of variable data is printed upon a sheet such as S, Fig. 61, under the control of a card as C, Fig. 60, and various other operative functions of the apparatus are effected as will be described hereinafter. As employed in the present description, the term "cycle of operation" primarily refers to a complete rotation of a driving cam shaft 160, Figs. 5 and 6, which is journaled in and carried between the side frame members 155 and 156 of the variable printer and accumulator B. This cam shaft controls the operation of the various operative mechanisms embodied in the apparatus B and insures correct timing of such mechanisms.

As shown in Figs. 5 and 6, a gear 161 is rotatably mounted on that portion of the cam shaft 160 which projects beyond the side frame 155, and this gear 161 meshes with a gear 162 that is rotatably mounted on a stub shaft 163 secured to the frame 155. The gear 162 is attached to a pulley 164 around which a belt 165, Fig. 1, is passed, this belt also passing around a pulley 166 on the main drive shaft 19 of the machine to thereby afford a driving connection between this drive shaft and the gear 162, Fig. 5, so that the gear 161 will be constantly driven while the machine is in operation.

Referring to Fig. 6, the gear 161 is provided with a hub in which clutch teeth 167 are formed that are adapted to engage complementary clutch teeth 168 formed in a collar 169 slidably but non-rotatably mounted on the cam shaft 160. Suitable spring means (not shown) tend to urge the collar 169 in such a direction that the clutch teeth 168 thereon will mesh with the driving clutch teeth 167 in the hub of the constantly driven gear 161. Normally, however, such movement of the collar 169 is restrained by a plate 170 pivotally mounted at 171 on the side frame 155, which plate normally rests on the collar 169 and has a shoulder 172 against which a pin 173 on the slidable collar 169 abuts.

As is best shown in Fig. 5, a solenoid 174 is mounted in a bracket 175 secured to the frame 155 above the cam shaft 160, and the core 176 of this solenoid is pivotally connected to a depending plate 177 which rests against the free end of the pivoted plate 170. The plate 177 has a lug thereon which, when the solenoid 174 is in a deenergized condition, underlies the free end of the plate 170. When the solenoid 174 is energized, in a manner to be described hereinafter, it retracts the plate 177 upwardly, thereby pivoting the plate 170, Fig. 6, upwardly and disengaging the shoulder 172 thereon from the pin 173 on the collar 169. The collar 169 is thereupon urged into engagement with the hub of the gear 161 and the clutch teeth 167 and 168 are thus engaged to operatively connect the driving gear 161 with the cam shaft 160. The collar 169 and shaft 160 thereby take motion with the gear 161, and as the pin 173 rotates to the right as viewed in Fig. 6, it strikes the plate 177 and swings this plate outwardly to thereby release the pivoted plate 170 so that the latter plate drops down and rests on the collar 169. Thus it will be seen that the plate 170 is released shortly after initiation of a cycle of rotation of the cam shaft 160, regardless of how long the solenoid 174 may remain energized.

As seen in Fig. 6, the pivoted plate 170 has a relatively narrow body portion which is connected to the shoulder 172 by a cam surface 178. Toward the end of a complete rotation of the cam shaft 160 the pin 173 on the collar 169 rides onto the cam surface 178 and as the shaft 160 and collar 169 continue to rotate, the pin 173 is urged along this cam surface and onto the shoulder 173 of the plate 170, thus causing the clutch teeth 168 on the collar 169 to move out of engagement with the clutch teeth 167 on the gear 161. Such separation of the clutch teeth 167 and 168 disconnects the cam shaft 160 from the gear 161 and further rotation of the cam shaft is arrested by engagement of a lug 179 on the plate 170 against the pin 173 which occurs at the termination of one complete rotation of the shaft 160. Further rotation of the shaft 160 cannot take place until the solenoid

174 is subsequently energized to retract the plate 176 from engagement with the pin 173.

The solenoid 174 which operates the one-revolution clutch for the cam shaft 160 is energized periodically during automatic operation of the machine. Such timed energization of the clutch solenoid is in the present instance effected by a switch 180, Fig. 57, which is closed at predetermined times in the rotation of the timing shaft 146, Fig. 2, of the printing machine by a double-lobed cam 187—B included in the cams 187 mounted on the shaft 146. The contacts of the switch 180 are in series with the winding of the solenoid 174 and when these contacts are engaged upon actuation of the switch 180 by either lobe of the cam 187—B, the winding of the solenoid 174 is energized to thereupon initiate a revolution of the cam shaft 160 of the printing apparatus B, which is to say, a cycle of operation of this apparatus, as is explained more fully under the heading, "Operation of the machine."

Card feed

The cards C from which the variable data V to be printed upon sheets as S, Fig. 61, are derived are stacked in the card magazine K, Figs. 1, 15 and 16, in the same sequential order as respects the account numbers represented on these cards, as are the printing and control devices D in the magazine H. These cards are withdrawn one at a time from the magazine K, synchronically with the withdrawal of the devices D from the magazine H and the cards are fed in an endwise relationship into the sensing position in the apparatus B. As each printing and control device D is advanced to detecting position II beneath the detector 120, Figs. 48 and 56, a corresponding card is advanced to a sensing station in the variable printing apparatus B. There, movement of the card is arrested while two successive sensing operations are performed by sensing members in the apparatus B disposed for cooperation with such card, to effect setting up of the variable printing means for printing the two lines of variable data upon the sheet S which is disposed in printing position at the printer B. When the aforesaid printing operation has been performed, the sheet S is advanced by the sheet feeding means to printing position beneath the platen P, and the card C is fed to a suitable collector N, Fig. 1.

As can be seen in Fig. 15, the magazine K and collector N are supported at opposite ends of a horizontal bed plate 183 that is carried by the side frame members 155 and 156 near the front ends thereof, this bed plate being secured to said frame members by a clamp bar 181 and bolts 182, also shown in Fig. 8. The stack of cards C contained in the magazine K rests in part upon the bed plate 183 and in part upon a flat blade or card picker 184, Figs. 7 and 15, which is reciprocated horizontally to and from the stack of cards C, in a manner to be described presently, for the purpose of enabling the forward end of the picker 184 to engage the rearwardly disposed edge of the lowermost card C and thereafter push such card through an opening defined between a vertically adjustable plate 185 secured to the front end portion of the card magazine K, and the bed plate 183, this opening being of a depth sufficient to permit only one card at a time to be advanced therethrough by the card picker 184.

The picker 184 is secured to a picker block 186, Fig. 15, in such a manner that the leading edge

of the picker blade projects upwardly from the block 186 sufficiently to engage the edge of but a single card. The picker block 186 is mounted for reciprocatory movement and is guided in such movement by horizontal rods 187 which are secured to the bed plate 183 and which extend through suitable openings in the block 186, these openings being sized to afford a sliding fit. A pin 188 projects downwardly from the bottom of the picker block 186 and is disposed in a slot 189 provided in one arm of a bell crank 190, Figs. 7, 15 and 16, which is pivotally connected at 191 to a bracket 192 on the bed plate 183 for horizontal swinging movement relative thereto. The other arm of the bell crank 190 is pivotally connected to one end of a link 193, and the other end of the link 193 is pivotally connected to an arm of the crank 194 secured to one end of a horizontal shaft 195 which is journaled in bearings 196 and 197, Fig. 15, depending from the bed plate 183.

A bevel gear 198 is fixed on the shaft 195 in spaced relation to a collar 199 on said shaft and the gear 198 meshes with another bevel gear 200 disposed at right angles thereto and secured to the upper end of a vertical shaft 201, Figs. 3 and 15. A frame generally designated 202 is provided for supporting the shaft 201 in upright position, this frame having at its lower end a bearing member 203 which receives a horizontal shaft 204 journaled in bearings 205 attached to the side frame 156. The bearing member 203 has a horizontally projecting arm 206 in which the vertical shaft 201 is journaled near its lower end. At its lowermost extremity the shaft 201 carries a bevel gear 207 which meshes with a bevel gear 208, Fig. 3, on the horizontal shaft 204. The upper end of the shaft-supporting frame 202 is provided with a bearing member 209 having a lateral arm in which the shaft 201 is journaled near its upper end. The arms of the bearing members 203 and 209 in which the shaft 201 is journaled about the bevel gears 207 and 208 respectively, Figs. 3 and 15, so that the shaft 201 is held against vertical displacement. To insure against horizontal displacement of the shaft 201, the arm of the lower bearing member 203 which receives the shaft 204 is held in position by collars 210 on the shaft 204, and the upper bearing member 209 has a laterally extending arm 211 having an opening therein through which the shaft 195 is passed, the arm 211 being clamped between the bevel gear 198 and collar 199 as shown in Fig. 15. Thus the shaft 201 is firmly supported in upright position between the horizontal shafts 195 and 204, and through the just described bevel gearing affords an operative connection between these two shafts.

Referring to Fig. 37, the right end of the shaft 204 extends through one of the aforesaid bearings 205, and a bevel gear 212 is fixed to the shaft 204 abutting the bearing 205. A horizontal stub shaft 213 is secured to the side frame 155 at right angles to the shaft 204 and in spaced relation with the end thereof, and a bevel gear 214 rotatably mounted on the stub shaft 213 meshes with the bevel gear 212 on the shaft 204. As shown in Fig. 6, the bevel gear 214 is attached to a gear 215 rotatably mounted on the stub shaft 213, which latter gear is adapted to mesh with a gear 216, also shown in Fig. 3, fastened on a hub 217 slidably but non-rotatably mounted on the cam shaft 160 of the printing apparatus B. The diameter of gear 215 is twice that of gear 216 so that when

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these gears are meshed with each other there is a two-to-one driving ratio between the cam shaft 160 and the shaft 204.

As has been explained, the shaft 204 is operatively connected to the shaft 195 through the medium of shaft 201 and associated bevel gearing, and shaft 195 carries a crank 194 connected by link 193 to an arm of the bell crank 190 that has a pin-and-slot connection with the picker block 186. Therefore, each time the shafts 204 and 195 are caused to make a complete revolution, the crank 194 reciprocates the bell crank 190, and in the course of such reciprocation the picker block 186 is moved rearwardly, or to the left as viewed in Fig. 15, of the stack of cards C and then forwardly, or to the right, to enable the picker blade 184 to push the lowermost card through the opening between the vertical retaining plate 185 and bed plate 183.

As the lowermost card is so passed out of the magazine K, it advances between a pair of guide strips 218, Fig. 7, and is engaged by one of a series of feed rollers 219 which are disposed at spaced points along the path of travel of the card from the magazine K to the collector L. Each of the rollers 219 is mounted on the end of a short shaft 220 journaled in a bearing 221 stationarily mounted on the bed plate 183. The other end of the shaft 220 projects slightly beyond its bearing 221 and carries a pulley 222. Suitable driving means is provided for rotating the rollers 219 in a counterclockwise direction, as viewed in Fig. 15, to urge the cards along the guide way toward the collector N, and such means may comprise, for example, an endless belt (not shown) passing about the pulleys 222 and a pulley similar to the pulley 166, Fig. 1, on the main drive shaft 19. The spacing between the first and second rollers 219 from the left, Fig. 15, is such that the card C is advanced into the bite of the second roller 219 prior to the time its trailing edge moves out of engagement with the first roller 219. Thereafter the card is advanced by the second roller 219 into engagement with a card stop finger 223, Fig. 7, which normally rests on the upper surface of the bed plate 183 in position to arrest a card C at the time such a card is fed toward this stop finger. Thus the card C is halted by the finger 223 in position indicated by dot-dash lines in Fig. 7, notwithstanding that the second of the constantly rotating rollers 219 is still in engagement with the upper surface of this card.

The card stop finger 223 extends transversely of the card guideway and is attached at its front end to a strip of spring steel 224 anchored in a block 225 that is attached to the bed plate 183. A pin 226, Figs. 8 and 15, mounted for vertical movement in the bed plate 183, is disposed beneath the stop finger 223 at a point intermediate the spring strip mounting and the card stopping surface of said finger. The lower end of the pin 226 bears upon the periphery of a cam 227 that is fast on the shaft 195, Fig. 15, and in the course of rotation of this shaft the cam 227 pushes the pin 226 upwardly to thereby lift the finger 223 from out of its card stopping position. When the finger 223 is so lifted the card C is advanced by the second roller 219 into the bite of the third of such rollers, which operates to discharge the card into the collector N. Continued rotation of the shaft 195 causes the lift pin 226 to ride onto the release portion of the cam 227 to enable restoration of the stop finger 223 to its lower or card stopping position so that it may arrest the next succeeding card.

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During the time the card C is engaged with the stop finger 223 and is held stationary thereby, the card sensing operations, which have been referred to hereinabove, are performed by the sensing members, which will be described in greater particularity presently. The continued rotation of the second roller 219 while the card C is being held by the stop finger 223 urges the card firmly against the stop finger and thereby prevents any accidental displacement of the card while it is being sensed. Inasmuch as the stop finger 223 and the card picker 184 are operated from a common shaft 195, accurate timing in the operations of these parts relative to each other is insured.

Card analyzing means

When a card C has arrived at the aforesaid sensing position whereat it is arrested by the stop finger 223, the card analyzing means which senses the variable data represented by perforations in the card may be rendered operative. Such analyzing means also includes means for sensing identification indicia which in the present instance constitute an account number that is perforated in the field of the card C, Fig. 60, labeled "Acct." The means for sensing the variable data, exclusive of the account number, comprises groups of sensing bars 229, Figs. 7 and 8, which are aligned with columns in the card C, wherein such variable data are represented, when the card is in sensing position, these sensing bars extending above the card guideway and transversely thereof in the directions of the card columns. Each of the sensing bars 229 is provided with a downwardly extending sensing point 230 which, when the sensing bar is caused to travel across the face of the card senses the position at which a perforation is located in the particular column, the construction and operation of such sensing means and associated mechanisms being described in detail presently.

The means for sensing the identifying or account number in the card C in the present instance comprises a group of sensing brushes generally designated 231, Figs. 7, 8 and 18 to 20, mounted in a block or head 232 of insulating material supported by vertical posts 233 that respectively extend through the bed plate 183 and a block 183a secured thereto, and which are slidable therein. The brushes 231 are electrically conductive and their lower ends are vertically aligned with stationary contacts 234, Figs. 19 and 21, mounted in an insulating block 235 secured in the bed plate 183. The tops of the contact members 234 are flush with the upper surface of the bed plate 183, and the various index point positions in the group of columns for the account number in the card C respectively overlie the contacts 234 when the card is in sensing position, as can be seen by reference to Figs. 18 to 21. There are in the present instance four sets of stationary contacts 234 and cooperating brushes 231, each set comprising a series of ten contacts or brushes respectively allocated to the index point positions on the card C representative of the digits 1 to 9, inclusive, and 0.

The lower ends of the posts 233 that support the insulating block 232 are secured to a plate 236, Figs. 8, 15, 19 and 20, that rests on a pair of rollers 237 carried by arms 238 secured to the rock shaft 239 journaled in the frame members 155 and 156. The shaft 239 is provided with a rock arm 240 to which a link 241 is pivotally connected by a rod 242 passed through the arm 240 and

link 241, the link 241 serving to connect the rock arm 240 with an arm of the lever 243 pivoted at 244 upon the side frame 155, as shown in Fig. 6. The other arm of the lever 243 is urged against the periphery of a cam 245 on the cam shaft 169, as shown best in Fig. 37, by a spring 246, Fig. 8, that is anchored in the frame member 153 and acts upon the opposite arm of this lever.

As shown in Fig. 8, compression springs 247 are disposed about the posts 233 between the plate 232 and the bed plate 183, these springs tending to depress the insulating block 232 and brushes 231. However, when the lever 243 is engaging the high portion of the cam 245, as shown in Fig. 3, the rollers 237 are maintained in their elevated positions to thereby prevent the head 232 from being so depressed by the springs 247 that the brushes 231 are brought into engagement with the stationary contacts 234, Figs. 19 to 21. At the proper time in the operation of the machine, the cam 245 is rotated to bring its low portion beneath the end of the lever 243, and a spring 246 retracts the opposite end of this lever upwardly to thereby lower the rollers 237 and enable the springs 247 to urge the head 232 downwardly at the time a card C is disposed in sensing position thereunder. The tips of those brushes 231 which are vertically aligned with perforations in the card pass through these perforations and engage the contacts 234, while those brushes beneath which there are no perforations bear on the top of the card and are thus held out of engagement with the contacts 234.

The stationary contacts 234, Figs. 19, 20 and 21, are in the form of elongated cylinders provided with rectangular heads, these heads being of a width equal to the diameter of the body portion of the contacts, but having a length greater than such diameter. The insulating block 235 in which the contacts 234 are mounted has a plurality of slots 248 therein, and a series of ten circular openings are afforded in the block 235 at the bottom of each slot 248. The slots have a width equal to the narrower dimension of the heads of contacts 234, and these contacts are seated in the block 235 in the manner shown in Figs. 19 and 21, the shanks of the contacts passing through the aforesaid circular openings and the rectangular heads thereof being disposed in the slots 248. The depth of the slots is equal to the thickness of the heads of the contacts 234 so that the upper surfaces of the heads lie flush with the card guideway when the block 235 is mounted in the bed plate 183.

As shown in Fig. 19, the insulating block 235 has a relatively small depth and the two opposite ends of this block respectively seat in recesses in the bed plate 183 adjacent the ends of a rectangular opening 249 provided in the bed plate. The block 235 is secured to the bed plate 183 by screws 250 which are freely passed through openings in this block and which are threaded into tapped openings in the bed plate, and the shanks of the contacts 234 project downwardly from the block 235 into the opening 249. Electrical conductors 251 are connected to the shanks of the contacts 234 in the manner shown in Fig. 20. Thus, in the case of the two outer sets of contacts, the ends of the conductors 251 are soldered to the contacts 234 at the points where these contacts emerge from the under side of the block 235. This prevents these contacts from being accidentally displaced upwardly during operation of the machine, such as might otherwise occur, for example, due to arcing and welding of the lower

tips of the brushes 231 to the contacts 234. The shanks of the outer sets of contacts 234 are shorter than are those of the two inner sets, and a thin plate 252 of insulating material, provided with openings to receive the shanks of the longer contacts, is positioned so as to abut the lower ends of the shorter contacts 234. The conductors 251 are soldered to the shanks of the longer contacts immediately beneath the plate 252 so that the plate 252 rests on the soldered connections. Inasmuch as the shorter contacts 234 are firmly held against upward displacement in the manner just explained, there can be no upward displacement of the plate 252 nor of the inner sets of contacts which are soldered to the leads 251 therebelow. The conductors 251 pass through a suitable opening in the plate 252 so that they are not disturbed when this plate is raised or lowered.

As has been mentioned hereinabove, the variable printer B effects two printing operations each time it functions. The electrical sensing means, including the brushes 231 and contacts 234, is rendered operative during the first of the two printing operations of the printing apparatus B, for the purpose of sensing the account number on the card C disposed in sensing position. The brushes 231 are all connected to a common conductor 253 which leads from a source of electric current, and upon establishment of electrical contact between any of the brushes 231 and the stationary contacts 234 disposed therebelow, through card perforations, circuits are partially established from the source of current through these brushes and contacts in accordance with the numerical value of the account number perforated in the card C. Such circuits are completed only if the account number perforated in the identification card 3 of a printing and control device D, Fig. 49, at detecting position II, Figs. 50 and 56, in the printing device guideway is identical with the account number perforated in the card C at sensing position in the card guideway, as will be explained under the heading, "Matching of cards against printing and control devices."

The sensing bars 229, Figs. 7, 8 and 15, which have been briefly referred to hereinabove, are mounted for lateral reciprocatory movement transversely of the card guideway. As shown in Figs. 3, 7 and 8, the sensing bars 229 are provided near their rearward extremities with rounded projections 254 which extend downwardly from these bars and rest on a horizontal plate 255 extending between and secured to the side frames 155 and 156. These sensing bars are made of thin material and are supported in edge-wise position as shown in Figs. 7 and 8 by a comb 256, also carried between the side plates 155 and 156, the sensing bars 229 passing through the slots in this comb to be guided thereby. To further assist in guiding the sensing bars 229, a flat guide plate 257 (shown in Figs. 7 and 8 but omitted from the other views) is supported by the card guide strips 218 and is provided with slots 258 extending transversely of the card guideway and in vertical alignment with the overlying sensing bars 229. The sensing points 230 of the bars 229 project downwardly into the corresponding slots 258 in the guide plate 257 to be accurately guided thereby in the course of movement of the sensing bars 229 across the face of the card disposed therebelow in the space between the guide plate 257 and the surface of the bed plate 183. The plate 257 is provided with

suitable openings to enable the roller 219 and sensing brushes 231 to engage the card.

The sensing bars 229 rest on a roller 259 near the medial portions in the extent thereof. The roller 259 is rotatably mounted on a rod 230 carried by two vertical posts 261, as shown in detail in Fig. 17, a recess being provided in the bed plate 183 directly beneath the roller 259 to allow clearance therefor, as shown in Fig. 8. The posts 261 extend through openings in the bed plate 183 and carry rollers 262 at their lower ends which bear upon arms 263, as shown also in Fig. 8, that are mounted on a shaft 264 carried by the side frame 155 and 156. Compression springs 265 extended between the bottom of the bed plate 183 and collars 266 on the posts 261 urge these posts into engagement with the arms 263. The rod 242, Fig. 8, which connects the link 241 to the rock arm 240 for operating the elevating and lowering means of the sensing brush assembly, also passes through rock arms 267 connected to the arms 263. Hence, when the lever 243 and link 241 are actuated to raise the brush assembly, the arms 263 are swung upwardly to raise the roller 259 and thus elevate the sensing bars 229 to their upper positions as shown in Fig. 8. Inasmuch as the head 233 in which the brushes 231 are mounted is lowered and elevated once during each rotation of the cam shaft 160, Fig. 3, the sensing bars 232 will likewise be lowered and elevated at the same time as are the brushes 231.

Bars 268, Figs. 3, 8 and 15, attached to the side frames 155 and 156, project horizontally over the bed plate 183 above the sensing bars 229, and a cross bar 269 is carried by the bars 268. Comb springs 270 are attached at their upper ends to the bar 269 and at their lower ends bear against the upper edges of the sensing bars 229 to urge these bars downwardly at all times. The sensing bars 229 are serrated along their upper edges toward the front thereof as indicated at 271, Fig. 8, and a series of lock pawls 272, respectively co-operable with the teeth 271 on the several sensing bars, are pivotally mounted on a rock shaft 273 carried by the support bars 238 above the sensing bars. Springs 274 attached to a rocker 275 that is fast to the shaft 273 bear on the pawls 272 and tend to urge these pawls into engagement with the notches or serrations 271 in the sensing bars 229. A bail 276 carried by arms 277 of the rocker 275, however, holds these pawls 272 out of engagement with the sensing bars 229 when the rocker 275 is in its extreme clockwise position, as viewed in Fig. 8. The positioning of rocker 275 in such a manner as to engage or disengage the pawls 272 and sensing bars 229 is controlled by the printing means of the variable printing apparatus B, as will be explained hereinafter.

Two strips 278, Figs. 5, 7, 8, 22 and 23, are secured to the plate 255 and the side frames 155 and 156 to the rear of the sensing bars 229, which extend horizontally along the inner faces of the aforesaid side frames. The upper edges of the strips 278 have grooves extending longitudinally thereof along the centers of the strips, and slide bars 279 are fitted in these grooves. At their forward ends the slide bars 279 carry a bail 280 which is received in recesses afforded in the rear ends of the sensing bars 229 when the parts are in their normal, at rest positions shown in Fig. 8. Upstanding lugs 281 are provided on the sensing bars 229 and a series of individual pusher arms 282, rotatably mounted on a shaft 282a, Fig. 3, bear against the forward edges of the lugs 281.

The arms 282 are slotted to receive these lugs for maintaining the sensing bars 229 in spaced relation, and are acted upon by springs 283, Fig. 3, which are effective, when the bail 280 is released in a manner to be described hereinafter, to urge the sensing bars 229 rearwardly or to the right, as viewed in Fig. 8.

As best shown in Figs. 7, 22 and 23, a rack 284 is formed in the upper edge of each of the slides 279. The racks 284 mesh with gears 285 that are fixed on a shaft 286 near either end thereof journaled in the side frames 155 and 156. A smaller gear 287 is secured to the shaft 286 adjacent each gear 285, and each pair of gears 285 and 287 in effect constitutes a compound gear, the purpose of which will be explained presently.

To control the actuation of the sensing bars 229 under the influence of the spring-urged pusher arms 282, there has been provided a drive lever 288, Figs. 3 and 22, pivotally mounted on the side frame 156 as indicated at 289, Fig. 37. A segmental gear 290 is formed in the upper end of the drive lever 288 and meshes with the small gear 287 at the left end of the shaft 286 as viewed in Fig. 5. The lower end of the lever 288 has a roller 291 which is urged against the periphery of a cam 292 on the cam shaft 160 by a spring 293, Fig. 22, acting upon the upper arm of the lever 288. When the cam shaft 160 is rotated and the roller 291 rides onto the low portion of the cam 292, the spring 293 draws the gear segment 290 on the lever 288 to the right as viewed in Fig. 22, thereby imparting counterclockwise rotation to the gear 287 and shaft 286. Gears 285 thereupon take motion and drive the slides 279 and bail 280 carried thereby rearwardly, or to the right as viewed in Figs. 8 and 22. The slide bars 229 thereupon take motion under the influence of the pusher arms 282, each bar 229 initially tending to move with the bail 280.

Shortly prior to the time when the sensing bars 229 are freed to the action of the pusher arms 282, the roller 259, Fig. 8, which functions to maintain these bars in their raised positions is retracted downwardly out of engagement with the bars 229 so that the sensing points 230 of these bars engage the surface of a card as C, Fig. 60, disposed in sensing position. Thus when the sensing bars 229 are moving rearwardly or to the right as viewed in Fig. 8 (this being referred to hereinafter as the sensing movement of the bars), they are supported by the sensing points 230 resting upon the card. The bed plate 183 is preferably grooved as indicated at 294, Fig. 8, directly beneath the path of travel of each sensing point 230, and hence when a point 230 encounters a perforation in the card therebelow, it drops through this perforation and to the bottom of the groove 294. The sensing bars 229 are, in effect, fulcrumed on the rounded projections 254 near their rear ends to enable the sensing points 230 to drop through the card perforations. A downwardly projecting lug 295 is carried by each sensing bar 229 near its forward or left end, as shown in Fig. 8. The aforesaid downward movement of the point 230 is multiplied in so far as the lug 295 is concerned so that this lug is displaced downwardly a considerable distance whenever a perforation is encountered by the point 230 on the same sensing bar 229.

As can be seen from the plan view in Fig. 7, the sensing bars 229 are arranged in two main groups on either side of the sensing brush assembly including the brushes 231 and vertically

movable head 232. The left-hand group of bars functions to sense the district and ledger numbers represented in the columns entitled "Dist." and "Led." on the card C, Fig. 60, while the other group of bars senses the data represented in the remaining active columns on the card. Each sensing bar is arranged to selectively operate one or more switches generally designated 300, Figs. 8 and 14, disposed therebelow in dependence upon and at a differential time determined by the numerical value of the digit in the card column that is being analyzed by the particular sensing bar. The means for enabling the sensing bars 229 to operate the switches 300 disposed therebelow is generally designated 301, Figs. 7 and 10. Inasmuch as the switch operating means 301 is of identical construction throughout, the following description pertains only to that portion of this switch-operating means which underlies the sensing bars responsive to the district and ledger numbers in the card C for this will serve to explain this entire portion of the apparatus.

A bar 296 is secured to and is carried between the side frames 155 and 156 so as to be disposed flush with the front ends of these frames and in spaced relation to the tops thereof, and a vertical plate 297 is fastened to the square bar 296 across the front of the side frames. A rectangular bar 298 is secured to the front edge of the bed plate 193 in horizontal alignment with the bar 296, Figs. 8, 10 and 12. Two rectangular strips 299 are supported by the bars 296 and 298, and included between these strips 299 is a series of switch-operating members 302 respectively aligned vertically with the sensing bars 229 as indicated in Fig. 12. Each of the members 302 comprises a thin flat piece supported on its lower edge by the bars 296 and 298 and having a length less than the distance between the front plate 297 and the forward edge of the bed plate 193, and being provided with notches or serrations 303 along its upper edge arranged for cooperation with the depending lug 295 on the corresponding sensing bar 229 when such lug is in its lowermost position which it attains when the point 230 on the sensing bar 229 penetrates a perforation in the card. Individual springs 304 seated in sockets in the front edge of the bed plate 193 act upon the members 302 to urge them forwardly or to the left as viewed in Fig. 8, these springs being arranged in staggered relation as shown in the sectional view, Fig. 13. To prevent accidental upward displacement of the members 303, the front plate 297 has a right angle projection at its top which overlies the adjacent end of the member 302, and the other end of the member 302 is restrained against upward movement by an overhanging strip 305, Figs. 8 and 10, fastened to the upper surface of the bed plate 193.

