

Nov. 25, 1958

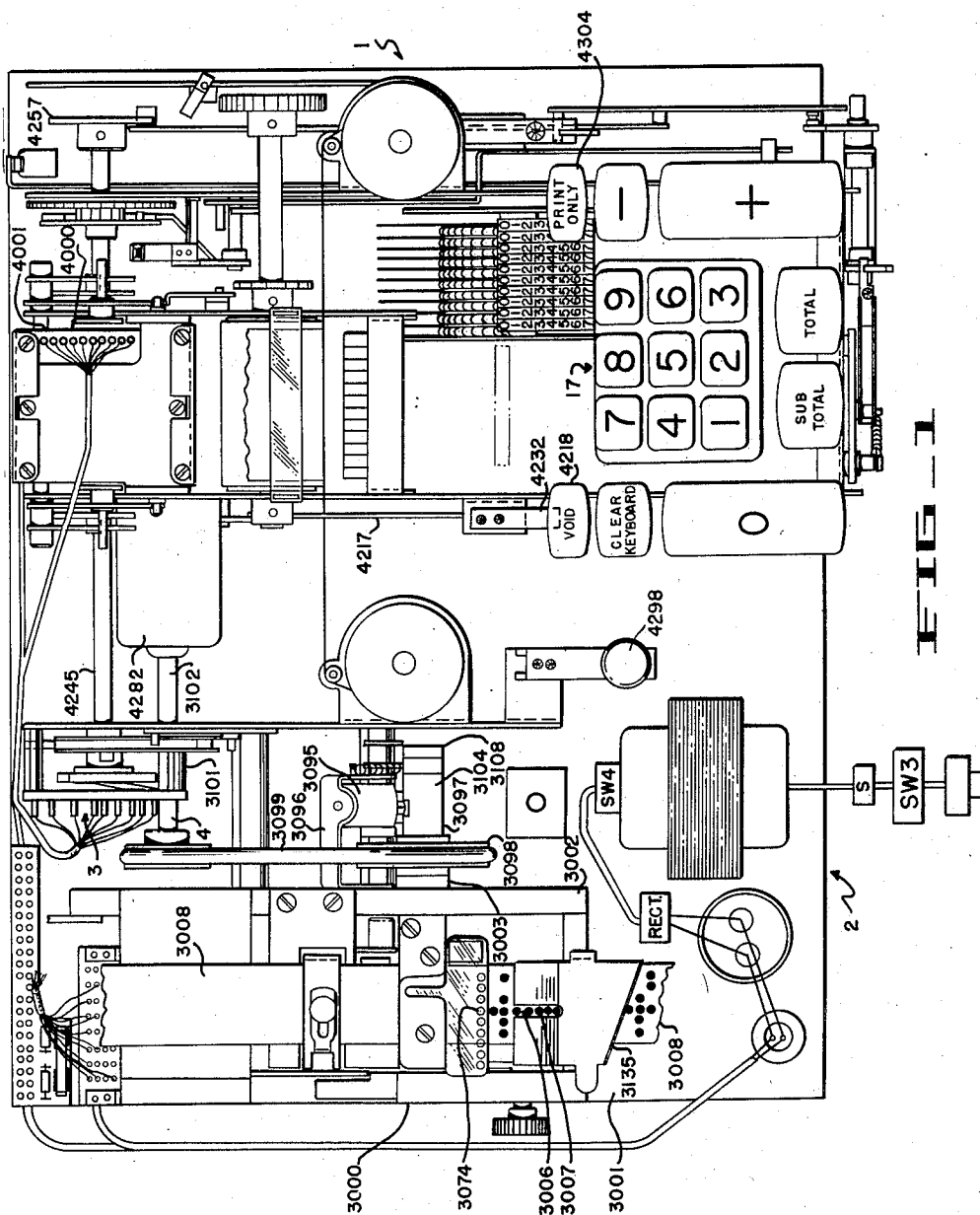
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PERFORATED RECORD MAKING ADDING MACHINE

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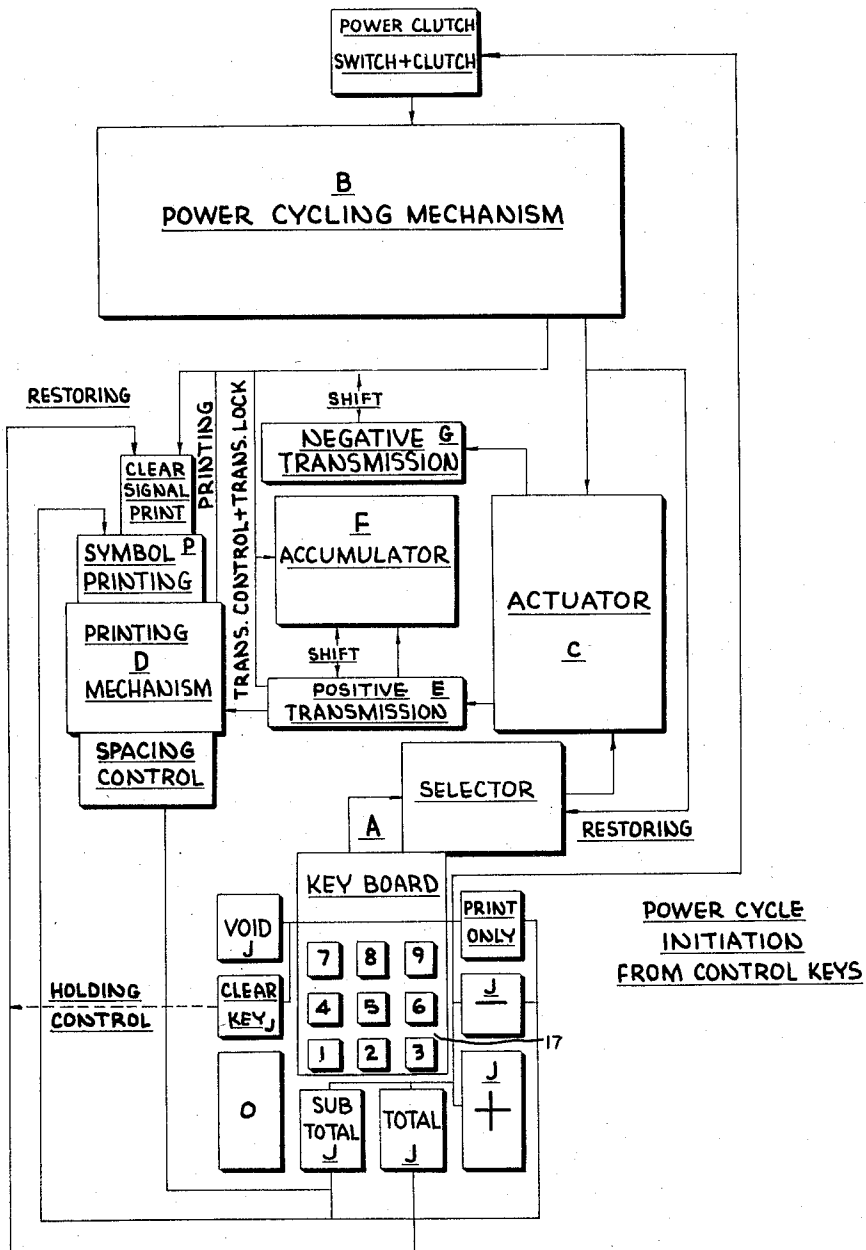


FIG. 1A

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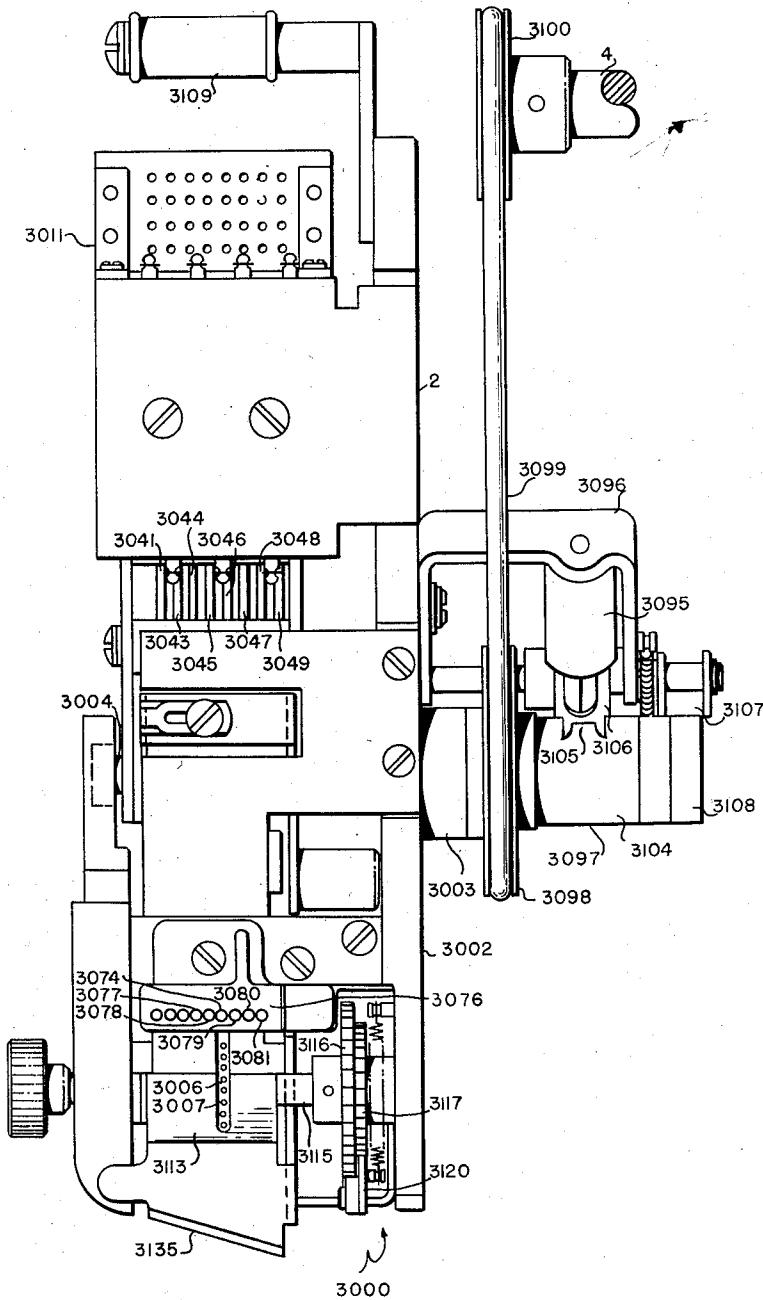
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FIG. 2



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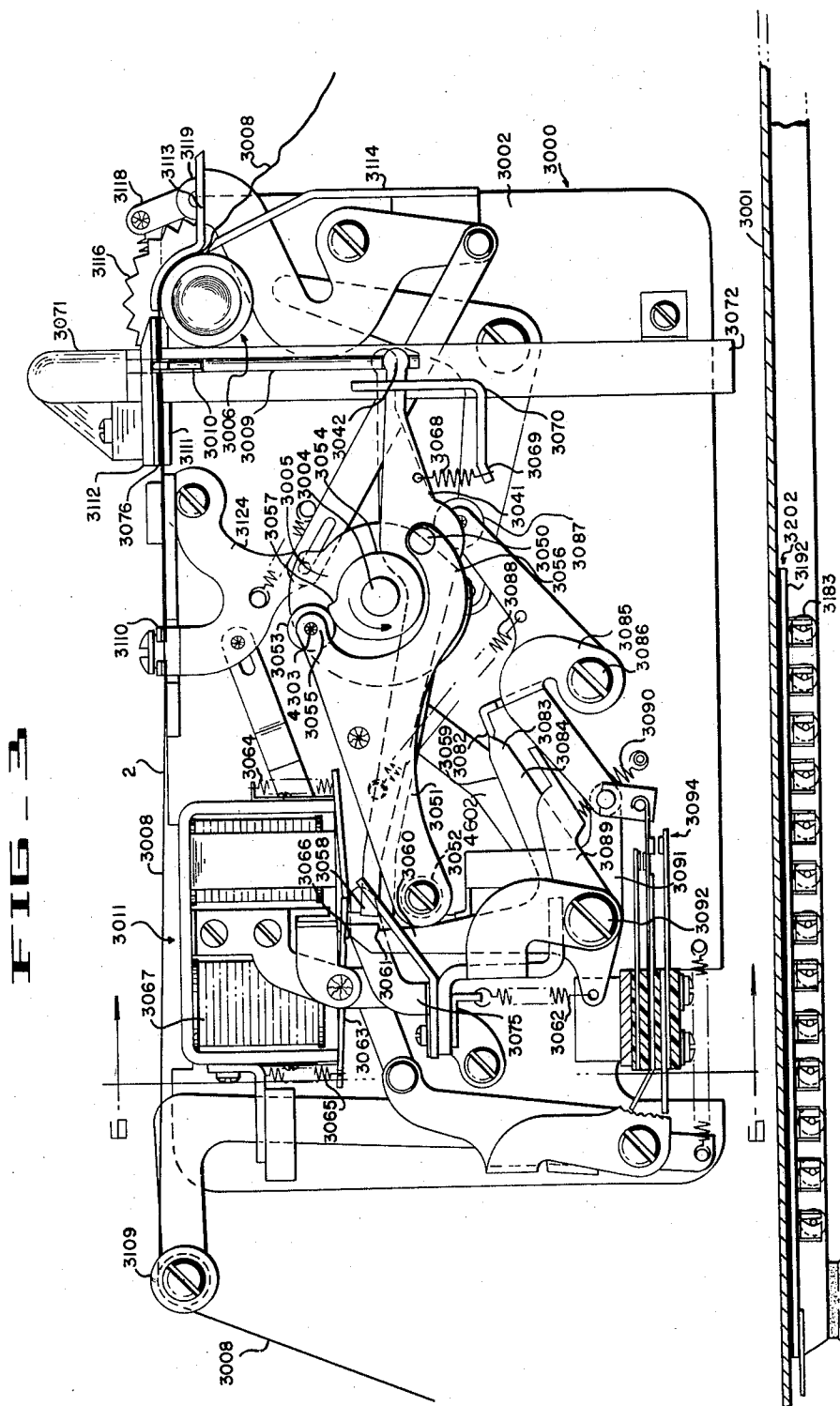
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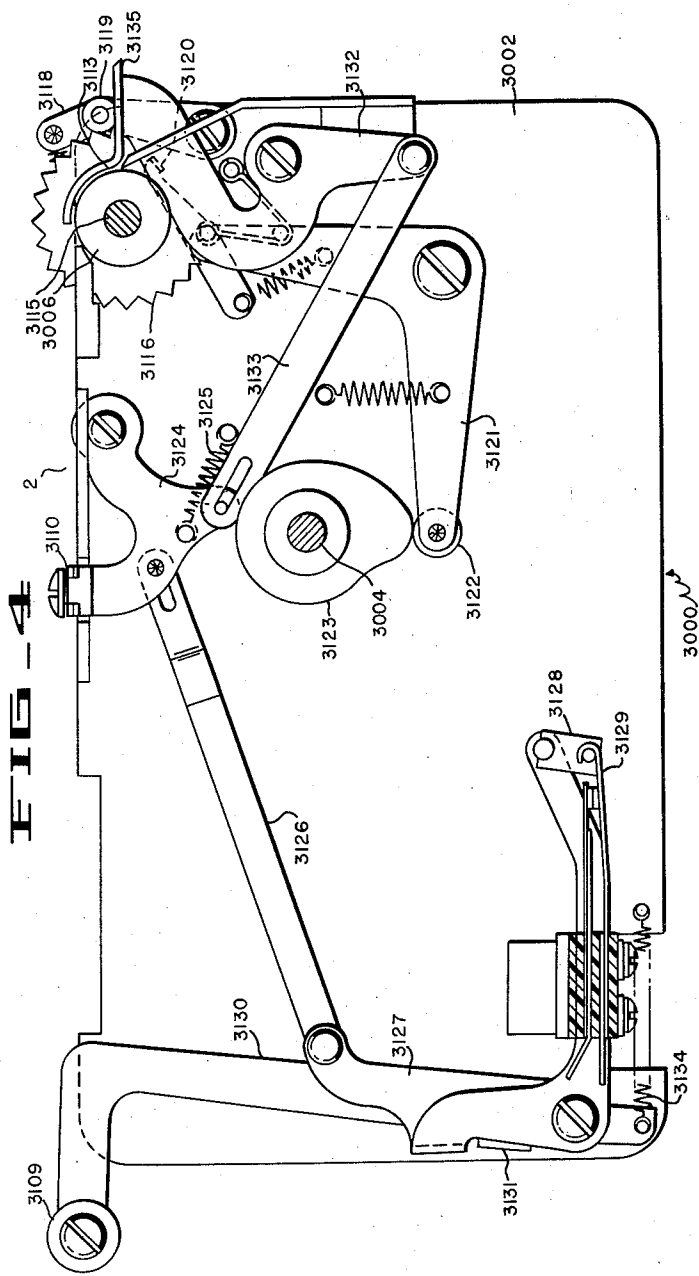
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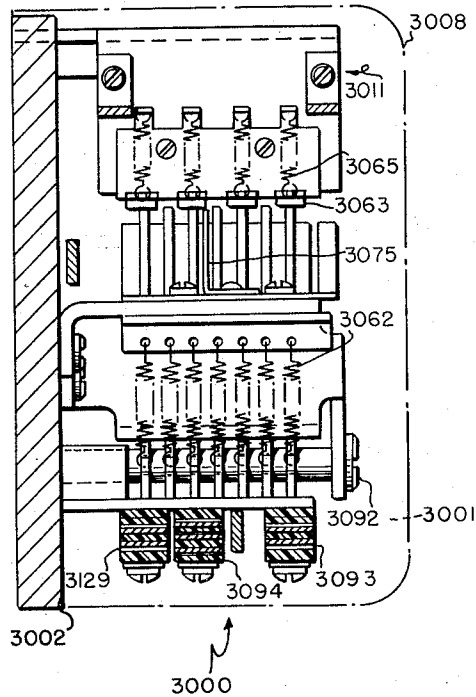
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FIG 5

0		2	•	3		5
1	1	2	•	3		5
2	1	2	•			5
3 ^{ORE}	1		•			
4		2	•		4	
5			•			5
6	1		•	3		5
7	1	2	•	3		
8		2	•	3		
9			•		4	5
LTRS	1	2	•	3	4	5
CR		2	•			
LF			•		4	
FIGS	1	2	•		4	5
STOP	1	2	•		4	
SPACE			•	3		

VOID-LTRS,E,CR,LF, FIGS
PO- STOP, FIGS

FIG 6



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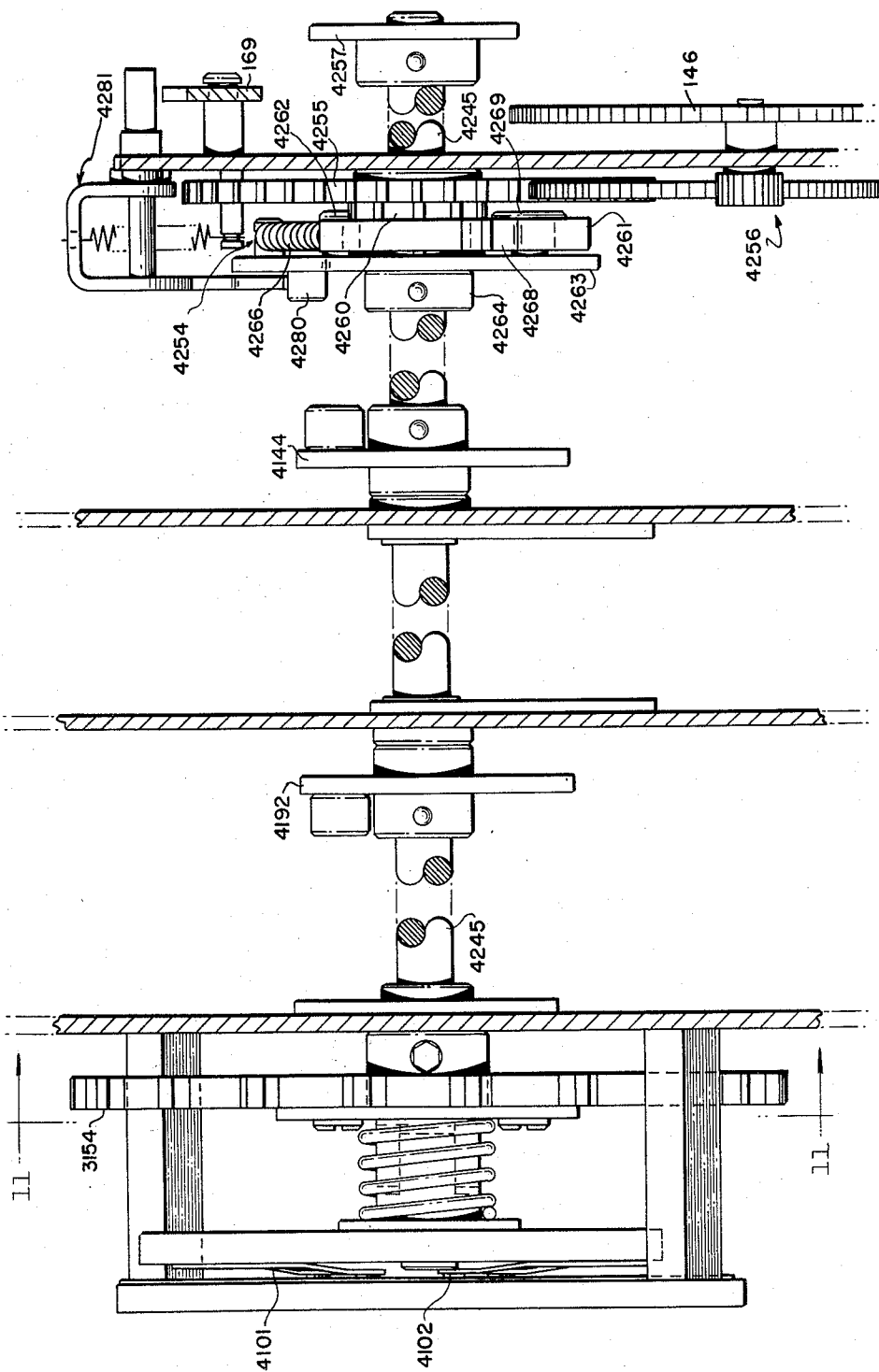
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FIG. 2



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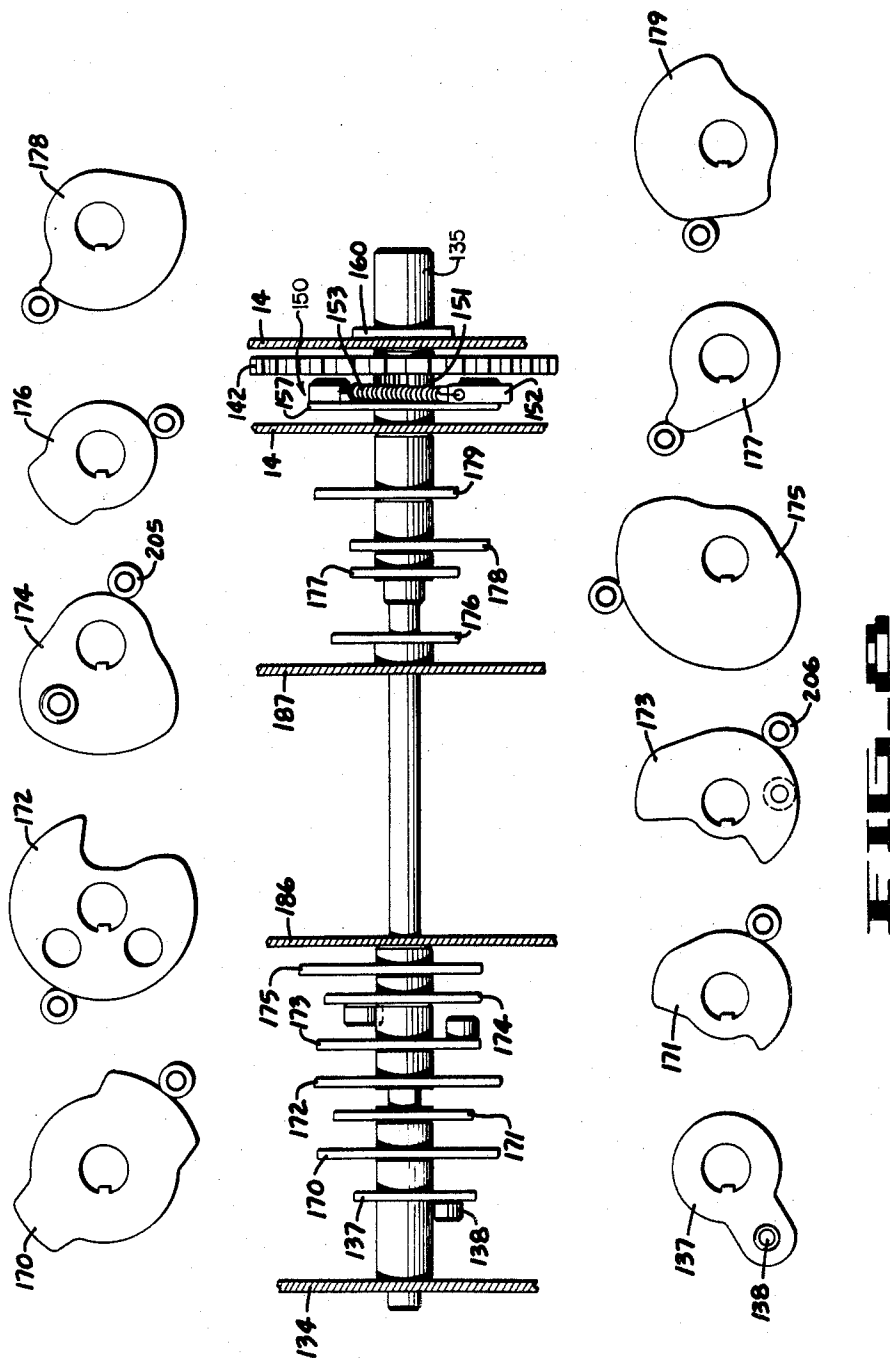
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FIG. 10

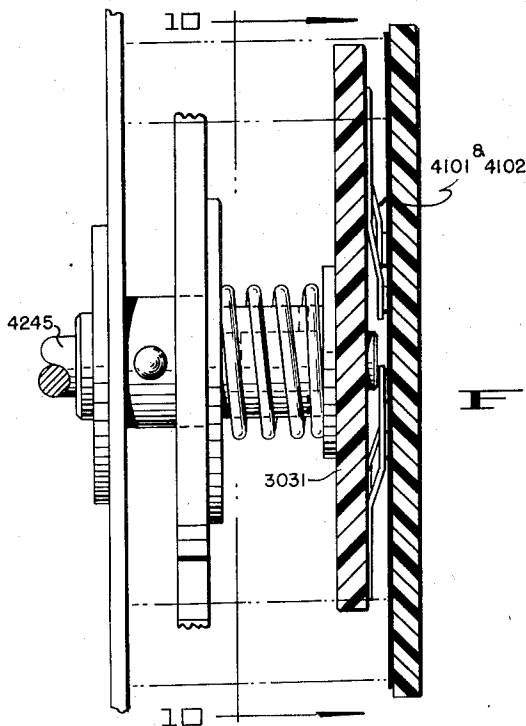
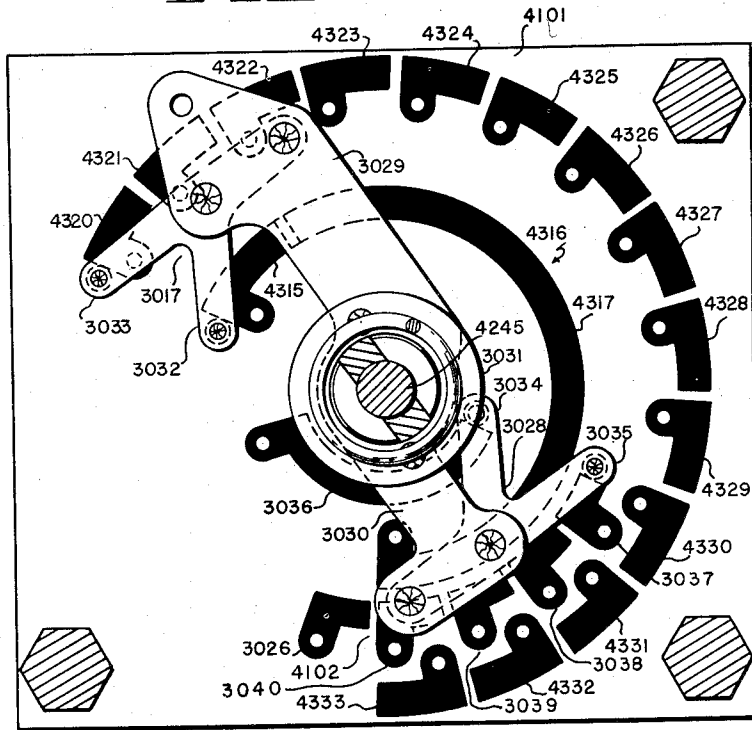


FIG. 9

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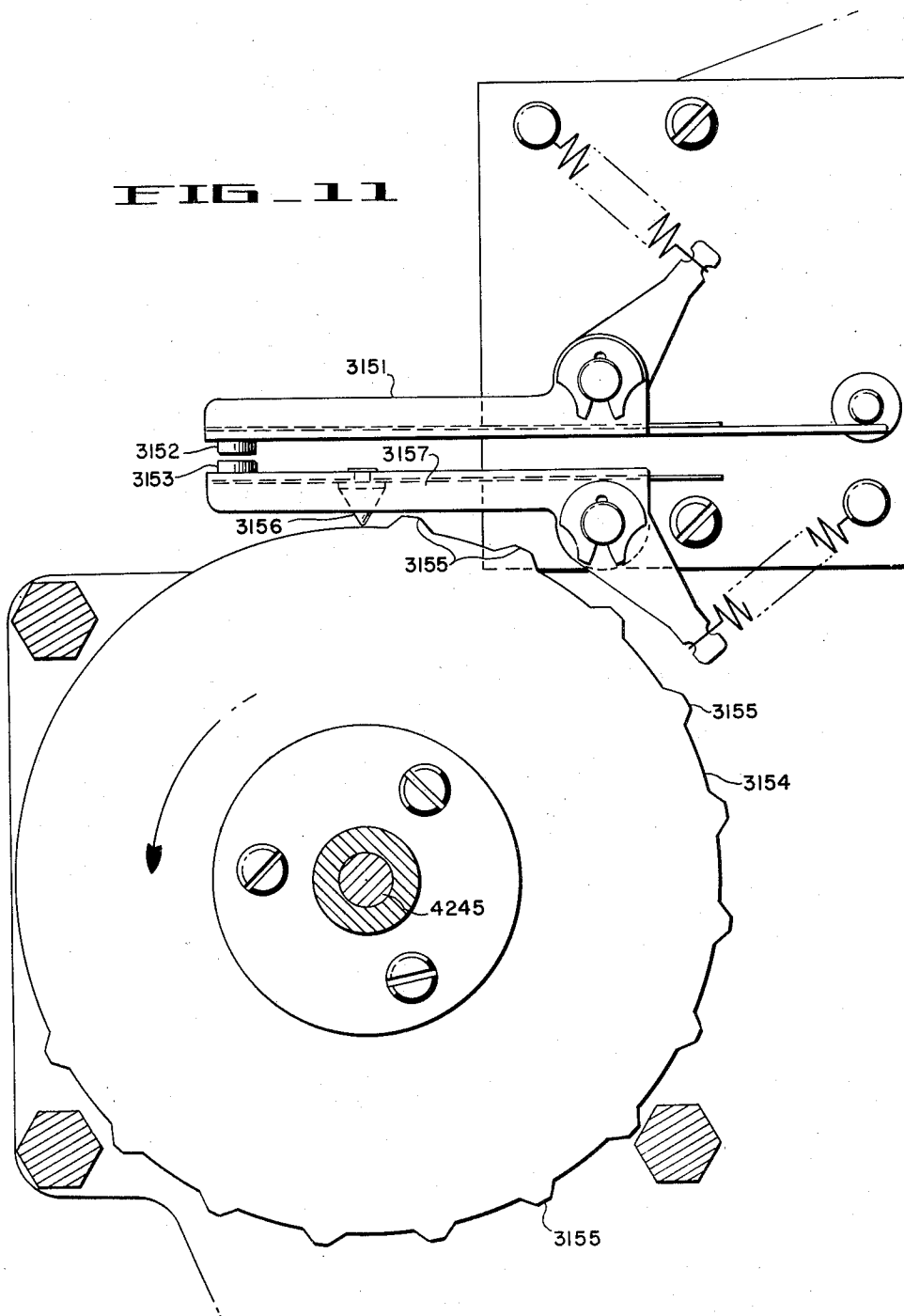
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FIG. 11