When the point 230 on a sensing bar 229 moves over the forwardly disposed edge of a perforation in the aligned card column, the sensing bar 229 immediately drops downwardly a limited distance sufficiently to cause engagement of the lug 295 with one of the notches 303 on the member 302 therebelow. As will be seen by reference to Fig. 60, the perforations in the card are of elongated shape and extend transversely of the card in the direction of travel of the sensing bars 229 thereof. Hence a limited amount of lateral movement may take place after the sensing point 230 has encountered and passed through the forward edge of the perforation, and this limited movement

is sufficient to enable the lug 295 on the sensing bar 229 to draw the member 302 rearwardly against the action of the springs 304.

Each switch operating member 302 controls a switch 300. These switches are in the present instance mounted in staggered relation on blocks of insulation 306, Figs. 8 and 14, that are supported by the side frames 155 and 156, Figs. 4 and 7. Pairs of insulating pieces 307 are secured in upright position to the respective blocks 306 and each pair of pieces 307 carries a metallic contact strip 308 extending beneath the switch operating members 302 transversely relative thereto. The conductive strips 308 have a common connection to one side of a source of electric current and constitute stationary switch contacts. Movable contact blades 309 are secured in vertical position to the insulating blocks 306 and project upwardly in spaced relation to the conductive strips 308, each blade 309 having a contact point 310 thereon in horizontal alignment with the strip 308. The movable blades 309 are individual to the sensing bars 229, which is to say that each sensing bar is vertically aligned with a corresponding contact blade 309 that is movable independently of the blades 309 aligned with the other sensing bars 229.

A connection is provided between each switch operating member 302 and the appropriate blade 309, as best shown in Fig. 8, the upper end of each blade 309 extending into a recess provided in a disc-shaped bearing 311 fitted in a circular opening in the bottom edge of the aligned member 302. Hence, as each member 302 is actuated by the lug 295 of a sensing bar 229, it moves in such a direction as to bring its blade 309 and contact point 310 toward the conductive strip 308 arranged for cooperation therewith. As has been explained hereinabove, there is a limited amount of shifting movement of the member 302 from the instant a perforation is initially sensed by the point 230 of the sensing bar 229, until the point 230 encounters the opposite edge of such perforation, and this amount of movement of the member 302 is sufficient to bring the contact 310 into engagement with the strip 308. Thus, the closure of a switch 300 is effected at a time in the sensing operation that is determined by the location of a perforation in the sensed card column, and hence the time which elapses from initiation of sensing movement of the bars 229 until the switch 300 controlled thereby is closed, is a measure of the numerical value of the digit represented in that card column.

As has been previously mentioned, the drive lever 280, Figs. 22 and 37, for the card analyzing means actuates the slides 279 and bail 280 to effect movements of the sensing bars 229, Fig. 8. In each rotation of the cam shaft 169, the cam 292 thereon rocks the lever 280 first in a clockwise direction, as viewed in Fig. 37, then in a counterclockwise direction, thereby producing sensing movement of the bars 229, to the right as viewed in Fig. 8, followed by restoring movement to the left as bail 280 is moved toward the front of the machine. This cycle of operation is effected as many times during each variable data printing operation as is necessary to control printing of the several lines of such data upon a sheet S, Fig. 61 (in the present instance, twice). In each sensing operation of the bars 229, the switches 300 are actuated in an identical manner, and the time in the cycle when each such switch closes may determine the setting up of a printing member such as a type wheel controlled thereby.

However, not all of the switches are effective in a particular sensing operation; nor does the same switch necessarily control setting up of the same printing member, since the interrelations of the switches and printing members will vary from cycle to cycle in some instances, the manner in which this is accomplished being described in detail hereinafter.

Matching of cards against printing and control devices

As explained hereinabove, the printing and control devices D, Fig. 49, from which the changeable data A are printed upon the sheets as S, Fig. 61, and the cards C, Fig. 60, under control of which the variable data V are printed upon the sheets as S, are successively advanced by feeding means from the magazines, in which such devices and cards are respectively deposited at the start of operation of the machine, to the positions whereat detecting or sensing operations are performed upon these devices and cards. In order to insure that the printing and control device D from which the data A are printed upon a sheet S, and the card C under control of which the variable data V are printed upon the same sheet, both relate to the same customer or account, an identifying number (in the present example, an account number) is perforated in the field 6 of the printing and control device D and a like identifying (account) number is perforated in the corresponding card C. As each printing and control device D and card C is withdrawn from its respective magazines, a comparison of the account numbers represented on each is made by suitable means to be described presently. If the account numbers do not match, it is desirable that automatic operation of the machine be suspended until the condition is corrected. It will be noted that the account number in the card C is represented in conventional single-hole notation, whereas the account number perforated in the identification card 6 of the printing and control device D is represented according to a five-unit code, shown in Fig. 62. The means which compares these two account numbers must, therefore, be capable of affording a comparison of a code representation with a non-code or conventional representation.

As each printing and control device D is withdrawn from position I in the magazine H, Fig. 56, it is advanced to position II beneath the detector 120, at which position it remains until early in the second cycle of the unit B. Thus while the printing and control device D is at rest at station II, and at the time indicated in the first cycle, Fig. 63, the solenoid 129 is energized so that the block 121 and sensing pins 122 are depressed in the manner described hereinabove to cooperate with the identification card 6 in which the perforations as 9A, 9B, and so on, representative of the customer's account number, are located. This is accomplished by a single lobed cam 131, Figs. 57 and 66 on the main control cam shaft 146, such cam 131 serving to close the switch 130 at the proper time to energize the solenoid for the period and at the time indicated in the timing chart of Fig. 63. Those sensing pins 122 which are aligned with perforations in the card 6 pass through these perforations and engage the push pins 133 disposed therebelow in the block 134, while those sensing pins 122 beneath which there are no perforations bear upon the surface of the card 6 and are forced back into

the block 121 against the action of their retaining springs as this block continues to descend. In the present example, the customer's account number is 4321, and, therefore, a perforation 9A is present in the second index point position from the bottom of the card 6 in the fourth column from the right, as viewed in Fig. 49, this perforation being representative of the digit 4 (see Fig. 62) in the thousands order. In the third column from the right, there are two perforations 9B and 9C, in the second and fifth positions from the bottom respectively, these two perforations representing the digit 3 in the hundreds order. Similarly, in the second column from the right there is a perforation 9C in the lowermost position to represent the digit 2 in the tens order, and in the extreme right-hand column, there are two perforations 9E and 9F, in the first and fifth positions, representing the digit 1 in the units order. If a cipher appeared in any of these orders, no perforation would be provided in the column pertaining to that order.

Those push pins 133 which are depressed by the sensing pins 122 passing through perforations in the card 6 actuate the connected Bowden cables 135. As shown schematically in Fig. 58A, the end of each Bowden cable opposite the end to which the push pin 133 is attached is disposed in position to actuate a switch, such as that generally designated 312, whenever the particular Bowden cable 135 is actuated. As shown in Fig. 58A, each switch as 312 comprises two normally open contacts *x* and *y* and a normally closed contact *z*. These contacts are mounted in an insulating block 321 secured to a support member 322 which is carried in any suitable means by the side frames of the printing apparatus, the flexibility of the Bowden cables enabling the switches to be mounted at any of a variety of locations. The end of each Bowden cable 135 passes through an opening in a plate 316 that is supported by the side frames of the apparatus, the sheath 136 of the cable being fastened to the plate 316. Preferably a pin of larger diameter than the cable is fastened on the end thereof and is passed through a suitable opening in a normally stationary plate 317 to be guided for reciprocatory motion thereby. A retaining spring 319 is interposed between the plate 317 and an abutment on the pin 318 for normally maintaining this pin and its connected cable 135 in such position that the switch 312 is in the condition shown in Fig. 58A, wherein the contacts *x* and *y* are open and the contact *z* is closed. However, when the push pin 133 attached to the other end of the cable 135, Fig. 56, is depressed by a sensing pin 122 passing through a perforation in the card 6 of the printing and control device D, the pin 318 is moved to the right, as viewed in Fig. 58A, and bears against an insulating block 320 secured to the movable blade of the contact *x*, thereby pushing this movable blade to the right and closing the contact *x*. A stud of insulating material on this blade bears against the movable blade of the contact *y*, closing this contact and causing a stud on the latter blade to bear against the outer blade of the contact *z*, thereby opening the contact *z*. Thus, such actuation of the Bowden cable 135 by a sensing pin 122 closes the *x* and *y* contacts of the associated switch as 312 and opens the *z* contact. Such a switch 312 will of course remain in its actuated condition as long as the solenoid 129 remains energized, and when the solenoid is deenergized, the detector head 120 is again raised by its spring 127 and the related spring 319 acts

to restore the Bowden cable 135, as will be evident in Fig. 58A of the drawings.

As shown in Fig. 58, there are five switches identical in construction to the switch 312, Fig. 58A, allocated to each of the thousands, hundreds, tens and units orders in which representations of an identifying or account number may appear on the card 6, Fig. 49, each such switch being allocated to a particular index point position in the corresponding column on the card 6. Thus, in the thousands order a switch 312-1-2, pertains to the lowermost index point position in which a perforation may appear for either of the digits 1 or 2, according to the code in Fig. 62; the switch 312-3-4 pertains to the second index point position in which there may be a perforation to represent the digit 3 or 4; switches 312-5-6 and 312-7-8 pertain to the digits 5 and 6, and 7 and 8, respectively. The switch 312-9 is actuated whenever a perforation appears in the uppermost index point position in the thousands order column, which is to say, whenever an odd digit is represented in this order. For example, if the digit were 1, then both the switches 312-1-2 and 312-9 would be actuated, but if the digit were 2, only the switch 312-1-2 is actuated. A similar arrangement of switches respectively designated 313, 314 and 315 is provided in each of the hundreds, tens and units orders respectively.

A multi-contact relay 323, Fig. 58, is associated with the thousands order switches 312 and includes five movable contacts generally designated 324, each of which contacts respectively cooperates with two stationary contacts in the series generally designated 325. Each of the ten stationary contacts 325 pertains to a digit from 1 to 9 or zero in the thousands order, and as indicated in Fig. 58, these contacts are respectively connected by conductors 251, Fig. 20, to the stationary contacts 234 (see Figs. 19, 20 and 21) positioned beneath the card sensing brushes 231 in the thousands order of the account number sensing means. Each of the five movable relay contacts 324 is connected by a conductor, such as 342 or 343 in the case of the contacts 324-1-2 and 324-3-4, respectively, to one terminal of the x contact in a corresponding switch as 312-1-2 or 312-3-4 in the group of five switches 312. The other terminals of the several x contacts of the switches 312-1-2, 312-3-4, 312-5-6, and 312-7-8 are connected to a conductor 345 leading to one end of the winding of a relay 330, the other end of which winding is connected by a conductor 346 to a line wire 335A leading to one side of a source of electric current. The other terminal of the x contact of switch 312-9 is connected to one terminal of a contact 329A of a relay 329, the other terminal of this relay contact being connected by a conductor 351 to the conductor 345.

The 324-9-0 contact is also connected by a conductor 346 to one terminal of the z contact of the switch 312-1-2. The z contact in the switch 312-9 is connected on one side to the conductor 345, and the z contacts of all the various switches 312 in the thousands order group are connected in series with each other intermediate the conductors 344 and 345, so that these conductors are in electrical contact only when all of the z contacts in the switches 312 are closed, which is to say, when there is a zero in the thousands order of the account number represented on the card 6 of the printing and control device, D, Fig. 49.

The relay 329 having the aforesaid contact 329A, which contact is normally closed when this relay is deenergized, has its winding connected at

one end to the conductor 346 and at the other end to a conductor 347 which leads to one terminal of each of the y contacts of the switches 312-1-2, 312-3-4, 312-5-6 and 312-7-8. The other terminals of these y contacts are connected by a common conductor 348 to the conductor 253 that is connected in parallel to all of the brushes 231 and which leads to one terminal of a timing switch 332, the other terminal of this switch being connected by a conductor 334 to the line wire 335 connected to the other side of the source of electric current. The switch 332 is controlled by a timing cam 333 in the manner to be more fully explained hereinafter under the headings "Selective control means" and "Operation of the machine." One terminal of the y contact of the switch 312-9 is connected by a conductor 349 to one side of the winding of relay 323 and the other side of this winding is connected by a conductor 350 to the conductor 346. The other terminal of the y contact of switch 312-9 is connected to the conductor 349, as are the y contacts of the other switches in the group 312.

An arrangement identical with the foregoing is provided in each of the hundreds, tens and units orders. Thus, multicontact relays 326, 327 and 328 identical with the relay 323 are respectively associated with the switches in the groups 313, 314 and 315, the contacts of these relays being interconnected with the x contacts of such switches and with the stationary contacts 234 beneath the sensing brushes 231 in the hundreds, tens and units orders respectively, in the same manner as are the contacts of the relay 323 in the thousands order. However, in Fig. 58, only the contacts 234 pertaining to the digit 9 in the lower three orders are shown connected with stationary contacts of their relays 326, 327 and 328, it being understood that there are other connections, not shown, from the contacts pertaining to the other digits to the appropriate relay contacts. Similarly, relays 331, 337 and 339, corresponding to the relay 329, and relays 336, 338 and 340, corresponding to the relay 330, are wired up in circuit with the switches in the groups 313, 314 and 315, respectively, in the same manner as that indicated in the thousands order. Because of the connections which have thus been provided, each relay as 329 is energized and opens its contact as 329A, upon closure of the timing switch 332 at the appropriate period in the cycle of operation of the machine, only if one of the switches as 312-1-2, 312-3-4, 312-5-6 or 312-7-8 has been actuated by its Bowden cable to close its y contact, circuit being extended from the line wire 335 through the conductor 346, winding of the relay as 329, conductor 347, the aforesaid y contact, conductors 349 and 253, switch 332, and conductor 334 to the line wire 335. Thus, each relay as 329 is energized to open its contact 329A if one of the digits from 1 to 8, inclusive, is represented in the corresponding column in the card 6, Fig. 49, but if the digit 9 or 0 is represented, in accordance with the code shown in Fig. 62, the relay as 329 does not energize and hence maintains its contact 329A closed, inasmuch as no electrical connection is afforded between the conductors as 347 and 348 under these circumstances.

Each of the relays 330, 336, 338 and 340 has a contact as 330A which is normally closed when the relay is deenergized. One terminal of each such relay contact is connected to a common conductor 352 and the other terminal is connected to another common conductor 353. A timing switch 332A controlled by a cam 333A is

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connected on one side to the line wire 335 and on the other side to the conductor 352. Hence, if any of the relay contacts 330A, 336A, 338A or 340A is closed at the time the cam 333A closes the switch 332A, circuit is extended from the line wire 335 through such closed relay contact to the conductor 353, Figs. 58 and 57, leading to the winding of a relay 354 that is connected to the line wire 324 by a conductor 355. As will be more fully explained under the heading "Operation of the machine," the relay 354, which will be referred to hereinafter as a stop relay, is effective when energized to interrupt automatic operation of the entire printing machine. In order to prevent such interruption of automatic operation, it is, therefore, necessary that all of the relays 330, 336, 338 and 340 shall be energized to maintain their contacts open during the time the switch 332A, Fig. 58, is held closed by the cam 333A, and it is during this interim that the number comparison operation is effected to determine whether or not the stop relay 354 is to be operated, as will now be described.

By way of example, it will be assumed that the digit represented in the thousands order column on the card 6 of the printing and control device D, Fig. 49, is "1," so that when the detecting operation is performed the switches 312-1-2 and 312-9 are actuated. The digit represented in the thousands order of the account number in the card C, Fig. 60, should be "1" in order that a matching condition will result insofar as the thousands order is concerned. Assuming that the account number has been correctly punched in the card C, a perforation is present above the contact 234 representative of the digit 1 in the thousands order (second contact 234 from the top, leftmost column, as viewed in Fig. 58) when the card has been advanced to sensing position. Closure of the timing switch 332 enables a circuit to be established from the line wire 335A through a conductor 346, winding of relay 329, conductor 347, *y* contact of switch 312-1-2, conductors 348 and 253, switch 332, and conductor 334 to line wire 335. Relay 329 thereupon energizes and opens the contact 329A to thereby disconnect the *x* contact of switch 312-9 from the conductor 345. Circuit is also extended from the conductor 346 through conductor 350 to the winding of relay 323, conductor 349, *y* contact of switch 312-9, and conductor 348 to the conductor 253, and relay 323 thereupon energizes to shift its movable contacts 324 from engagement with the stationary contacts 325 pertaining to the even-numbered digits into engagement with the contacts 325 pertaining to the odd-numbered digits; for example, the contact 324-1-2 is thereby engaged with the contact 325-1. A third circuit is concurrently extended from the conductor 346 through winding of relay 330, conductor 345, *x* contact of switch 312-1-2, conductor 342, relay contacts 324-1-2 and 325-1, a conductor 251, the contact 234 in the thousands order representative of the digit 1, brush 231 engaged therewith, and conductor 253 through the timing switch 332 to the line wire 335. Relay 330 is, therefore, energized and opens its contact 330A. If a similar matching condition occurs in each of the other orders, then each of the relays 336, 338 and 340 likewise energizes to open its contact. The timing cam 333A closes its switch 332A later than the cam 333 closes its switch 332, and opens the switch 332A prior to the opening of the switch 332. If a matching condition prevails in all orders as just explained, circuit between the conductors 352 and

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353 is broken during the time the switch 332A is closed and hence, the stop relay 354, Fig. 57, is prevented from energizing and thus the machine continues in automatic operation.

However, if the card had been punched with a digit 1 in the thousands order of the account number, whereas the printing and control device D had a numeral 2 represented in the thousands order of the account number, then only the switch 312-1-2 would be actuated (see Fig. 62). The relay 323 would then remain deenergized inasmuch as the *y* contact of the switch 312-9 is open; hence, the relay contact 324-1-2 remains engaged with the contact 325-2. Inasmuch as no card perforation appears above the contact 234 representative of the digit 2 in the thousands order, no circuit will be established through the winding of the relay 330 between the line wires 324 and 335 upon closure of the timing switch 332 and, therefore, the relay 330 remains deenergized to maintain its contact 330A closed. Closure of the timing switch 332A extends circuit from the line wire 335 through conductor 352, contact 330A, conductor 353, winding of relay 354 and conductor 355 to the line wire 325. Relay 354 thereupon energizes and suspends the automatic operation of the machine. It will thus be seen that non-matching in any of the orders of the account numbers represented in the card C and printing and control device D is effective to energize the stop relay 354.

When a digit 9 is represented in the thousands order of the account number perforated in the printing and control device D, the switch 312-9 alone is actuated, and the relay 329 remains deenergized since none of the *y* contacts of the switches 312-1-2, 312-3-4, 312-5-6 or 312-7-8 is closed; hence, relay contact 329A remains closed. Upon closure of the timing switch 332, circuit is extended from the line wire 324 through conductors 346 and 350, winding of relay 323, conductor 349, *y* contact of switch 312-9, conductors 348 and 253, switch 332, and conductor 334 to the line wire 335, thus energizing relay 323 and causing the contact 324-9-0 to move into engagement with the contact 325-9. Concurrently therewith, circuit is extended from the conductor 346 through winding of relay 330, conductor 351, relay contact 329A, *x* contact of switch 312-9, conductor 343, relay contacts 324-9-0 and 325-9, and a conductor 251 to the contact 234 representative of the digit 9 in the thousands order. If the proper card is in sensing position, there is a perforation present above this contact 234 and circuit, therefore, continues through the brush 231 engaged therewith, conductor 253 and switch 332 to line 335, thus energizing relay 330. It will be noted that if the digit represented in the thousands order in the printing device D had been 1 rather than 9, the switch 312-1-2 would have been actuated simultaneously with the switch 312-9 and would have caused the relay 329 to energize and open its contact 329A, thereby preventing the relay 330 from energizing and giving a false indication of a matching condition.

In the event a zero is present in any of the orders, for example, the thousands order, of the account number perforated in the printing device D, none of the switches in the group as 312 is actuated inasmuch as no perforations are present above the push pins 133, Fig. 56, attached to the corresponding Bowden cables 135 in that particular order. Under these circumstances, all of the *z* contacts in the switches 312 remain closed at the time the cam 333 closes the switch

332. Circuit is thus extended from line wire 335A through conductor 345, the winding of relay 330, conductor 345, z contacts of the switches 312 (these contacts being connected in series as aforesaid), conductor 344, relay contacts 324-9-0 and 325-0 (relay 323 being deenergized inasmuch as the y contact of the switch 312-9 is open) and a conductor 251 to the contact 234 in the thousands order representative of zero. It has been previously mentioned that a perforation such as X or Y, Fig. 60, is provided in any of the active card columns wherein the numerical quantity to be represented is zero. Hence, if the digit in the thousands order of the account number is zero, a perforation is present above the underlying contact 234 and this circuit is continued through the brush 231 engaged therewith, conductor 253, switch 332 and conductor 334 to the line wire 335. Relay 333 thereupon energizes and opens its contact 330A with the effect described hereinabove. Relay 329 associated with the switches 312 is not energized since the y contacts of all of these switches are open and, therefore, the relay contact 329A remains closed. However, this is without effect in the present instance inasmuch as the x contact of the switch 312-9 is open.

The foregoing examples are illustrative of the operation of the number comparison circuits disclosed in Fig. 58 and it will be understood that others operate in a similar manner.

Variable printer

As each sheet S is severed from the web W, Figs. 1 and 2, and is deposited in the guideway G, it is advanced by the sheet feeding means into engagement with the stop finger 149 where it comes to rest between the sheet guiding strips 360, Figs. 2 and 22, beneath a series of platens 361 arranged in a single line longitudinally of the sheet guideway. In this position the surface of the sheet that is to be printed upon faces downwardly and rests on the bed plate 362 of the printing machine. An opening 363 is provided in the bed plate 362 directly beneath the platens 361, and a row of type wheels 364, shown in detail in Fig. 22A, is rotatably mounted on a shaft 365, journaled in the side frames 155 and 156, directly beneath the opening 363 and the platens 361. An individual platen 361 is provided for each type wheel 364. Type characters 366 are arranged along an upper arc of each wheel 364 to be successively presented at the opening 363 when such type wheel is rotated on the shaft 365. In the normal at rest position of the type wheels 364 shown in Fig. 22, the type character 366 for the digit 0 on each wheel (or a blank in the case of the type wheel which prints the alphabetical portion of the rate designation, Fig. 61) faces upwardly beneath the corresponding platen 361. An ink ribbon IR₂ is disposed in the opening 363 so that an impression of a single line of variable data V may be made in each printing cycle upon a sheet S in printing position beneath the platens 361, from the type characters 366 positioned therebelow, in a manner to be explained presently.

As shown in the plan view, Fig. 23, the type wheels 364 are arranged in groups for printing the various items of variable data V upon the sheets as S, Fig. 61. Thus, as viewed in Fig. 23, the lowermost group of four type wheels prints the preceding and present meter readings; the second group consisting of two type wheels prints the rate designation; the next three wheels print the total and first step consumption in kilowatt-hours; the following four wheels print the net

bill and gross bill; the succeeding two wheels print the district number; the next three wheels print the ledger number; and the last or topmost four wheels 364 print the duplicate net bill upon the stub of the sheet S. As explained in greater detail hereinafter, the groups of type wheels 364 are placed in controlled relation to the appropriate card sensing bars 229, Figs. 7 and 8, allocated to the card columns from which data V are to be transferred to the sheet S, during the printing of each line of data, so that a particular group of type wheels may print a different item in each of the two lines, or a single item in a selected line only, as the case may be. As is best shown in Fig. 23, the type wheel 364 that prints the alphabetical portion of the rate designation disposes a blank at the printing line when it is in its normal, at rest position, but as this wheel is rotated through its first, second, third, and so on, positions, it successively displays the letters A, B, C, and so on, at the printing line. Each of the remaining type wheels is provided with numerical type characters for printing the digits 0, 1, 2, and so on up to 9, as the wheel is rotated away from its normal position shown in Figs. 22 and 23.

Each platen 361 is fixed to the end of an individual platen arm 367 rotatably mounted on a stationary shaft 368 supported by the side frames 155 and 156. Each platen arm 367 has an arm 369 depending therefrom beneath the shaft 368, and springs 370 acting on the arms 369 tend to urge the platen arms 367 and platens 361 downwardly. However, the platen arms are normally latched in their upper inoperative positions, shown in Fig. 22, by a latch bar 371, Figs. 22 and 24, that extends upwardly from a cross arm 372 carried by arms 373 and 374 that are pivotally mounted on stub shafts as 375, Fig. 22, fastened to the side frames 155 and 156. A spring 376 normally maintains the cross bar 372 in engagement with the bottoms of the depending arms 369 of the platen arms 367 to enable the latch bar 371 to restrain the arms 369 from rearward movement under the influence of the springs 370.

The shaft 286, as has been previously described, is rotated under control of a drive lever 288 whenever the sensing bars 229, Figs. 7 and 8, are to be operated, one of the pair of gears 287 on the shaft 286 meshing with a segmental gear 290 formed in the upper end of the drive lever 288. The gears 287 also mesh with gear segments 377 formed on the lower ends of three-armed levers generally designated 378, Figs. 5, 22 and 22B, that are rotatably mounted on the shaft 365. Hence, whenever the drive lever 288 is rocked clockwise, as viewed in Fig. 22, to drive the slides as 279 rearwardly during a sensing movement of the sensing bars 229, Fig. 8, the levers 378 are rotated clockwise as viewed in Fig. 22. However, inasmuch as levers 378 are driven by the smaller gears 287, whereas the slides 279 are driven by the larger gears 285 on the shaft 286, the levers 378 move more slowly than do the slides 279, the utility of this arrangement being explained presently.

Another arm 379 of each of the levers 378 is provided with a lug 380, and spring anchor rods 381 are extended between and carried by the lugs 380, as shown in Fig. 5. Springs 382 are fastened at one end to the rods 381 and at their other ends are anchored in the ribs 383 of the type wheels 364 so that the type wheels 364 tend to rotate clockwise as viewed in Fig. 22 under the influence of the springs 382. Such movement of the type wheels is restrained, however, by a bail 384 which extends transversely of the type wheels 364 to the

rear of the ribs 383 and is secured at either end to an upstanding arm of a bell crank generally designated 385 rotatably mounted on the shaft 365. The bell cranks 385, Fig. 22C, are located adjacent the levers 378 and have arms 386 extending in the same direction as the arms 379 of the levers 378. Each arm 386 has a circular opening 387 near its outer end, and a pin 388 fastened in each arm 379 extends through each circular opening 387.

A spring as 389 affords a yielding connection between each bell crank 385 and its lever 378. Movement of the bell cranks 385 under the influence of the springs 389, when the parts are in their normal at rest positions, shown in Fig. 22, is restrained by pins 390, Figs. 5, 22 and 23, fixed in the side frames 155 and 156, against which pins the bail 384 abuts. As shown in Fig. 22, the circular opening 387 in each bell crank 385 is larger in diameter than is the pin 388 in the arm 379 of the associated lever 378. This clearance between the pin 388 and the sides of the opening 387 enables a limited amount of displacement of each lever 378 relative to its bell crank 385. Therefore, when the gears as 285 and 287 are driven counterclockwise, as viewed in Fig. 22, by the gear segment 290 and the drive lever 288 to thereby initiate sensing movement of the sensing bars 229, Figs. 7 and 8, and clockwise rotative movement of the levers 378, the arms 379 of the levers 378 move downwardly a short distance before the pins 388 therein engage the lower edges of the openings 387 in the arms 386 of the bell cranks 385, and thereafter continued rotation of the levers 378 rotates the bell cranks 385 and bail 384, Figs. 5 and 22, in unison clockwise as viewed in Fig. 22. The springs 389 which yieldingly connect the levers 378 to their bell cranks 385 have a strength greater than the total strength of the springs 382 which interconnect the type wheels 364 and the levers 378. Hence, the bail 384 is effective to restrain the type wheels 364 against movement while the levers 378 are rotating relative to the bell cranks 385 and thus a lost motion connection is afforded between the type wheels 364 and the levers 378.

A series of teeth 391, Figs. 22 and 22A, is formed in the periphery of each type wheel 364 below the type characters 366, these teeth having substantially radial edges facing in the direction of clockwise movement of the type wheels. A stationary shaft 392 is supported in the side frames 155 and 156 outside of the type wheels and near the top portions thereof and a pawl 393 is pivotally mounted on the shaft 392 in alignment with each type wheel 364 for cooperation with the teeth 391 therein. Springs as 394 normally maintain the pawls 393 against a stationary rod 395 out of engagement with the teeth 391. An arm 396 extends laterally from each pawl 393 and is connected by a link 397 to the core of a solenoid 398 supported on a shelf 398a carried between the side frames 155 and 156 by bars 398b, Figs. 5 and 37, there being one such solenoid for each pawl 393 and associated type wheel 364, as shown in Fig. 23. Energization of any of the solenoids 398 actuates its link 397 and connected pawl 393 and causes the nose of the pawl to seat in whichever one of the teeth 391 on the aligned type wheel 364 that happens to be disposed for cooperation therewith at that instant. The solenoids 398 for the various type wheels 364 are energized under the control of the switches 300 associated with the sensing bars 229, Fig. 8. When the sensing point 230 on a bar 229 encounters a card perforation during sensing movement of the bars 229, the lug

295 on the sensing bar 229 actuates the switch operating member 302 therebelow and closes the switch 300 connected therewith, in the manner previously explained. This is effective to close a circuit to a selected solenoid 398, Figs. 5, 22 and 23, for causing the pawl 393 that is linked with the core of such solenoid to engage a tooth 391 of the type wheel 364 and prevent the rotation of the type wheel in a clockwise direction, as viewed in Fig. 22.

With respect to the sensing of numerical data from the different fields of the data bearing card C, Fig. 60, it should be observed that zero is represented in a particular column by a perforation in the upper line of index points, while the digits 1 to 9 respectively are represented by a perforation in the appropriate one of the succeeding lines of index points. With this arrangement the sensing operations are performed by moving the sensing bars 229 from the initial position shown in Fig. 8 in a right hand direction. When the sensing bar 229 is in its initial position the sensing point 230 thereof is located so as to be opposite the zero index point on a card C disposed at sensing station, and hence in the right hand or sensing movement of the sensing bar 229, the sensing point 230 senses the index points successively from zero and through 1, 2, 3, 4, 5, 6, 7, 8 and 9.

At the initiation of sensing movement of the sensing bars 229 (to the right, as viewed in Fig. 8) the levers 378 on the type wheel shaft 365 commence to rotate clockwise, Fig. 22, but because of the compounding of the gears 287 and 285, the levers 378 move more slowly than do the sensing bars 229. Moreover, the above described lost motion connection, including the pins 388 and openings 387 in the levers 378 and bell cranks 385, respectively, between the levers 378 and type wheels 364 enables the sensing bars 229 to move a limited distance before the type wheels 364 commence to rotate. Hence, if there should be a zero perforation in a particular card column, the aligned sensing bar 229 will have time to close the corresponding one of the switches 300, Fig. 8, to thereby energize the solenoid 398 controlled by this switch and seat the pawl 393 against the toothed surface 391 of the appropriate type wheel 364 before this wheel has commenced to move, and thereby the type wheel is locked in its zero position. The lost motion connection, therefore, insures that the type wheel 364 will be properly positioned for printing a zero or leaving a blank, as the case may be, under the above circumstances.

Those type wheels 364 which are not arrested in their zero positions as aforesaid commence to rotate when the clearances between the pins 388 and openings 387 are taken up and the bell cranks 385 start moving with the levers 378. The spacings between the type characters 366 are such that a rotative movement of the type wheels 364 representative of a single character or digit is effected when the sensing bars 229 pass from one index point position in the columns of the card C to the next succeeding one of such positions. Because of the ratio between the gears 285 and 287, however, the arc along the periphery of each type wheel 364 occupied by the type characters 366 is not as great as would need be the case if the ratios of the gears 287 and 285 were one-to-one. When the sensing point 230 on the sensing bar 229, Fig. 8, rides over the forwardly disposed edge of the perforation in the card column which it senses, the type wheel 364

under control of this sensing bar is lagging slightly behind the angular position at which it will have arrived to dispose the corresponding type character 366 in printing position, due to the lost motion connection between the type wheel 364 and its driving lever 378. This allows a sufficient time for the corresponding solenoid 393 to be energized and seat the pawl 393 against the periphery of the type wheel 364 slightly ahead of the radial edge of a tooth 391. Immediately thereafter the type wheel 364 is arrested when the clearance between the radial edge of the tooth 391 and the end of the pawl 393 is taken up. The pawls 393 are self-locking in action, which is to say, so long as a type wheel 364 is under the tension of the springs 332 connecting this wheel to the driving lever 378, after separation of the bail 334 from the rib 333 of the type wheel following engagement of the pawl 393 with the radial edge of a tooth 391, the pawl 393 is frictionally held in engagement with such tooth 391 and will not thereafter be released, even though the solenoid 393 is deenergized, until the bail 334 is again caused to engage the rib 333 during restoring movement of the parts to thereby release the pawl 393 from locking engagement with the tooth 391.

It is desirable, where a numerical quantity of more than one order is to be printed by the type wheels 364, that the printing of zeros in all orders above the highest order in which a significant digit appears shall be suppressed and to this end the following zero-suppressing mechanism has been provided for the various sets of type wheels 364 which respectively print the numerical quantities included in the variable data V, Fig. 61. As has been described above, there is an individual platen arm 367 for each type wheel 364, and the depending arm 369 of each such platen arm is substantially in alignment with the corresponding type wheel 364. Each arm 369 is provided with a lug 399, Fig. 22, that is received in a notch 400 near the end of an arm 401 of a lever generally designated 402 that is pivotally mounted on a stationary shaft 403, Figs. 22 and 23, supported by the side frames 155 and 156 in a position between the type wheels 364 and the depending portions 369 of the platen arms 367. Springs 404 anchored to the side frames are connected to other arms of the levers 402 to urge the arms 401 of these levers into engagement with the lugs 399 on the depending arms 369. So long as the platen arms 367 are maintained in their upper inoperative positions shown in Fig. 22 by the latch bar 371 engaging the lower ends of the arms 369, however, a slight clearance remains between each lug 399 and the end of the notch 400 in which it is seated and under these conditions the arms 401 of the levers 402 may be selectively raised, in the manner to be described presently, for enabling the platen arms 367 controlled thereby to be snapped downwardly for causing an imprint to be made by the platens 361 from the type characters 366 disposed therebelow when the latch bar 371 is lowered out of engagement with the arm 369.

As shown in Figs. 22, 22A and 23, each type wheel has an arcuate cam surface 405 formed on one lateral face thereof, and an arm 406 of each lever 402 depends into the path of travel described by the cam surface 405 when the type wheel 364 is rotated away from its normal at rest position. Upon movement of the type wheel 364 beyond its zero position and in a position to display the digit 1 at the printing line, the cam

surface 405 engages the aligned arm 406 and pivots the lever 402 counterclockwise, as viewed in Fig. 22, to bring the arm 401 thereof upwardly so that the end of the notch 401 therein is no longer aligned with the lug 399 in the arm 369. As shown in Fig. 23, each arm 401 has a right angle extension 407 which underlies the arm 401 in the next lower order in the same group. Hence, if an arm 401 allocated to the hundreds order, for example, is raised when its type wheel 364 has been positioned to represent a significant digit, the lug 407 thereon lifts the tens order arm 431, and the lug 407 on the tens order arm 431 in turn lifts the units arm 481. In all orders above the hundreds order, however, the arms 401 remain in engagement with their lugs 399, in the absence of significant digits in these higher orders. Hence, when the latch bar 371 is withdrawn from the depending arm 369, in a manner to be explained presently, the printing of zeros will be suppressed in all orders above the hundreds order, inasmuch as the lugs 399 will engage the ends of the notches 400 in the arms 401, but printing may take place in the hundreds, tens and units orders because the notches 400 have been retracted out of alignment with the lugs 399.

A bar or lever 408 is pivoted near its middle on the stub shaft 375 on which the arm 373 carrying the latch bar 371 is pivotally mounted, and a spring 409 anchored in the side frame 156 is connected to the lever 408 and normally urges this lever against a stop pin 410A, Figs. 22 and 23, fastened to the inner face of the side frame 155, and when so positioned the lever 408 is disposed at an angle with the arm 373. A pawl 411 is pivotally mounted on the end of the lever 408 near the arm 373, this pawl being so pivoted that it tends to be held by its own weight against a pin 410, which is received in a notch 412 in the pawl 411, this pin 410 extending through a suitable opening in the side frame 156 and being secured in the upper end of an arm 415, Figs. 3 and 23, which is preferably disposed at a small angle with the vertical along the outer face of the frame 156. The arm 415 has a slot therein through which a pin 416 is passed to be secured in the side frame 156. The lower end of the arm 415 is connected by a link 417 to an arm 418 secured to a rock shaft 419, Figs. 3 and 6, that is journaled in bearings 420 fastened to the outer face of the side frame 156. During normal printing operations, the rock shaft 419 is stationary and hence the pin 410, Fig. 22, remains in a fixed position, those instances in which the pin 410 is not fixed being described hereinafter under the heading "Total taking." In this position of the pawl 411, the free end thereof nearest the arm 373 is parallel with the main extent of the arm 373 and is in spaced relation therewith when the parts are in their normal at rest positions shown in Fig. 22. The pawl 411 is of a sufficient width that it spans a notch 413 formed in the adjacent edge of the arm 373, the purpose of this notch being explained hereinafter in connection with a description of the total-taking operation.

A pin 414, Figs. 22, 22B and 23, is secured in the face of one of the drive levers 378 for the type wheels 364, and the end of the lever 408 opposite the end on which the pawl 411 is mounted is disposed in position to be engaged by the pin 414 when this drive lever 378 has been displaced clockwise to a position slightly beyond that sufficient to display the last of the type characters 366 on the type wheels 364 at the printing line,

assuming the type wheels have not been previously arrested as described hereinabove. The lever 378 is imparted a limited additional movement after engagement of the pin 414 with the end of the lever 408, and thus the lever 408 is rocked about its pivot 375 against the action of the spring 409 and causes the pawl 411 to push against the edge of the arm 373, bridging the notch 413 therein, to thereby retract the latch bar 371 from engagement with the arms 369 of the platen arms 367. The type wheels 364 will have been selectively positioned by the time the platen arms are so released, and the springs 370 thereupon snap the platen arms 367 and platens 361 downwardly to cause an impression to be made upon the sheet S in printing position from the type characters 366 disposed along the printing line.

A bell crank 421, Figs. 5, 22 and 22D, is pivotally mounted on the shaft 365 between the side frame 156 and the adjacent bell crank 385. One arm of the bell crank 421 is disposed in the path of the pin 414 on the adjacent drive lever 378, and the other arm of the bell crank 421 is connected by a link 422, Figs. 3, 15 and 22, to a rock arm 423 on the shaft 273 on which the arms 277 carrying the bail 276 for the lock pawls 272, Fig. 8, are secured. A spring 424, acting on the bell crank 421 and link 422, tends to maintain the rock arm 423 and shaft 273 in such angular position that the bail 276 holds the lock pawls 272 clear of the teeth 271 in the upper edges of the sensing bars 229. However, at the completion of the sensing movement of the bars 229, when the drive lever 378 for the type wheels 364 is nearing its extreme clockwise position, as viewed in Fig. 22, the pin 414 on the lever 378 engages an arm of the bell crank 421 and rotates it against the action of the spring 424, thereby pulling the link 422 to the right as viewed in Figs. 3 and 22, to rotate the shaft 273, bracket 275 and arms 277 counterclockwise and lower the bail 276. The lock pawls 272 thereupon seat on the serrated edges 271 of the sensing bars 229.

When the sensing bars 229, type wheels 364 and associated parts are to be restored to their normal at rest positions, the roller 291, Fig. 37, on the lower end of the drive lever 288 rides up onto the rise in the cam 292 on the cam shaft 160, and the drive lever 288 is rocked counterclockwise, Fig. 22, to thereby rotate the gears 285 and 287 clockwise and thus drive the racks 284 carrying the bail 280, Figs. 7 and 8, forwardly, and rotating the driving levers 378 for the type wheels counterclockwise. While this is taking place, the lever 243, Figs. 3, 8 and 37, rides onto the high portion of the cam 245 and is rocked counterclockwise, as viewed in these figures, to depress the link 241 and connected rock arm 267 to thereby elevate the arms 263, posts 261, and roller 259, Figs. 8 and 17, thus elevating the sensing bars 229 so that their lugs 295 and sensing points 230 are out of engagement with the switch operating members 302 and the record card respectively. The sensing bars 229 are elevated prior to the time the pin 414 moves out of engagement with the crank 421, Fig. 22. However, because of the springs 274 interposed between the lock pawls 272 and the bracket 275 that is secured to the shaft 273, the pawls 272 may be moved upwardly while remaining in engagement with the sensing bars 229 without causing the bracket 275 and shaft 273 to be rotated, so that no undue stress is exerted upon the link 422.

The pawls 272 are self-locking in action, which is to say that even after the pin 414 is disen-

gaged from the bell crank 421 during restoring movement of the parts, the pawls 272, having been selectively engaged with the adjacent teeth 271, will be frictionally retained in such locking engagement therewith when the sensing bars 229 have been elevated by the roller 259, so long as the spring-urged pusher arms 282 are free to act upon the sensing bars 229. Thus, the sensing bars 229 are prevented from forcibly striking against the bail 280 after they have been thus elevated out of contact with the card and switch operating members 302. As the bail 280 engages the ends of each bar 229 in its restoring or leftward movement, Fig. 8, and commences pushing this bar, the lock pawl 272 for that bar is no longer held in locking contact with the serrated edge 271, and as the teeth 271 advance past the pawl 272, it yields against the action of its spring 274 to enable passage of the teeth 271 thereunder. When the last sensing bar 229 has been engaged by the bail 280 and the pawl 272 acting thereon has been released, all the pawls 272 are thereupon freed to the action of the spring 424, Figs. 22 and 22D, which urges the bail 276 upwardly and raises the pawls 272 to their upper inoperative positions. Referring to Figs. 3 and 23 it will be noted that the end of the link 422 to which the bell crank 421 is connected has a hooked portion which passes into an opening 422A in the side frame 156. When the link 422 and bell crank 421 are being restored by the spring 424 as aforesaid, and the pawls 272 have been lifted clear of the serrations 271 in the sensing bars 229, this hook portion engages the edge of the opening 422A and thereby limits such restoring movement.

When the pin 414 on the drive lever 378, Fig. 22, disengages the lever 408 during counterclockwise restoring movement of the lever 378, the spring 409 acts to swing the lever 408 about its pivot 375 back into engagement with the pin 410, thereby raising the pawl 411 out of engagement with the arm 373. The arms 373 and 378, Figs. 22 and 24, are thereupon lifted by the spring 376 and the latch bar 371 is drawn up against the bottom edges of the depending arms 369 of those platen arms 367 which were released to effect printing. A bail 425 extends transversely of the depending arms 369 to the rear thereof and is carried by arms 426 mounted on a rock shaft 427 journaled in the side frames 155 and 156. An arm 428 is secured to one of the arms 426 adjacent the side frame 155 and is connected by a link 429, Figs. 3, 22 and 40, to one arm of a bell crank 430 pivotally mounted on a stub shaft 431 secured to the frame 155. The other arm of the bell crank 430 carries a roller 432, and a spring 433 acting on the bell crank urges this roller against the periphery of a cam 434 on the cam shaft 160. When an impression has been effected by the platens 361 from the type wheels 364, as aforesaid, the cam 434 rocks the bell crank 430 in such a direction as to elevate the link 429 and move the bail 425 to the left as viewed in Fig. 22, to thereby restore the platen arms to their normal inoperative positions. As the lower edges of the depending arms 369 move out of alignment with the latch bar 371, the arms as 373 are raised by the spring 376 until the cross bar 372 strikes the bottom edges of the arms 369 whereby the latch bar 371 is seated behind the arms 369. Continued rotation of the cam 434, Fig. 40, enables the bell crank 430 to be restored by the spring 433 to a position in which the bail 425 is retracted from engagement with the de-

pending arms 369, and the platen arms 367 are thereby held latched by the bar 371, until this bar is again retracted in a succeeding printing operation.

During the time that the bell cranks 385 and bail 384, Figs. 5 and 22, associated with the type wheels 364, are away from their at rest positions, the lower edges of the circular openings 387 in the bell cranks 385 are engaged by the pins 388 in the drive levers 378, the parts being held in these positions by the springs as 389, Figs. 22, 22B and 22C, anchored in the bell cranks 385 and levers 378. While the levers 378 are being rotated counterclockwise, as viewed in Fig. 22, back to their at rest positions, the bell cranks 385 are likewise rotated counterclockwise, as viewed in Fig. 22, and the bail 384 engages the ribs 383 of the type wheels 364 and pushes the type wheels toward their zero positions. Shortly prior to the time the levers 378 are restored to their extreme counterclockwise or at rest positions, shown in Fig. 22, the bail 384 engages the fixed stops 390. Counterclockwise movement of the bell cranks 385 then ceases but the levers 378 are rotated a slight distance farther to bring the pins 388 approximately to the centers of the openings 387. As those type wheels 364 which are positioned in accordance with significant digits are restored to their zero positions, the arms 408 of the zero-suppressing levers 402 ride off the cam surfaces 405 on these wheels and the springs 404 rock the levers 402 until they again engage the lugs 399 on the depending portions 369 of the platen arms 367.

Line shifter

Each sheet S, when it has been severed from the web W by the knife 12, Fig. 2, and deposited in the guideway G, is advanced by the sheet feeding means along the guideway G and between the guide strips 360, Figs. 2, 3, 4 and 22, into engagement with the stop finger 149 which arrests the sheet in position to be printed upon by the variable printing means including the type wheels 364 and platens 361 of the printing apparatus B. As best shown in Fig. 4, the guide strips 360 are connected together by arcuate cross pieces 435 and one of the strips 360 has a pair of horizontal, right angle extensions 436 which are guided for reciprocatory movement transversely of the guideway G by brackets 437 secured to the bed plate 362 of the printing machine. The extensions 436 are spaced apart in an amount greater than the separation of the side frames 155 and 156 of the apparatus B and each extension 436 has a socket member 438, Fig. 5, attached thereto which projects downwardly below the surface of the bed plate 362 and receives a tongue on the upper end of an arm 439 or 440, Figs. 3 and 22, which arms are secured at their lower ends to a rock shaft 441 journaled in the support bars 268. The arm 439 is part of a bell crank which also includes the arm 442 that is pivotally connected at its outer end to the upper end of a vertical rod 443. The rod 443, Figs. 3, 37 and 39, is fastened at its lower end to a block 444 having a roller 445 rotatably mounted on one face thereof, said roller bearing on the periphery of a cam 446 on the shaft 204, which shaft, as has been explained, is journaled in bearings 205 on the outer face of the side frame 156 and is driven by the cam shaft 160 in a two-to-one stepdown ratio. As shown in Fig. 37, the block 444 is snugly positioned between the cam 446 and one of the bearings 205, and a

bifurcation 447, Fig. 39, in the lower end of the block 444 receives the shaft 204 to thereby prevent lateral displacement of the rod 443. A spring 448, Fig. 3, anchored in the side frame 156, is connected to the arm 439 and under the influence of this spring the roller 445 on the rod 443 is maintained in firm contact with the periphery of the cam 446.

When the roller 445 is on the high circular part of the cam 446, the arms 439 and 440, Figs. 3 and 22, are maintained in their extreme clockwise positions whereby the guide strips 360, Fig. 4, are positioned in alignment with the sides of the sheet guideway G. As has been mentioned, a plurality of lines of variable data V (in this instance, two) are printed upon each sheet S, Fig. 61, under control of a record card as C, Fig. 60. The printing means including the platens 361 and type wheels 364 is adapted to print only a single line of variable data upon the sheet S in each printing operation thereof. During the first of these printing operations, the guide strips 360 maintain the sheet in alignment with the guideway G to have the bottom line of variable data V printed thereon. When the printing of the bottom line has been completed, the roller 445 rides onto the lower portion of the cam 446 and shifts the guide strips 360 and the sheet S transversely of the guideway G to a position in which the second, or top line in this instance, of variable data V can be printed upon the sheet S by the platens 361. In this second printing operation, the guide strips 360 are positioned in alignment with the sides of the guideway G', which is displaced transversely relative to the guideway G. When the second printing operation is finished, the sheet is advanced away from printing position beneath the platens 361 and toward the platen P, Fig. 2, along the guideway G'. Prior to the next variable data printing operation, the cam 446, through the medium of the intermediate parts including the rod 443, restores the guide strips 360 into alignment with the sides of the sheet guideway G in position to receive the next succeeding sheet.

Selective control means

As has been described, the printing apparatus B in the present machine is adapted to print two superposed lines of variable data V upon each sheet as S, Fig. 61. Since there is but a single printing station at which these lines of variable data are impressed upon the sheet, the two lines of variable data are printed successively, the sheet S being shifted transversely of the sheet guideway intermediate the first and second impression-making operations as has just been described. It has also been explained that the sensing bars 229 are operated a plurality of times (in this instance, twice) to sense each card C disposed for cooperation therewith, and that in each such sensing operation the switches 303, Figs. 8 and 11, are selectively manipulated by the sensing bars 229 to energize the solenoids 308, Figs. 22 and 23, for controlling the setting up of the type wheels 364. The particular instant during sensing movement of the bars 229 at which any of the solenoids 308 is energized is determined by the position of a perforation in the card column to which such solenoid is allocated during that sensing operation, and this in turn determines the angular position at which the corresponding type wheel 364 is arrested by its pawl 393 to dispose the appropriate type character 366 in printing position. In order to operate the

sensing bars 229, type wheels 364 and associated parts for obtaining the aforesaid results, the cam shaft 160 is sent through two cycles of rotation, in the manner briefly referred to hereinabove and more fully explained hereinafter, during each of which cycles the sensing bars 229 sense the card C therebelow, and effect setting up of the type wheels 364, the parts being restored to their normal at rest positions toward the conclusion of each cycle.

Obviously, however, the sheet stop finger 149, Fig. 2, and card stop finger 223, Fig. 7, must remain in position to maintain the sheet and card respectively against longitudinal feeding movement throughout the substantial portion of both cycles of operation, in order that two successive printing and sensing operations may be performed upon each sheet and card, and the line shifter including the parts 360 and 439, Figs. 3 and 4, should have a cycle of operation twice as long as the sensing and printing cycles. The card stop finger 223 and line shifter are not operated directly from the cam shaft 160, but from the shaft 204 which is geared to the cam shaft 160 in a two-to-one ratio, as aforesaid, so that the cam shaft 160 must make two complete revolutions in order to send the shaft 204 through a single revolution. Hence, the card stop finger 223 is raised and lowered once for every two cycles of the cam shaft 160 (which will be referred to hereinafter as a cycle of printing apparatus B) while the line shifter positions the sheet S to have the bottom line of variable data V printed thereupon during the first cycle, and the top line of such data during the second cycle. The sheet stop finger 149, Fig. 2, is operated in timed relation to cams 147 on the timing cam shaft 146 associated with the form printer U and is thus controlled to release each sheet S only after it has had both lines of variable data V printed thereupon.

Referring to Figs. 23 and 61, it will be noted that certain of the groups of type wheels 364, namely, those which print the present and preceding meter readings, first step and total consumption in kilowatt-hours, and gross bill and net bill, serve to print different items of data for the different lines on the same sheet. Other type wheels, namely, those which print the rate, district and ledger numbers, and the net bill upon the stub of the sheet S, print one item of data in a selected line only on each sheet. Moreover, it will be noted that the net bill is represented only once on the card C but is printed at two places on the sheet S. When the bottom line of variable data V is being printed, the sensing bars which are allocated to the group of columns designated "Net" on the card C (the four uppermost bars 229 as viewed in Fig. 7) must therefore control setting-up of two groups of type wheels 364 for printing the amount of the net bill on both the body and stub of the sheet S, while the bottom line of data V is being printed. However, when the top line of data is printed, no impression is to be made from the group of type wheels which printed the net bill upon the stub of the sheet S, while the type wheels which printed the net bill upon the body of the sheet S are now placed under control of the sensing bars which read the amount of the gross bill on the card C (the fifth to eighth bars 229, inclusive, from the top as viewed in Fig. 7).

To enable the interrelation between the switches 300 operated by the sensing bars 229, and the solenoids 398 which in effect selectively

position the type wheels 364, to be varied for the purpose of placing the printing wheels 364 under control of the appropriate sensing bars 229 when printing of the different lines of variable data V is to be effected, I have provided a selective control means which is operatively interposed between the switches 300 and solenoids 398. Thus, the shaft 204 projects slightly beyond the left-hand bearing 205 on the frame 156, Fig. 3, and a bevel gear 450 is mounted on this end of the shaft 204 and meshes with a bevel gear 451, Figs. 3 and 6, secured on the end of a shaft 452 journaled in the side frames 155 and 156. A cam 453, Figs. 6 and 41, is secured by a set screw to the shaft 452 adjacent the inner face of the side frame 156, in vertical alignment with a roller 454 rotatably mounted on an arm 455 which is secured to a rock shaft 456 journaled in the side frames 155 and 156. Another arm 455 is fastened to the shaft 456 adjacent the side frame 155 and a bar 457 extends between and is secured to the outer ends of the arms 455, this bar projecting slightly forward beyond the ends of the side frames 155 and 156. Sixteen switches, generally designated 458, Figs. 6 and 42, are mounted in blocks 459 of insulation material which are secured to the under side of a bar 460 that extends between and is secured to the side frames 155 and 156 slightly above the bars 455, as shown in Fig. 5. Each switch 458 comprises a movable contact 461 which is supported at one end by the block 459 between relatively stationary upper and lower contacts 462 and 463. The contacts 461 are made of resilient strip material and extend forwardly to within a relatively short distance of the bar 457 carried by the arms 455. The contacts 461, 462 and 463 are provided with contact points as 464, and when the various parts of each switch 458 are in their normal positions as shown in Fig. 42, the points of the movable contact 461 and the upper contact 463 are in engagement, while the points of the movable contact 461 and lower contact 462 are separated.

A pin 465 is aligned with each switch 458 and extends laterally through a suitable opening in the bar 457 and is adapted to be positioned with its inner end overlying the movable contact blade 461. A spring-urged dog 466 is positioned in a vertical recess in the bar 457 communicating with the opening in which each pin 465 is positioned, each such dog having a tooth which may cooperate with either of two notches formed in the cooperating pin 465. Each pin 465 may thus be yieldingly retained by its dog 466 in one of two optional positions. When a pin 465 is held by the dog 466 in its more rearward position as shown in Fig. 42, it rests upon the upper surface of the forward end of the aligned movable contact 461, but when the pin 465 is latched in its more forward position, its inner end does not overlie the movable contact 461.

The movable contacts 461 of the various switches 458, with which the aligned pins 465 are positioned to cooperate, act to maintain the bar 457 and arms 455 yieldingly raised to thereby urge the roller 454, Fig. 41, against the periphery of the cam 453. The ratio of the bevel gears 450 and 451 interconnecting the shafts 204 and 452, Figs. 3 and 6, is one-to-one and, as explained above, the ratio of the gears interconnecting the shafts 204 and 160, including the gears 215 and 216, is two-to-one so that the shafts 204 and 452 make only one revolution for every two revolutions of the cam shaft 160 of the printing apparatus B. During the first cycle of the cam

shaft 160 in each variable data printing operation of the apparatus B, the roller 454 engages a relatively low portion of the periphery of the cam 453, Fig. 41, and hence during this first cycle the movable contacts 461, Fig. 42, of the various switches 458 remain in engagement with the upper contacts 462 of these switches. During the second cycle of each printing operation the roller 454 engages a high portion of the periphery of the cam 453 and the arms 455 are, therefore, rocked downwardly, thereby lowering the bar 457 and pins 465. In the case of those pins 465 which have been positioned to cooperate with the movable contacts 461 of the switches 458, the pins, in moving downwardly, separate the middle and upper contacts 461 and 464 and bring the movable contacts 461 into engagement with the lower contacts 462. In the present embodiment of the invention it is not necessary to retract any of the pins 465 into their inoperative positions in the pin bar 457, but in those instances, such as are referred to hereinafter, where any of the pins 465 are so retracted, the middle and upper contacts as 461 and 463 of these switches 458 that are aligned with such pins remain engaged throughout both cycles of operation, while the middle and lower contacts 461 and 462 remain separated.

Another series of thirteen switches generally designated 467, Fig. 6, is mounted on the bar 460 in the same manner as are the switches 458, these switches extending forwardly slightly beyond the shaft 452. As shown in Figs. 6 and 42 to 46, inclusive, the shaft 452 is provided with two diametrically opposed grooves 468 extending longitudinally of the shaft. Cams 469 are disposed on the shaft 452 respectively in alignment with the switches 467, each cam 469 being held yieldingly in engagement with the shaft 452 by a spring-pressed dog 470, Figs. 43 and 44, mounted in the hub as 471, Figs. 5, 6 and 47, of each such cam and having its point seated in one of the grooves 468. The cams 469 are all of the same configuration, but depending upon in which of the grooves 468 the dog 470 is seated, each cam 469 is normally positioned with its semi-circular raised portion to one side or the other of a vertical plane passed through the shaft 452.

Each switch 467 comprises an upper contact 472 and a lower contact 473, Figs. 43 and 44. A lug 474 is fastened to the upper surface of the upper contact 472 in vertical alignment with the shaft 452, and this lug constantly bears against the periphery of the cam 469 positioned thereabove. As the shaft 452 is rotated in the manner aforesaid, the cam 469 closes the switch 467 by causing the contacts 472 and 473 thereof to engage during either the first or the second printing cycle, depending upon the initial angular position of the cam 469 on the shaft 452. If it is desired to reverse the order in which a particular switch 467 is opened and closed, the operating cam 469 can be rotated by hand 180° on the shaft 452 until its dog 470 seats in the diametrically opposite groove 468.