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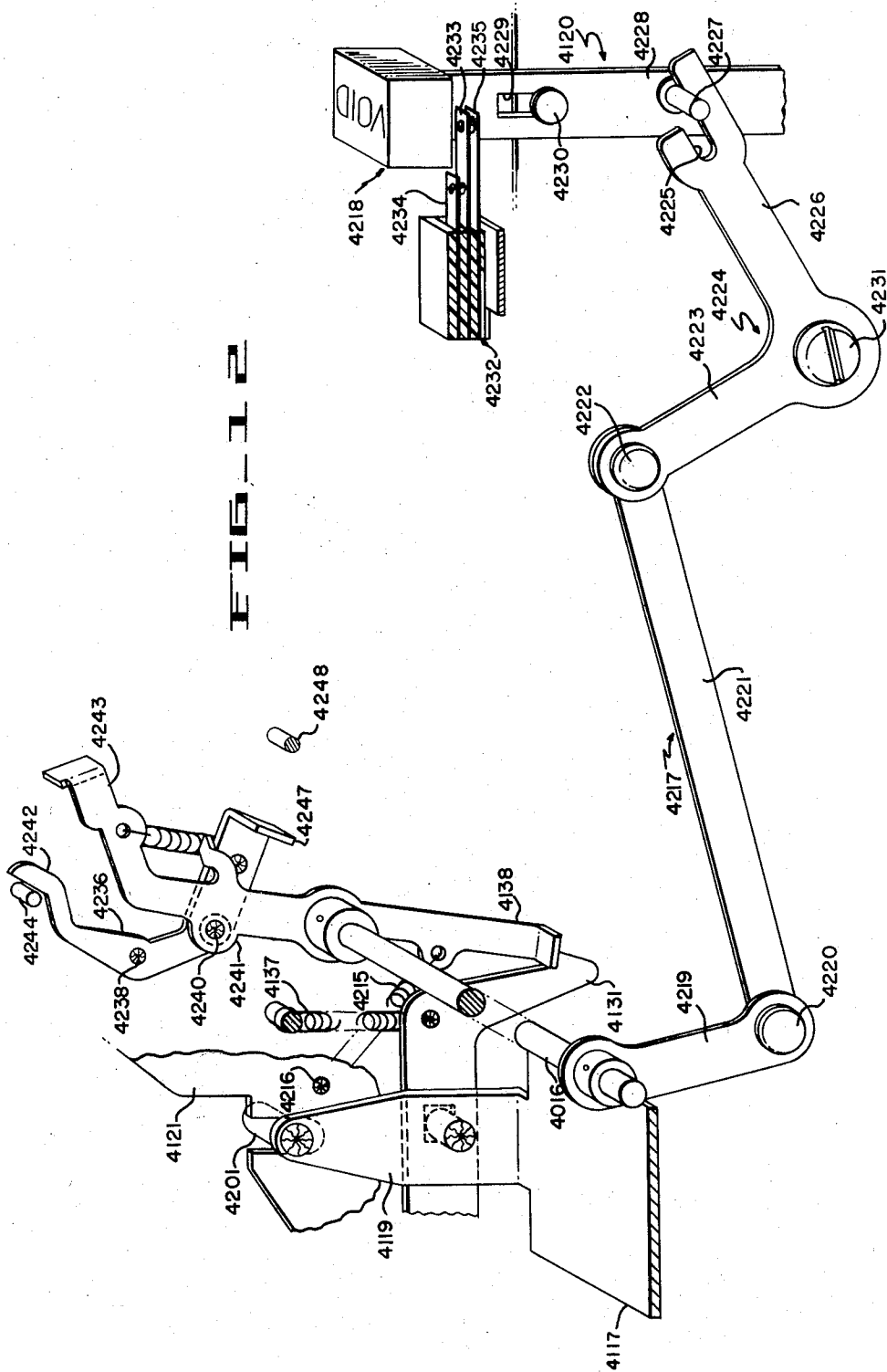
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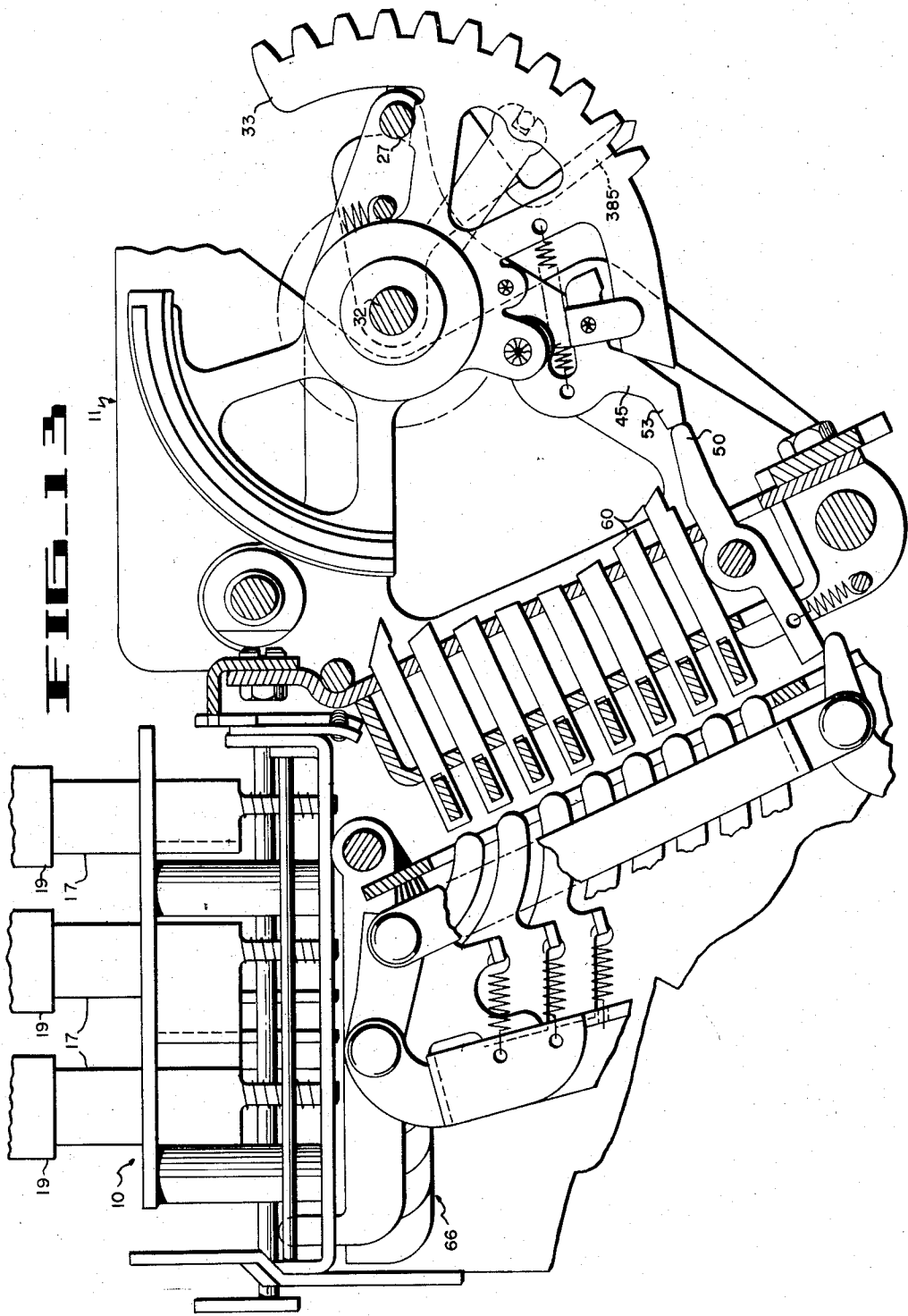
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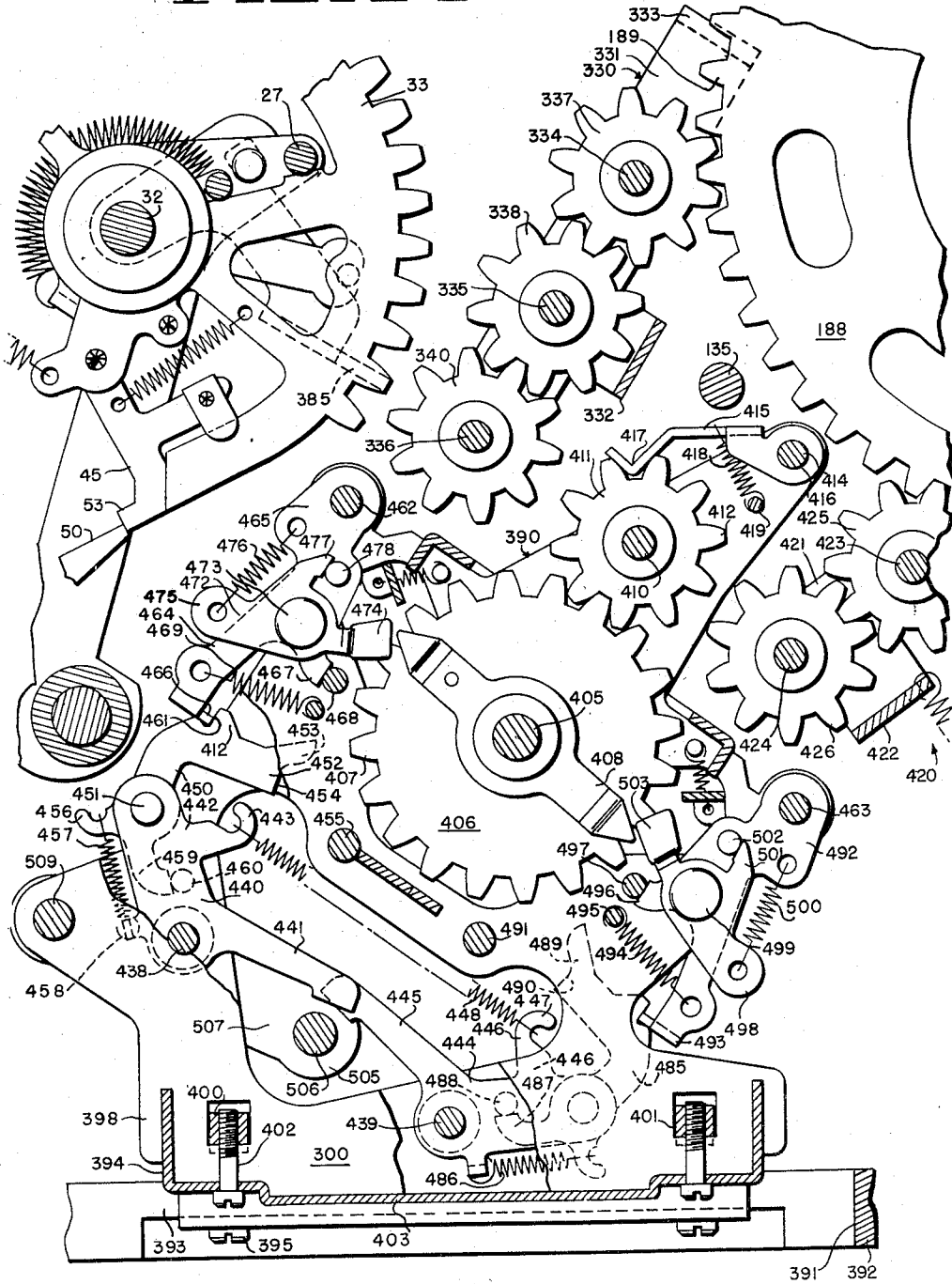
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FIG. 14



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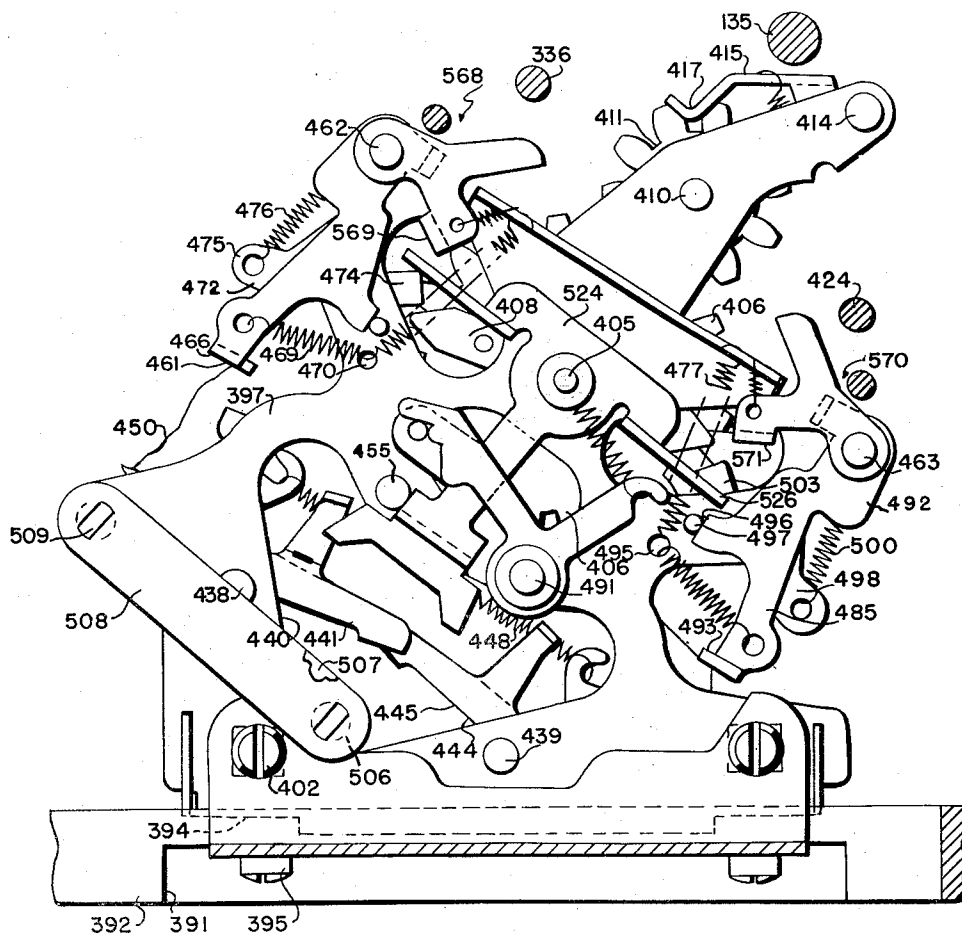
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FIG. 15



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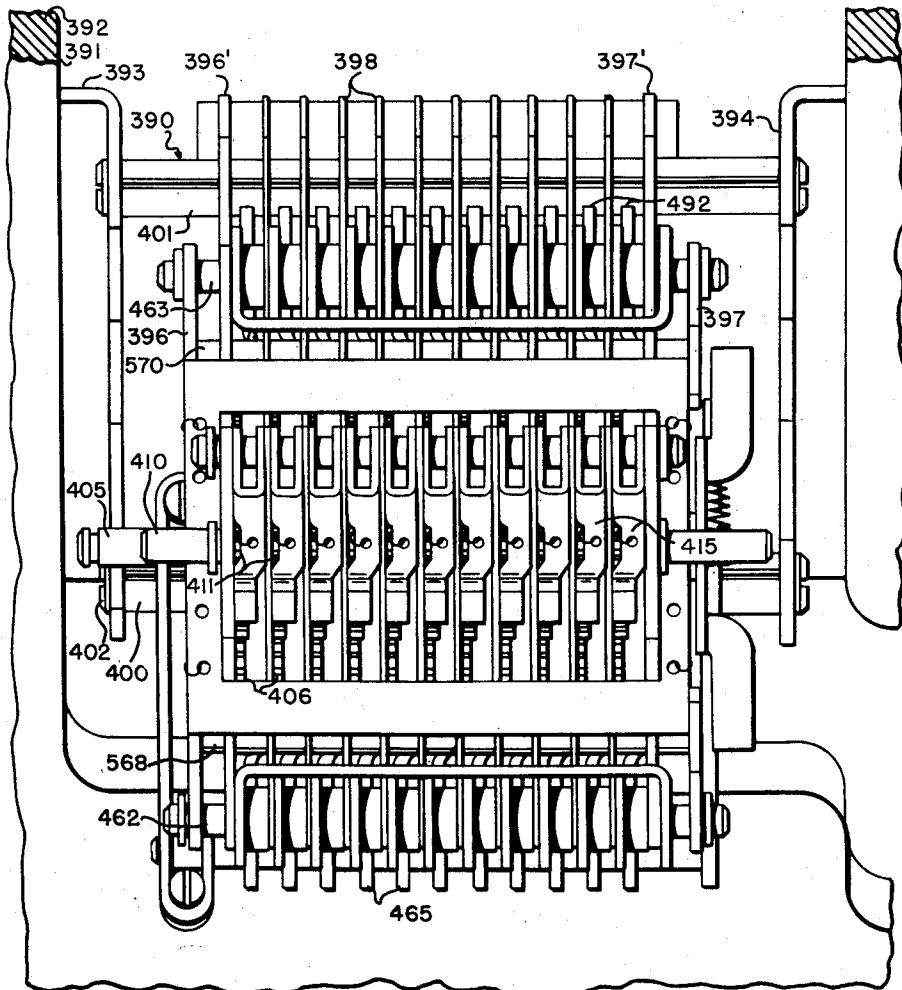