In addition to the switches 458 and 467, switches 475, 332 and 332A, Figs. 6, 45, 46 and 46A, are mounted on the bar 460, these switches being identical in construction and mounting to the switches 467, Figs. 6, 43 and 44. Cams 476, 333 and 333A are mounted on the shaft 452 in a position to cooperate with the switches 475, 332 and 332A, respectively. The cams 333 and 333A are generally similar in construction to any of the cams 469 and are so positioned on the shaft

452 that they close their switches 332 and 332A only during portions of the first printing cycle, the cam 333 closing its switch 332 prior to closure of the switch 332A, and maintaining the switch 332 closed until after the switch 332A has opened. The switches 332 and 332A control the establishment of the circuits in the electrical network shown in Fig. 58 for comparing the account numbers of the card C and printing device D, as described hereinabove under the heading "Card analyzing means." Cam 476 is generally similar in construction to the cams 469 except that its periphery is so formed that it maintains the switch 475 closed for a predetermined time during the first portion of each printing cycle and opens this switch during the remainder of each such cycle. The switch 475, when closed, renders the various cam-operated switches 458 and 467 effective to electrically interconnect the aforesaid switches 300 with the solenoids 303 in a manner which will now be explained.

In Fig. 59, a number of different typical circuit arrangements for accomplishing the aforesaid purpose have been diagrammatically represented. The elements of these various circuits include the switches 300, Figs. 3, 8 and 11, operated by the sensing bars 229, the switches 456, Figs. 6 and 42, operated by the pin bar 457, the switches 467, Figs. 6, 43 and 44, operated by the cams 469, and the solenoids 303, Figs. 3, 22 and 23, which operate the stop pawls 393 for the type wheels 364. In referring to these circuit elements, the same reference characters are employed as have been used hereinabove in connection with the descriptions of these parts, but in the present instance such reference characters are modified by suffixes to distinguish structurally similar elements shown in Fig. 59 from each other in accordance with their respective functions. Each of the switches 300 is represented in Fig. 59 as having a movable contact and a fixed contact, the movable contact corresponding to the contact 309, Fig. 8, and the fixed contact corresponding to the conductive strip 308. It has been mentioned that all of the conductive strips 308 are connected to one side of the source of electrical current. In the present instance, this connection is afforded by a conductor 477 which is shown connected to the stationary contacts of all the switches generally designated 300 in Fig. 59. This conductor 477 leads to one contact of the switch 475, Figs. 6 and 45, which cooperates with the cam 476 on the shaft 452, and the other contact of this switch is connected to the line wire 335A. Circuit from the line wire 335A to the stationary contacts of the various switches 300 is established only during that portion of each printing cycle in which the cam 476 maintains the contacts of the switch 475 closed, and hence this switch serves to time the establishment of such circuit and will be referred to hereinafter as the timing switch for the type wheels.

In printing the amount of the net bill of the customer upon the sheet S, Fig. 61, duplicate impressions must be made upon the body and the stub of the sheet, in the bottom line of variable data V. Each of the sensing bars 223, Fig. 7, allocated to the group of card columns in which the amount of the net bill is represented controls a switch as 300n, Fig. 59. The stationary contact of each such switch is connected to the conductor 477 as aforesaid, and the movable contact is connected by a conductor 470 to one side of the winding of a solenoid 303n controlling a type wheel 364 for printing the net bill upon the stub of the

sheet S, Fig. 61, and by conductors 478 and 479 to the upper contact of a switch 458gn controlled by the pin bar 457, Figs. 6 and 42. The middle terminal of the switch 458gn is connected by a conductor 480 to one side of the winding of a solenoid 398gn that controls a type wheel 364 for printing both the net bill and the gross bill upon the body of the sheet S. The other sides of the windings of these solenoids 398n and 398gn are connected by conductors 481 and 482 to the line wire 335. The lower contact of the switch 458gn is connected by a conductor 483 to the movable contact of a switch 300g which is controlled by a sensing bar 229 in the group allocated to the card columns in which the amount of the gross bill is represented, the sensing bars controlling the switches 300g and 300n shown in Fig. 59 being in the same denomination in each respective group. One side of the switch 467n, controlled by a cam 469n on the selective control cam shaft 462, Fig. 6, is connected to the conductor 477 and the other side is connected by conductors 484 and 485 to the side of the winding of the solenoid 398n to which the conductor 478 is connected. The cam 469n is positioned in the same manner as is the cam 469 shown in Fig. 44 so that the switch 467n remains open during the first printing cycle but is closed throughout the second cycle. The pins as 465 operating the switches as 458gn are so positioned in the pin bar 457 that they may cooperate with the middle contact of the switch 458gn and, therefore, inasmuch as the pin bar 457 is elevated during the first printing cycle and is depressed in the second printing cycle, the middle blade of this switch engages the upper contact during the first cycle and the lower contact during the second cycle.

It will be understood that electrical connections substantially identical with the foregoing are provided for each of the solenoids as 398gn and 398n which control printing of the digits in the various orders of the net bill and gross bill amounts. During the first cycle of operation of the printing apparatus, the switches as 300n and 300g are closed at times in the course of sensing movement of their sensing bars 229 corresponding to the numerical values of the digits sensed by these bars in their respective card columns. The type wheels 364, Fig. 22, controlled by the solenoids as 398n and 398gn are in motion so long as the sensing bars controlling the switches as 300n and 300g continue their sensing movements. However, when each such sensing bar encounters a perforation in its card column, it closes its switch 300n and 300g, as described hereinabove under the heading "Card analyzing means." Closure of each switch as 300n extends circuit from the conductor 477 through the conductors 478 and 479 to the upper contact of the corresponding switch 458gn which, as has been explained, is in engagement with the middle contact of this switch, thence through conductor 480, winding of solenoid 398gn and conductor 482 to the line wire 335. Circuit is also extended through the switch 300n and conductor 478 to the winding of solenoid 398n and thence through conductor 481 to line 335. The timing switch 475 is closed by the cam 476 during that portion of each printing cycle in which a card is sensed by the bars 229, Fig. 3. Hence, conductor 477 is in electrical contact with the line wire 324 at the time the switch 300n closes, and the solenoids 398n and 398gn are concurrently energized upon closure of this switch to thereby arrest the type wheels 364 in position to print the amount of the net bill in duplicate

upon the body and stub of the sheet S. Closure of the switches as 300g controlled by the sensing bars allocated to the card columns in which the amount of the gross bill is represented is without effect in this first cycle because the middle and lower contacts of the switches as 458gn are separated in this cycle and hence, switches as 300g have no effect upon the solenoids as 398gn.

At the initiation of the second cycle of operation, the cams as 469n close their switches as 467n to extend circuit from the conductor 477, which is connected to the line wire 324 through the timing switch 475 that is closed during the first portion of each cycle, through the switches as 467n, conductors as 484 and 485, windings of solenoids as 398n which control the type wheels that print the amount of the net bill on the stub of the sheet S, Fig. 61, and conductor 481 to the line wire 335. The solenoids as 398n thereupon energize and lock their type wheels in their zero positions. Inasmuch as the cams as 469n maintain their switches 467n closed throughout the second cycle, the solenoids as 398n remain energized to hold their type wheels 364 (the group of four type wheels at the top as viewed in Fig. 23) in their zero positions during the second cycle. Hence, the cam surfaces 405 on these wheels, Fig. 22, cannot raise the cooperating arms 406 of the zero-suppressing levers 407, and thus the arms 401 remain engaged with the lugs 399 on the depending portions 369 of the platen arms 367 so that when the latch bar 371 is withdrawn to release the arms 369, the lugs 399 remain seated in the notches 400 in the arms 401 and thus printing from these type wheels in the second line on the sheet S above the net bill printed on the stub of this sheet is suppressed, as is indicated in Fig. 61.

During the second printing cycle, the pin bar 457 is lowered in the manner previously described and the pins 465 separate the middle contacts of the switches as 458gn, Fig. 59, from the upper contacts of these switches and cause them to engage the lower contacts thereof. The switches as 300n, that are actuated by the sensing bars 229 allocated to the group of card columns in which the amount of the net bill is represented, are ineffective to control either of the solenoids as 398n or 398gn during the second cycle, inasmuch as all of the solenoids as 398n are maintained energized throughout the entire second cycle by the cam controlled switches 467n irrespective of the times at which the switches 300n are closed, and circuit from the switches 300n to the solenoids 398gn is broken when the pins 465 separate the middle and upper contacts of the switches 458gn.

The switches as 300g controlled by the sensing bars allocated to the group of card columns in which the gross bill is represented are closed at times dependent upon the numerical values of the digits sensed by these bars. As each such switch 300g closes, it extends circuit from the conductor 477 through a conductor 483 to the lower contact of its switch 458gn, thence through the middle contact of the switch 458gn, conductor 480, winding of the associated solenoid 398gn and conductor 482 to the line wire 335. The solenoids as 398gn are thus energized upon closure of the switches 300g connected in circuit therewith during the second cycle and are, therefore, effective to arrest those type wheels 364, which previously were positioned to enable printing of the net bill in the bottom or lower line upon the body of the sheet S (the tenth to the thirteenth wheels 364

from the bottom as viewed in Fig. 23), in positions to enable the amount of the gross bill to be printed upon the sheet S, the sheet being shifted intermediate the first and second printing operations, as described hereinabove, so that the gross bill is printed in the upper line of data V on the body of the sheet S directly above the amount of the net bill.

The seventh, eighth and ninth type wheels 364 from the bottom, as viewed in Fig. 23, are utilized to print the total consumption in kilowatt-hours in the bottom line of data V, and the kilowatt-hours, first step, directly thereabove in the second line of such data. The sensing bars 229, Figs 7 and 8, that are allocated to the groups of card columns designated "Total units" and "First step," Fig. 60, control switches as 300t and 300f, respectively, Fig. 59. The movable contact of each switch 300t is connected by a conductor 439 to the upper blade of a switch 453tf that is included in the series of switches 450, Figs. 6 and 42, and the movable blade of the switch 300f in the same denomination is connected by a conductor 487 to the lower blade of the same switch 453tf, the stationary contacts of the switches 300t and 300f (that is, the contact strips as 302, Figs. 3 and 11) being permanently connected to the conductor 477 as in the case of the other switches 300. The pins 465 in the pin bar 457 opposite the switches 453tf are positioned to cooperate with the middle contacts of these switches so that the middle and upper contacts are engaged during the first printing cycle and the middle and lower contacts are engaged during the second printing cycle. The middle contact of each switch 453tf is connected by a conductor 430 to the winding of a solenoid as 393tf that controls one of the aforesaid type wheels for printing either the total consumption in kilowatt-hours or the kilowatt-hours, first step, depending upon which line of variable data is being printed, the other side of the winding of such solenoid 393tf being connected by a conductor 439 to the line wire 335.

During the first cycle the switches 300f are ineffective inasmuch as the lower contacts of the switches 453tf are separated from the middle contacts thereof during this cycle. However, closure of a switch 300t extends circuit from the conductor 477 through conductor 426, upper and middle contacts of the connected switch 453tf, conductor 430, winding of solenoid 393tf and conductor 439 to line wire 335. Solenoid 393tf thereupon energizes (timing switch 475 being closed) and arrests its type wheel 364 at substantially the instant that the associated switch 300t is closed by its sensing bar 229, and thereby each of such type wheels is positioned to print one of the digits of the total number of kilowatt-hours in the lower line upon the sheet S. During the second cycle, the switches 300t are ineffective due to separation of the middle contacts from the upper contacts of the switches 453tf, and the switches 300f are effective to energize the solenoids 393tf in accordance with the number of kilowatt-hours in the first rate step as represented in the card C, closure of each switch 300f extending circuit from the conductor 477 through conductor 437, lower and middle contacts of switch 453tf, and conductor 430 to the winding of the solenoid 393tf to energize such solenoid for selectively arresting its type wheel 364 in accordance with the value of the digital entry.

The scheme of electrical connections from the switches 300, controlled by the sensing bars that are allocated to the groups of card columns in

which the present and preceding meter readings are represented, to the solenoids 393 controlling the type wheels 364 (the lower four wheels, Figure 23) from which these meter readings are printed upon the sheet S, as well as the principle of operation thereof, are identical with the circuits described above in connection with the printing of the total and first step kilowatt-hours, and hence a detailed description and illustration of such structure and circuit connections are not presented herein.

Each of the sensing bars 229 allocated to the card columns in which the district number is represented controls a switch 300d, the movable contact of which is connected by a conductor 490 to the upper contact of the switch 450d. The middle contact of this switch is connected by a conductor 491 to the winding of a solenoid 398d which controls positioning of one of the type wheels for printing the district number, the other side of this winding being connected by a conductor 492 to the line wire 335. The lower contact of each switch 450d is not utilized, for the reason that the district number is printed only in the lower line of data V on the sheet S, and the space above this district number in the upper line of data is left blank. To suppress printing from the district number type wheels during the second cycle, a switch 467d, included in the series of switches 467, Fig. 6, is connected in circuit with the winding of each solenoid 398d, one terminal of each switch 467d being connected to the conductor 477 by a conductor as 493, and the other terminal of such switch being connected by a conductor 494 to the conductor 491 which leads to the winding of the corresponding solenoid 398d. A cam 469d, which is identical with and is positioned on the shaft 452 in the same manner as is the cam 469 shown in Fig. 44, cooperates with the switch 467d for maintaining this switch closed throughout the second cycle. During the first printing cycle, the bars 229, Fig. 8, for sensing the district number in the card C close their switches 300d at times in the cycle representative of the digit sensed, and as each switch 300d is closed, it extends circuit from the conductor 477 through a conductor 490, upper and middle contacts of its switch 450d and conductor 491 to the winding of its solenoid 398d and thence by conductor 492 to the line wire 335. The solenoid 398d thereupon energizes to arrest its type wheel in position to display the appropriate character at printing position. During initiation of the second cycle, each cam 469d closes its switch 467d, thereby extending circuit from the conductor 477 through conductors 493, 494 and 491 to the winding of solenoid 398d and causing the solenoid to energize and lock its printing wheel in zero position. Closure of the switches 300d in the course of the sensing operation performed by the bars 229 in the second printing cycle therefore has no effect upon the solenoids 398, inasmuch as these solenoids remain energized throughout the course of the second printing cycle to maintain their type wheels in their zero positions.

If it were desired to print the district number in the upper line of data V instead of in the lower line of such data, Fig. 61, the movable contact of each switch 300d would be electrically connected to the lower contact of its switch 450d rather than to the upper contact of this switch and the cams as 469d would be manually adjusted rotatably on the shafts 452, 180° from their positions as shown in Fig. 59, and into the positions as shown in Fig. 43, prior to any operation of the machine. Then

the switches 467d would close at the initiation of the first printing cycle and would remain closed throughout this cycle to lock the type wheels in their zero positions and thus suppress printing therefrom, but would open in the second printing cycle to enable the switches 300d to selectively control the solenoids 398d.

Printing of the ledger number on the sheet S is, in the present instance, effected in a manner identical with that described above in connection with the printing of the district number and hence a detailed description thereof is not included herein.

The printing of the rate number or designation (C3 in the present example) on the sheet S is controlled in the present instance by utilizing an arrangement embodying two cams as 469r and 469r' included in the series of cams 469, Figs. 6, 43 and 44, for each column of this designation. The movable contact of each switch 300r that is under control of a sensing bar 229 allocated to the group of card columns in which the rate number is represented, is connected by a conductor as 495 to one contact of a switch 467r controlled by a cam 469r that is positioned on the shaft 452 as is the cam 469 in Fig. 44 prior to commencement of the first printing cycle so that the switch 467r remains open during the first cycle and is closed throughout the second cycle. The other contact of the switch 467r is connected by a conductor 496 to one side of the winding of a solenoid 398r that controls the positioning of a type wheel 364 in the rate number group (fifth and sixth wheels 364 from the bottom, as viewed in Fig. 23), the other side of the winding of this solenoid being connected to the line wire 335. The cam 469r' is positioned on the shaft 452 with its high portion rotated 180° away from the angular position occupied by the high portion of the cam 469r, and hence the cam 469r' maintains its switch 467r' closed throughout the first printing cycle only. The contacts of the switch 467r' are connected by conductors 497 and 498, respectively, to the conductor 477 and to the winding of the solenoid 398r. Upon initiation of the first printing cycle, the cams 469r' close the switches 467r' to energize the solenoids 398r to thereby lock the associated type wheels in their zero positions to suppress printing from these wheels while the first line of variable data V is being printed upon the sheet as S, Fig. 61. Upon initiation of the second printing cycle, the switches 467r' are opened and the switches 467r are closed, thus placing the solenoids 398r under the direct control of the switches as 300r beneath the sensing bars 229. Thus, the type wheels under control of the solenoids 398r are positioned to enable the rate number to be printed in the second line of variable data V, in a manner similar to that described hereinabove in connection with the printing of other items upon the sheet S.

It is believed to be apparent from the foregoing that I have provided an arrangement such as is schematically illustrated in Fig. 59 which is capable of operatively interconnecting the type wheels 364 and the sensing bars 229, Figs. 7, 8, 22 and 23, in the desired manner, during each cycle of operation of the printing apparatus. While this arrangement constitutes a preferred embodiment for accomplishing the purposes hereinabove set forth, it is obvious that changes may be made in the circuit connections without departing from the ambit of my invention. For example, where printing is effected in only one line of the sheet S and the portion of the other

line aligned therewith is to be left blank, the arrangement described hereinabove, including the switches 458d operated by the pin bar 457 and switches 467d controlled by the cams 469d, that is utilized to govern the printing of the district and ledger numbers, may be used interchangeably with an arrangement such as that embodying the cams 469r and 469r' and switches 467r and 467r' that governs the printing of the rate number, the necessary adjustments being made in the positions of the various cams on the cam shaft 452, as suggested hereinabove, to print the items in one of the other of the lines of variable data V. Likewise, the arrangement for printing the gross bill and net bill could be expeditiously altered so that one item, such as the net bill, could be printed in two places on the top line of data V and the other item, such as gross bill, could be printed at one place in the bottom line.

It may be desirable for some purposes to adapt the machine for printing certain of the items repeatedly in a plurality of lines, particularly where one complete line of data is printed on a separable stub, and another line upon the body of the sheet. Where this is the case, the pins 465 opposite those switches 458 that are to control the printing of such items are adjusted to their inoperative or retracted positions in the pin bar 457, out of alignment with the middle blades of these switches, and the cam-controlled switches as 467 are not employed, that is, they are rendered ineffective. When this has been done, the middle and upper blades of the switches 458 will be in contact at all times, and the item which was printed in the first cycle under control of such switches 458 and the associated sensing bar switches 300 will again be printed in the second cycle.

Proof printer

In the present machine, provision has been made for keeping a permanent or office record of certain of the items printed on each bill or sheet S. For instance, referring to Fig. 61, it may be desired to keep a list of the items of total kilowatt-hours, net bill, and district and ledger numbers, recorded in the bottom lines of data V on the various sheets S. To this end, I have provided an auxiliary proof printer in the printing apparatus B, the unit affording this printer being supported near the upper right-hand corners of the side frames 155 and 156, as viewed in Fig. 3, to the rear of the printing station above the type wheels 364.

As shown in Figs. 3, 4, 24 and 25, vertical side plates 500 and 501 are secured near their lower ends to the outer faces of the side frames 155 and 156, respectively, and project upwardly a substantial distance above these side frames. A shaft 502 extends between and is journaled in the plates 500 and 501 and a feed roller 503 is fast on this shaft. A rod 504 extends between and is secured to the side frames 155 and 156 near their rear edges and brackets 505, having circular openings through which the rod 504 is passed, are secured to this rod by set screws, as shown in Figs. 24 and 25. A box 506 is carried by the brackets 505 and a roll of paper 507—R, Figs. 3 and 24, is contained in the box 506. A web 507—W is led from the roll 507—R over an upstanding front wall of the box 506 and around the feed roller or platen 503 beneath an ink ribbon IRb, this ribbon being intermittently advanced across the web in a step-by-step manner in the course of operation of the apparatus by a

conventional reversing ink ribbon advancing means (not shown).

A flat bar 503 is supported by the side plates 503 and 501 adjacent the platen 503 somewhat to the rear of the ribbon IRb and has its wider surface positioned radially with respect to the platen 503. A flat strip 509 is secured to the bar 503 in parallel relation therewith to define an open slot therebetween through which the web 507—W may pass. Projections 510 extending angularly from the front or lower edge of the strip 509 aid to guide the leading edge of the web 507—W into this slot between the bar 508 and strip 509. As best shown in Fig. 25, circumferential grooves 511 are afforded in the platen 503 and narrow strips 512, Fig. 24, secured in the bar 503 so as to be flush with the upper surface thereof, project downwardly into the grooves 511 slightly below the paper-supporting surface of the platen 503, thus preventing the leading edge of the web 507—W from being caught by or carried past the lower edge of the bar 508.

Levers generally designated 513 are rotatably mounted on a shaft 514 secured at its ends to the side plates 509 and 501 below the platen 503, these levers being provided at their upper ends with arcuate arms 515 and 516 which partially embrace the platen 503. Rollers 517 are mounted on the arms 515 which are disposed rearwardly of the platen 503 and springs as 518, anchored by suitable means to the side frames 155 and 156, act upon the depending arms 519 of the levers 513 to urge the rollers 517 against the web 507—W to thus press the web firmly against the periphery of the platen 503 and thereby insure frictional contact of the web and platen. The arms 516 of the levers 513 about a shaft 520 journaled in the side plates 509 and 501, these arms being received in a relieved portion of the shaft 520. One end of the shaft 520 is extended beyond the side plate 501 and is formed to provide a crank handle 521, Figs. 3, 4 and 25. When it is desired to release the web 507—W from the grip of the rollers 517 or to insert a new web, the crank 521 is manually rotated slightly to cause the periphery of the shaft 520 to bear against the arms 516, thereby rotating the levers 513 in such a direction as to withdraw the rollers 517 from the platen 503. A new web may then be inserted between the arms 515 and platen 503, and the handle 521 is then rotated back into position in which the relieved surface of the shaft 520 receives the arms 516, thereby enabling the springs 518 to rock the levers 513 and thus cause the web to be clamped by the rollers 517. A knob 502a is provided on the end of the shaft 502 outwardly of the side plate 501 to enable the platen 503 to be manually rotated for bringing the leading edge of the web around the platen, the web being guided by the arms 515 and 516, and beneath the ink ribbon IRb and guide piece 510 into the slot between the bars 503 and 509.

The platen 503 is advanced rotatively in a step-by-step manner by a pawl and ratchet mechanism including a pawl 522 pivotally mounted on one arm of a bell crank, generally designated 523, Fig. 24, that is rotatably mounted on the shaft 502 adjacent the side plate 509, the pawl 522 being vertically aligned at one end thereof with a ratchet 524, Fig. 25, secured to the shaft 502. A spring 525 yieldingly connects one end of the pawl 522 with the bell crank 523 and tends to urge this end of the pawl into engagement with the teeth of the ratchet 524. However, when the

bell crank 523 is moved to its extreme clockwise or normal position, shown in Fig. 24, by means to be described presently, the other end of the pawl 522 bears against a pin 526 fixed to the side plate 509, and the pawl 522 is rocked about its pivot on the arm of the bell crank 523 and is thereby prevented from engaging the ratchet 524. The other arm of the bell crank 523 is connected by a link 527 to an arm 528 of a lever, generally designated 529, mounted on a rock shaft 530 carried by the side frames 155 and 156. Another arm 531 of the lever 529 is connected by the link 532, Figs. 3, 22, 24 and 40, to one end of a lever 533 pivotally mounted at 534 on the inner face of the side frame 155 (see also Fig. 5). The other end of the lever 533 carries a roller 535, and a spring 536 acting on the link 532 and lever 533 urges the roller 535 against the periphery of the cam 537 on the cam shaft 160. The cam 537 is circular throughout the greater portion of its periphery but is provided with a relief comprising a sharp drop 538, a circular dwell 539 and a rise 540 intermediate the dwell 539 and the periphery of cam 537.

In the course of rotation of the cam shaft 160, the roller 535 rides down into the relief in the cam 537, and the spring 536 thereupon pulls the link 532 downwardly, thereby rocking the lever 529 and shaft 530 clockwise, as viewed in Fig. 24, and pushing the link 517 to the right to thereby rock the bell crank 523 associated with the platen 503 counterclockwise. As the pivot point of the pawl 522 is thus displaced relative to the stop pin 526, the spring 525 becomes effective to urge the nose of the pawl toward the ratchet 524, and continued counterclockwise rocking movement of the bell crank 523 causes the pawl 522 to engage the next rearward tooth of the ratchet 524. When the roller 535 rides out of the relief in the cam 537, Fig. 40, and onto the circular periphery of this cam, the link 532 is pushed upwardly to thereby pull the link 527 to the left as viewed in Fig. 24, and rock the bell crank 523 and pawl 522 clockwise as seen in this view. The pawl 522 thereupon advances the platen 503 substantially in the amount of one tooth of the ratchet 524. A roller 541 carried by a spring-urged lever 542 acts upon the teeth of the ratchet 524 to insure a full step of movement of the platen 503. The pawl 522 is disengaged from the ratchet wheel 524, upon engaging the pin 526, toward the completion of such advancing movement of the platen 503, so that the platen may thereafter be manually rotated in either direction if the need arises so to do. This arrangement also insures that the pawl 522 will remain disengaged from the ratchet teeth 524 until it has been retracted one tooth at the initiation of the next succeeding web feeding operation, and hence there is no tendency for the pawl 522 to drag the ratchet wheel 524 and platen 503 in a reverse direction before feeding movement is initiated.

It will be understood that, if desired, the mechanism for advancing the web 507—W may also be utilized to actuate the ribbon feeding means (not shown), so that the ribbon IRb will be advanced in a step-by-step manner concurrently with the web.

Intermediate the successive proof web feeding operations, impressions of the items of total kilowatt-hours, net bill and district-ledger numbers are made upon the web 507—W from type bars generally designated 543, Figs. 3, 4, 22, 24 and 25, which are normally supported diagonally and in raised position, with their type characters 544

above the platen 503 and ink ribbon IRb, by a tie rod 545 secured at its ends to arms as 546 of the levers 529, Figs. 24 and 25, that are mounted on the rock shaft 530. The lower ends of the type bars 543 are passed through slots in a comb 547 extending between the side frames 155 and 156 to be partially supported and guided thereby, and a similar comb 548 having downwardly opening slots, Figs. 24 and 25, is secured to the side plates 500 and 501, and receives the upper ends of the type bars 543. The lower ends of the type bars 543 of the proof printer are in spaced relation and respectively aligned with those type wheels 364 of the variable printer which print the aforesaid items of total kilowatt-hours, net bill and district-ledger number.

As shown in detail in Fig. 22A, each type wheel 364 has gear teeth 549 formed in the rearwardly disposed portion of its periphery, and the adjacent edge of the alignment type bar 543 has a rack 550 formed therein, Fig. 22. A series of pinions 551 is rotatably mounted on a shaft 552 journaled in the side frames 155 and 156 intermediate the type wheels 364 and the type bars 543, each pinion 551 meshing with the gear teeth 549 of a type wheel 364 and the rack 550 of a type bar 543, thereby affording a geared interconnection between the type wheels and type bars. Springs 553 are fastened to the type bars 543 above the supporting rod 545 and are anchored in rods 554 extending between the side frames 155 and 156, these springs tending to rock the type bars 543 about the rod 545 to urge the rack teeth 550 into engagement with the teeth of the pinions 551. A roller 555 is carried by the side frames 155 and 156 near the comb 547 in position to further support the type bars 543 at points on the lower edges thereof lying in the radii extended from the centers of the pinions 551 perpendicularly of the type bars 543.

As the type wheels 364 of the variable printer are selectively positioned to enable a line of variable data V, Fig. 61, to be printed therefrom onto a sheet as S, the movements of these type wheels are transmitted by the pinions 551 to the type bars 543 to move these type bars longitudinally into positions whereat selected of the type characters 544 are positioned substantially radially of the platen 503, and above ink ribbon IRb, in accordance with the settings of the type wheels 364, to thus enable a corresponding line of certain of the items of variable data, as aforesaid, to be printed upon the web 507—W. As in the case of the data printed upon the sheets S, it is undesirable that zeros be printed by the type bars 543 above the highest order in which a significant digit appears in any of the items of data printed upon the web 507—W, and to this end suitable zero suppressing mechanism has been provided.

Each type bar 543 has a lug 556 formed in one face thereof and when the type bars 543 are in their lowermost or zero positions as indicated in Fig. 24, the lugs 556 are engaged by hooks 557 formed in levers, generally designated 558, that are pivotally mounted on a stationary shaft 559, Figs. 24 and 25, carried by the side plates 500 and 501 above the type bars 543, springs 560 anchored in a suitable manner to the side plates 500 and 501 acting upon arms 561 of the levers 558 to urge the hooks 557 into engagement with the lugs 556. Other arms 562 of the levers 558 extend parallel with the type bars 543 along the upper edge thereof and each arm 562 carries a roller 563 that rests upon the upper edge of its

type bar 543. A cam 564 is formed in the upper edge of each type bar 543, and if the type bar is moved away from its zero position shown in Fig. 24, the cam 564 engages the roller 563 and lifts the arm 562 of the lever 558 to thereby swing the hook 557 to a position in which it is ineffective to engage the lug 556. However, if a particular type bar 543 remains in its zero position, the cam 564 is ineffective and the hook 557 remains engaged with its lug 556. A lug 565 on the arm 561 of each lever 558 extends laterally and overlaps the arm 561 of the lever 558 in the next lower order in that particular group of type bars 543, as is shown in Fig. 25. Hence, if a type bar 543 in, say, the hundreds order, is moved away from its zero position, its lever 558 is rocked by the cam 564 and the lug 565 of this lever depresses the arm 561 of the lever 558 for the type bar in the next lower or tens order, and this in turn effects depression of the arm 561 of the lever 558 for the type bar in the units order. Thus, all of the hooks 567 in the hundreds, tens and units orders are swung away from their lugs 556, but if no significant digit is set up in the thousands order, the lug 556 on the thousands type bar 543 in that group is still engaged by its hook 557.

When printing is to be effected from the type bars 543, the tie rod 545 carried by the levers 529 is lowered, this occurring concurrently with the retraction of the pawl 522 of the proof web feeding means rearwardly to engage the next succeeding tooth of the ratchet 524, since the tie rod 545 is carried by the levers 529 which actuate the web feeding mechanism. Inasmuch as the cam 537 is provided with the sharp drop 538, the levers 529, Figs. 24 and 25, are rocked suddenly to effect a rapid withdrawal of the rod 545 from the type bars 543 when a proof printing operation is to be effected. The springs 553 thereupon act upon those type bars 543 which are not latched by the zero-suppressing levers 558 to snap these type bars sharply downwardly and cause the selected type characters 544 to strike the ribbon IRb and effect an imprint upon the web 507—W. Downward movement of the type bars 543 is in the nature of a pivotal movement about the roller 555, the rack teeth 550 of each type bar 543 rolling slightly over the teeth of the pinion 551 meshed therewith during such movement. When the roller 535, Fig. 40, rides back up onto the circular periphery of the cam 537 and the link 532, Figs. 40 and 24, is pushed upwardly, the tie rod 545 is elevated and raises the type bars 543 to their upper inoperative positions. Concurrently with this restoration of the type bars 543, the link 547 is actuated to advance the feed pawl 522 and step the platen 503 around for disposing the next blank line of the web 507—W in printing position.

It has been mentioned hereinabove that in the present construction none of the items of variable data V printed in the upper line of such data upon the sheet S, Fig. 61, is to be printed upon the proof web 507—W. It is, therefore, essential that the type bars 543 be prevented from making an impression upon the web 507—W during every second printing cycle. To this end, a dog 566, Fig. 3, is remotely attached to one end of the shaft 530, Fig. 24, which projects beyond the side frame 156, and a latch 567 is pivotally mounted on the frame 156 in position to cooperate with the dog 566. A spring 568 tends to urge the latch 567 into engagement with the dog 566, but a link 569, pivotally connected at one end to the arm

439 included in the line shifter mechanism and having a pin-and-slot connection with the latch 567, maintains the parts 566 and 567 disengaged at all times except when the arms as 439 have been rocked counterclockwise as viewed in Fig. 3 to shift the guide strips 369 and thus bring the top line in which the data V are printed on the sheet S, Fig. 61, beneath the platens 361. Therefore, when the bottom line of data V is being printed, the arms as 439 are in their extreme clockwise positions and the link 569 renders the latch 567 ineffective as just described, to enable the roller 535, Fig. 40, to descend into the relief in the cam 537, when a proof printing operation is to be effected. Link 522 thereupon rocks the shaft 530 and this causes the tie rod 545, Fig. 24, to be lowered for enabling the type bars 543 to be pulled downwardly against the ink ribbon IRb and web 567—W during the first printing cycle.

However, during the second printing cycle, when the sheet S is shifted transversely to bring the upper variable data line beneath the platens 361, the link 569 moves to the left as viewed in Fig. 3, and the latch 567 is urged by the spring 568 into engagement with the dog 566 to thereby lock the shaft 530 against movement. Thereafter, when the drop 532 in the cam 537, Fig. 40, moves past the roller 535, there will be no effect upon the rock shaft 530, the roller 535 being held out of engagement with the relief portion of the cam 537. The levers 529, and tie rod 545, Figs. 24 and 25, secured to the rock shaft 530 are thus held stationary during the second printing cycle inasmuch as the shaft 530 will be locked against clockwise rocking movement. The type bars 543 are, therefore, prevented from moving transversely, even though they are still free to move longitudinally in accordance with the settings of the connected type wheels 364, and hence, no proof printing operation is effected in the second cycle. Likewise, the mechanism for feeding the web 567—W is inoperative during this cycle inasmuch as it is operated from the levers 529 which are also held stationary at this time. Restoration of the line shifter mechanism at the conclusion of the second printing cycle causes the link 569 to move to the right as viewed in Fig. 3, to disengage the latch 567 from the dog 566 and thus place the proof printer under the sole control of the cam 537, Fig. 40, during the first cycle of the next succeeding printing operation.

Accumulator

In the present machine, provision has been made for keeping a total of certain of the items of variable data printed by the type wheels 364 and type bars 543, and specifically, the net bill amounts and total kilowatt-hours of consumption that are printed in the bottom line of data V upon each sheet S, Fig. 61, are accumulated in the present instance. In the same cycle in which these items are printed, namely, the first printing cycle, an entry of the net bill amount and total kilowatt-hours consumption is effected into an accumulating mechanism, now to be described, this being done in the manner which will be presently described.

Each type wheel 364 has gear teeth 570 formed in the bottom portion of its periphery as shown in Figs. 22 and 22A. Comb bars 572, Figs. 5 and 22, are attached at their ends to the side frames 155 and 156 below the level of the gear teeth 570, and horizontal slides 571 are positioned in the slots in the comb bars 572 in vertical alignment with the type wheels 364 from which the amounts of the net bill and total kilowatt-hours consump-

tion are printed. Other slides 571S, Fig. 5, similar in construction and mounting to the slides 571, are positioned in other of the slots in the comb bars 572, beneath the type wheels 364 from which the district and ledger numbers are printed. The slides 571 are operatively associated with the accumulator devices but the slides 571S are not so associated. The only function of the slides 571S is to enable the type wheels in the district and ledger number groups to be locked in their zero positions under certain circumstances, as will be described under the heading "Total taking."

The slides 571 and 571S are supported for longitudinal movement by individual rollers 573 disposed in longitudinal slots 574 in the slides, Figs. 22, 28 and 29, these rollers being rotatably mounted on shafts 575 fixedly mounted in brackets 576 secured to the comb bars 572. A rack 577 is formed in the upper edge of each slide 571 and 571S, and the gear teeth 570 of each of the type wheels 364 in the net bill, total kilowatt-hour, and district and ledger numbers groups respectively mesh with the rack teeth 577 of the aligned slide 571 or 571S. As each type wheel 364 that is geared to a slide 571 and 571S is rotated to display the selected type character 365 in printing position and is thereafter restored, the connected slide 571 or 571S is reciprocated longitudinally to and from its normal position shown in Fig. 22, the displacement of each slide 571 or 571S being proportionate to the numerical value of the digit set up in printing position on the type wheel 364.

In the present construction, provision is made for printing a net bill extending into not more than four orders of significant digits (\$99.99 or less), and kilowatt hour consumption quantities of not more than three orders (999 or less), making a total of seven type wheels 364 which are instrumental in printing these quantities upon the sheets S. However, it will be noted in Fig. 5 that eleven of the slides 571 are provided, inasmuch as there are two extra wheels 364a, Fig. 5, that are not equipped with type characters 366 in each of the net bill and kilowatt hour groups. No platens are provided above these special wheels 364a so that no impressions are made therefrom. However, the wheels 364a are interconnected with type bars as 543, Figs. 22 and 24, by pinions as 551 so that they may control positioning of these type bars under certain circumstances, as will be explained subsequently under the heading "Total taking." In ordinary operations, however, the slides 571 meshing with the special wheels 364a are held stationary by pawls 578, Fig. 22, mounted on a rock shaft 579 journaled in the side frames 155 and 156, these pawls being seated in notches 580 afforded in the slides 571, and being disengaged therefrom only during total taking operations, as will be described hereinafter.

A rock shaft 581, Figs. 5, 26 to 30, inclusive, and 37, is journaled in the side frames 155 and 156 a considerable distance below the type wheels 364 and is passed through bearings 582 formed in the lower portions of vertical side plates 583 and 583a which support the accumulator assembly. A tie rod 584 carried by the side frames 155 and 156 passes through other openings in the side plates 583 and 583a near the tops thereof so that the plates 583 and 583a are thus firmly supported against rotative movement. Elongated openings or slots 585 are formed in the plates 583 and 583a near their top edges and a shaft assembly generally designated 586, Figs. 28 and

29, is journaled in these openings so as to be vertically movable therein. The assembly 588 includes a central rod 587 that is threaded at each end. A number of spacing collars 588, Fig. 29, are mounted on the rod 587 between end spacers 589. The two end spacing collars 588 have bosses abutting the end spacers 589, and plates 590, Figs. 29 and 30, are hung from these bosses. Suitable bosses are formed in the other spacing collars 588 to afford bearings for a series of accumulator pinions 591, Figs. 26 to 29, inclusive, that are respectively aligned vertically with only the slides 571 in the bill amount and kilowatt-hour consumption groups. Outer spacing sleeves 592 are disposed on the rod 587 adjacent the spacers 589, and washers 593 having diameters larger than the widths of the slots 585 are positioned next to the spacing sleeves 592 and adjacent the outer faces of the plates 583 and 583a. Nuts 594 are screwed onto the ends of the rod 587 into tight engagement with the washers 593, thereby holding the parts of the shaft assembly 586 in place, there being sufficient clearance between the washers 593 and the side plate 583 and 583a to enable the shaft assembly 586 to slide freely up or down within the openings 585 in these plates. There is enough friction afforded in the bearings of the pinions 591, when the nuts 594 have been tightened, to prevent these pinions from being displaced rotatively except when they are positively driven in the manner described hereinafter.

A second shaft assembly generally designated 595, Figs. 28 and 29, is mounted between the side plates 583 and 583a directly beneath the shaft assembly 586. This second shaft assembly 595 includes a series of spacing collars 596 that are of substantially the same shapes as are the spacing collars 588 in the shaft assembly 586, and which are mounted upon a rod 597 that extends between and is removably secured to the side plates 583 and 583a. End spacers 598 mounted on the rod 597 adjacent the inner faces of the side plates 583 and 583a maintain the outermost of the spacing collars 596 in spaced relation to the side plates, the bosses of these spacing collars abutting the end spacers 598 to afford bearings for rockers 599, Figs. 26 to 30, inclusive, that are thus positioned beneath the sleeves 592 in the shaft assembly 586. The upper portions of the rockers 599 are provided with cam surfaces 600, Figs. 26 and 30, which are adapted to cooperate with the sleeves 592. Springs 605 are extended between the rods 587 and 597 and are normally effective to urge the shaft assembly 586, Figs. 28 and 29, into its lowermost position in which the sleeves 592 are seated in the bottoms of the slots 585, Fig. 30, in the side plates 583 and 583a, the cam surfaces 600 of the rockers 599 being then positioned to one side of the sleeves 592. The portions of the rockers 599 extending below the rod 597 carry rollers 602 that are received in bifurcants 603 formed in the upper edges of rock arms 604 which are secured to the rock shaft 581 adjacent the inwardly facing ends of the bearings 582 in the side plates 583 and 583a.

The rock shaft 581 extends beyond the outer face of the side frame 156, and a bell crank 606, Figs. 3, 26 and 37, is rotatably mounted thereon. One arm 607 of the bell crank 606 is connected by a link 608 to one end of a lever 609 which is pivoted at its other end to the frame 156. A roller 610 is rotatably mounted on one face of the lever 609 at the middle thereof, and a spring 611, Figs. 3 and 26, acting upon the lever 609, urges the roller 610 against the periphery of a cam 612

mounted in fixed relation on the sleeve 217, Figs. 5 and 6, that is slidably but non-rotatably mounted on the cam shaft 160, the sleeve 217 being normally positioned as shown in Fig. 6, to enable the cam 612 to cooperate with the roller 610. During approximately the first half of each normal cycle of rotation of the cam shaft 160, the roller 610 rides on a relieved circular part of the cam 612, but during the latter half of the cycle, the roller 610 is on the high portion of the cam 612 and the lever 609 is moved to advance the bell crank 606, Fig. 37, counterclockwise. A rock arm 615, Figs. 5, 37 and 38, is secured to the shaft 581 adjacent the inner face of the side frame 156 and carries a pin 616 which serves as a pivot for a short lever 617 having a notch 618 formed in one edge thereof. A spring 619 extended between one end of the lever 617 and the arm 607 of the bell crank 606 tends to swing the lever 617 about its pivot 616 to cause a lug 614 carried by the arm 613 of the bell crank 606 (which lug extends inwardly of the side frame 156 through a suitable opening therein) to be seated in the notch 618, in which position the lug 614 is firmly held between one end of the notch 618 and the free end of the rock arm 615.

During approximately the first half of the first printing cycle, the type wheels 364 are selectively positioned under control of the sensing bars 229, as has been described hereinabove, and concurrently therewith the slides 571, Fig. 22, are positioned in accordance with the settings of their connected type wheels 364. It has been noted that the roller 610 of the lever 609, Fig. 26, rides on the lower portion of the cam 612 during this first half cycle. Hence, the bell crank 606 occupies its extreme clockwise position as viewed in Fig. 37 and the lug 614 on this bell crank bears against the rock arm 615 to maintain the rock shaft 581, and its connected arms 604, Figs. 28, 29 and 30, in their extreme clockwise positions, as viewed in these figures. The rockers 599 are held in their counterclockwise positions, in which the cam surfaces 600 thereof are ineffective, and therefore the shaft assembly 586 remains in its lowermost position, the sleeves 592 resting in the bottoms of the vertical slots 585. Under these circumstances the accumulator pinions 591 are out of engagement with the racks 601 of the slides 571, as shown in Fig. 26.

Shortly prior to initiation of restoring movement of the type wheels 364 and slides 571, the roller 610 rides up onto the high portion of the cam 612 and the bell crank 606 is thereby swung counterclockwise, as viewed in Fig. 37, pulling the lever 617 and its connected arm 615 to the left, rocking the shaft 581 and arms 604 counterclockwise and the rockers 599 clockwise, as viewed in Fig. 30. The cam surfaces 600 thereupon bear against the sleeves 592 and urge the shaft assembly 586 upwardly in the slots 585, causing the pinions 591 to be raised and meshed with the racks 601. The type wheels 364 are subsequently restored to their zero positions and in so doing, move the slides 571 to the right as viewed in Figs. 22 and 26 so that the accumulator pinions 591 are rotated clockwise in amounts proportionate to the numerical settings of the type wheels 364 with which they are vertically aligned. At the conclusion of the first printing cycle, the roller 610 on the lever 609 again drops into the relief in the cam 612 and the intermediate mechanism thereon is operated to restore the accumulator pinions 591 to their lowermost posi-

tions out of engagement with the slides 571. It will be noted in Fig. 30 that the depending plates 599 included in the shaft assembly 586 have bifurcations 620 at their lower ends which receive the bosses of the spacing collars 596 of the shaft assembly 586 positioned therebelow, and hence, the plates 599 are free to move up or down with the shaft assembly 586 and are guided in such vertical movement by the aforesaid bosses.

It will be recalled that only the slides 571 in the bill amount and kilowatt hour groups have accumulator pinions 591 associated therewith. The slides 571S in the district-ledger number group, therefore, are operated idly during the above described entry-effecting operations, the functions of these latter slides being explained in the description of the total taking operation.

During the first half of the second printing cycle, the roller 610, Fig. 26, rides on the low portion of the cam 612, and the bell crank 606 remains in its extreme clockwise position, as shown in Fig. 37, to maintain the accumulator pinions 591 out of mesh with the racks 601 in the slides 571. A pin 621 projects upwardly from the lever 617 to one side of the pivot 616 in lateral alignment with a roller 622 carried by an arm 623 rotatably mounted on the outer end of the tie rod 584, Figs. 5, 37 and 38. A link 624 connects the arm 623 with the rock arm 439 included in the line shifting mechanism, as shown in Figs. 3 and 5. During substantially all of the first printing cycle, the arm 623 is maintained out of engagement with the pin 621. However, in the second printing cycle, when the rock arm 439 has been shifted to bring the second variable data line on the sheet S beneath the platens 361, the rock arm 439 shifts the link 624 and arm 623 to the left, Fig. 37, and causes the roller 622 to bear against the pin 621, swinging the lever 617 counterclockwise and withdrawing it from engagement with the lug 614, thereby uncoupling the bell crank 606 from the rock arm 615. Then, in the latter half of the second cycle when the roller 610 rides onto the high part of the cam 612, the bell crank 606 swings idly counterclockwise, Fig. 37, and the rock shaft 581 remains stationary to thereby maintain the accumulator pinions 591 out of engagement with the racks 601 during the restoring movement of the slides 571. Hence, during the second printing cycle, no items are entered into the accumulator.

After the sheet S is advanced away from printing position beneath the platen 361, the line shifting mechanism is restored to its bottom line position and as an incident to this, the arm 623 is swung to retract the roller 622 from engagement with the pin 621, enabling the spring 619 to swing the lever 617 back into engagement with the lug 614. Then, as the roller 610 returns to the relieved portion of the cam 612, the arm 613 of the bell crank 606 moves to the right to bear against the end of the rock arm 615 on the shaft 631, whereupon the spring 619 elevates the lever 617 slightly to seat the lug 614 in the notch 613. When the lug 614 bears against the ends of the rock arm 615 in its clockwise restoring movement, further lateral relative movement of the arm 613 and lever 617 ceases inasmuch as the lever 617 is connected to the arm 615 which is moved to the right along with the arm 613. Because of this arrangement a very close fit may be had between the lug 614 and the left end of the notch 613 since the lug 614 cannot ride past the end of the notch 613 beyond the point at which such close fit is afforded. If the lug 614 did not bear against the arm 615, and the notch 613 alone were relied

upon to couple the lug 614 to the lever 617, a much looser fit between the lug and the notch would be necessary to insure proper seating of the lug, and this would give rise to undesirable play between the parts.

In the course of effecting an entry into the accumulator pinions in the manner described above, it may be necessary to effect a carry-over from a lower order to a higher order as is well understood in the art, and means for effecting this are provided in the accumulator apparatus.

A number of gear segments 625, Figs. 27 and 29, are rotatably mounted on the bosses of the spacing collars 596 of the shaft assembly 586, each in vertical alignment with a respective one of the accumulator pinions 591. When the shaft assembly 586 is in its lowermost position, the pinions 591 mesh with the teeth of the gear segments 625, but when the pinions 591 are raised to be meshed with the racks 601, they move out of mesh with the gear segments 625. Each gear segment 625 has an arm 626 extending laterally therefrom that is acted upon by a spring 627 anchored on a rod 628 extending between and secured to the side plates 583 and 583a. The springs 627 tend to urge the gear segments 625 counterclockwise, as viewed in Fig. 27, to thereby advance the pinions 591 clockwise, but such movement of the gear segments 625 is restrained by latches 629 rotatably mounted on a shaft 630 carried by the side plates 593 and 583a, these latches having shoulders 631 that cooperate with lugs 632 on the arms 626 of the gear segments 625, springs 633 anchored in a rod 634 carried by the plates 593 and 583a serving to urge the latches 629 into positions whereat they are effective to restrain movement of the segments 625. Each latch 629 has an upstanding arm that abuts an eye 635 formed in an aligned pawl 636 that is pivotally mounted on a rod 637 carried by the vertically movable plates 599 of the shaft assembly 586. A pin 638 carried by the plates 599 passes through the eyes 635 of the pawls 636 and limits movement of these pawls and the latches 629 under the influence of the springs 633.

Insofar as the carry-over arrangement is concerned, it should be noted that each accumulator pinion 591 is, in the present instance, provided with twenty teeth. Two of these teeth, 639 and 639a, situated diametrically opposite from each other on each pinion 591, are thickened to afford lugs on the face of the pinion. The pawls 636 are positioned on the rod 637 in alignment with the thickened portions of the teeth 639 and 639a but out of alignment with the remaining teeth of the respective pinions 591, there being one pawl 636 for each such pinion. Each pawl has a nose 640 that is positioned in the path of the movement of the teeth 639 and 639a when the eyes 635 of these pawls bear against the pin 638 under the influence of the springs 633 acting upon the latches 629. The noses 640 are so shaped that when a thick tooth 639 or 639a of a pinion 591 engages the nose 640 in the course of rotative movement of the pinion 591 during an entry-effecting operation therein, the pawl 636 is cammed out of the path of the tooth 639 or 639a, thereby tripping the latch 629 and releasing the shoulder 631 thereon from engagement with the lug 632 in the arm 626 of the associated gear segment 625, and thereby conditioning this segment to effect a carry-over entry into the next higher order accumulator pinion 591 in a manner which will be subsequently explained.

Referring to Figs. 28 and 29, a rocker 641 is

rotatably mounted on the bosses of two of the spacing collars 596 outside of the plates 590, this rocker having upwardly extending arms 642 and 643, Figs. 26 and 27, positioned intermediate the plates 590 and the rocker arms 591. A pin 644, screw-threaded at one end to the rocker arm 642, passes through enlarged openings 645, Fig. 30, in the plates 590 and 646, Fig. 27, in the gear segments 625 and thereafter extends through an opening in the other rocker arm 643 sized to provide a close fit of the pin 644 therein. The pin 644 also extends through an enlarged opening 647, Figs. 29 and 30, in the side plate 583a.

A spring 648, Fig. 27, anchored on a pin 649, secured to the side plate 583, is attached to the rocker 641 and tends to urge the rocker arms 640 and 642 counterclockwise, as viewed in Figs. 26 and 30, until the pin 644 carried thereby is arrested by engagement with an edge of the opening 647 in the side plate 583a, Figs. 29 and 30. The rocker arm 642 has a lug 650 thereon, Fig. 26, and a latch 651, pivotally mounted on the shaft 630, is arranged to cooperate with the lug 650 to restrain movement of the rocker 641 under influence of the spring 648. When the shaft assembly 586 is in its lower position, however, a pin 652, Fig. 26, carried by the adjacent depending plate 590, prevents the latch 651 from being pivoted by its retaining spring 653 into engagement with the lug 650.

A typical carry-over operation is effected in the following manner, reference being particularly made to Figs. 31 to 36, inclusive. It will be understood that the gear segment 625 shown in these views cooperates with the pinion 591 in the next order above that in which the pinion 591 shown in these views is situated. The carry-over operation is described as entailing an initial entry of 9 on the illustrated accumulator pinion 591 and subsequent entry of 2, the carry-over operation being performed as an incident to the entry of the digit 2. To facilitate explanation of these operations, the accumulator slide 571 above the pinion 591 has been shown with a reference arrow RA thereon that cooperates with a fixed scale, this arrangement illustrating the displacement of the slide 571 from its normal zero position in terms of the digital entry to be effected onto the pinion 591 for the purposes of this description.

At the initiation of the first printing cycle, the parts are in the positions shown in Fig. 26, the shaft assembly 586 including the pinions 591 resting on the bottoms of the slots 585 in the side plates 583 and 583a so that the pinions 591 are disengaged from the racks 601 in the slides 571 thereabove. The latch 651 is prevented from engaging the lugs 650 on the rocker arm 642 by the pin 652 in the adjacent depending plate 590 of the shaft assembly 586, and hence, the rocker 641 occupies its extreme counterclockwise position, as viewed in Fig. 26, where the pin 644 carried thereby rests against the edge of the openings 647, Figs. 29 and 30, in the side plate 583a. The parts remain in these positions during the first half of the printing cycle, while the roller 610 of the lever 609 is riding on the low portion of the cam 612. In this interval, the type bars 364, Fig. 22, are selectively positioned for printing the bottom line of variable data V on the sheet S, Fig. 61. Assuming that the digit set up on the type wheel 364 geared to the slide 571, Fig. 31, is 9, the slide 571 is displaced from its initial position, in which position the arrow RA is aligned with "0" on the scale, through nine

digital positions until the arrow RA is opposite the numeral "9" on the scale, the pinion 591 remaining out of engagement with the rack 601 while this displacement of the slide 571 is being effected.

Prior to the initiation of the restoring movements of type wheel 364 and slide 571, a lobe 612a on the cam 612, Fig. 26, comes under the roller 610, swinging the lever 609 and bell crank 606 to rock the shaft 581 and rock arms 604 counterclockwise, as viewed in Fig. 31. This causes the rock arms 599 to be swung clockwise to thereby elevate the shaft assembly 586 and bring the pinions as 591 into mesh with the racks as 601. The plates 590 are raised with the shaft assembly 586 to thereby retract the pin 652 from the latch 651. As shown in Fig. 30, the pin 644, carried by the rocker arms 643 and 642, projects into the path of movement of the rocker 599 adjacent the side plate 583a. Engagement of the lobe 612a on the cam 612 with the roller 610, Fig. 26, insures that the rocker 599 will displace the pin 644 and rocker 641, of which the arms 640 and 642 are a part, sufficiently to enable the latch 651 to hook the lug 650 and maintain the rocker 641 in its extreme clockwise position, as viewed in Fig. 31.

As the lobe 612a passes from beneath the roller 610, this roller drops slightly to cause a slight retraction of the rockers 599 counterclockwise, as shown in Fig. 32, to afford a small clearance between the rocker 599 and the pin 644 and lug 650. The roller 610, however, remains on the high circular portion of the cam 612 for the greater part of the second half of the first printing cycle, thereby maintaining the pinions as 591 in engagement with their racks as 601. It will also be noted in Fig. 32 that there is a slight clearance between the pin 644 and the edge of the opening 646 in the gear segment 625. As shown in Fig. 32, the slide 571 has been restored to the right back to its zero position, and in the course of this restoring movement, the pinion 591 engaged therewith is advanced clockwise nine digital positions, which is to say, nine teeth. Assuming that the pinion 591 originally stood in a position indicative of zero, as shown in Fig. 31, the aforesaid rotation of the pinion 591 through nine digital positions brings the thick tooth 639 into a position adjacent the nose 640 of the aligned pawl 636 where it is in position to cooperate with a cam edge on this nose. However, inasmuch as there is no carry-over entailed in adding nine to zero, the movement of the pinion 591 in this entry-effecting operation is not sufficient to bring the thick tooth 649 beyond the nose 640 of the pawl 636. The pawl 636 and latch 629, therefore, remain stationary so that there is no displacement of the gear segment 625 controlled thereby.

At the conclusion of the first printing cycle, the roller 610, Fig. 26, will have ridden on to the low portion of the cam 612, and the rock shaft 581 and rock arms 604 are thus restored clockwise to their normal positions as shown in Fig. 26, swinging the rockers 599 counterclockwise and enabling the shaft assembly 586 to drop to the bottoms of the slots 585 to withdraw the pinions 591 from the racks 601. As has been mentioned, the pawls 636 are pivotally mounted on a rod 637 carried by the plates 590 of the shaft assembly 586 and hence, these pawls are raised and lowered together with the pinions 591, the eyes of the pawls 636 sliding along the vertical edges of the latches 629 cooperating

therewith. The pin 652 on the adjacent plate 590 is lowered into engagement with the latch 651, swinging this latch downwardly to release the lug 650 and enable the spring 548 to return the rocker 641 counterclockwise as viewed in Fig. 33, until the pin 644 is arrested by the edge of the opening 647, Figs. 29 and 30, in the side plate 583a.

During the second printing cycle, the accumulator drive is disabled by the mechanism including the arm 623, Fig. 37, and link 624 that is under the control of the line shifting mechanism, as has been explained hereinabove, and the parts of the accumulator mechanism, therefore, remain in their normal at rest positions, as shown in Fig. 26, throughout the second cycle wherein the top line of data V is printed upon the sheet S, Fig. 61. When the next succeeding sheet S has been advanced into printing position beneath the platens 361, Fig. 22, the cam shaft 160, Fig. 26, is sent through a cycle of rotation to bring about printing of the bottom line of data V upon such sheet. Assuming that the digit 2 has been set up on the connected type wheel 364, the slide 571 is displaced in the amount of two digital positions to the left, as shown in Fig. 33, during the first half of this cycle. The roller 610, Fig. 26, however, remains on the low part of the cam 612 to maintain the accumulator pinions 591 out of engagement with the racks 601, as shown in Fig. 33.