FIG. 16

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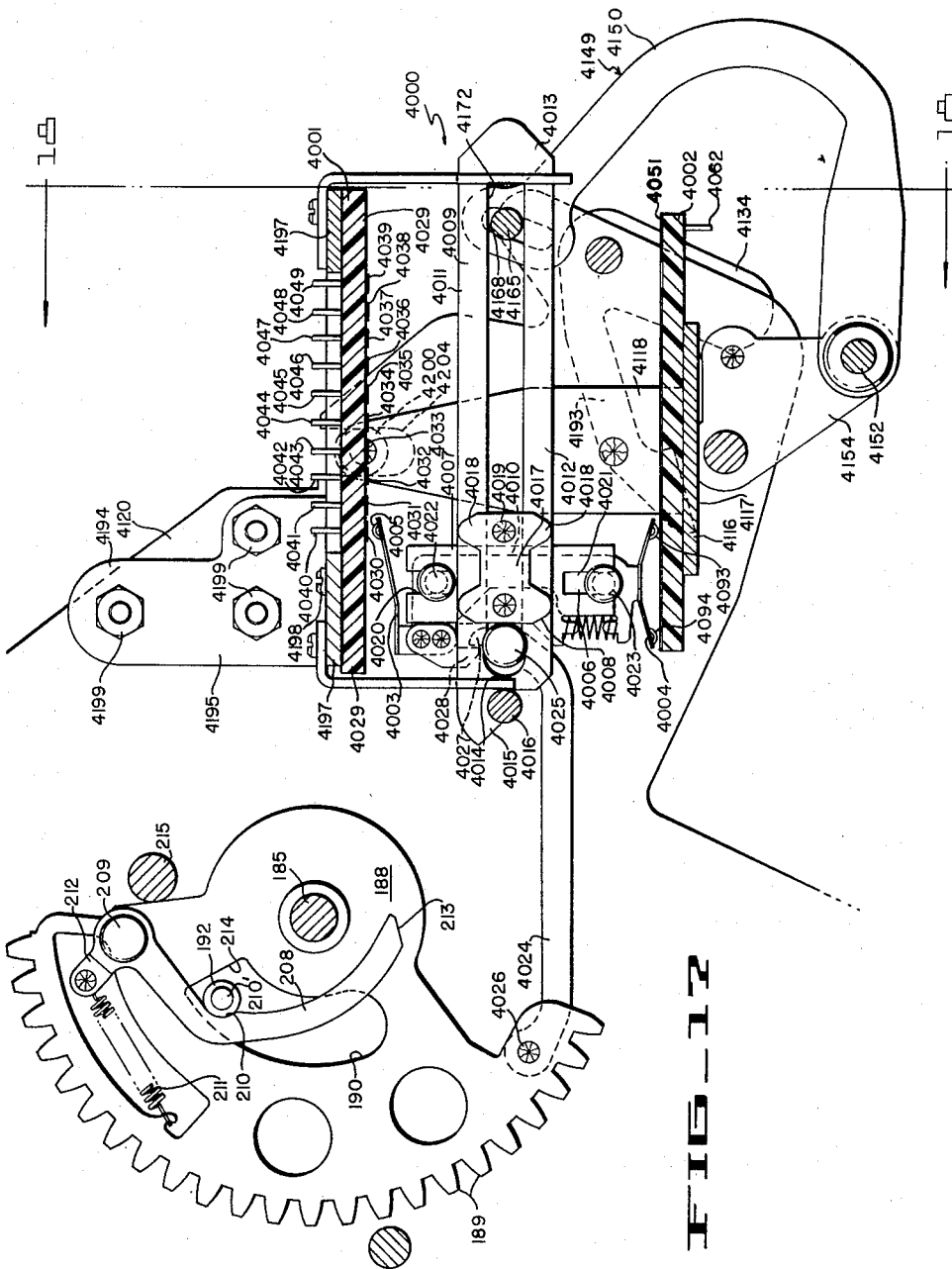
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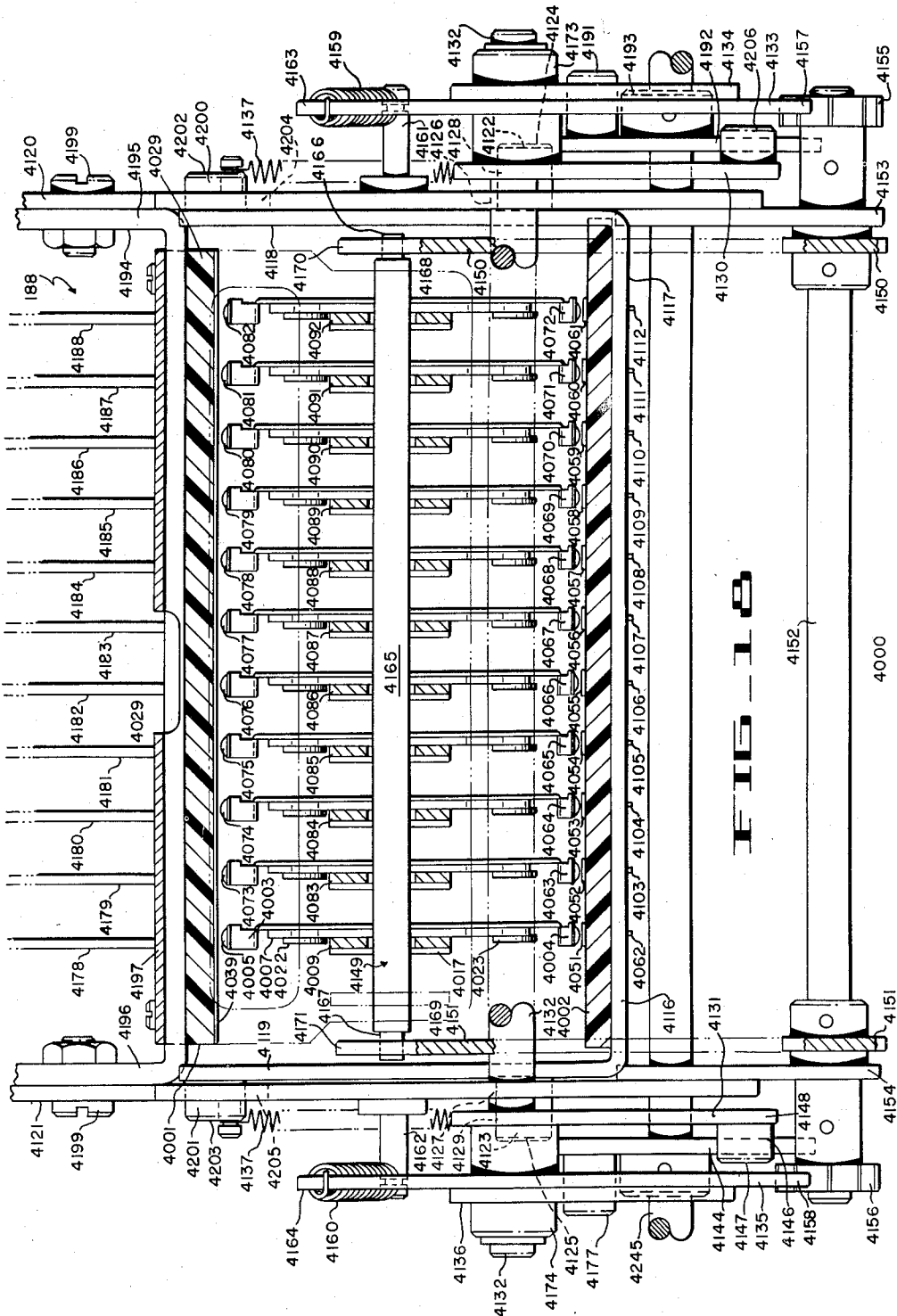
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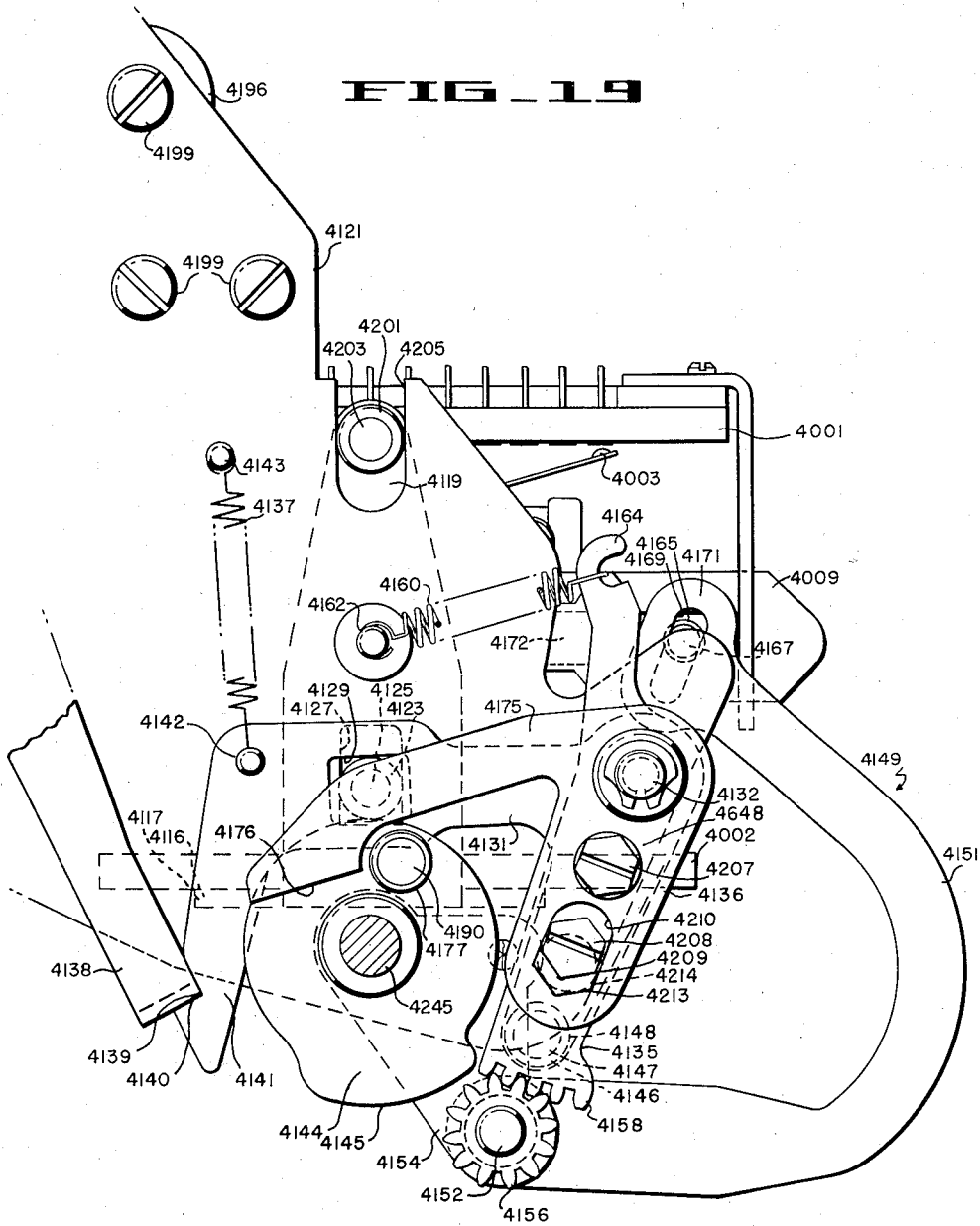
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FIG. 20

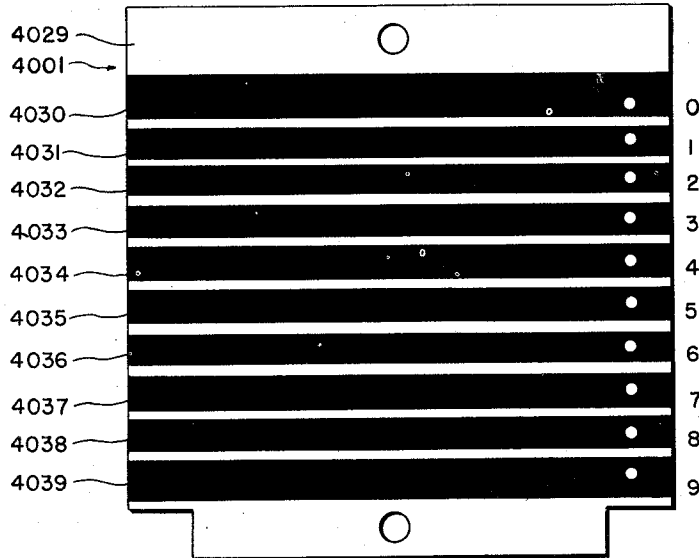
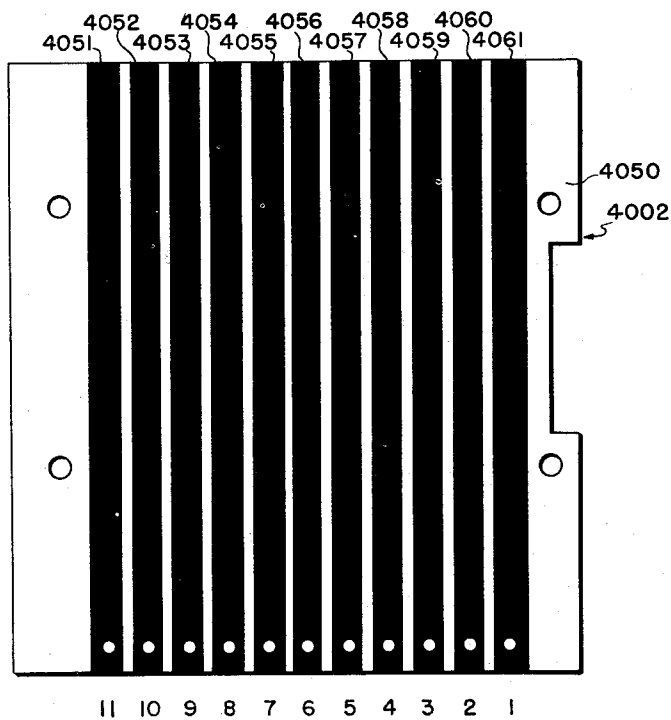
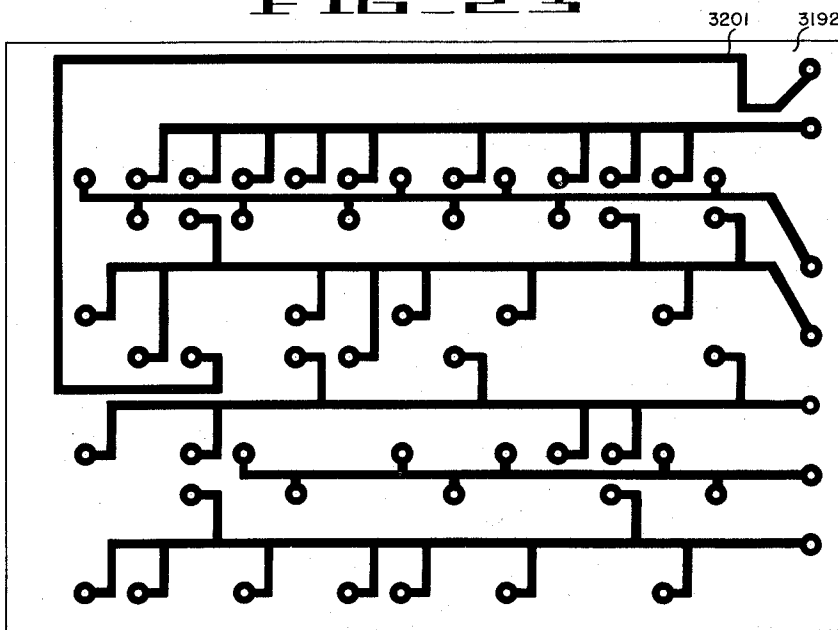


FIG. 21



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FIG. 24

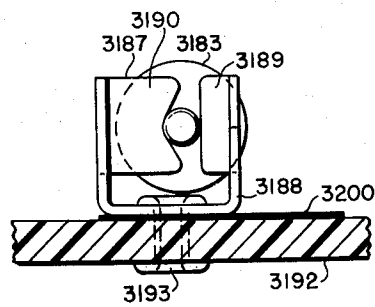
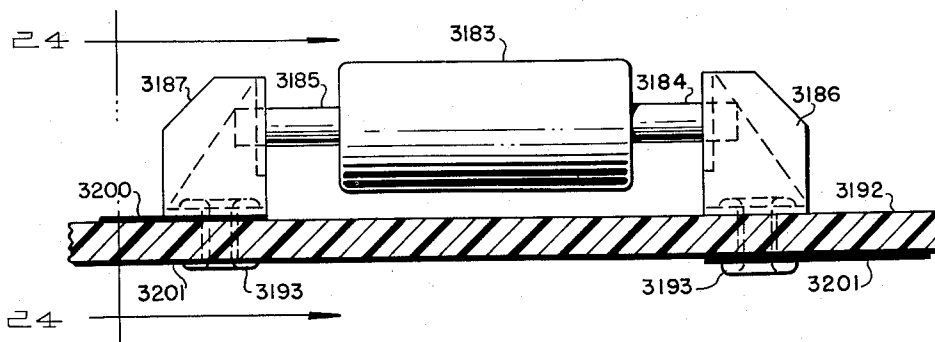


FIG. 25



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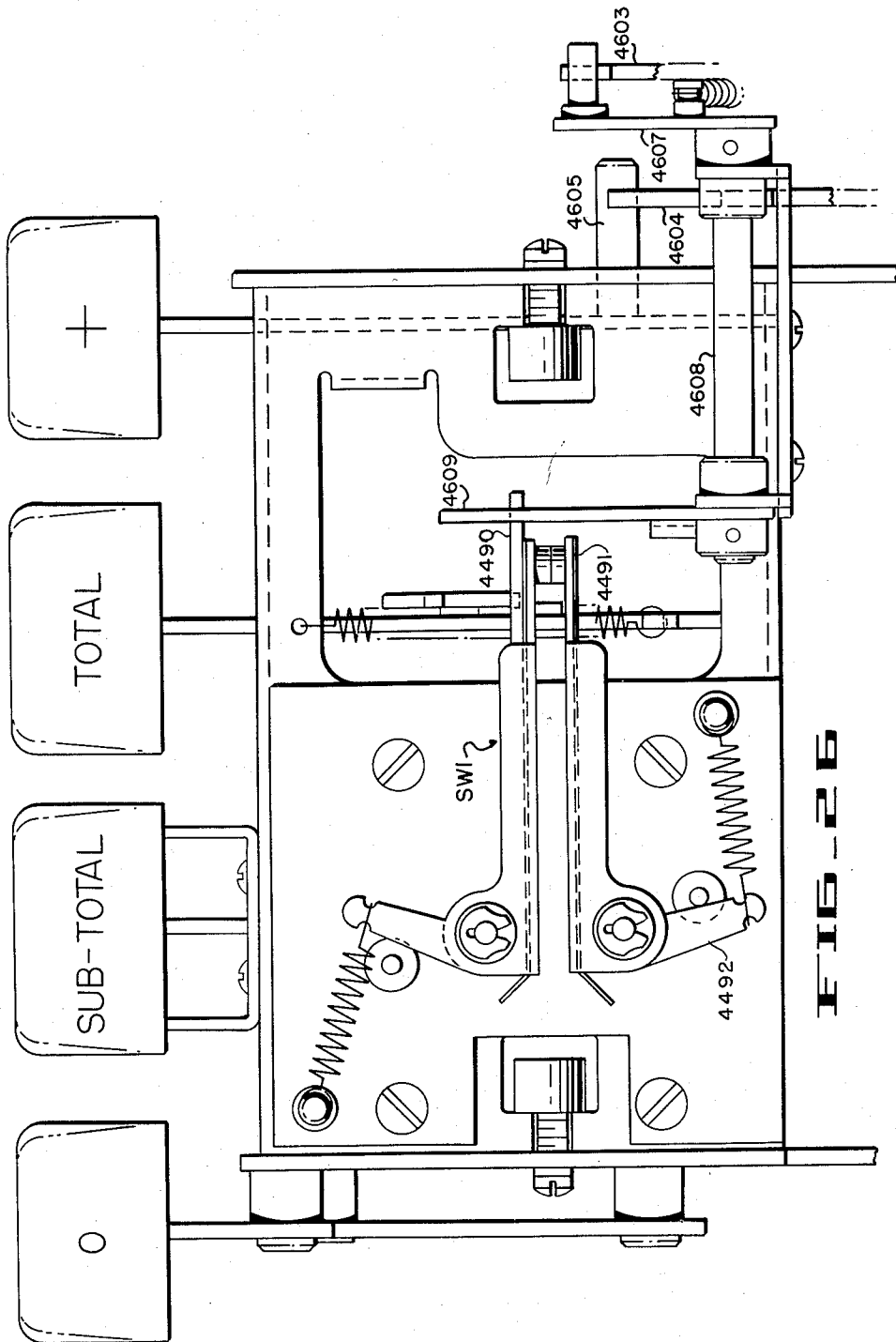
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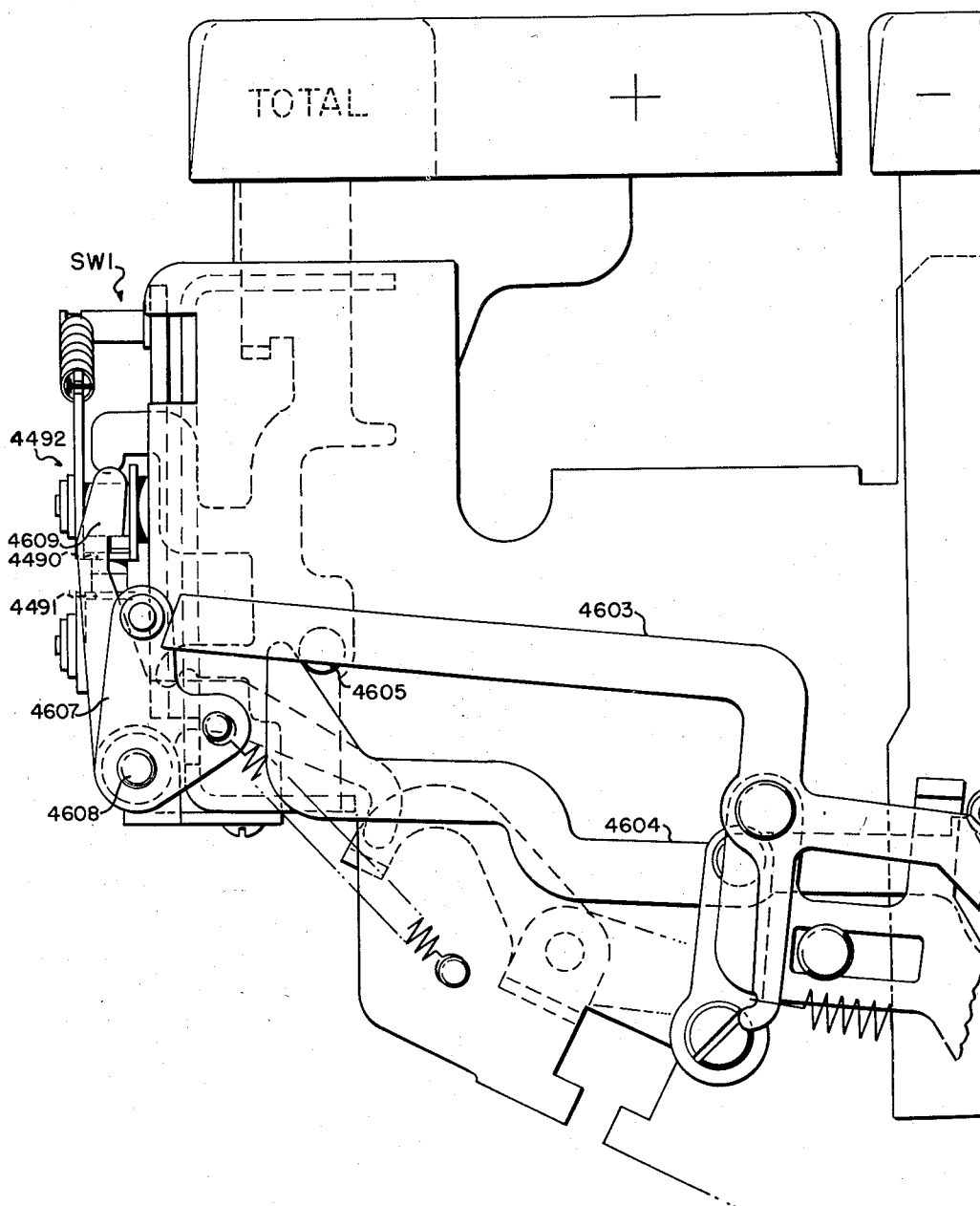
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FIG. 27