As the lobe 612a comes under the roller 610, the rockers 599 are swung clockwise, as viewed in Fig. 34, to elevate the pinions 591 into engagement with their racks 601, the rocker 599 adjacent the side plate 583a, Figs. 28 and 29, engaging the pin 644 to push the rocker arms 640 and 642 clockwise and enable the latch 651 to hook the lug 650. The lobe 612a on the cam 612 then moves away from the roller 610 and this roller drops slightly onto the high circular portion of the cam 612 to retract the rocker 599 slightly from the pin 644 and lug 650, as shown in Fig. 35. The slide 571 is thereupon restored to its zero position, rotating the pinion 591 through two digital positions, that is, in the amount of two teeth thereof, to a position representative of the digit 1, inasmuch as this is the units component of the sum of 9 plus 2 or 11.

It has been mentioned that a slight clearance is normally afforded between the pin 644 and the openings as 646 in the gear segments as 625 when the arms 626 of these gear segments are held against movement by the latches 629. However, as the tooth 639 of the pinion 591, Fig. 35, is carried past the nose 640 of the pawl 636, in passing from the position representative of the digit 9 to that representative of zero, it cams the pawl 636 outwardly to thereby swing the latch 629 clockwise, and move the shoulder 631 thereof out of latching engagement with the lug 632. Spring 627 thereupon pulls the arm 626 upwardly a limited distance until the clearance between the opening 646 in the gear segment 625 and the pin 644 is taken up. The lug 632 is thus moved slightly upwardly out of alignment with the edge of the shoulder 631 to thereby prevent the spring 633 from restoring the latch 629 when the tooth 639 has been advanced past the nose 640 of the pawl 636. The latch 629 is, therefore, rendered ineffective and movement of the gear segment 625 under the action of the spring 627 is restrained only by the pin 644 carried by the rocker 641, as shown in Fig. 35. This small displacement of the gear segment 625 is not suffi-

cient to move its teeth out of substantial alignment with the teeth of the pinion 591 in the next higher order aligned therewith. Hence, when the roller 610 rides onto the lower portion of the cam 612, toward the end of the cycle, and the pinions 591 are lowered, the aforesaid pinion in the next higher order meshes with the gear segment 625, as do the other pinions 591 with their gear segments 625.

The cam surface 600, Figs. 26 and 30, on the upper end of each of the rockers 599 is of such a configuration that it enables the pinions 591 to be lowered and mesh with their gear segments 625 prior to the time the pin 652 on the plate 590 engages the latch 651 and thereafter releases the rocker 641 to the action of its spring 548. Those gear segments 625, such as shown in Fig. 35, which are restrained against movement under the tension of their springs 627 solely by the pin 644, by reason of the corresponding latch 629 having been tripped to condition the mechanism for effecting a carry entry, are swung counterclockwise by their springs 627, as shown in Fig. 36, when the rockers 599 are restored to their normal or extreme counterclockwise positions. Such rocking movement of those gear segments 625 that were released to effect carry entries continues until the pin 644 is arrested by engagement thereof with the edge of the opening 647 in the side plate 583a (see Fig. 30), and this limited movement of the gear segment 625, Fig. 36, is sufficient to advance the pinion 591 that is meshed with such gear segment 625 in the amount of one tooth clockwise to thus effect the carry entry of 1.

In the next entry-effecting operation, when the shaft assembly 536 is to be again elevated, the rockers 599 are swung clockwise, as viewed in Figs. 31 and 34, engaging the pin 644 and swinging the rocker 641 and those gear segments 625 which were released in the above described carry-entering operation clockwise. The lobe 612a on the cam 612, in engaging the roller 610, imparts sufficient clockwise movement to the rocker 641 to bring the lugs 632 on the arms 626 of the gear segments 625 below the shoulders 631 on the latches 629 so that the springs 633 acting upon the latches 629 bring these shoulders 631 over the lugs 632, thereby latching the gear segments 625 in their normal inoperative positions, as shown, for example, in Fig. 31.

There may be instances in which long carries are to be effected. To illustrate, an accumulator pinion 591 may be standing in a position representative of the digit 9 prior to the time a carry-over onto such a pinion occurs. Upon entry of such carry digit, the aforesaid accumulator pinion thereupon moves into a position representative of zero, and a carry must then be effected into the accumulator pinion 591 in the next higher order. In this event, the carry segment 625, which was tripped when the lower order accumulator pinion 591 passed from a position representative of the digit 9 to a position representative of zero, is immediately rocked by its spring 627 from the position shown in Fig. 34 into the position shown in Fig. 36, without pausing at the intermediate position shown in Fig. 35. This occurs for the reason that the pin 652 on the plate 590 will have already descended into the position shown in Fig. 36 prior to the time the carry segment 625 is released by disengagement of the shoulder 631 on the pawl 629 from the lug 632 on the segment 625, the plate 590 and pin 652 having been lowered at the initiation of the carry entering oper-

ation as explained hereinabove. Hence, when a long carry is to be entered into a higher order accumulator pinion, such a carry will take place immediately upon passage of the lower order accumulator pinion 591 from a position representative of the digit 9 into a position representative of the digit 0, the higher order pinion 591 having been lowered into engagement with the gear segment 625 before this segment is tripped by the lower order pinion 591.

As has been described previously, the slides 571, Fig. 22, that are meshed with the special wheels 364a, Fig. 5, in the two highest orders in the kilowatt-hour consumption and bill amount groups are restrained against movement by pawls 578, as shown in Fig. 22, during ordinary printing operations. Hence, those accumulator pinions 591 that are disposed in alignment with these slides 571 in the aforesaid two highest orders in each group, do not receive any entries as a direct consequence of the setting up and restoration of the type wheels 364, as do the other pinions 591. These pinions are adapted to receive carry-over entries which may accrue in the course of addition of the successive numerical quantities entered in the accumulator. It will be understood that if the anticipated totals obtained in any one run of the machine exceed the two additional orders thus provided for in the accumulator mechanisms, additional special wheels 364a, Fig. 5, and associated accumulator slides 571 and pinions 591, together with the attendant mechanisms required, will be provided to accommodate the spill-over, as it is termed in the art, into the higher orders.

Total taking

As will be noted from the foregoing description of the accumulating operations entailed in the printing of certain of the items of variable data V upon the sheets as S, Fig. 61, the cam 612, Figs. 3, 5, 6 and 26, is instrumental in governing the operation of the accumulator during the usual variable data printing operations. When it is desired to furnish a record of the total of such items as have been entered into the accumulator in the course of the several printing operations, the accumulator must be conditioned for enabling a total standing therein to be recorded, as by being printed, upon the proof web 507—W. In the present instance, this is accomplished by disabling the cam 612 and rendering effective another cam 655 having a shape substantially identical with that of the cam 612. This cam, however, is mounted in such angular relation to the cam 612, upon the sleeve 217 on the cam shaft 160, that the corresponding parts of the two cams are approximately 180° displaced from each other, the effect of such configuration of the cam 655 upon the operation of the accumulator mechanism being described presently.

It will be noted in Fig. 26 that when the cam shaft 160 is at rest, the portion of the periphery of the cam 612 adjacent the roller 610 is the same radial distance away from the shaft 160 as is the point on the periphery of the cam 655 horizontally aligned therewith. Moreover, a stop pin 609a anchored in the side frame 155 limits movement of the lever 609 under influence of the spring 611, thereby maintaining a slight clearance between the roller 610 and aligned cam 612, in the positions of the parts shown in Fig. 26.

Hence, the sleeve 217 may be shifted along the cam shaft 160, while this shaft is stationary, to move the cam 612 out of alignment with the

roller 610 and to move the cam 655 into alignment with this roller, or vice versa. For the purpose of shifting the sleeve 217 along the cam shaft 160, a yoke 656 is secured to the rock shaft 419, Figs. 3, 5 and 26, and depends therefrom in such a manner that rollers carried at the lower ends of the arms thereof are received in a channel defined between the gear 216 and a raised bearing portion on the sleeve 217, as shown in Figs. 5 and 6.

A spring 657, Figs. 3 and 6, anchored in the side frame 156, is connected to the end of the rock arm 418 on the shaft 419 and tends to urge this shaft counterclockwise, as viewed in Fig. 5. As shown in Fig. 3, the shaft 579, on which the pawls 578 (see Fig. 22) are mounted, projects beyond the side frame 156 and is provided with a rock arm 658 that is connected by the link 417 to the rock arm 418, Fig. 6, on the shaft 419. Hence, rotation of the shaft 419 under the influence of the spring 657 is limited by engagement of the pawls 578 with the aligned accumulator slides 571, it being recalled that these are the slides which are geared to the spillover wheels 364a, Fig. 5, in the kilowatt hour consumption and bill amount groups of type wheels 364. Link 417 is also connected to the arm 415 carrying the pin 410, Figs. 3 and 22, which cooperates with the platen control lever 408, as described hereinabove, and hence the uppermost position of the pin 410 is likewise defined by engagement of the pawls 578 with their slides 571. In the positions of the parts as just described, the yoke 656 on the rock shaft 419 is so located that the cam 612 is aligned with the roller 610 on the accumulator operating lever 609.

A bell crank including the arms 659 and 660, Figs. 5 and 6, is secured to the shaft 419, and the arm 659 is pivotally connected to the core of a solenoid 661 supported by a bracket 662 fastened on the outer face of the side frame 156. The arm 660 extends upwardly from the shaft 419 and is pivotally connected at its upper end to a horizontal bar 663, which extends through suitable openings in the side frames 155 and 156 and which is guided for lateral reciprocatory movement therein. A lever generally designated 664, Figs. 3 and 37, is pivotally mounted on a bracket 665 secured to one of the bars 398b carried by the side frames 155 and 156, and an arm 666, Figs. 3, 8 and 9, of the lever 664, extends laterally above and is urged into engagement with the upper edge of the bar 663 by a spring 667 acting upon a depending arm 668 of the lever 664. When the bar 663 is shifted to the right, the arm 666 engages in a notch 669 in the bar 663, Fig. 9, and serves as a latch for holding the bar 663 in its right-hand position.

When a total-taking operation is to be effected, the key 671, Figs. 4, 7 and 57, is depressed, thereby rocking a key lever 672 that is rotatably mounted on a pin 673 secured to and projecting inwardly from the side frame 156, the key lever 672 being extended through an opening in the plate 297 at the front of the machine. The lever 672 thereupon closes a switch 674 (which comprises a movable contact 675 cooperating with a conductive strip 398a, Figs. 7 and 14, that is permanently connected to the line wire 335A as diagrammatically shown in Fig. 57) thereby extending circuit from the line wire 324, Fig. 57, through switch 674, and conductor 676 to the winding of the solenoid 661, thence through conductor 677 to the other line wire 335. Solenoid 661 thereupon energizes and retracts its plunger to there-

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by swing the arms 659 and 660, as well as the shaft 413, clockwise as viewed in Fig. 5, and pushing the bar 663 to the right until the notch 669 therein comes beneath the end of the lever arm 666. The arm 666 thereupon drops into the notch 669 and locks the bar 663 against movement toward the left as viewed in Fig. 5. The rock shaft 419 is thus moved to its extreme clockwise position, as viewed in Fig. 5, to swing the yoke 656 outwardly and thereby shift the sleeve 217 along the cam shaft 180, Figs. 5 and 6, away from the frame 156, so that cam 612 is moved out of alignment with the roller 610, while the cam 655 is brought beneath this roller, the shaft 413 being held by the aforesaid locking arrangement in such position that the cam 612 is rendered ineffective and the cam 655 becomes operative. Concurrently with the shifting of the sleeve 217, a laterally extending arm 670 secured on the left end of the shaft 413, Figs. 3 and 6, is rocked downwardly to hold the lever 243 in such position that the roller 259, Figs. 7 and 8, is maintained in its uppermost position throughout the ensuing total-taking operation, so that the sensing bars 229 are maintained in their raised positions and hence are ineffective to operate the solenoids 393, Fig. 22, for the type wheels 364. Likewise, the account number sensing brushes 231, Figs. 3, 8, 19 and 56, are maintained in their uppermost positions out of engagement with the stationary contacts 234 throughout this operation.

As another incident to the shifting of the sleeve 217 on the cam shaft 180, the gear 213, Figs. 5 and 6 on this sleeve, moves out of mesh with the gear 215 that is connected to the shaft 204, and hence, the shaft 204 remains stationary so long as the sleeve 217 is held in its outermost position as just described, even though the cam shaft 180 may be rotated. Therefore, the selective control cam shaft 452, Figs. 3 and 6, remains stationary so that the timing switches 475, 322 and 332A, Figs. 6, 45, 46, 46A, 57 and 59, remain open. Thus the number comparison circuits, Fig. 59, insofar as the switches as 453 and 437, Fig. 6, and 390, Fig. 8, are concerned are rendered ineffective. Since the cam shaft 185 is driven from the shaft 204 the disconnection of the gears 215 and 216 also causes the card feed mechanism to be disabled. Likewise, the line shifting mechanism remains in its lower line position inasmuch as the cam 443, Figs. 37 and 39, on the shaft 204 is stationary in this operation.

As a further incident to the rocking of the shaft 419 by the solenoid 661, the link 417, Fig. 3, is pulled downwardly to thereby rock the connected arm 615 and shaft 579 and withdraw the pawls 578 from engagement with the accumulator slides 571 in the two highest orders of the kilowatt hour consumption and bill amount groups, and thereby enable the wheels 364a, Fig. 5, to be moved, as will be described. The end of the rock arm 653 opposite that to which the link 417 is connected has a pin and slot connection with the end of a rock arm 678 on a shaft 679, Figs. 3 and 22, on which shaft is mounted a pawl 680 positioned above those slides 571S that are meshed with type wheels 364 which do not have accumulator pinions 591 associated therewith (district and ledger numbers). As the pawls 578 are raised, the pawl 680 is pivoted downwardly to seat in notches 681 in the slides 571S positioned therebelow, thereby locking the type wheels 364 in the district and ledger number groups against movement.

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Concurrently with this actuation of the pawls 578 and 680, the arm 415 is pulled diagonally downwardly. The pin 410 mounted in the upper end of the arm 415 thus moves downwardly and slightly to the left as viewed in Fig. 22, bearing against the side of the notch 412 and causing the pawl 411 to be pivoted counterclockwise away from its normal position shown in Fig. 22E into the position thereof shown in Fig. 22F. Because of the clearance between the upper edge of the arm 373 and the lower edge of the pawl 411, Fig. 22E, such rocking of the pawl 411 does not disturb the setting of the arm 373. The combined downward and sideward movement of the pin 410 enables a relatively small displacement thereof away from its normal position to rock the pawl 411 clockwise, Fig. 22F, through a considerable distance, for a purpose which will be explained presently.

Actuation of the key lever 672 merely conditions the machine for performing a total-taking operation, which is to say, that it results in rocking the shaft 419 to its extreme clockwise position, as viewed in Fig. 5, with the various effects described above. If for any reason it should be desired to cancel this set-up of the apparatus for performing a total-taking operation, the key 682 is pressed inwardly, thereby actuating a link 683 that is slidably mounted in the plate 297 and which has a pin-and-slot connection with an upstanding arm 684 of the lever 664, as shown in Fig. 37. The lever 664 is thereby swung to retract the arm 686 from the notch 669, Fig. 9, in the slide bar 663, thereby releasing this bar and enabling the spring 657, Figs. 3 and 6, to restore the rock shaft 419 counterclockwise, as viewed in Fig. 5, to its normal position in which the yoke 656 maintains the sleeve 217 in its innermost position toward the side frame 156.

Assuming, however, that the bar 663 is held latched by the arm 666 and it is not necessary to cancel the total-taking set-up of the machine, which was effected by energization of the solenoid 661 as aforesaid, the key 685, Figs. 3, 4, 7, 14 and 57, is depressed, thereby rocking the key lever 686, that is pivotally mounted on the pin 673, and closing the switch 687 (this switch comprising a movable contact 688 that cooperates with the fixed conductive segment 308a, as shown in Fig. 14). This extends circuit from the line wire 324 through the closed switch 687, and conductors 689 and 690 to the winding of the clutch solenoid 174, Figs. 5 and 57, connected by conductor 691 to the line wire 335. The solenoid 174 thereupon becomes energized to cause the cam shaft 180 of the variable printing and accumulating apparatus B to go through a cycle of rotation.

Shortly after initiation of such rotation of the cam shaft 180, the lobe 655a, Fig. 26, on the cam 655 engages the roller 610 and swings the lever 609 upwardly to cause the accumulator pinions 591 to mesh with the racks 601 on the aligned slides 571, as shown in Fig. 31. Subsequently, the low portion of the cam 292, Fig. 37, comes beneath the roller 291 on the drive lever 288, thus enabling the spring 293, Fig. 22, to urge the lever 288 clockwise, thereby rotating the gears 285 and 287 on the shaft 286 counterclockwise. Such rotation of the gears 285, Figs. 22 and 23, retracts the slides 279 toward the rear of the machine, thereby releasing the sensing bars 229, Fig. 8, to the action of their spring-urged pusher arms 282. This is without effect in the present instance, however, other than to cause the sensing

bars 229 to move idly rearwardly along with the bail 280 carried by the slides 279, inasmuch as these bars are maintained in their raised positions, as has been described. Rotation of the gears 287 swings the driving levers 378 clockwise, Fig. 22, to retract the bail 384 for the type wheels 364 in the same direction. The type wheels 364 and 364a, Figs. 22 and 5 (except those in the district and ledger number groups), thereupon commence to rotate clockwise, as viewed in Fig. 22, being pulled by the springs 382, Figs. 22A and 22B, extended between these type wheels and the lugs 380 on the levers 378, thus shifting the accumulator slides 571 to the left as viewed in Fig. 22. The noses 640, Figs. 27 and 31, on the pawls 636 that cooperate with the thick teeth 639 and 639a on the accumulator pinions 591 are so shaped that they operate to arrest one or the other of such teeth when the pinion 591 is rotated counterclockwise, as viewed in these figures, sufficiently to engage the tooth with the nose 640. Hence, as each pinion 591 is rotated counterclockwise due to the shifting of the connected slide 571 to the left, it rotates through an angular distance representative of the value of the digit registered thereon and is then arrested by engagement of a tooth 639 or 639a thereof with the nose 640 of the cooperating pawl 636. Thus, the accumulator pinions 591 are returned to their zero positions and the slides 571 are enabled to shift through distances respectively determined by the numerical values of the digits in the accumulated total that was previously accumulated on the pinions 591, the slides 571 being halted when the pinions 591 have been arrested in their zero positions.

The type wheels 364, pinions 551 and type bars 543, Figs. 22, 24 and 25, in the kilowatt-hour consumption and bill amount groups, are moved in the just described operation through distances proportionate to the accumulated totals of the net bill amounts and total kilowatt hours consumption quantities entered in the accumulator subsequent to a preceding total-taking operation. The type wheels 364 in the district and ledger number groups, however, are prevented from rotating by the pawl 680 which has been seated in the notches 681 in the slides 571S geared to these wheels, as described hereinabove, there being no accumulator pinions associated with these slides. Hence, the zero suppressing mechanism including the pawls as 558, Figs. 24 and 25, for the type bars 543 connected with the district and ledger number type wheels 364 functions to hold these type bars in their upper inoperative positions throughout the total-taking cycle. The type wheels 364 which ordinarily function to print the meter readings, rate designation, and duplicate net bill, are merely moved idly with the bail 384, Fig. 22, during the total-taking operation. Such idle operation of these type wheels 364 at this time is however immaterial, since the hammers 361 are all rendered inoperative during the total cycle by the latch 411.

A switch 692, Figs. 3, 6, 37 and 59, is mounted on the outer face of the side frame 156 in position to be closed by the arm 670 on the rock shaft 419 when this arm is lowered to lock the bar 243 in its inoperative position at the commencement of the total-taking operation. Another switch 693 is mounted on one of the bars 398b carried by the side frames 155 and 156 in a position to be closed by the shank of the drive lever 288 when this lever has reached its extreme clock-

wise position, as viewed in Fig. 37. When the lever 288 reaches such position, the type wheels 364 and associated parts will have been locked either in their zero positions (as in the case of the district-ledger number group) or in positions representative of significant digits that have been read out from the accumulator (net bill and total kilowatt-hours), or will have moved idly with the bail 384 to its extreme operative position (meter reading, rate designation, and duplicate net bill groups), and thereupon the switch 693 is closed. As can be seen in Fig. 59, the switches 692 and 693 are connected in series with each other and with the winding of a multi-contact relay 694. Hence, closure of the switches 692 and 693 extends a circuit from the line wire 335A through conductors 695 and 696, switches 692 and 693, winding of multi-contact relay 694, and conductor 697 to the other line wire 335. Relay 694 thereupon energizes and closes its several contacts.

One terminal of each of the contacts of relay 694 is connected by a conductor 698 to the conductor 695 and the other terminal of each of these contacts is connected by a conductor 699 to one side of the winding of a respective type-wheel-control solenoid 398, Fig. 22, the other side of each such winding being connected to the line wire 335, as indicated in Fig. 59. Preferably, there are as many contacts of the relay 694 as are necessary to individually connect the conductor 698 with the various solenoids 398. Alternatively, however, a plurality of relays as 694 may be connected in parallel to afford the necessary number of contacts; although, as will be explained, it is not necessary in the illustrated arrangement that all of the solenoids 398 be so connected with the aforesaid relay contacts. It will be apparent from the foregoing that all of the solenoids 398 are energized when the relay 694 becomes energized, this occurring when the type bars 543 and type wheels 364 have been adjusted to selected positions, as aforesaid, and thereupon the pawls 393 engage the teeth 391 on the several type wheels 364.

Prior to the time the drive lever 288 is moved by the cam 292 out of engagement with the switch 693, Fig. 37, during its restoring movement, the roller 610, Fig. 26, rides onto the low portion of the cam 655 to thereby cause the lever 699 to be lowered and retract the accumulator pinions 591 downwardly out of engagement with their racks 601. When this occurs the type wheels 364 associated with these accumulator pinions are urged by the springs 382 to take up the slight clearance between the pawls 393 and the adjacent teeth 391 so that these type wheels are thereupon held in self-locking engagement with the pawls 393 so long as they are under the action of the springs 382. Therefore, when the drive lever 288 subsequently moves away from the switch 393, Fig. 37, thus opening this switch to deenergize the relay 694, Fig. 59, and consequently the solenoids 398, the pawls 393, Fig. 22, are held in frictional locking engagement with these type wheels 364 under the tension of the springs 382. The type wheels 364 for the district and ledger numbers are held locked in their zero positions by the pawl 680 cooperating with the connected slides 571S. The remaining type wheels will have already been moved to their extreme operative positions, and hence there is very little, if any, spring tension on these wheels, so that the pawls 393, though actuated by the sole-

noids 398, have substantially no effect upon such wheels.

When the type bars 543 (which, it will be recalled, are associated only with the bill amount, kilowatt-hour, and district-ledger number groups of type wheels 364) have been selectively positioned to represent the totals of the net bill amounts and the kilowatt-hour consumption quantities, the roller 535 on the lever 533, Fig. 40, drops into the relief in the cam 537 to thereby actuate the link 532 and thus retract the tie rod 545 which supports the type bars 543 in their raised positions. The springs 553 thereupon snap the type bars 543 downwardly (except for the several type bars 543 in the district and ledger number groups, as well as any type bars 543 in the net bill and consumption quantity groups upon which the zero suppressing mechanism is operative) to make an impression of the net bill and kilowatt hour totals upon the proof web 507—W.

The pin 414, Figs. 22 and 23, on the drive lever 370 is ineffective to cause the release of the platen arms 367 above the type wheels 364 in this total-taking operation, because of the manner in which the pawl 411 has been positioned by the pin 410, Fig. 22F. Thus, as the lever 408 is engaged and rocked by the pin 414 its right end, Fig. 22G, is lowered, but this merely enables the pawl 411 to rock slightly clockwise, Fig. 22G, about its pivot until the lowermost corner of this pawl is disposed in the notch or recess 413 in the arm 373. The depth of this recess is such that the pawl 411 is unable to push the arm 373 downwardly while the lever 408 is being rocked by the pin 414, and hence no impression is made from the type wheels 364.

As the bail 384 engages the ribs 353 of the various type wheels 364 during counterclockwise restoring movement thereof, as viewed in Fig. 22, the pawls 393 are released from their self-locking engagement with the teeth 391 of these type wheels and are restored by their springs 354, out of engagement with these teeth. This arrangement insures that the type wheels will not be prematurely released to forcibly strike the bail 384 during the restoring operation. The sensing bars 223, Figs. 7 and 8, being held in their raised positions throughout the total-taking cycle, move idly back and forth during this cycle. Those type wheels 364 which do not have type bars 543 connected therewith likewise move idly and are, of course, ineffective during the printing of the total. As the tie rod 545 is restored to its upper position, it raises the type bars 543 which were instrumental in printing the totals, and the link 527 is concurrently actuated to advance the proof web 507—W for bringing the next blank line beneath the ribbon IRb.

As the final step in the total-taking operation, a lobe 700 on a cam 701, Fig. 37, mounted on the cam shaft 160 comes into engagement with the roller 702 on the lower end of the arm 658 of the lever 654 and swings this lever to raise the arm 656 and thereby release the slide bar 603, Figs. 5 and 6. This occurs at about the same time as the cam shaft 160 completes its cycle of rotation so that the cams 612 and 655, Fig. 26, on the sleeve 216, Figs. 5 and 6, are stationary when the spring 657, Fig. 3, restores the rock shaft 419 upon release of the bar 603. Hence, the yoke 650 moves the sleeve 217 inwardly to bring the cam 612 beneath the roller 610 and to move the cam 655 out of alignment with this roller. Return of the rock shaft 419 to its normal position raises

the arm 670 from engagement with the lever 243 but this is ineffective inasmuch as the cam 245, Fig. 37, has come to rest with its high point engaging the end of the lever 243. The link 417 is pushed upwardly to its normal position, thereby rocking the arm 658, Fig. 3, to disengage the pawl 680 from the slides 571S in the district and ledger number groups and engage the pawls 578 with the slides 571 geared to the spill-over wheels 364a, Fig. 5, in the kilowatt-hour and bill amount groups. The pin 410 is also raised to restore the pawl 411 from the position shown in Fig. 22F to the position shown in Figs. 22 and 22E, this pawl having been rocked from the position shown in Fig. 22G to that shown in Fig. 22F upon disengagement of the pin 414 from the lever 408 during restoration of the drive lever 270.

OPERATION OF THE MACHINE

In the following description of machine operation, reference is made particularly to the illustrated embodiment of my invention in which, in addition to the novel variable data printing and accumulating apparatus disclosed herein, a number of other machine units are provided, for example, the web withdrawing and severing means, platen P, and form printing unit U, all of these machine units being required for the production of a complete record sheet such as S, Fig. 61. The description, however, will be chiefly directed to the operation of the present invention and only such references will be made to the operation of other units of the machine as are essential to the understanding of my invention.

Prior to setting the machine into automatic operation, and as is explained more fully in my co-pending application, Serial No. 221,841, now Patent No. 2,296,277, referred to hereinabove, the web withdrawing and severing means is operated to sever a sheet S from the web W leading from the roll R, Figs. 1 and 2. Such web withdrawing and severing means are fully described on pages 13 to 19 of my aforesaid Patent No. 2,296,277, the structure being fully illustrated in Figs. 4 to 16, 16A, 17A, 18A, 19A and 20A of such patent. As herein shown the web withdrawing means are set into operation through manual closure of a switch 148D by means of a push button 1647, Fig. 57, which corresponds to the push button shown in my aforesaid Patent No. 2,296,277. Such closure of the switch 148D completes a circuit between the two line wires 335A and 335 so as to energize the solenoid 148C, thereby starting the web withdrawing means through its cycle of operation. The switch 148D is arranged in parallel relation with a switch 148E that governs the operation of the web withdrawing means during automatic operation of the machine, and such switch 148E is arranged for closure at the proper time in the cycle of machine operation by a single-lobed cam 147E, Fig. 57, mounted on the timing shaft 146. In this operation, the date E, Fig. 61, is printed on the sheet S. After being severed from the web W the sheet S is fed through the sheet guideway G, Fig. 2, to a position beneath the platens 361 of the printing apparatus B, the sheet being arrested at such position by the stop finger 149 which is in sheet stopping position at this time. Likewise, in such preliminary operation of the machine, the first printing and control device D, Fig. 49, is fed from the station I in the magazine H to the sensing station II, Figs. 48, 50 and 56, where it is disposed in position to have the identification card 6 thereon sensed by the detector 120, in a subsequent machine operation. Such opera-

tion of printing device feeding mechanism is initiated through actuation of a push button 1621, Fig. 57, that corresponds to a push button 1621 in my aforesaid Patent No. 2,296,277, and the push button 1621 serves to close a switch 80A to thereby establish circuit through the solenoid 80 from the line wires 335A to 335. This energizes the solenoid 80 and causes operation of printing device feeding means through its cycle of operation. During automatic operation of the machine, the solenoid 80 is energized by closure of a switch 80B that is in parallel with the switch 80A, and such switch is closed at the proper time in the machine cycle by a single-lobed cam 80C that is mounted on the timing shaft 146, as shown in Fig. 57.

The printing apparatus B must also be conditioned for operation, and this entails advancing the first card C, Fig. 60, from the bottom of the stack in the magazine K, Figs. 1 and 15, into position to be sensed by the bars 229, Figs. 7 and 8. To perform this function, the key 685, Figs. 7, 14 and 57, is depressed to close the switch 687 thereby energizing the clutch solenoid 174 of the printing apparatus B in the manner described hereinabove, and causing the cam shaft 160 of the apparatus B to go through a cycle of rotation. As can be seen by reference to the timing chart, Fig. 63, the card picker 184, Fig. 15, is ineffective during this initial cycle of operation inasmuch as it is not in position to engage the rear edge of the bottom card C in the stack, but is initially disposed beneath this bottom card so that in the first cycle the picker 184 merely advances idly to the right into the extreme position shown in Fig. 15 and then, at approximately 190° in the rotation of the cam shaft 160, it is retracted rearwardly, coming to rest at the end of this cycle in a position where it is still disposed beneath the bottom card in the stack. The other operations of the printing apparatus B which are normally performed during such rotation of the cam shaft 160, and which will be explained more fully hereinafter, are performed idly in this initial conditioning cycle. Thus, the sensing bars 229, Fig. 8, are lowered by the roller 259 and the bail 280 is retracted, but inasmuch as no card has been positioned as yet beneath the sensing bars 229, these bars close all of their switches 300 in their zero positions. Therefore, the type wheels 364, Figs. 22 and 23, remain in their zero positions, as do the connected accumulator slides 571 and type bars 543. The zero suppressing mechanisms including the levers 402 and 558, Figs. 22 and 24, are thereby effective to suppress the operation of the platen arms 367 and type bars 543 so that no printing operations are effected by the apparatus B.

When the foregoing has been effected, the key 685 is depressed a second time to send the cam shaft 160 through another cycle of rotation and in this cycle, as can be seen by reference to the timing chart, Fig. 64, the card picker 184, Fig. 15, is retracted rearwardly of the magazine K to enable the bottom card C in the stack to drop into the path of travel of the picker at approximately 190°. In this second cycle the picker 184 commences to advance toward the stack of cards in the magazine K and in the course of such advancing movement engages the rearward edge of the bottom card and carries this card forwardly until the card is engaged by the first feed roller 219, Figs. 7 and 15, whereupon this roller advances the card rapidly toward the second roller 219, which latter roller advances it into

engagement with the card stop finger 223, in which position the card comes to rest toward the end of this second preliminary cycle. As in the case of the first preliminary cycle, the other operations of the printing apparatus B are idle inasmuch as the sensing bars 229 are imparted sensing movement a substantial time before the lowermost card C is advanced from the magazine K; hence, printing is suppressed, and the sensing bars 229 are restored and returned to their upper inoperative positions to enable the card to be subsequently advanced thereunder.

The foregoing preliminary operations having been performed, the machine is now ready for automatic operation. A start-stop switch SS, Fig. 57, is mounted in the main control panel of the printing machine, as shown in Fig. 2, this switch comprising a central push button 705 and a movable shell 706. A set of contacts generally designated 707 is positioned to be actuated by the switch SS, this set comprising an upper contact 708, two middle contacts 709 and 710 that are electrically connected but independently movable, and a lower contact 711. The contacts 708 and 709 are normally engaged and are separated only when the shell 706 of the switch SS is depressed, whereas the contacts 710 and 711 are normally disengaged and are only engaged when the push button 705 is depressed.

To start the machine in automatic operation, the push button 705 is depressed to engage the contacts 710 and 711, and then a circuit is extended from the line wire 335A through a conductor 712, contacts 708 to 711, inclusive, in series, and conductor 713 to the winding of a relay 714, thence through conductor 715, the normally closed contact 354A of the stop relay 354, referred to hereinabove, and a conductor 716 to the line wire 335. Relay 714 thereupon energizes and closes its normally open contact 714A, to establish a holding circuit as follows: from the electrical connection between the contacts 709 and 710 of the switch 707 through a conductor 717 to the contact 714A thence through the winding of the relay 714, conductor 715, relay contact 354A, and conductor 716 to line wire 335. This holding circuit continues so long as the contacts 708 and 709 are not disengaged and the stop relay 354 remains deenergized to maintain its contact 354A closed.

Energization of the relay 714 also closes its contact 714B to extend a circuit from the line wire 324 through conductor 718, contact 714B, and conductor 719 to the winding of a clutch solenoid 720 which controls the clutch for the timing cam shaft 146, Fig. 2, thence through conductor 721 to the line wire 335. Solenoid 720 is thus energized, and at the proper time in the rotation of the printing drum 144 of the form printing unit U, the timing shaft 146 becomes clutched to the drive shaft of the unit U. As is explained more fully in my aforesaid co-pending application, Serial No. 221,841, now Patent No. 2,296,277, patented September 22, 1942, such rotation of the cam shaft 146 continues, so long as the printing machine is in operation, until the clutch solenoid 720 is deenergized, whereupon the cam shaft 146 is released from the drive shaft of the printing unit U at the end of the cycle of rotation of the drum 144 in which the solenoid 720 was deenergized. The timing cams 147 on the shaft 146 are rotated at one-half the rate of the drum 144, in the present machine, because of the gear ratio between the shaft 146 and its drive shaft, as explained above. Hence,

a complete machine cycle is equivalent to two full revolutions of the drum 144 of the form printing unit U and in each such machine cycle the printing and control device feeding means, illustrated in Figs. 48 to 56, inclusive, goes through a cycle of operation under control of the related one of the timing cams 147 which controls the clutch solenoid for this feeding means. The platen P is operated once for each rotation of the form printing drum 144 so that in each complete machine cycle duplicate impressions of the changeable data A may be made upon each sheet as S, Fig. 61.

The timing cam 147—B, Fig. 57, which controls the printing apparatus B and which is included in the series of cams generally designated 147, Figs. 2 and 66, is provided with two lobes so that it may close its switch 180 twice in each complete machine cycle. Each closure of the switch 180 completes a circuit from the line wire 335A through a conductor 722, switch 180, conductor 690, winding of solenoid 174, Figs. 1 and 5, and conductor 691 to the line wire 335. Thus, the cam shaft 160 of the printing apparatus B, that is controlled by the clutch solenoid 174, goes through two cycles of rotation for each rotation of the timing cam shaft 146. From the foregoing it will be clear that the main timing shaft 146 as well as the stop finger cam shaft 148 operate in timed relation to the rotary printing unit U, while all of the other mechanisms of the machine are started through their operating movements in properly timed and coordinated relationship through the action of the timing cams 147 of the main timing shaft 146. Thus as will be evident in Figs. 57, 63, and 64, the several cam operated switches that are associated with the main cam shaft 146 are closed in proper timed relation to cause cooperative functioning of the several units of the machine in each complete machine cycle. However, as employed hereinafter, the term "cycle" will be understood to mean a cycle of the cam shaft 160 and not a complete machine cycle (represented by a rotation of the cam shaft 146).

In this connection, it may be stated that the printing machine may be provided with sheet detecting means associated with the sheet stop fingers 149 and 150, Fig. 2, at the printing apparatus B and beneath the platen P, respectively. As described in my co-pending application, Serial No. 221,841, now issued as Patent No. 2,296,277, patented September 22, 1942, such sheet detecting means, if utilized, control a circuit which includes a conductor as 723, Fig. 57, connected to the winding of the stop relay 354, this circuit being established in the absence of a sheet in either of these positions at a time in the operation of the machine when a sheet should be present. The stop relay 354 is thereupon energized to open its contact 354A and thus break the holding circuit for the relay 714, which relay thereupon deenergizes and opens its contact 714 to deenergize the clutch solenoid 720 and interrupt rotation of the timing cam shaft 146 of the machine at the end of the current cycle of the form printing drum 144. It will be recalled that prior to initiation of automatic operation of the machine, a sheet is positioned at the stop finger 149 but no sheet is present at the stop finger 150 beneath the platen P. If a sheet feed safety circuit such as just described is employed, this condition will result in the holding circuit for the relay 714 being interrupted until a sheet reaches the printing position beneath the platen P and it will,

therefore, be necessary to either maintain the central push button 795 of the switch SS depressed, or to repeatedly depress it until a sheet is advanced beneath the platen P, after which the push button 795 may be released, and automatic operation of the machine will ensue until it is desired to stop the machine, or unless an abnormal condition arises which prevents the regular feeding of the sheets to the several printing positions.

First cycle

Upon the first closure of the switch 180, Fig. 57, by the timing cam 147—B during the first cycle of automatic operation of the machine, the printing apparatus B goes through its first regular cycle of operation, diagrammatically represented in Fig. 63, in which cycle the bottom line of variable data V, Fig. 61, is printed upon the sheet S. It will be recalled that a card as C, Fig. 60, has been advanced into association with the card stop finger 223, Fig. 7, beneath the sensing bars 229, and brushes 231, and that a printing and control device D has been disposed in sensing position beneath the detector 120, Figs. 48 and 56. Referring to Fig. 63, it will be noted that the card stop finger 223, Fig. 7, and the sheet stop finger 149, Fig. 2, remain in their lower or stopping positions throughout the first cycle, maintaining the sheet S and card C stationary. The card picker 184 is advanced through the latter portion of its feeding movement and is partially retracted in this first cycle, but as has been seen hereinabove in connection with the description of the first preliminary cycle of the apparatus, this movement of the picker 184 is without effect. The timing cam 473, Figs. 6, 45 and 59, closes its switch 475 shortly after the first cycle commences, and at about the same time the sensing brushes 231, Figs. 7 and 18 to 20, inclusive, are lowered into cooperation with the columns in which the account number is represented in the card C disposed therebelow. Likewise, the roller 250, Figs. 7, 8, 15 and 17, beneath the sensing bars 229 is lowered to enable the sensing points 230 of the bars 229 to cooperate with the aligned columns in the card C. It will be understood that while the operations of the various parts are represented on the timing chart in exact terms of degrees in the cycle of rotation of the cam shaft 160, the precise timing there shown need not be faithfully followed so long as the illustrated timed interrelation of the various mechanism is retained. Thus it will be understood that deviations can be made from the precise time of operation of each part that has been charted without materially affecting the operation of the machine, it only being important that the various parts be timed to operate so as not to interfere with the respective operation of each other.

Closure of the timing switch 475 conditions the switches 300 beneath the sensing bars 229 for their functions of governing the type wheel-controlling solenoids in a manner explained fully hereinabove. During substantially the initial 220° in the first cycle, the pin bar 457, Figs. 6, 41 and 42, remains in its upper position to maintain the upper contacts of the switches 458 closed. Those switches 467 controlled by cams 469 that are positioned as shown in Fig. 44 remain open during the first cycle (it being recalled that the cam shaft 452 makes only one-half a revolution for each rotation of the cam shaft 160), while those cams 469 which are positioned as shown in Fig. 43 close their switches 467 during this cycle.

Shortly after the sensing bars 229 have been lowered by the roller 259 into position to sense the card C, the bail 280, Figs. 7 and 8, is retracted rearwardly to initiate sensing movement of the bars 229, thereby causing these bars to travel across the face of the card until their sensing points 230 detect the presence of perforations in the several card columns, and the switches 300 are selectively closed by the sensing bars 229 at times in the cycle representative of the values of the digits sensed in the card columns. Because of the above described lost motion connection between the bail 384, Figs. 5, 22 and 23, and the driving levers 378, the bail 384 commences its movement a short interval after sensing movement of the bars 229 has been initiated, thereby enabling sufficient time for the pawls as 393 to be actuated in the event a type wheel 364 controlled thereby is to be held in its zero position, as explained hereinabove. Those type wheels which are not held in their zero positions move with the bail 384 as it is retracted, until these wheels are selectively arrested under control of the switches 300, Figs. 8 to 14, inclusive, and 59, that are operatively interconnected with the solenoids 398 controlling these type wheels, these interconnections being effected by the selective control means including the switches 458 and 467, Fig. 6, in such a manner that the type wheels 364 are positioned to print the bottom line of variable data V upon the sheet as S, Fig. 61, by the time the bails 280 and 384 cease their movement at about 180° in the cycle. Concurrently with this positioning of the type wheels 364, the connected type bars 543 of the proof printer and the slides 571, Figs. 5 and 22 to 26, inclusive, are shifted longitudinally in amounts proportionate to the values manifested on the type wheels.

During the interval while the type wheels and connected parts are being selectively positioned, the detector 120, Figs. 48 and 56, is lowered to bring the sensing pins 122 into cooperation with the printing and control device D disposed in sensing position II, these pins passing through perforations such as 9A, 9B and so on in the printing and control device D, Fig. 49, that are representative of the customer's account number, and thereby actuating the aligned Bowden cables 135. It will be noted in this connection that although the operation of the detector 120 is graphically illustrated in Fig. 63, in conjunction with the operation of the various parts of the printing apparatus B, this detector is, in the actual construction of the machine, being controlled by the cam 131, Fig. 57, on the cam shaft 146 of the machine, and is operated as shown in Figs. 57, 63 and 64, only during the first cycle of operation of the variable data printing apparatus B inasmuch as the printing and control devices D are fed only once during every two cycles of operation of the apparatus B.

As to the printing and control device that is located at station III, the desired first impression may of course be made at any time in the first cycle of operation of the unit B and this is accomplished under control of a cam 147G on the cam shaft 146. The cam 147G serves to close a switch 147F that extends circuit to a solenoid 620A, such solenoid serving to cause operation of the pump that operates the platen P through its printing cycle. The cam 147G has two lobes as shown in Fig. 57, thereby to cause similar operation of the platen P in the second cycle when the sheet S has advanced into contact with the stop finger 150a.

The Bowden cables 135, upon being selectively actuated by the sensing pins 122, operate their respective switches as 312, Figs. 58 and 58A. Thereafter, the cam 333, Figs. 6, 46 and 58, closes the timing switch 332, and depending upon whether or not the account number in the printing and control device D matches with the account number in the card C, a condition of concurrent energization of the relays 330, 336, 338 and 340, Fig. 58, is or is not produced. If there is a discrepancy in the account numbers, at least one of these relays remains deenergized and upon closure of the timing switch 332A by the cam 333A subsequent to the closure of the switch 332, a circuit is completed to the winding of the stop relay 354, Fig. 57, thereby breaking the holding circuit to the relay 714 and deenergizing this relay and the timing solenoid 720, Figs. 57 and 2, and causing the timing cam shaft 146 to cease rotating at the end of the current cycle of rotation of the drum 144 of the form printing unit U. In such event, the printing apparatus B completes its first cycle of operation and then ceases further operation, since the timing cam 147—B, Fig. 57, is no longer in rotation, and hence is not effective to energize the clutch solenoid 174 that operates the cam shaft 160. However, in the event the account numbers match, which is the normal and intended condition, the stop relay 354 does not energize when the timing switch 333A is closed and, therefore, the timing cam shaft 146, Fig. 2, continues in operation to send the printing apparatus B through its succeeding cycles of operation.

As the final step in the positioning of the type wheels 364 under control of the sensing bars 229, at 180° in this cycle, the pin 414 on the drive lever 378, Figs. 22 and 23, engages and rocks the bell crank 421, Figs. 22 and 22D, and actuates the link 422, Fig. 3, to thereby engage the locking pawls 272, Figs. 8 and 15, with the sensing bars 229 for maintaining these sensing bars in the positions to which they have been selectively adjusted, until they are subsequently restored by the bail 280. It will be understood that although the type wheels and sensing bars have been represented in Fig. 63 as being moved during the entire interval in which the bails 280 and 384 are in motion, that this merely represents an extreme condition and that the type wheels and sensing bars may be selectively arrested at any earlier time in the cycle.

Bails 280 and 384 pause for a brief interval, between 180° and approximately 205°, before the initiation of restoring movement thereof. During this dwell period, the printing of the bottom line of variable data V is effected upon the sheet S, the platens 361 being actuated to make this impression from the type wheels 364 shortly after the pin 414 on the lever 378, Fig. 22, has engaged and rocked the lever 408 to release the platen arms 367 to the action of the springs 370. The tie rod 545, Figs. 22 and 24, is lowered to enable the springs 553 to snap the type bars 543 downwardly and make an impression upon the proof web 507—W of the items of total kilowatt hours, net bill, district and ledger numbers, Fig. 61, which were printed in the bottom line upon the sheet S. After these impressions have been effected, the platens 361 and type bars 453 are restored by the bail 425 and tie rod 545, respectively, and during this restoration of the type bars 543 the proof web 507—W is advanced to bring the next line into printing position.

During the interval when the sensing bars 229

are at rest, the timing switch 475 opens, and the roller 259 is raised to elevate the sensing bars 229 from out of contact with the card. Shortly after the sensing bars are so elevated, the bails 289 and 334 commence to restore the sensing bars 229 and type wheels 364 toward their zero positions. However, prior to the commencement of such restoring movement, the rockers 599, Figs. 26 to 36, inclusive, of the accumulator mechanism will have been swung to raise the accumulator pinions 591 into meshing engagement with the slides 571 connected with the type wheels 364 which were instrumental in printing the total kilowatt-hours and net bill. Hence, as the bail 334 restores the type wheels 364, type bars 543 and slides 571 toward their zero positions, the slides 571 are displaced to effect entries of the total kilowatt-hour and net bill amounts into the accumulator pinions. The bail 334 is fully restored at about 320° in the cycle, at which time it strikes the stop pins 390, Figs. 5, 22 and 23, as the type wheels 364 and their connected type bars 543 and slides 571 arrive at their normal zero positions. It will be noted in Fig. 63 that the accumulating period covers the entire interval in which the type wheels are restored, it being understood that the maximum amount of such restoring movement has been represented on the chart and that a lesser movement may occur in many instances where the type wheels were positioned to print digits of a numerical value lower than the maximum value. During this accumulating period, those carry segments 625 which are to effect carry-over entries are tripped and thus conditioned to subsequently effect the carry entries.

Because of the lost motion connection between the drive levers 379 and bail 334, Fig. 22, the bail 289 which restores the sensing bars 229 moves a short time after the bail 334 has come to rest to thereby establish the necessary clearance between these parts. The timing switches 332A and 332 are opened in the order named, and the detector 123 and sensing brushes 231 are thereafter raised to their upper inoperative positions in the course of the first cycle and preferably prior to the initiation of restoring movements of the parts. Likewise, the pin bar 457 which controls the switches 453, Figs. 6 and 59, is shifted from its upper to its lower position as the cam shaft 452 approaches the end of its first half of a revolution, which is equivalent to the first cycle of the cam shaft 160, and the switches 453 and 459, controlled by the bar 457 and cams 467 on the cam shaft 452, are conditioned for subsequently interconnecting the sensing bars 229 with the type wheel solenoids 398 during the ensuing second cycle of operation. Also, prior to completion of the first cycle, the line shifter mechanism is operated to shift the sheet guide strips 360 transversely of the guideway G to thereby bring the sheet S into alignment with the guideway G' and enable the platens 361 to subsequently print the upper line of variable data V upon the sheet S.

As the final step in the first cycle of operation, the carry segments 625 which were tripped during the entry-effecting operation, are operated to effect carry-over entries on the accumulator pinions 591, as explained hereinabove in connection with Figs. 35 and 36. Restoration of these carry segments is not effected until the next subsequent actuation of the rockers 599, as shown in Fig. 31, during a succeeding entry-effecting or total-taking operation. In the timing chart, Fig. 63, the carry entry operation is represented as taking place within the last 10° of the first cycle, this being the interval in which the seg-

ments are rocked by their springs 627 as shown in Fig. 36.

At the conclusion of the complete rotation of the cam shaft 160, the clutch for this shaft is disengaged and the shaft remains stationary until another lobe on the timing cam 147—B, Fig. 57, engages and closes the switch 139 to energize the clutch solenoid 174, thereupon initiating the second cycle of operation, which will now be described.

Second cycle

At the commencement of this cycle, the pin bar 457 is in its lower position to separate the middle contacts of the switches 453 from the upper contacts of these switches and engage them with the lower contacts of these switches. Moreover, those switches 467 which were closed during the first cycle are now open, while those which were open during the first cycle are now closed. Thus, the selective control means is conditioned to operatively interconnect the sensing bars 229 and type wheels 364 to effect printing of the upper line of variable data V on the sheet S under control of the card C. The general operation of the timing switch 475, roller 259, bail 289, bail 334, lock pawls 272 and platens 361 is the same as has been described hereinabove in connection with the first cycle of operation. However, in the second cycle the type bars 543 are prevented from making any impression upon the proof web 507—W, and the proof web feed is disabled.

The sensing brushes 231 are lowered into co-operation with the card C concurrently with the lowering of the sensing bars 229 into their operative positions, but the sensing brushes 231 are ineffective during this second cycle inasmuch as the detector 123, Fig. 56, remains in its upper inoperative position throughout this cycle and the timing switches 332 and 332A remain open. The accumulator mechanism is disabled due to the rockers 599 having been uncoupled from the lever 609, Fig. 26, when the line shifter mechanism is operated to effect the shift to the upper line of data. Hence, no entries are effected into the accumulator during the second cycle.

When the sensing bars 229 have ceased their sensing movement and have been raised by the roller 259 preparatory to being restored by the bail 289, the card stop finger 223 is raised to enable the card C to be fed away from sensing position and discharged into the collector N, Fig. 1. The card picker 124, prior to the time the finger 223 was raised, had been moving rearwardly or to the left as viewed in Fig. 15, of the magazine K, but when the first card starts to advance away from sensing position to be discharged, the picker 124 pushes the card C from the bottom of the stack toward sensing position, and this card is engaged by the roller 219 and is advanced toward the finger 223, this finger being lowered to arrest the card C at the appropriate time in the cycle. After the platens 361 have been operated to print the upper line of variable data V upon the sheet S and while these platens are being restored, the sheet stop finger 148, Fig. 2, is raised and the first sheet S is advanced into the guideway G' and is fed into printing position beneath the platen P, being arrested in such position by the stop finger 156. Such operation corresponds to the operation of the stop fingers 491 by the cam shaft 195 in my aforesaid Patent No. 2,296,277.

The line shifter mechanism is operated toward the close of the second cycle to restore the sheet guide strips 360 back into alignment with the guideway G, as shown in Figs. 2 and 66, for re-

ceiving the next sheet that is advanced along this guideway. The sheet stop finger 149 is operated under control of the cam shaft 148 which is geared to the timing cam shaft 146, Figs. 2 and 66, and is operated in such timed relation with the web feeding and web severing means that after the first sheet has been fed away from printing position beneath the platens 361, the finger 149 is lowered to arrest the next succeeding sheet as it is advanced beneath these platens. As shown in Fig. 64, this takes place prior to the completion of the second cycle of the apparatus B so that a new sheet is disposed in position at the beginning of the next succeeding cycle of operation. The pin bar 457 is raised toward the end of the second cycle to thereby restore the switches 458 into their normal positions, shown in Fig. 42, and at the end of the cycle the cam shaft 452 will have completed its first revolution to dispose the cams 469 and switches 467 in the positions which they occupied in the beginning of the first cycle.

Subsequent machine operation

The operation of the printing apparatus B following the printing of the first sheet S is substantially a repetition of that described hereinabove, the apparatus B going through a first cycle similar to that illustrated in Fig. 63 to print the lower line of data V upon the sheet S, this being followed by a second cycle similar to that illustrated in Fig. 64 for printing the upper line of such data. The total kilowatt hours, net bill, district and ledger numbers are printed upon the proof web 507—W concurrently with the printing of these items upon each sheet as S, and entries of the total kilowatt-hours and net bill are also effected into the accumulator mechanism.

In the flow charts of Figs. 67 and 68, a succession of sheets S—1, S—2, S—3 and S—4 are illustrated in the positions that such a succession of sheets would occupy in the operation of the machine, and similar series of printing devices D—2, D—3 and D—4, and data cards C—2, C—3 and C—4 that are related to such sheets are also illustrated in the positions that such cards and printing devices would occupy in the machine. In Figs. 67 and 68 the cards C, printing devices D and sheets S are designated by numerical suffixes that indicate the relationship between such elements, so that, for example, the variable data V is printed on the sheet S—2 is derived from the data card C—2, while the changeable data A on such sheet is printed from the printing device D—2.

Thus in a first cycle of operation of the unit B a printing device D—3 is located at the sensing station II, and when the related card C—3 is located at the card sensing station, the corresponding sheet S—3 will be located at printing station in the unit B in alignment with the supply guideway G as shown in Fig. 67. In this first cycle of operation of the unit B, the account numbers represented on the printing device D—3 and on the card C—3 are sensed and compared, as diagrammatically indicated in Fig. 67, and if these numbers are found to correspond, the variable printing unit B operates through its first printing operation so as to print the lower line of variable data V on the sheet S—3, as indicated by lines included on the sheet S—3 of Fig. 67. During this first cycle of operation of the unit B, the preceding sheet S—2, upon which both lines of variable data have previously been printed under control of the card C—2, will be located at

printing station III in such a position that operation of the platen P serves to print the changeable data A on the stub portion of the sheet S, as indicated by lines included on the sheet S—2 in Fig. 67. The sheet S—1 which preceded the sheet S—2 will at this time be located in the collecting hopper, having passed through the rotary printing unit U so as to have the form F printed thereon, as indicated in Fig. 67.

In the second cycle of operation of the variable printing unit B, the sheet S—3 is located in alignment with the guideway G' as indicated in Fig. 68, thereby to enable the second or upper line of variable data V to be derived from the card C—3 and to be printed in the proper position on the sheet, as indicated by lines included on the sheet S—3 in Fig. 68. In this second cycle of operation of the unit B the sheet S—2 is advanced along the guideway G' so as to be positioned for formation of a second or duplicate impression of the changeable data A on the main bill portion of the sheet S—2 from the printing device D—2, as indicated by lines included on the sheets S—2 in Fig. 68. After the formation of such printing impressions in the second cycle, the sheet S—2 is passed from station III so as to pass through the printing unit U; the sheet S—3 is passed to station III where it is positioned by the stop finger 150; and after the line shifting section of the sheet guideway has been again aligned with the initial guideway G, the web feed unit is operated so as to pass a sheet S—4 along the guideway and into the position determined by the stop finger 149, to thereby condition the machine for the succeeding two cycles of operation in which the sheet or bill S—3 will be completed.

In the printing and control device feeding operation which takes place prior to the initiation of the next cycle of operation of the printing apparatus B following the second cycle, Fig. 64, the printing and control device D which was in sensing position II is advanced to printing position III beneath the platen P, and a new printing and control device D is advanced from the magazine H into sensing position II beneath the detector 120. Thereafter, as the lower line of variable data V is being printed upon the next sheet S, the platen P makes an impression of the changeable data A from the first device D onto the first sheet S. The stop finger 150, Fig. 2, is then raised by means that are similar in form and construction to the cam employed for operating the stop finger 191 in my aforesaid Patent No. 2,296,277, the cam being angularly displaced in the well-known manner to effect proper timed operation of the stop finger to enable the first sheet S to be advanced a short distance into engagement with the stop finger 150a, and when the upper line of data V is being printed upon the second sheet S, the platen P makes a duplicate impression of the changeable data A from the first device D upon the stub of the first sheet S. Thereafter, the stop finger 150a is raised to enable the first sheet S to be fed to the form printing unit U to have the form F, Fig. 61, printed thereupon, the sheet being thereafter discharged into a suitable collector. The timing of the various stop fingers 149, 150 and 150a is illustrated in the timing charts of Figs. 63 and 64. After the duplicate impressions have been made from each printing and control device D by the platen P, such printing device is discharged into the drawer J, Fig. 1, from which it was removed. Thus, in each complete rotation of the timing cam shaft 146 following the first revolution thereof, a com-

plete printed sheet such as the bill S, Fig. 61, is produced by the machine.

The printing and control devices D and cards C, as has been mentioned hereinabove, are advanced concurrently from their respective magazines to positions whereat sensing operations are performed thereupon for the purpose of comparing the account numbers represented in the cards and printing and control devices. The sheets S are, of course, cut from the web W and advanced to printing position in the unit B in timed relation to the operation of the card feed means and the printing device feed means, and the timing of such sheets, as well as the sensing operations and the operations of the platen P and the unit B is illustrated in the timing charts of Figs. 63 and 64. The number comparison operation is always performed in the first cycle of each variable data printing operation of the apparatus B and if a discrepancy should be detected, the machine is thrown out of automatic operation upon completion of this first cycle, at which time the sheet S disposed beneath the platens 351 will have received only the bottom line of variable data V. Then in order to print the upper line on the sheet S, the machine will have to be manually operated. The sheet is then removed and the correct address is added at some other convenient time, it being then necessary to make the proper re-arrangement of the printing and control devices D relative to the card C or to locate such other fault, for example, incorrect punching of the account number in a card or printing and control device, as might have caused the non-matching condition.

If at any time it should be desired to interrupt automatic operation of the machine before the run of cards and printing and control devices has been completed, the shell 708 of the switch SS, Figs. 2 and 57, is depressed to separate the contacts 708 and 709 and thereby break the holding circuit for the relay 714. This relay thereupon deenergizes and opens the contact 714B to deenergize the solenoid 720 and thus interrupt automatic operation.