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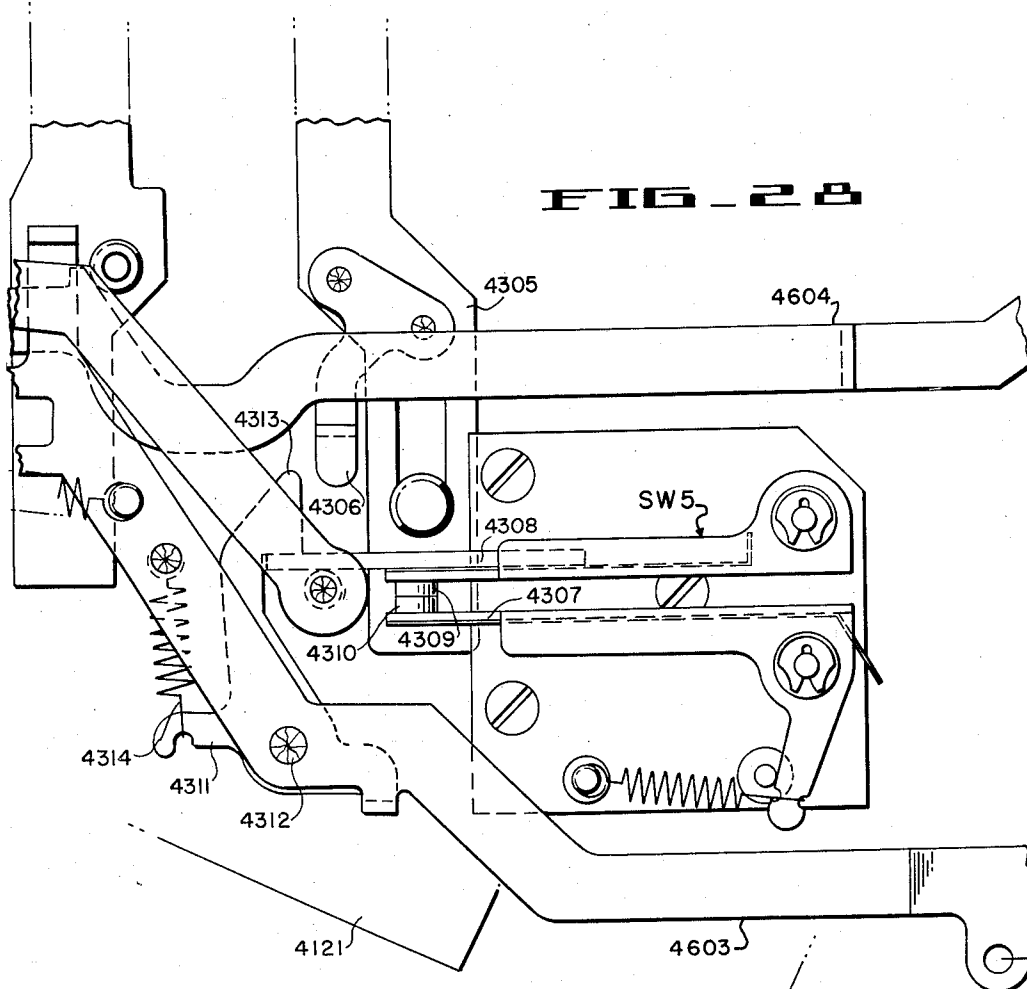
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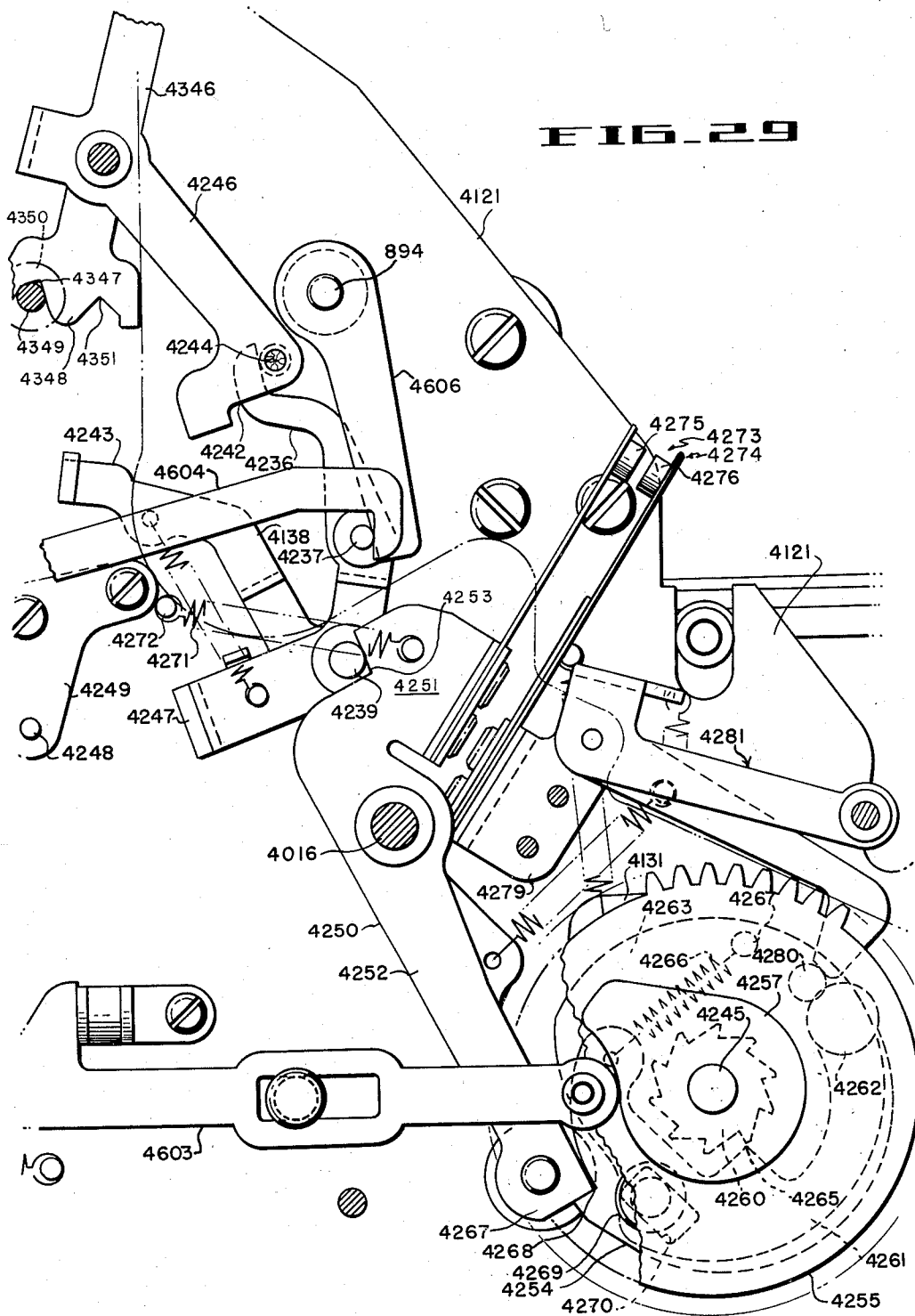
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FIG. 30

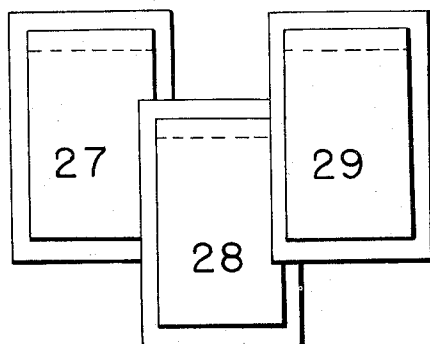


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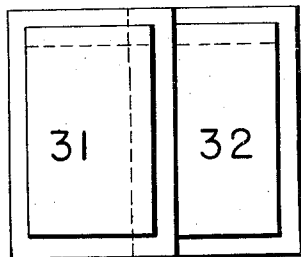
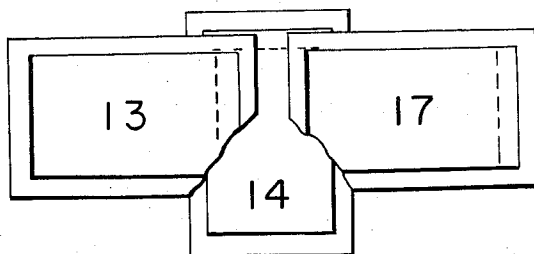
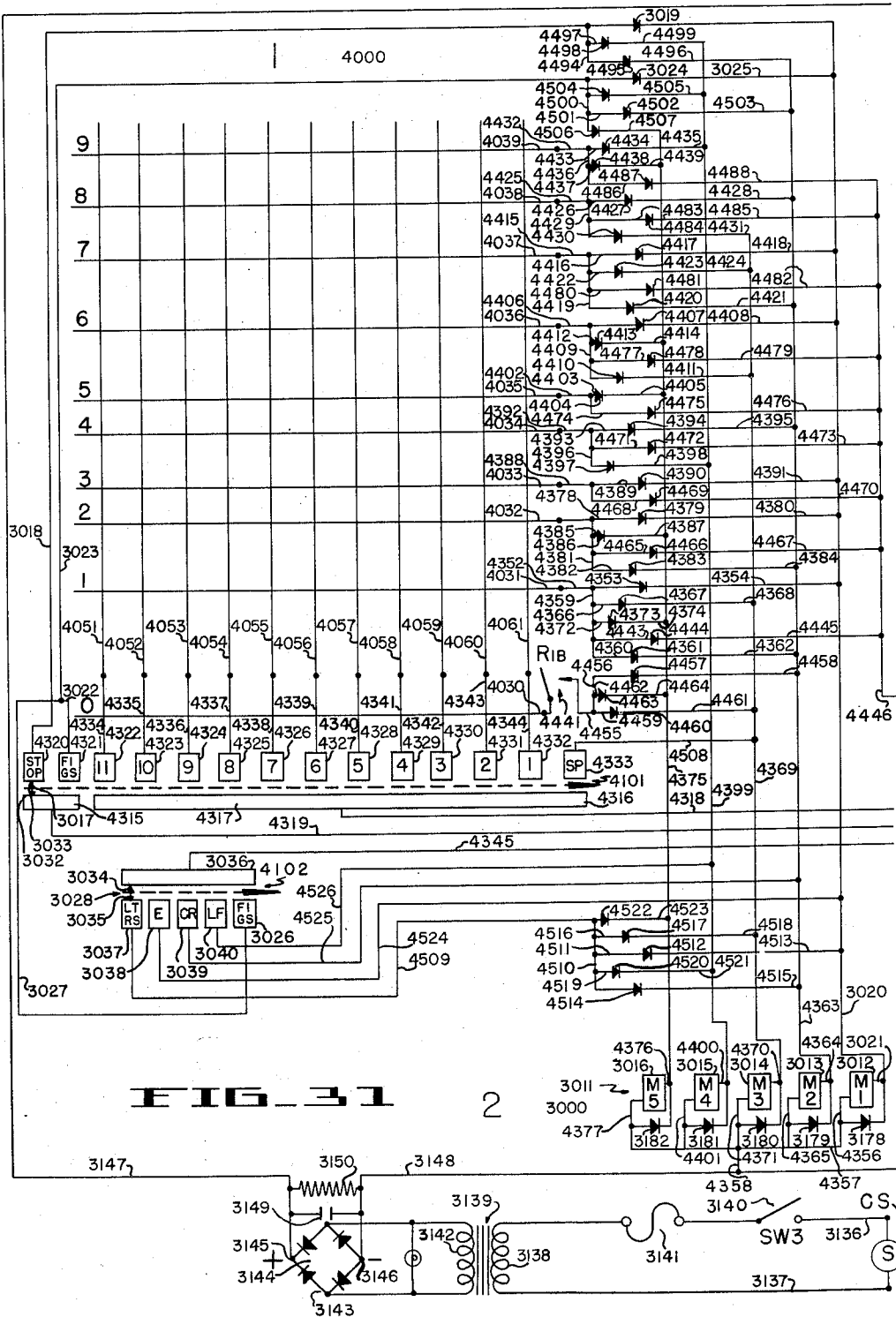


FIG. 42



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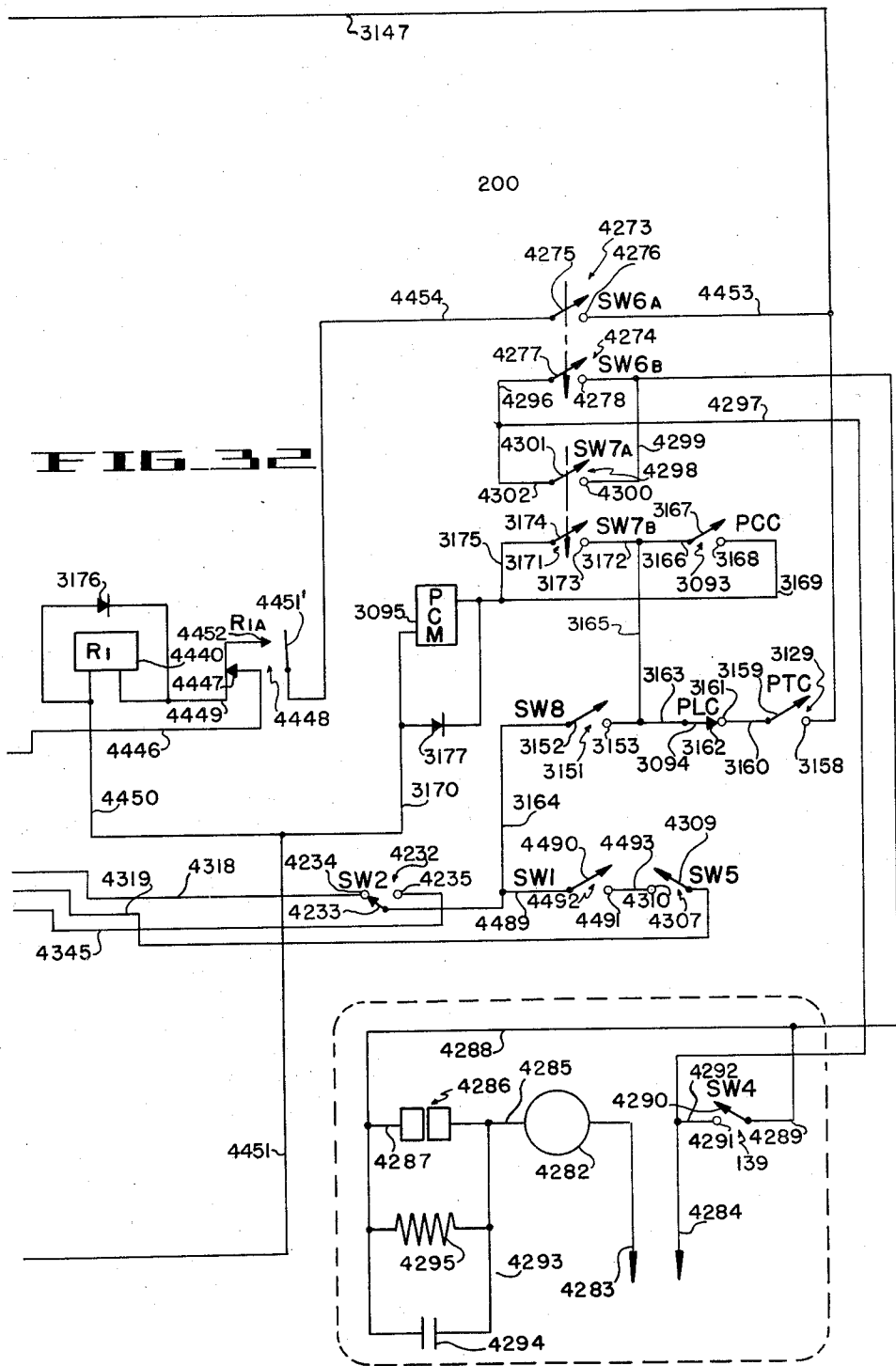
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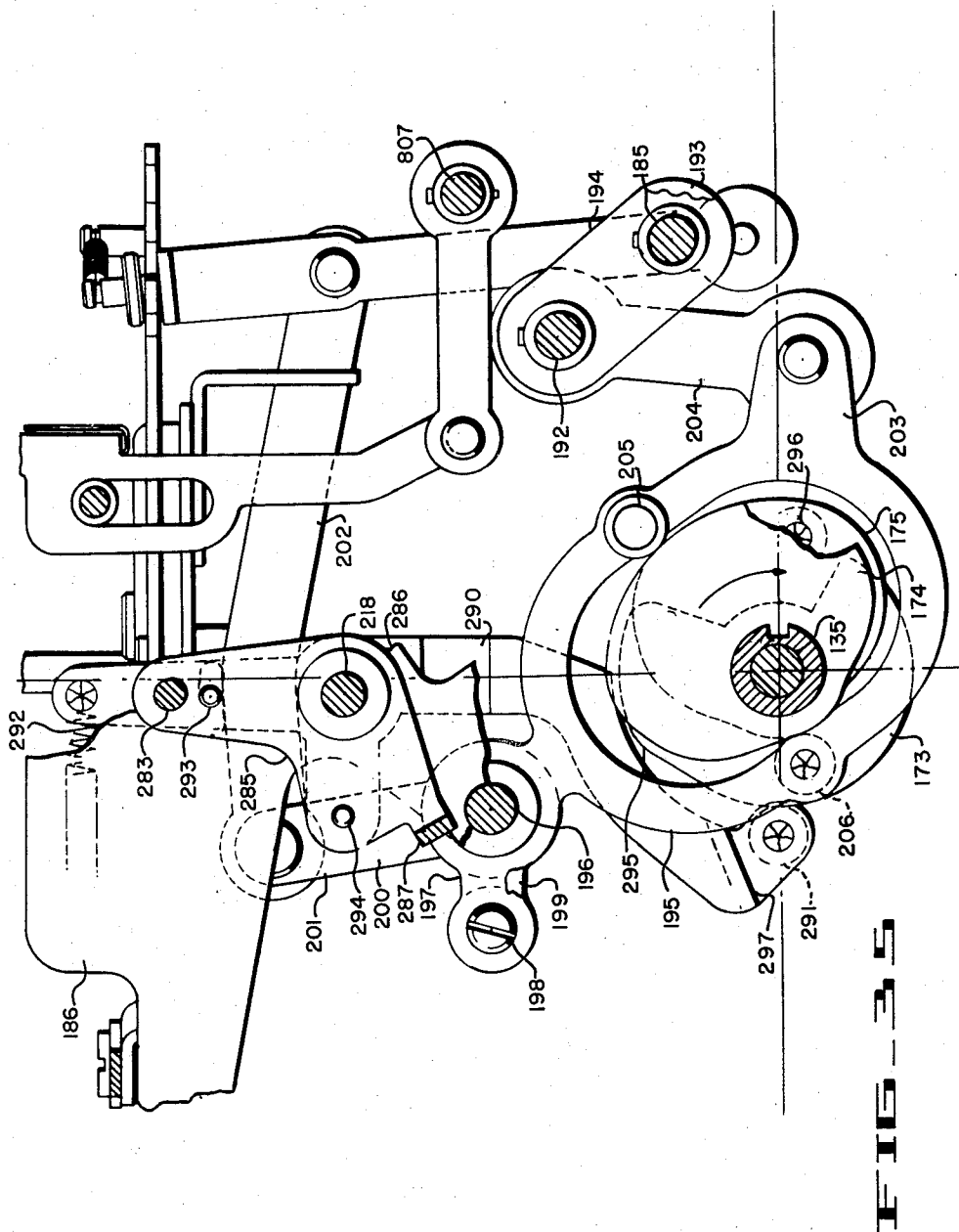
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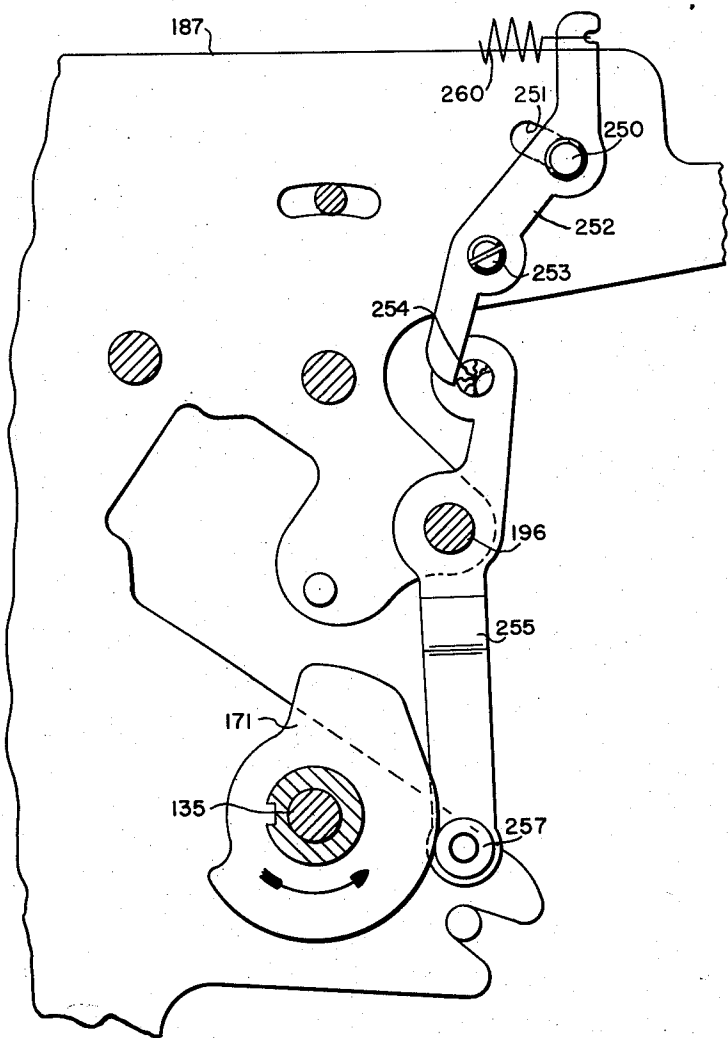
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FIG. 36



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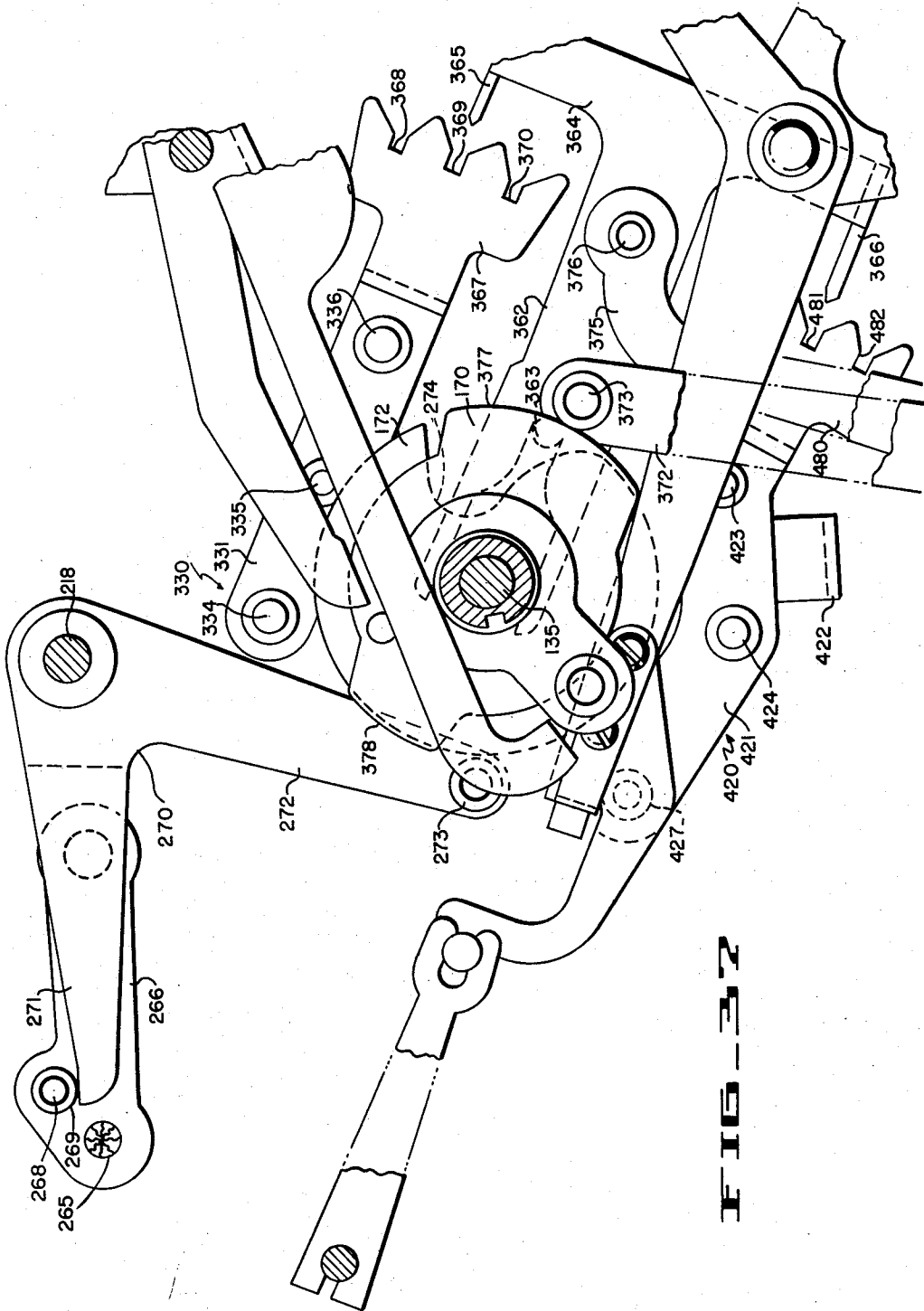
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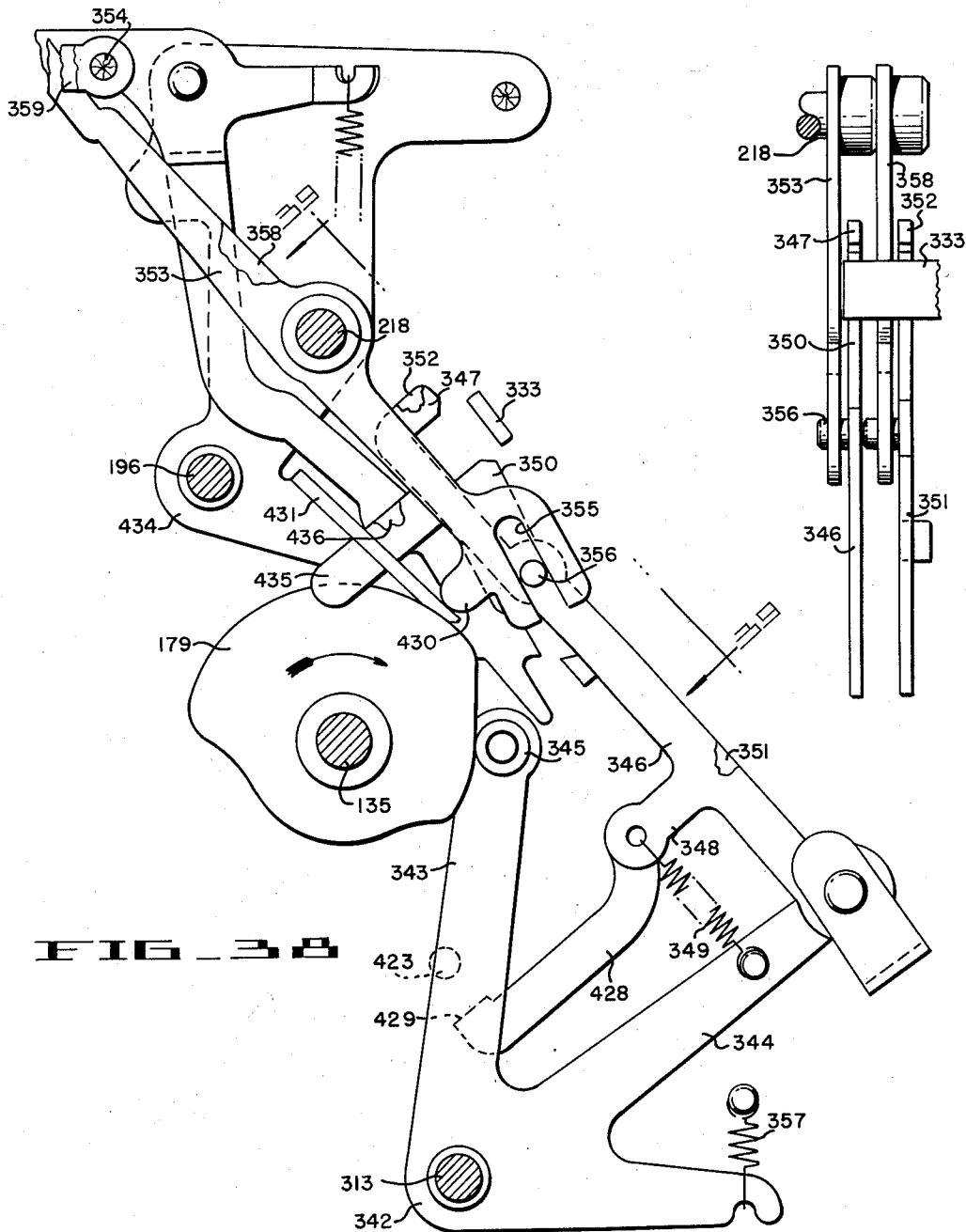
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FIG. 39



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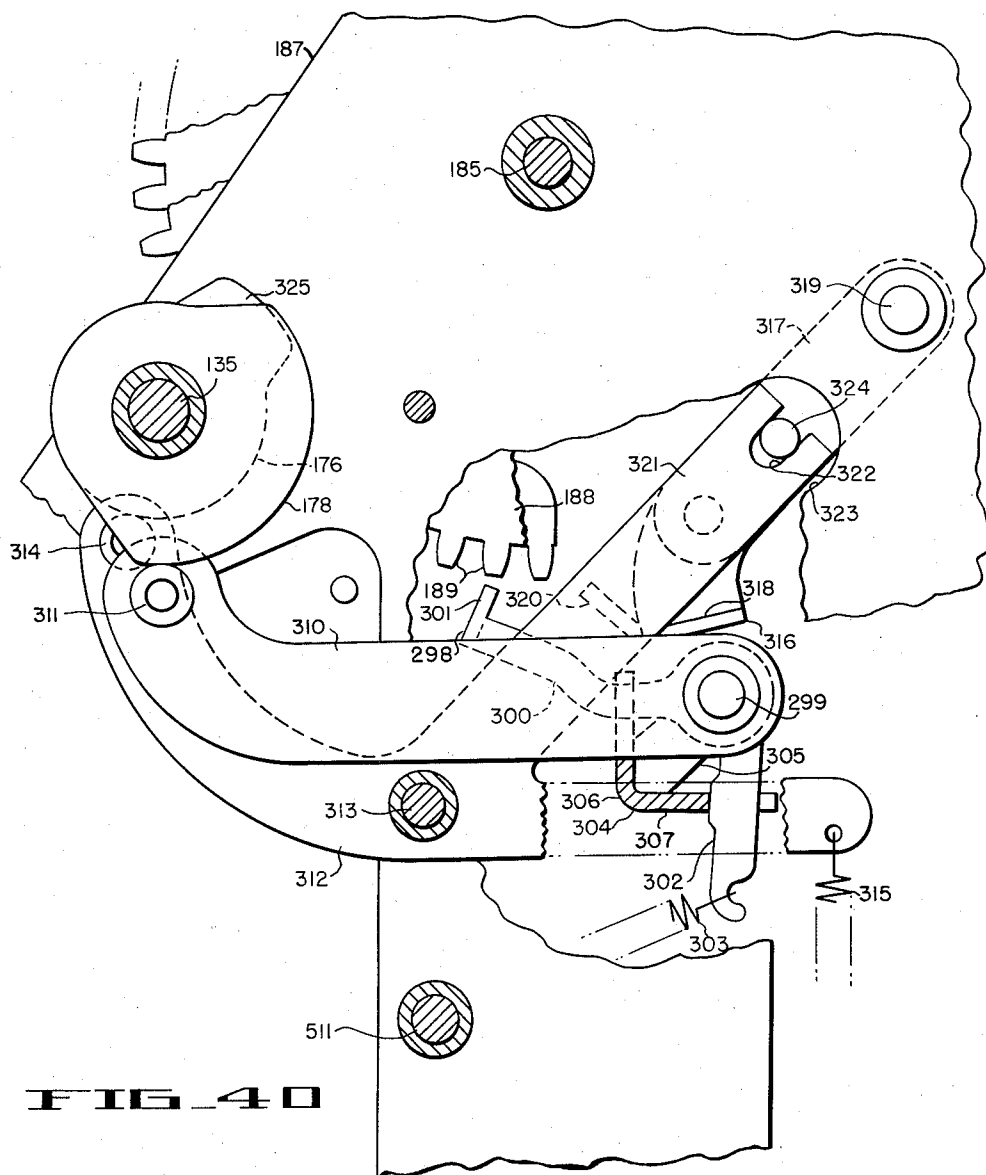
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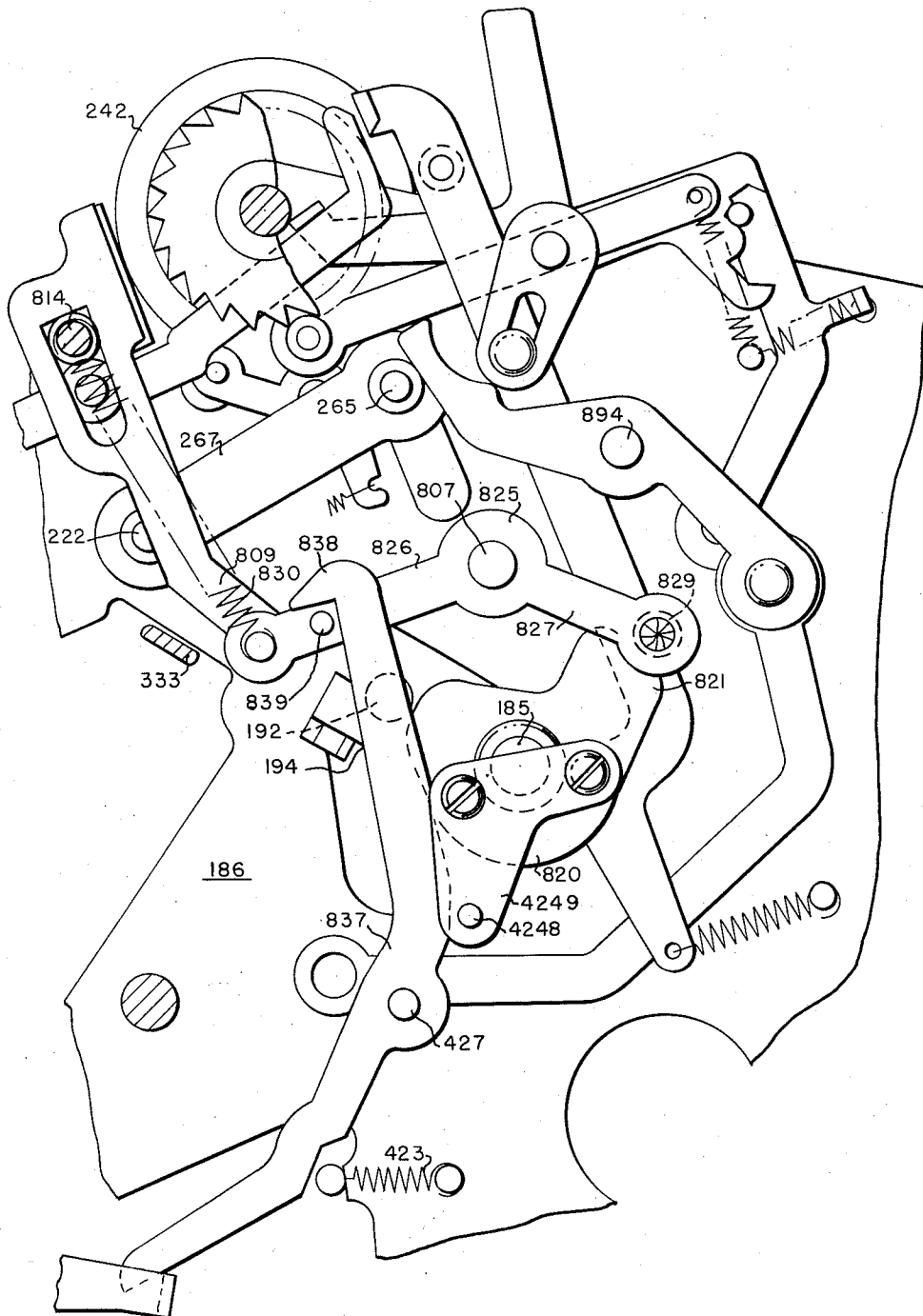
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FIG - 4 1