Total taking cycle

This operation is conveniently performed at the completion of a run of cards and printing and control devices or at any other time when normal operation of the machine has been suspended. As explained hereinabove, under the heading "Total taking" the first step in this operation is to depress the key 571, Figs. 1, 4, 7 and 57, to energize the solenoid 551, Figs. 5 and 6, and thereby condition the machine for a total taking operation. As an incident to the operation of the solenoid 551, the sleeve 217 is shifted along the cam shaft 150 to disengage the gear 216 from the gear 215. Hence, the shaft 204 remains stationary, causing the cam shaft 452 to remain stationary. Timing switches 475, 332 and 332A, controlled by the cams 476, 333 and 333A, mounted on the shaft 452, therefore remain open throughout the total taking cycle and hence the number comparison circuits, Fig. 58, and the selective control circuits, Fig. 59, are rendered inoperative. The line shifter mechanism, being controlled from the shaft 204, is likewise disabled. The arm 570, Figs. 3 and 6, on the rock shaft 419 controlled by the solenoid 551 is lowered into position to prevent operation of the lever 243, Figs. 8 and 37, thereby causing the rollers 259 and 237 to maintain the sensing bars 220 and brushes 231

in their raised positions as shown in Figs. 8 and 19.

Thereafter the key 555, Figs. 7, 14 and 57, is depressed to close the switch 537 and energizes the clutch solenoid 174, Fig. 5, and thereby send the cam shaft 150 through a cycle of rotation. The cam 555, Fig. 26, acts through the intermediate mechanism to swing the rocker 599 of the accumulator mechanism and raise the accumulator pinions 591 into engagement with the racks 551 on the slides 571 in the total kilowatt-hour and net bill groups (the slides 571S in the district and ledger number groups being held and locked by the pawl 520, Fig. 22) prior to the initiation of movement of the bails 230 and 304, as shown in Fig. 65, the operation of the bails 230 and 304 being the same as shown in Fig. 63. The slides 571 are thereafter yieldingly urged to the left as viewed in Fig. 22 until the accumulator pinions reach their zero positions, thereby positioning the type wheels 334 to print the total that has thus been read out from the accumulator. Before the accumulator pinions are disengaged from the slides 571, the multi-contact relay 594, Fig. 59, is energized upon closure of the switch 533, Fig. 37, by the drive lever 233 toward the completion of movement of the bail 304. The stop pawls 393 are thereupon engaged with the teeth 381 of the type wheels 364, Fig. 22, to lock these type wheels in the positions in which they have been selectively adjusted, and the accumulator pinions 591 are subsequently lowered out of engagement with the slides 551.

Type bars 543 are operated to print the totals of the kilowatt-hours and net bill amounts read out from the accumulator onto the proof web 537—W in the interval while the bail 304 is at rest. Thereafter, the type bars 543 are restored, the proof web is fed another step, and the bails 230 and 304 restore the sensing bars and type wheels, the pawls 393 being released upon restoration of the type wheels, as aforesaid. As the final operation in the total taking cycle, the latching lever 664, Figs. 3 and 37, is actuated to release the slide bar 503, Figs. 5 and 9, thereby conditioning the machine for normal operation in the manner explained hereinabove.

SUMMARY

It will be apparent from the foregoing description that I have provided a novel printing apparatus which is operable to print a plurality of superposed lines of variable data upon a bill sheet or the like, such as the bill S, Fig. 61, under control of a record card as C, Fig. 60, the impressions of such data being effected in a line-by-line manner from a single row of type wheels adapted to print one line at a time in each of a plurality of cycles of operation of the apparatus. The means which analyzes the record card is rendered effective a plurality of times corresponding to the number of lines of variable data to be printed, and is operatively interconnected with the type wheels in such a manner during each card analyzing operation that the data represented in selected columns of the card are transcribed by selected of the type wheels onto the sheet S.

Thus, the arrangement of cam-controlled switches shown in Figs. 6, 41 to 47, inclusive, and 59, operatively interconnects the switches 360 controlled by the card sensing bars 220 with the control solenoids 333 for the type wheels 364 in a different manner in each cycle of operation as required in the printing of the several lines of

variable data. It will be manifest that this is an extremely flexible system for accomplishing this purpose. For example, the type wheels 364 which print the total kilowatt-hours (426) in the bottom line upon the sheet S, Fig. 61, under control of the set of sensing bars 229 allocated to the "Total units" columns in the cards C, Fig. 60, also print the kilowatt-hours, 1st step (250) in the upper line on the sheet S under control of the sensing bars which analyze the "first Step" card columns, the control of these type wheels by the appropriate sensing bars in each printing cycle being governed by the selective control means. The type wheels which print the district and ledger numbers in the lower line are ineffective while the upper line is being printed so that a blank space is left in the upper line above the district-ledger number (95-549). Similarly, the type wheels which print the rate number or designation are ineffective when the lower line is being printed but are rendered effective to print the rate number (C3) in the upper line. In the case of the net bill and gross bill amounts, the sensing bars for the net bill columns on the card C concurrently control two sets of type wheels for printing the net bill amount (18.12) at two places in the lower line on the sheet S. During the second printing cycle when the upper line of variable data is printed, the set of type wheels which printed the net bill upon the stub of the sheet S is rendered ineffective, and the type wheels which printed the net bill in the lower line upon the body of the sheet S are now placed under control of the sensing bars for the "Gross" bill card columns to print the gross bill amount (20.13) in the upper line above the net bill. Still other control combinations can be provided in the manner hereinabove suggested. Moreover, the present invention is adapted to the printing of additional lines of variable data, if more than two lines are required, by merely utilizing a duplication of the described apparatus.

There has also been described means for comparing an identifying number perforated in code in each printing and control device as D, Fig. 49, with a corresponding identifying number (for example, the account number 4321 in the illustrated example) perforated in conventional single-hole notation in each card as C, Fig. 60, that is advanced to sensing position concurrently with the advance of the printing and control device D to its sensing position. In the event a non-matching condition arises, the operation of the printing machine is interrupted until the condition is rectified. In the present construction, only the bottom line of variable data V is printed upon the sheet S under these circumstances and the machine may then be manually operated to print the top line of data V so that all of the data from the card as C is printed on the bill sheet. Thereafter, in any manner desired, the proper address A and form F may be printed on such sheet.

A suitable accumulator has been provided for keeping a total of certain of the items of data (in the present construction, the total kilowatt-hours and net bill amounts) printed upon the sheets S. Likewise, certain of the items (total kilowatt-hours, net bill amount and district-ledger number) are printed upon a proof sheet concurrently with the printing of these items upon a sheet as S, this list being prepared for accounting purposes. When totals of the items entered into the accumulator are desired, the

machine is sent through a total talking operation in which the proof printer is placed under the control of the accumulator, and the totals are thereupon read out and printed upon the proof web.

As mentioned hereinabove, my novel variable data printing and accumulating apparatus is particularly adapted to be embodied in a printing machine of the type disclosed in my co-pending application, Serial No. 221,841, now Patent No. 2,296,277, patented September 22, 1942, supplanting the multiplying apparatus disclosed in said application. However, the invention is obviously capable of more extensive use in all instances where it is desired to print a plurality of lines of superposed data under control of a common sensing means responsive to record bearing instrumentalities such as perforated record cards. Furthermore, although the preferred embodiment of the invention disclosed in the instant application shows the use of a mechanical card sensing means and an electrically operated arrangement for selectively establishing operative interconnections between the sensing means and the printing means, I contemplate the substitution of, say, electrical card analyzing devices (such as the brushes 231 and associated parts disclosed herein for analyzing the account numbers represented in the card C) for the mechanically operated sensing bars 229. Likewise, it would be possible to employ a mechanical selective control means in lieu of the electrical circuit arrangements to which I have resorted in the present invention. Furthermore, while the machine has been described as being a printing machine, it could also be adapted to produce perforated or other kinds of records, if the need should arise.

Thus, while I have illustrated and described a selected embodiment of my invention it is to be understood that it is capable of variation and modification and I, therefore, do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. In a progressive record-controlled printing machine having means affording a sensing station at which successive records may be positioned, a plurality of groups of record sensing members disposed at said sensing station and each responsive to a predetermined portion of a record sensed thereby, and a plurality of groups of printing members each operable to print at least a portion of a record to be produced, means operatively interposed between said sensing members and said printing members and operable to place certain of said groups of printing members under control of certain of said groups of sensing members and to render ineffective the other of said groups of printing and sensing members in each of a series of combined sensing and printing operations of the machine, said last-named means including selective control means automatically varying the operative interrelations between said groups of sensing and printing members and determining which of the sensing and printing members are to be ineffective for different machine operations.

2. In a calculating and printing machine, a series of relatively displaceable type members, a bail movable from an initial position to a final position and thence back to its initial position, resilient means interconnecting said type members individually with said bail and tending to main-

tain said type members and said bail against relative displacement, a series of teeth provided in each of said type members, stationarily mounted pawls one for each of said members, individual actuating means for said pawls to individually actuate the same to cooperate with the teeth in its type member, control means operable selectively upon said individual actuating means to differentially set said type members, an accumulator comprising a series of members adjustable to represent the digits of a numerical amount, means placing said type members under the control of respective digit-representing members, said accumulator including means enabling each of said digit-representing members to selectively arrest its type member at a time in the forward movement of said bail indicative of the corresponding digit in said numerical amount, whereupon said bail is displaced relative to such type member against the action of said resilient means, means rendered effective when said bail is in its final position to actuate all of said pawls into cooperation with the teeth of said type members and thereby enable said accumulator to be withdrawn from controlling relation with said type members without substantially disturbing the selected positioning of such type members, each of said pawls and its cooperating teeth being of such configuration that such pawl is held in self-locking engagement with the abutting tooth under the influence of the resilient means acting upon the particular type member, until the relative displacement of such type member and the bail is taken up during the return movement of said bail.

3. In a record-controlled machine, a sensing member for reading a digital indicium represented on a record-bearing device, driving means producing relative movement between said sensing member and said device to thereby cause successive index point positions representative of zero and the digits 1 to 9 on said device to move into cooperating relation with said sensing member in the order named, a recording member differentially adjustable to any of a number of positions to record a selected digit upon a record sheet or the like disposed for cooperation therewith, other means operatively connected to said driving means and imparting movement to said recording member to successively adjust it away from an initial zero position into positions whereat it may record the digits 1 to 9 in unison with the relative displacement between said sensing member and said record-bearing device, means controlled by said sensing member and rendered operative when said member encounters an indicium at one of said index point positions to render said driving means ineffective to further displace said recording member, and a lost motion means embodied in the connection between said driving means and said other means whereby relative displacement between said sensing member and said device may occur prior to the time the zero index point position moves into cooperation with said sensing member without producing displacement of said recording member away from its zero position.

4. A machine for printing numerical data derived from a record card onto a bill sheet or the like, such data being represented in various columns on said card by perforations each located in a numerically significant index point in a separate card column, comprising means affording a sensing station at which a record card may be disposed, sensing means at said sensing station

and including movable sensing members each adapted to detect the presence of a perforation in a respective card column and means for imparting movement to each of said sensing members relative to said card from an initial inoperative position into positions in which it successively senses the index points in its card column until it detects a perforation therein, a plurality of switches each controlled by a respective sensing member and closable when its sensing member detects a perforation in the corresponding card column, a plurality of movable printing members each carrying a series of numerical type characters respectively corresponding to the various numerically significant index points in any of said columns on said card, yielding means for driving each of said printing members from an initial position in which it disposes the type character corresponding to the first index point on said card sensed by said sensing members in position to print on said sheet, toward a position in which it can dispose in said printing position the type character corresponding to the last index point that can be sensed by a sensing member, said printing members being driven in substantial synchronism with the advance of said sensing members, a plurality of electrically operated devices one associated with each of said printing members and operable to arrest such member against the action of its driving means in any selected one of the positions in which it disposes a type character in printing position, and selective control means selectively establishing and controlling electrical interconnections between said switches and said electrically operated devices in each operation of said sensing and printing members to determine which of said sensing members shall be operative to control certain printing members for transcribing card data onto said sheet, said last-named means including a plurality of other switch means each operable to establish a control circuit from a certain one of said sensing member-controlled switches to a selected one of said electrically operated devices for enabling said device to arrest its printing member when the associated sensing member detects a perforation, and governing means for rendering certain of said other switch means effective during each operation of said sensing and printing members to establish a predetermined pattern of interconnections between said sensing member-controlled switches and said electrically operated devices, such pattern of interconnections being varied for successive operations.

5. A machine according to claim 4, in which said selective control means includes a plurality of still other switch means respectively connected to certain of said electrically operated devices and each closable to operate such device, and other governing means operating during certain sensing and printing operations to close at least some of said still other switch means to arrest the associated printing members in their initial positions and thereby render the corresponding sensing members ineffective.

6. In a calculating and printing machine, a series of relatively displaceable type members, means for actuating said type members including resilient means for individually urging the respective type members in one direction and a restoring bail movable from an initial position to a final position and thence through a restoring movement back to its initial position, said resilient means tending to maintain said type

members and said bail against relative displacement, a series of teeth provided in each of said type members, a series of pawls, one for each of said type members, individual actuating means for said pawls to individually actuate the same to cooperate with the teeth in its type member, control means operable selectively upon said individual actuating means to differentially set said type members, an accumulator comprising a series of members adjustable to represent the digits of a numerical amount, means placing said type member under the control of respective digit-representing members, said accumulator including means enabling each of said digit-representing members to selectively arrest its type member at a time in the forward movement of said bail indicative of the corresponding digit in said numerical amount, whereupon said bail is displaced relative to such type member against the action of said resilient means, means rendered effective when said bail is in its final position to actuate all of said pawls into cooperation with the teeth of said type members and thereby enable said accumulator to be withdrawn from controlling relation with said type members without substantially disturbing the selected positioning of such type members, each of said pawls and its cooperating teeth being of such configuration that such pawl is held in self-locking engagement with the abutting tooth under the influence of the resilient means acting upon the particular type member, until the relative displacement of such type member and the bail is taken up during the restoring movement of said bail.

7. In a printing machine having a printing position, a pair of parallel sheet guideways stationarily disposed on opposite sides of said printing position in longitudinally spaced relation to each other and disposed out of alignment with each other in a transverse sense, an intermediate sheet guideway parallel to and disposed between said stationary sheet guideways and extending across said printing position, means mounting said intermediate sheet guideway for transverse shifting movement from a first position wherein the intermediate sheet guideway is aligned with the first one of said stationary guideways and a second position wherein said intermediate sheet guideway is aligned with the second one of said stationary sheet guideways, means for advancing a sheet along said first stationary sheet guideway and into a predetermined position in said intermediate sheet guideway when intermediate sheet guideway is located in said first position, impression means operable to form an impression on such a sheet while the intermediate sheet guideway is located in said first position, means operable in timed relation to said impression means to shift said intermediate guideway to said second position, means controlling said impression means to form another impression upon the sheet in a different position while the intermediate sheet guideway is located in second position, and sheet feeding means operable thereafter to discharge the sheet from said intermediate sheet guideway into said second sheet guideway.

8. In a printing machine having a printing position, a pair of parallel sheet guideways stationarily disposed on opposite sides of said printing position in longitudinally spaced relation to each other and disposed out of alignment in a transverse sense, an intermediate sheet guideway parallel to and disposed between said stationary sheet guideways and extending across said printing position, means mounting said in-

intermediate sheet guideway for transverse shifting movement from a first position wherein the intermediate sheet guideway is aligned with the first one of said stationary guideways and a second position wherein said intermediate sheet guideway is aligned with the second one of said stationary sheet guideways, means for advancing a sheet along said first stationary sheet guideway and into a predetermined position in said intermediate sheet guideway when intermediate sheet guideway is located in said first position, impression means operable to form an impression on such a sheet while the intermediate sheet guideway is located in said first position, means operable in timed relation to said impression means to shift said intermediate guideway to said second position, means controlling said impression means to form another impression upon the sheet in a different position while the intermediate sheet guideway is located in second position, sheet feeding means operable thereafter to discharge the sheet from said intermediate guideway into said second sheet guideway, and means for returning said intermediate guideway to said first position after the sheet has been thus discharged into said second stationary sheet guideway.

9. In a printing machine having a pair of spaced printing positions, a sheet guideway comprising first and second end sections disposed in stationary and parallel relation and in longitudinally spaced relation to each other, said sheet guideway also including an intermediate section disposed between said stationary end sections in parallel relation thereto and for shifting movement selectively into alignment with one or the other of said end sections, said intermediate section of said guideway extending across one of said printing positions, and said second end section of said sheet guideway extending across the other of said printing positions, sheet feeding means operable to feed a sheet along said first end section of said guideway and into said intermediate section, impression means at said one of said printing positions operable to form an impression upon a sheet disposed in said intermediate section, means for shifting said intermediate guideway to align said intermediate section with said second end section of said guideway and thereby to align another portion of such a sheet with said impression means, means operable to actuate said impression means through another printing operation after the sheet has been thus shifted, means for discharging the sheet from said intermediate section along said second end section and into printing position at said other printing station to form still another impression on the sheet.

10. In a machine for producing business instruments, means for passing a series of printing devices in succession along a predetermined path through said machine in a step by step manner such that each device comes to rest at a printing station, means for passing a series of data-bearing cards in succession through the machine along a predetermined path through the machine and in a step by step manner such that each data-bearing card comes to rest at a card-sensing station, a variable printer affording a variable-data printing station, sheet feeding means operable to feed sheets in succession and in a step by step manner through said machine to said variable-data printing station and then to the other printing station, sensing means associated with said variable printing means for controlling the same and operable to sense a data-bearing card at said

card-sensing station, means operable upon a sheet while it is located at said variable data printing station to shift the sheet laterally of said guideway from one relationship to another at said station, governing means operable to operate said sensing means and said variable printer through a first operation when such a sheet is in one of said relationships and through another operation when the sheet is the other relationship, and impression means at said first mentioned printing station controlled by said governing means to make at least one impression from the related printing device onto such sheet when the sheet is located at said first mentioned printing station.

11. In a machine for producing business instruments, means for passing a series of printing and control devices in succession along a predetermined path through said machine in a step by step manner such that each device comes to rest at a device-sensing station and thereafter comes to rest at a printing station, means for passing a series of data-bearing cards in succession through the machine along a predetermined path through the machine in a step by step manner such that each data-bearing card comes to rest at a card-sensing station, a variable printer affording a variable-data printing station, sheet feeding means operable to feed sheets in succession and in a step by step manner through said machine to said variable-data printing station and then to the other printing station, and sensing means associated with said variable printing means for controlling the same and operable to sense a data-bearing card at said card-sensing station, certain of said cards and said devices being related to each other and having identifying means thereon indicative of such relationship, other card sensing means associated with said variable printing means for sensing such identifying means on a card located at said card-sensing station, device sensing means at said first mentioned sensing station, means operable upon a sheet while it is located at said variable data printing station to shift the sheet laterally of said guideway from one relationship to another at said station, governing means operable to operate both of said card sensing means and said variable printer through a first operation when such a sheet is in one of said relationships and through another of operation when the sheet is the other relationship, means for operating said device sensing means when said other card sensing means are operated in said first operation of said variable printing means, comparing means cooperating with said device sensing means and said other card sensing means to compare the sensed identifying means of the card and device located at the respective sensing stations, means governed by said comparing means and operable to stop said machine when there is variance between the identifying means of the sensed card and device, and impression means at said first mentioned printing station controlled by said governing means to make at least one impression from the related printing and control device onto such sheet when the sheet is located at said first mentioned printing station.

12. In a printing machine, a multiple order variable printer including a plurality of settable type segments at least certain of which constitute number-printing segments, means for variably setting said type segments, a plurality of hammers for printing cooperation with the respective type segments, zero suppressing means

operatively associated with those hammers that cooperate with said number-printing segments, and proof printing mechanism including a platen, differentially settable type members mounted for setting movement transversely of said platen and for printing movement toward and into printing cooperation with said platen, gearing means affording geared driving connections between the individual type members and at least selected of said number-printing type segments to effect individual setting of said type members and concurrently with the setting of their related number-printing type segments, means yieldingly urging said type members toward said platen, a common latch for controlling said type members, and a zero suppressing means operatively associated with said type members for controlling printing movement thereof in accordance with their numerical setting.

13. In a printing machine, a multiple order variable printer including a plurality of settable type segments at least certain of which constitute number-printing segments, means for variably setting said type segments, a plurality of hammers for printing cooperation with the respective type segments, zero suppressing means operatively associated with the hammers that cooperate with said number-printing segments, and proof printing mechanism including a platen, a plurality of elongated type-carrying members each having number printing type elements disposed at points spaced longitudinally of such members, means mounting said members for differential setting movement in directions longitudinally of said members and transversely of said platen and for printing movement toward and into printing cooperation with said platen, gear segments formed for movement with the respective type segments in the differential setting movements thereof, transmitting pinions meshed with the respective gear segments for rotation, thereby, racks formed on said type-carrying members and meshed with the respective transmitting pinions and cooperating therewith to afford geared driving connections between the individual type-carrying members and at least selected of said number-printing type segments to thereby effect corresponding setting of said type-carrying members when their related number printing type segments are set, means yieldingly urging said type carrying members toward said platen, a common latch for controlling said type-carrying members by said yielding means, and zero suppressing means operatively associated with said type members for controlling printing movement thereof in accordance with their numerical setting.

14. In a business machine that utilizes two series of record bearing devices, one series being made up of first devices having individual multiple order identifying numbers represented thereon in a first code having ten index positions allocated respectively to the significant digits and zero, and the other series being made up of second devices of a second class having individual multiple order identifying numbers represented thereon in a second code having five index positions the first four of which when used alone being arranged to represent a different digit falling in a first group that also includes zero, the fifth index position when used alone being representative of another digit falling in a second group the other digits of which second group are represented by said fifth index position used in combination with one or the other of the first

four index positions, and the absence of a designation in all five index positions being representative of zero, said devices in the two series being supposedly arranged in a predetermined order with respect to such designations, means for feeding the two series of devices in a timed step-by-step manner through the machine, the devices in each series being successively advanced through respective sensing positions for that series, means for stopping said machine including an electrically operable stopping device and a timing circuit operable to close an electrical energizing circuit for said stopping device at a predetermined time in the cycle of operation of said machine, a plurality of governing relays having normally closed contacts included in parallel in the energizing circuit of said stopping device, one of said governing relays being allocated to each of the orders of said identifying designations, and designation comparing means comprising a set of numerically significant conductors for each order allocated respectively to the significant digits and zero, a set of switch units for each order each having a normal position and an actuated position and allocated one to each of the elements of said second code, each of said switch units including first and second normally open switches and a third normally closed switch, a group selecting relay for each order having five movable contacts normally connected respectively with the numerically significant conductors of that order that are allocated to the digits of said first group and zero and shiftable when said relay is operated to connect with the respective conductors allocated to the digits of said second group, individual circuits in each order controlled by the respective first normally open switches of said switch units and extended to the respective movable contacts of the group selecting relay of the related order, an energizing circuit for each group selecting relay extended from the second normally open switch of said fifth switch unit of the related order, a zero indicating circuit for each order connected to the governing relay of that order and including in series all of said normally closed third switches of the switch units of the related order and extended to the movable contact of the related group selecting relay that is connected to the first switch of said fifth switch unit of the related order, other energizing circuits for each governing relay extended in parallel from the first switches of each of said switch units of the related order so as to constitute extensions of said individual control circuits, a disabling relay for each order having normally closed contacts included in the individual circuit controlled by said first normally open switch of the fifth of said switch units of the related order, parallel energizing circuits for each disabling relay extended respectively to the second normally open switches of the other four switch units of the related order, sensing means for sensing said first devices disposed at the aforesaid sensing position allocated to said first devices and operable in each order to extend circuit selectively to one of the numerically significant conductors of the related set in accordance with the data representations of the device sensed, and sensing means disposed at the aforesaid sensing position allocated to said second devices for sensing said second devices and operable to actuate said switch units in each order in accordance with the data representation of the device sensed.

series of record bearing devices, one series being made up of first devices having individual identifying digits represented thereon in a first code having ten index positions allocated respectively to the significant digits and zero, and the other series being made up of second devices having individual identifying digits represented thereon in a second code having five index positions the first four of which when used alone being arranged to represent a different digit falling in a first group that also includes zero, the fifth index position when used alone being representative of another digit falling in a second group the other digits of which second group are represented by said fifth index position used in combination with one or the other of the first four index positions, and the absence of a designation in all five index positions being representative of zero, said devices in the two series being supposedly arranged in a predetermined order with respect to such designations, means for feeding the two series of devices in a timed step-by-step manner through the machine, the devices in each series being successively advanced through respective sensing positions for that series, means for stopping said machine including an electrically operable stopping device and a timing circuit operable to close an electrical energizing circuit for said stopping device at a predetermined time in the cycle of operation of said machine, a governing relay having normally closed contacts included in the energizing circuit of said stopping device, and designation comparing means comprising a set of numerically significant conductors allocated respectively to the significant digits and zero, a set of five switch units each having a normal position and an actuated position and allocated one to each of the elements of said second code, each of said switch units including first and second normally open switches and a third normally closed switch, a group selecting relay having five movable contacts normally connected respectively with the numerically significant conductors allocated to the digits of said first group and zero and shiftable when said relay is operated to connect with the respective conductors representative of the digits of the second group, individual circuits controlled by the respective first normally open switches of said switch units and extended to the respective movable contacts of the group selecting relay, an energizing circuit for said group selecting relay extended from the second normally open switch of said fifth switch unit, a zero indicating circuit connected to said governing relay and including all of said normally closed third switches of said switch units and extended to the movable contact of said group selecting relay that is connected to the first switch of said fifth switch unit, other energizing circuits for said governing relay extended from the first switches of each of said switch units so as to constitute extensions of said individual control circuits, a disabling relay having normally closed contacts included in the individual circuit controlled by said first normally open switch of the fifth one of said switch units, parallel energizing circuits for said disabling relay extended respectively to the second normally open switches of the other four switch units, sensing means for sensing said first devices disposed at the aforesaid sensing position allocated to said first devices and operable to extend circuit selectively to one of the numerically significant conductors in accordance with the data representations of the device sensed, and sens-

ing means for sensing said second devices disposed at the aforesaid sensing position allocated to said second devices and operable to actuate said switch units in accordance with the data representation of the device sensed.

16. In a business machine, designation comparing means comprising a set of numerically significant conductors allocated respectively to the significant digits and zero, a set of switch units each having a normal position and an actuated position and allocated one to each of the elements of a five element code, each of said switch units including first and second normally open switches and a third normally closed switch, a group selecting relay having five movable contacts normally connected respectively with those numerically significant conductors which are allocated to four of the digits and zero and shiftable when said relay is operated to connect with the conductors allocated to the other digits, individual circuits controlled by the respective first normally open switches of said switch units and extended to the respective movable contacts of the group selecting relay, an energizing circuit for said group selecting relay extended from the second normally open switch of said fifth switch unit, a zero indicating circuit including all of said normally closed third switches of the switch units and extended to the movable contact of the group selecting relay that is connected to the first switch of said fifth switch unit, other indicating circuits extended in parallel from the first switches of each of said switch units so as to constitute extensions of said individual control circuits, a disabling relay constituting a manifesting means for manifesting the result of a comparison and having normally closed contacts included in the individual circuit controlled by said first normally open switch of the fifth one of said switch units, parallel energizing circuits for said disabling relay extended respectively to the second normally open switches of the other four switch units, means for sensing a first numerical designation and operable to select one of said numerically significant conductors in accordance with a sensed first designation, and means for sensing a second numerical designation and operable to selectively actuate said switch units in accordance with a sensed second designation.

17. In a printing machine having a printing position and adapted for printing variable data on a record sheet at said printing position under control of record-bearing control devices fed successively through the machine, a pair of parallel sheet guideways stationarily disposed on opposite sides of said printing position in longitudinally spaced relation to each other and disposed out of alignment with each other in a transverse sense, an intermediate sheet guideway parallel to and disposed between said stationary sheet guideways and extending across said printing position, means mounting said intermediate sheet guideway for transverse shifting movement between first and second positions wherein the intermediate sheet guideway is aligned respectively with one or the other of said stationary guideways, means for advancing a sheet along one of said stationary sheet guideways and into a predetermined position in said intermediate sheet guideway when intermediate sheet guideway is located in said first position, variable printing means disposed at said printing position to print on a sheet located in the intermediate sheet guideway, sensing members disposed for sensing cooperation with a record-bearing control device fed through the machine, means for operating said sensing members through a first sensing operation when said intermediate sheet guideway is in said first position and through a second sensing operation while said intermediate sheet guideway is located in said second position, electrical controlled means for variably setting said printing means, circuit closing devices controlled by said sensing members in the sensing movements thereof and governing said electrically controlled means, selecting means operatively interposed between said circuit closing devices and said electrically controlled means and settable to first and second selecting positions wherein said sensing members are rendered effective to control said variable printing means in different relationships, means operable to set said intermediate guideway and said selecting means in their first and second positions in alternation, and means for discharging a sheet from said intermediate guideway into the other of said stationary guideways when said intermediate guideway is located in its second position.

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