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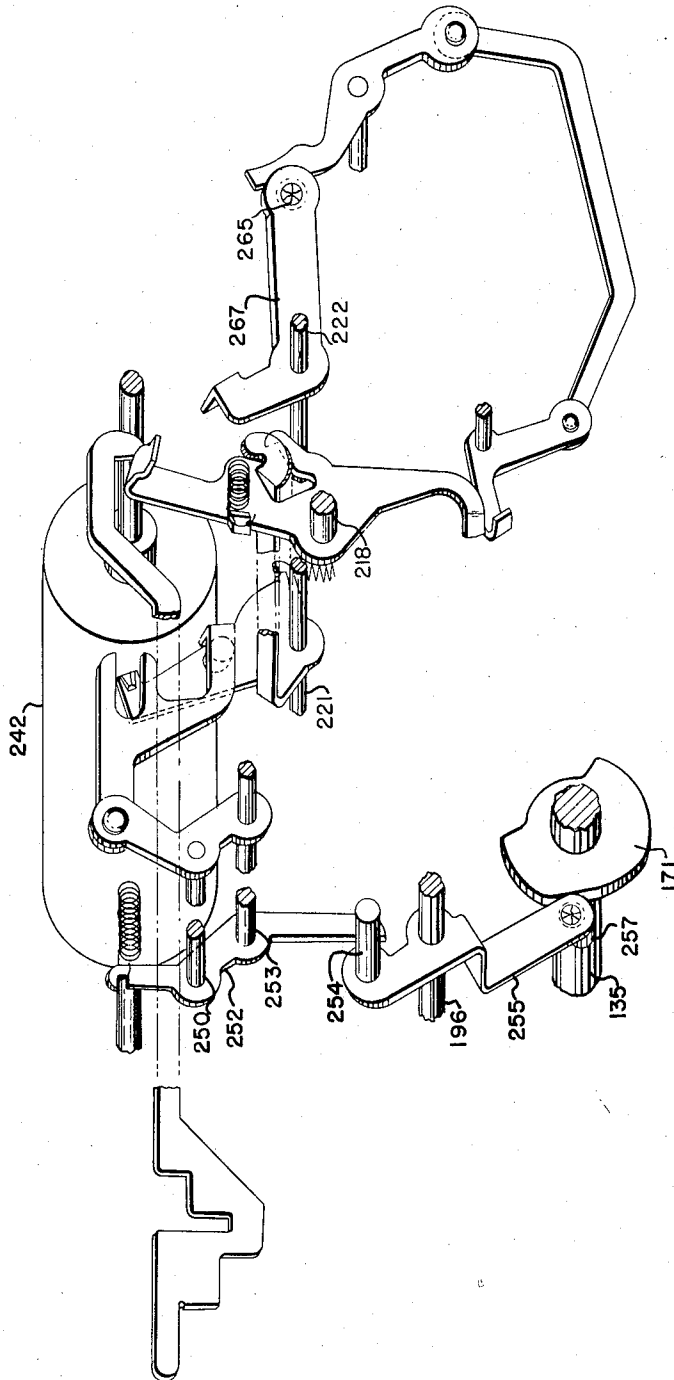
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FIG. 43



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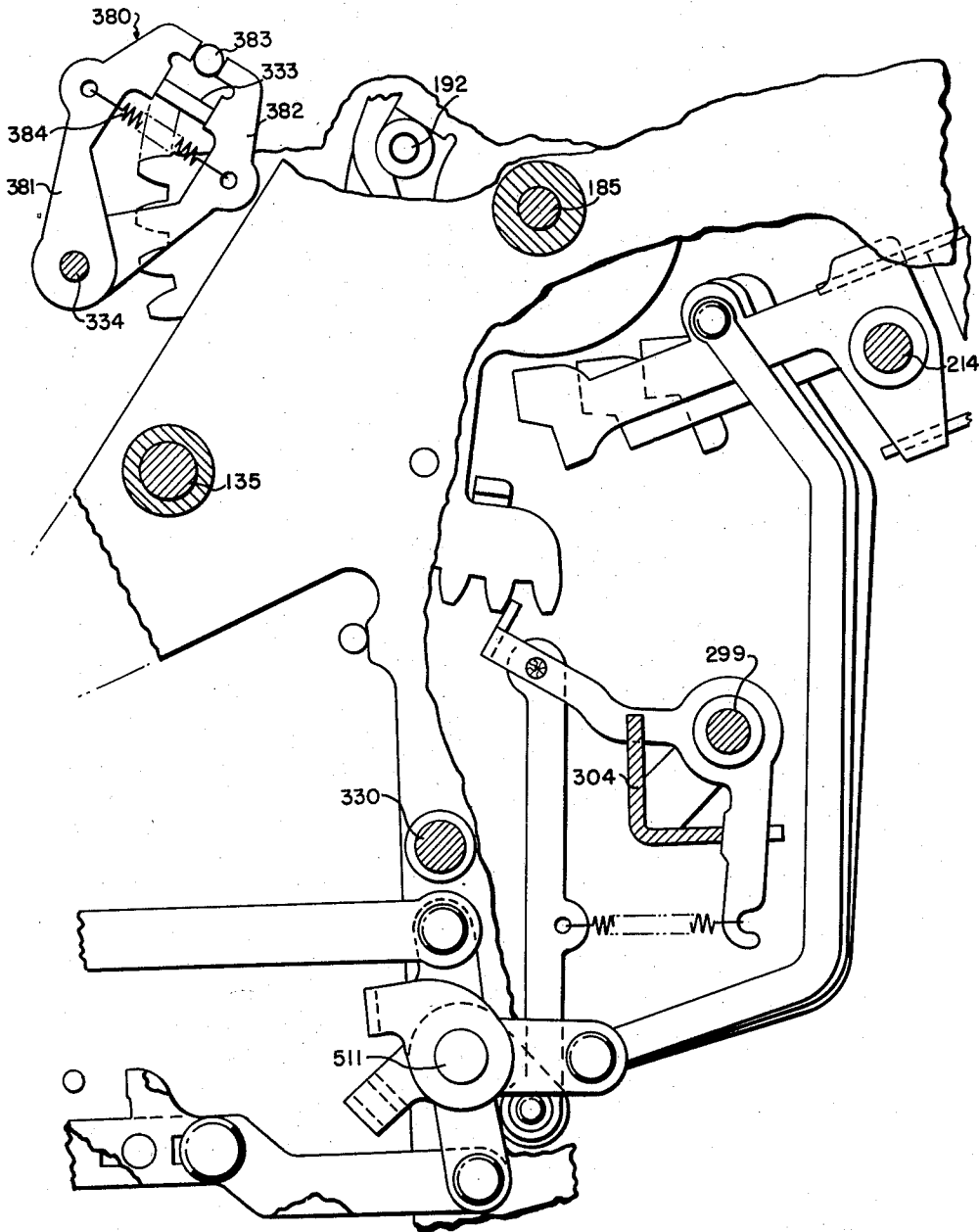
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FIG. 44



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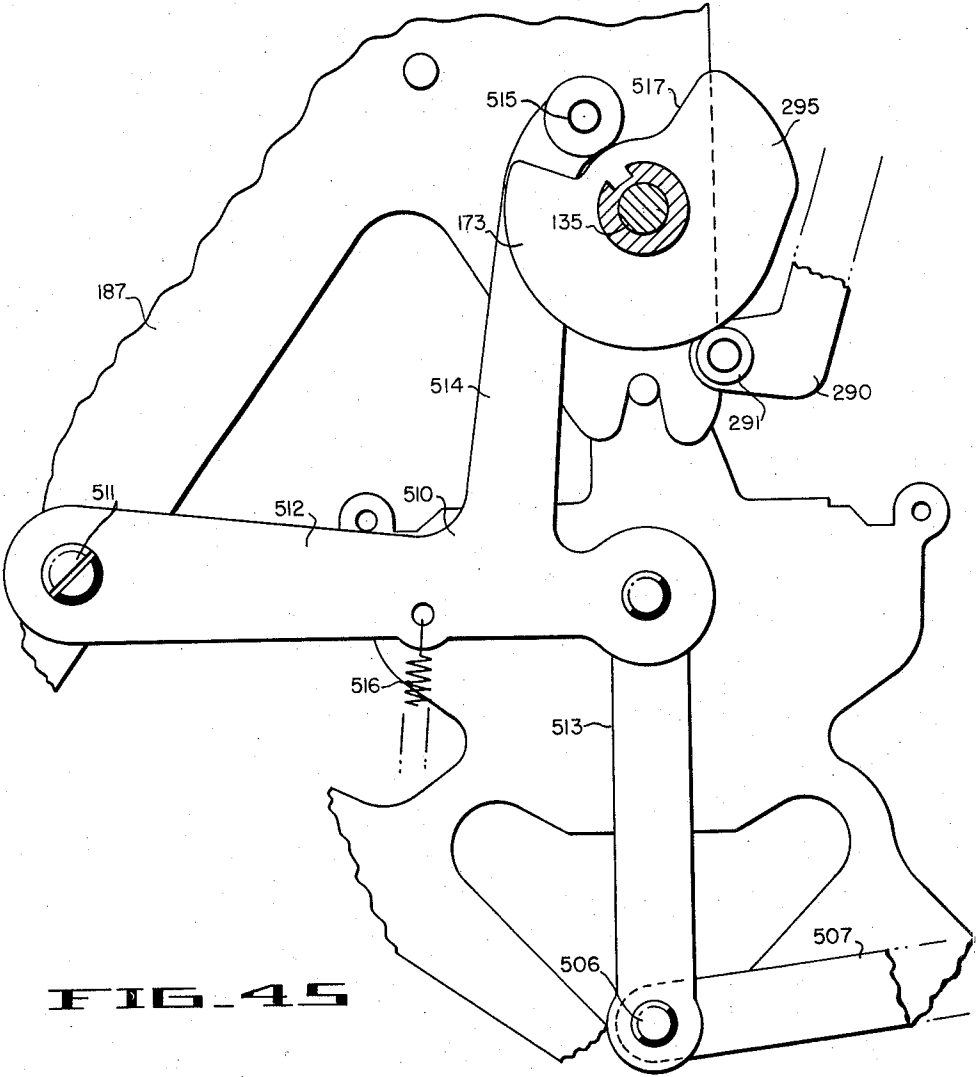
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PERFORATED RECORD MAKING ADDING MACHINE

Harold J. Chall, San Leandro, and Bernard P. Silverman, Oakland, Calif., assignors to Friden, Inc., a corporation of California

Application November 16, 1954, Serial No. 469,128

4 Claims. (Cl. 235—60.29)

This invention relates to computing apparatus and more particularly to computing apparatus operable to make reproducible records of the amounts computed.

An object of the invention is to provide a computing apparatus of the simplified and small keyboard type operable to compute amounts and read them out into a record-making device operable to make a record of the amounts read out from the computer.

Under the broad aspects of the invention, the records may be produced in any suitable manner and form, since the computing portion of the apparatus is provided with a readout means suitable for controlling the operation of either printing or perforating apparatus.

A feature of the invention resides in electrical switch means operable to electrically set up switching conditions representing amounts accumulated in the computing apparatus.

Another feature of the invention resides in a drive connection for operating the electrical switch means in accordance with amounts accumulated in the computer.

Another feature resides in the combination with the computing apparatus and the readout switch therein of the reproducible record-making apparatus.

For the purpose of illustrating and explaining the invention and not in a limiting sense thereof, the invention is shown and described as involving a so-called ten-key adding machine and a tape perforating machine. The adding machine is operable to add and subtract and to print records of the amounts entered in and obtained by computation in the adding machine. The electrical switch means in the adding machine is operable to control the tape perforating machine to perforate a tape in accordance with the amounts accumulated in the adding machine.

The adding machine per se, shown in the drawings of the present application, in general, is of the type shown and described in an application, S. N. 407,016, filed January 29, 1954, Patent No. 2,832,530, issued April 29, 1958, under the name of Harold J. Chall, entitled "Value Selecting and Transmitting Mechanism for Listing Adding Machine," continuation-in-part of application, S. N. 354,151, filed May 11, 1953, abandoned January 20, 1955, in favor of S. N. 407,016.

In the drawings—

Fig. 1 is a top plan view showing in combination a ten-key adding machine, in general, of the type shown and described in the aforementioned application, but improved to include the present invention and a tape perforator apparatus, the adding machine being operable to compute amounts and read them out into the tape perforator which is operable to make a perforated record of the amounts accumulated in the adding machine apparatus. The adding machine is improved to include the electrical switch means enabling control of the tape perforator apparatus in accordance with amounts accumulated in the adding machine;

Fig. 1A is a diagrammatic illustration of the ten-key adding machine;

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Fig. 2 is a top plan view of the tape perforating apparatus;

Fig. 3 is a side elevational view of the tape perforator, a portion of the casing being removed to disclose apparatus parts contained within the casing;

Fig. 4 is a view corresponding to Fig. 3, but with some of the apparatus parts left out to more clearly disclose other apparatus parts which are particularly pertinent to the operation of an electrical switch member;

Fig. 5 shows a code record strip representing positions on a tape to be perforated in accordance with a required code record of the operations of the apparatus in combination;

Fig. 6 is a view in cross-section of the tape perforating apparatus and taken on the line 6—6 in Fig. 3;

Fig. 7 is an enlarged view, partly in section, of portions of a cam shaft and a commutator type switch forming a control member in the apparatus of this invention;

Fig. 8 is an assembled view of the main cam shaft of the adding machine and plan views of the cams included therein;

Fig. 9 is a view, partly in section, of the commutator type switch operated by means of the first-mentioned cam shaft;

Fig. 10 is a view of the commutator type switch taken on the lines 10—10 in Fig. 9;

Fig. 11 is a view of a cam-operated switch operable to complete circuit connections at required predetermined intervals;

Fig. 12 shows a view of a single pole, double throw switch operated by means of a manually operable key and a lever system extending from the manually operable key to mechanically operate corresponding parts in the adding machine apparatus;

Fig. 13 is a view, partly in section, of the digitation mechanism employed in the adding machine apparatus;

Fig. 14 is a view, partly in section, of portions of an accumulator employed in the adding machine apparatus, and showing a transfer gear system provided therein;

Fig. 15 is a side view of the accumulator unit;

Fig. 16 is a top plan view of the accumulator unit taken from the right of Fig. 15;

Fig. 17 is a side view, partly in section, of a sector gear employed in the adding machine apparatus, and with the sector gear mechanically connected to the electrical readout switch provided in this invention;

Fig. 18 is a plan view, partly in section, of parts of the electrical readout switch employed in the adding machine apparatus;

Fig. 19 is a side view of portions of the readout switch apparatus and showing the restoring mechanism provided therein for restoring movable contacts in the switch to their home positions;

Fig. 20 shows an upper contact structure in the readout switch;

Fig. 21 shows a lower contact structure in the readout switch, the contact members running in a direction 90 degrees with respect to those shown in Fig. 20;

Fig. 22 shows a frame of diodes employed in the electrical system of the apparatus of this invention, the arrangement shown in Fig. 22 being the lower face of the diode frame;

Fig. 23 shows the upper face of the diode frame and is, in effect, a printed circuit operable to conductively connect diodes, mounted on the lower face of the frame, into the electrical system as required for operation of the apparatus of this invention;

Fig. 24 is an enlarged view, partly in cross-section, of an insulating strip with a terminal mounted thereon and an end portion of a diode connected to the terminal, taken on the lines 24—24 of Fig. 25;

Fig. 25 is a side view of the diode taken on the lines

25—25 shown in Fig. 22, the terminals of the diode being mounted in clip type terminals supported in spaced relation on an insulating strip;

Fig. 26 is a front elevational view of the keyboard control portion of the adding machine;

Fig. 27 is a side elevational view of the keyboard portion of the adding machine and should be placed in position relative to Figs. 28 and 29 as shown in Fig. 30, to cooperatively form an illustration of a lever system provided in the adding machine apparatus and operable to control electrical switches used in the electrical system of the apparatus of this invention;

Fig. 31 is a circuit diagram of the readout switch provided in the computing apparatus, commutator type switches provided in the electrical system and electromagnetic devices operable to control the operation of perforating pins provided in the tape perforator. Fig. 31 also shows the source of current supply for the apparatus of this invention;

Fig. 32 shows the power supply for the motor of the computing apparatus and also shows the electrical switching system provided in the computing apparatus and operable to control the operation of the electrical readout means and the tape perforating members in accordance with the operation of control keys in the computing apparatus;

Fig. 33 shows the relative arrangement that should be made of Figs. 31 and 32 to illustrate the electrical system employed in this invention;

Fig. 34 is a view showing a portion of the printing mechanism and particularly the print wheels, the print wheel drive and the operating mechanism for the print wheels;

Fig. 35 is an elevational view of the actuator sector trail and lead cams, a print controlling cam and tens-carrying accumulator operating cam, and the mechanism operated by these several cams;

Fig. 36 is a left side elevational view of the zero foil releasing cam for the printing mechanism and the mechanism operated by this cam;

Fig. 37 is an elevational view from the left-hand side of the machine showing the crank for operating the return mechanism of the shiftable selector unit, the positive and negative transmission gear locking cam, the crank pin for releasing the control keys at the left-hand side of the keyboard and the print controlling cam together with the mechanisms operated by the several cams;

Fig. 38 is a side elevational view, looking from the right side of the machine, of the means operated by the addition and subtraction keys for controlling the shifting of the positive and negative transmission gear mechanisms;

Fig. 39 is a fragmentary top plan view of the mechanism shown in Fig. 38, looking from a plane indicated by the section line 39—39 of Fig. 38;

Fig. 40 is an elevational view, from the right-hand side of the machine, showing the mechanism for aligning the actuator sectors of the machine in proper rotational position for the printing operation and means for releasably looking the actuator sectors in properly aligned condition during the printing operation;

Fig. 41 is a general illustration of the ribbon shifting and tape feeding mechanism of the machine;

Fig. 42 shows the relative arrangement that should be made of Figs. 13, 14 and 17 to enhance a ready understanding of the gear connections provided between the selector sectors and the actuator sectors through the accumulator.

Fig. 43 shows in perspective, a view of some of the lever system involved in the printing portion of the calculating machine and includes the signal symbol printing mechanism of the machine;

Fig. 44 is a right side view, partly in section, of a portion of the computing apparatus showing the symbol printing and latching mechanism; and

Fig. 45 is a left side elevational view of the cam and

associated mechanism for operating the accumulator sector actuating bail and the print wheel detenting mechanism.

The add-punch machine, embodying this invention, is operable to list items entered in the adding machine, compute amounts therefrom, print required totals and make a perforated record of the required amounts and is believed to be the first adding and listing machine of its kind with a tape-punch apparatus.

As shown in Fig. 1, this apparatus comprises a computing apparatus 1 and a tape perforating apparatus 2, the computing apparatus and the tape perforating apparatus being disposed in side-by-side spaced relation and being electrically and mechanically coupled through a system commutator switch 3 and a power transmitting shaft 4.

The computing apparatus 1 is operable to receive and record entries of values such as are normally received and recorded by a computing apparatus and to compute from these entries the sums or differences in the individual amounts entered and to record subtotals and totals as required.

The tape perforator 2 is operable to make perforated records in a tape, and electromagnetic devices are provided in the tape perforator 2 to control the pattern of perforations made in the tape in accordance with signals coming into the tape perforator from some remote point such, for example, as the electrical control system involving the commutator 3, which is in electrical association with an electrical readout switch 4000 provided in the computing apparatus 1. The readout switch 4000 is operable to electrically record, in effect, the amounts computed in the computing apparatus 1.

With continued reference to the drawings and particularly to Fig. 1A, the computing apparatus employed in the present invention comprises in addition to a suitable base, a suitable mechanism supporting framework and a mechanism cover, digitation mechanism A including a ten-key keyboard and a selector device having selector racks which are sequentially set to selected values from a higher to the lowest order corresponding to values entered therein by manual depression of selected keys of the keyboard. The computing apparatus also comprises a printing mechanism D, an accumulator F, a power-driven actuator C controlled by the selector device, power-cycling mechanism B, a positive transmission E which drivingly connects the actuator with the printing mechanism at all times, and alternatively connects the actuator with the selector mechanism or the accumulator, a negative transmission G which at times connects the actuator to the accumulator, and a set of control keys J including an Addition (+) key, a Subtraction (—) key, a Total key, a Print Only key, a keyboard Clear key and a Void key, all as diagrammatically indicated in Fig. 1A. The Subtotal key normally used in a ten-key adding machine of the type illustrated is, in this invention, not employed, and may be omitted or permanently locked against operation in this case.

The power-cycling device includes a motor-driven cam shaft carrying a plurality of mechanism actuating cams and transmission means between the motor and the cam shaft effective to turn the cam shaft through one complete cyclic rotation and bring it to a stop each time a control key of the machine is operated.

The positive and negative transmissions each have a neutral position and one transmission always occupies its neutral position while the other is in its operative position, and both are bidirectionally operative to either transmit values from the selector mechanism to the accumulator or to transmit values from the accumulator to the printing mechanism.

The selector includes a unit laterally shiftable relative to the actuator and accumulator under control of an escapement mechanism as values are entered therein, so that the digits of a value of any number of digits within

the capacity of the selector are simultaneously transmitted through the actuator to the printing mechanism and the accumulator upon the operation of the Addition or Subtraction control keys.

Before operation of a value transmitting control key, a value can be cleared from the selector by operation of the keyboard Clear key without printing and without changing the total in the accumulator or feeding the printing tape.

The printing mechanism includes a paper tape on which the values are printed, and an ink-carrying ribbon which is preferably divided longitudinally into two portions of different colors. There is a tape feeding mechanism provided with a spacing adjustment which is effective to feed the tape in single spaced steps while entry values are being entered into the machine and printed, and when a value is printed without entry into the machine accumulator, to double space the tape feed whenever a total value is printed to thereby clearly offset the total figures from the following column of entry value figures on the tape, and to interrupt tape feeding when the keyboard Clear key is depressed. There is also a ribbon shift means which is effective to position the ribbon in a one color position when a positive or additive quantity is printed, and in a different color position when a negative or subtractive quantity is printed, and means are provided for winding the ribbon back and forth between spaced-apart ribbon spools.

The actuator includes a plurality of sectors which are power oscillated to accomplish an advance stroke and a return stroke each time a control key is operated. On the advance stroke the actuators are moved to an extent determined by the positioning of the associated selector sectors by the keyboard keys, and on the return stroke are moved to their home or full-cycle position. On their advance stroke the actuator sectors transmit the selector values through the positive transmission to the printing mechanism, the printing ribbon being shifted in accordance with whether the Addition or Subtraction control key is operated, and on their return stroke transmit the value through either the positive or negative transmission to the accumulator in accordance with the operation of the Addition or Subtraction control key. The accumulator is operated in one direction by the positive transmission and in the opposite direction by the negative transmission, and includes tens-transfer mechanism effective to transfer tens from any order to the next higher order in either direction of operation. The accumulator will thus accumulate both positive and negative values to a positive or negative total as the case may be.

The accumulator also includes mechanism which senses the sign of the total value in the accumulator and conditions the associated total-taking mechanism to take either a positive or a negative total.

The accumulator will carry the true total whether the sign be positive or negative.

When the Subtotal control key is depressed, the actuator is drivingly connected with the accumulator through either the positive or negative transmission, depending on the condition of the sign sensing mechanism of the accumulator, and, upon cycling of the machine by the power cycling mechanism, reads out the total in the accumulator and transfers the total to the printing mechanism which prints it on the associated tape near the middle of the machine cycle.

When the Total key is depressed, the actuator is connected to the accumulator during the advance stroke of the actuator to read out the total in the accumulator and transfer this value to the printing mechanism and is disconnected from the accumulator at the end of the advance stroke of the actuator so that the accumulator is not operated during the return stroke of the actuator but is left in its zero setting or cleared condition.

The control keys are all connected to the power cycling mechanism in a manner to initiate a cycle or rotation

of the power cycling mechanism whenever a control key is operated. The power cycling mechanism is so constructed and arranged that it will automatically complete a full cycle of rotation and come to a stop at a predetermined angular position once the cycle has been initiated by depression of a control key. Blocking means are also provided so associated with the control keys that only one control key can be operated at a time and no other control key can be operated until after the completion of the cycle initiated by this operated key.

The machine will thus print positive and negative entries and distinguish between the positive and negative values printed; will accumulate the entry values into positive and negative totals and compensate inherent mechanical errors to provide true total values; will read out and print totals and automatically sense the positive or negative nature of such totals; will repeat-add the same value any desired number of times; will print numbers without entering such numbers into the accumulator; will clear itself whenever a total is taken, but will retain its total until cleared; will print appropriate symbols indicating the nature of the entry or the total and can be cleared of an erroneous entry before the entry is printed or accumulated.

I.—SELECTION MECHANISM

While the selection mechanism is similar in construction and operation to that disclosed in the Taylor Patent No. 2,628,030, and in the Friden Patents Nos. 2,371,752, patented March 20, 1945, and 2,376,997, patented May 29, 1945, it differs in several respects from these prior art devices particularly in that the selector segments of the prior art devices are read out seriatim and in the device of the present invention the value-carrying sectors are all read out simultaneously.

Referring to Figs. 13, 14 and 17, when placed in the relative positions shown in Fig. 42, it will be seen that when keys in the selection mechanism A shown in Fig. 13 and involving the keys 17, for example, are manually operated in the keyboard assembly 10, pin-setting bell-crank levers 66 are operated to operate a stop pin assembly to set, for example, stop pins 60 to extend beyond their normal positions shown in Fig. 13. By selective operation of the pins 60, sector gears 33 are controlled in their clockwise rotative movement to rotate to a required extent in accordance with the setting of the digital mechanism above-mentioned. During the rotation of the sector gears 33 back to their normal positions, a set of gears 337, 338 and 340, shown in Fig. 14, are brought into gear connection with the sector gears 33 to transmit movements of the sector gears 33 to a set of corresponding sector gears 188 to move the gears 188 to the same extent as the gears 33 were initially moved. The set of gears 337, 338 and 340 are subsequently pivotally moved to gear connect the sector gears 188 to a set of gears 411 in an accumulator 390 operable to store, in effect, settings of the sector gears 188 after the sector gears 188 have been restored to normal position. By suitable operations of the gears 337, 338 and 340, the movements of the sector gears 33 may be gear-transmitted to the sector gears 188 and movements of the sector gears 188 may be transmitted through the gear systems involving the gears 337, 338 and 340 to the accumulator 390. Also, by operation of the gears 337, 338 and 340 in the required manner, rotations of the gears in the accumulator 390 may be subsequently transmitted from the accumulator 390 to the sector gears 188 so that the sector gears 188 may be operated to an extent required to represent an amount stored in the accumulator 390.

1. Improvement provided by the present invention

In accordance with the present invention the sector gears 188 are mechanically connected to a readout electrical switch means 4000 as shown in Fig. 17, which is included in an electrical control system operable to con-

trol the operation of a tape perforator 2 shown in Figs. 1, 2, 3 and 4, and which is operable to perforate a tape in accordance with the code shown in Fig. 5.

II.—READOUT SWITCH 4000

1. General construction and operation of the switch

The readout switch 4000 comprises two contact supporting plates 4001 and 4002 as shown in Figs. 17, 18, 19, 20 and 21, and sets of wiper contacts 4003 and 4004, one of each set of which is shown in Fig. 17. The contact supporting plates 4001 and 4002 are supported in spaced relation, the spacing being sufficient to accommodate the wiper contacts 4003 and 4004, and normally the spacing is such that the wiper contacts 4003 will be out of contact with the contact supporting plate 4001. The contact supporting plates 4001 and 4002 are arranged so that the contact supporting plate 4001 is supported in spaced relation above the contact supporting plate 4002, and in parallel relation therewith. The contact supporting plate 4002 shown in Fig. 17, is upwardly movable from the position shown in order that the wiper contact 4003 may be brought into engagement with the contact supporting plate 4001. When the contact supporting plate 4002 is moved upwardly to bring the contact point 4005 on the contact 4003 against a contact in the contact supporting plate 4001, an electrical connection is formed from a contact in the contact supporting plate 4001 to a contact in the contact supporting plate 4002, the electrical connection being by way of the wiper contacts 4003 and 4004.

2. The wiper contacts and carriage members of the switch

The wiper contacts 4003 and 4004 are in electrical connection with each other through a conducting body portion 4006 carried by an insulating member 4007 attached to a carriage 4008 which is movably supported on a link block 4009 along which the carriage 4008 is reciprocated. The carriage 4008 comprises an inner member 4010 adapted to ride in between and in engagement with the parallel arms 4011 and 4012 of the link block 4009, the arms 4011 and 4012 terminating at one end in a common end portion 4013, and terminating at the other end in a cross-web portion 4014 having extending therefrom, a portion 4015 operable to hook over a rod 4016. The body portion 4017 of the carriage 4008 has wing portions 4018 extending to the outer edge portions of the arms 4011 and 4012 of the link block 4009, and is attached by means of rivets 4019 or other suitable fastening means to the inner member 4010 and insulating member 4007, the rivets 4019 extending through the body portion 4017, the insulating member 4007 and the inner member 4010, the body portion 4017 being on one side of the link block 4009 and the insulating member 4007 being on the other side of the link block member 4009, so that escapement of the carriage 4008 from the link block 4009 is prevented. The insulating member 4007 has open end slots 4020 and 4021 formed therein to accommodate respectively, the reduced diameter shank portions of stud members 4022 and 4023 which are mounted in the body portion 4006, the spacing of the studs 4022 and 4023 being such that the wiper contact assembly may be moved upwardly in the insulating supporting member 4007 without the wiper contact assembly becoming detached from the insulating supporting member 4007.

The carriage 4008 together with the insulating member 4007 and the wiper contacts associated therewith, may be moved along the link block 4009 by operation of a connecting rod 4024, one end of which is attached to the sector gear 188, the other end of the connecting rod 4024 being provided with a button 4025 extending into the space between the parallel spaced arms 4011 and 4012 of the link block 4009, the arrangement being such that when the connecting rod 4024 is moved toward

the right as shown in Fig. 17, the carriage 4008 is moved endwise along the link block 4009 to carry the wiper contacts 4003 and 4004 in a straight line movement along the space between the spaced supporting plates 4001 and 4002. It will be seen that the connecting rod 4024 is attached at one end by means of a rivet 4026 to the sector gear 188 so that when the sector gear 188 is moved in either a counter-clockwise or a clockwise direction, the connecting rod 4024 is moved to the right or left, respectively. The right-hand end portion of the connecting rod 4024 terminates in an upwardly directed nose portion 4027 which extends in such position that it is adapted to engage a downwardly directed nose portion 4028 which is attached to and extends from the conducting body portion 4006 carried in the insulating member 4007, so that normally the carriage 4008 and the right-hand end portion of the connecting rod 4024 are cooperatively latched together by the nose pieces 4027 and 4028 as shown in Fig. 17. It will be seen, however, that with upward movement of the body portion 4006 in the insulating member 4007, which occurs when the supporting plate 4002 is moved upwardly relative to the insulating supporting plate 4001, and the body portion 4006 is moved sufficiently high to cause disengagement of the nose pieces 4027 and 4028 on the respective connecting rod 4024 and the body portion 4006, that the connecting rod 4024 will be uncoupled from the body portion 4006 so that the carriage 4008 and the wiper members carried thereby are released from backward movement of the connecting rod 4024 when the sector gear 188 is moved in a clockwise direction and the insulating member 4007 is restrained against following the rod 4024 in a left-hand movement. It will be seen therefore, that the insulating body portion 4017 together with the wiper contacts 4003 and 4004 may be moved outwardly along the link block 4009 to a distance corresponding to the extent of counter-clockwise movement of the sector gear 188 and that the connecting rod 4024 may be uncoupled from the nose portion 4028 so that the connecting rod 4024, after moving outward to the right along the link block 4009, may be moved backward to the left and to the position shown in Fig. 17 without returning the body portion 4017 and wiper contacts 4003 and 4004 to the original position shown in Fig. 17.

The contact supporting plates 4001 and 4002 form, in effect, two sides of a circuit included in which are commutator switches 4101 and 4102 shown in Figs. 7, 9 and 10, and which are employed as controlling means for the electromagnetically operable punch controlling members in the tape perforator 2.

3. Contact supporting plates of the switch

As shown in Fig. 20, the contact supporting plate 4001 is an apertured sheet 4029 of insulating material bearing conducting strips 4030, 4031, 4032, 4033, 4034, 4035, 4036, 4037, 4038 and 4039, the conducting strips 4030 to 4039, inclusive, being located on one face of the insulating sheet 4029 and being in parallel spaced relationship, the spacing of the conducting strips being sufficient to completely insulate one conducting strip from the other. The conducting strips 4030 to 4039, inclusive, terminate at one end in apertured end portions which, as shown in Fig. 17, are in mechanical and electrical connection with tubular terminals 4040, 4041, 4042, 4043, 4044, 4045, 4046, 4047, 4048 and 4049, which serve as jacks and into which pin type terminals on conductor wires, not shown, may be connected by thrusting the pin type terminals selectively into the tubular terminals as required.

The contact supporting plate 4002 is constructed somewhat like the contact supporting plate 4001 and, as shown in Fig. 21, comprises an insulating sheet 4050, bearing on the one face conducting strips 4051, 4052, 4053, 4054, 4055, 4056, 4057, 4058, 4059, 4060 and

4061. The conducting strips 4051 to 4061, inclusive, terminate at one end in apertured end portions in which are supported as shown in Fig. 18, tubular terminals 4062, 4103, 4104, 4105, 4106, 4107, 4108, 4109, 4110, 4111 and 4112, respectively, and into which pin type terminals on conductor wires, not shown, may be inserted as required to connect the conducting strips 4051 to 4061, inclusive, to required parts of the electrical control system. The conducting strips 4030 to 4039, inclusive, in the plate 4029, extend in a direction at 90 degrees from the direction of extension of the conducting strips 4051 to 4061, inclusive, in the contact supporting plate 4002 so that the conducting strips 4051 to 4061, inclusive, in effect, cross under the conducting strips 4030 to 4039, inclusive, and the arrangement is such that the conducting strips 4051 to 4061, inclusive, extend, as shown in Figs. 17 and 18, in parallel spaced relation with the link blocks 4009, 4083, 4084, 4085, 4086, 4087, 4088, 4089, 4090, 4091, and 4092, respectively

The sector gear 188, shown in Fig. 17, is only illustrative of one of many sector gears employed in the readout switch 4000 such, for example, as the sector gears shown in Fig. 18 and comprising the sector gears 4178, 4179, 4180, 4181, 4182, 4183, 4184, 4185, 4186, 4187 and 4188, to provide one sector gear in the readout switch 4000 for each ordinal position in the adding machine portion of the apparatus of this invention. It will be understood, therefore, that for each ordinal position in the adding machine portion of the apparatus there is a sector gear such as 33, Fig. 14, a set of gears 337, 338 and 340 and a corresponding sector gear such as 188. The sector gears 4178 to 4188, inclusive, shown in Fig. 18 are in the readout switch 4000 and correspond to the single representation of these sector gears shown at 188 in Fig. 17. When the gear 340 is in engagement with the sector gear 33 and the sector gear 188 is, by operation of the bail 192, caused to rotate in a counter-clockwise direction as viewed in Figs. 13, 14 and 17, the sector gear 188 is rotated in a counter-clockwise direction to the extent permitted by the setting of the sector gear 33, and is effective to thrust the connecting rod 4024 toward the right to move the wiper contacts 4003 and 4004 toward the right, the extent of thrust being in accordance with the degree of rotation of the sector gear 33 to normal position and which degree of rotation is in accordance with the value of the key 17 manually operated in the selecting mechanism A shown in Fig. 1A.

Subsequent to the movement of the wiper contacts 4003 and 4004 to the right, as viewed in Fig. 19, the lower insulating supporting plate 4002 is raised to make contact with the wiper contact 4004 and to lift the wiper contact 4003 into engagement with the insulating supporting plate 4001. The wiper contact 4004, as shown in Fig. 17, is flexible and has two spaced contact points 4093 and 4094 operable to ride along or rest on a conducting strip such as the conducting strip 4051 on the insulating supporting plate 4002. The raising of the insulating supporting plate 4002 is sufficient to bring the wiper contacts into engagement with the associated contacts on the insulating supporting plates 4001 and 4002 and is also sufficient to disengage the nose portions 4027 and 4028 and thus uncouple the connecting rod 4024 from the carriage 4008 so that the sector gear 188 may be rotated clockwise to the position shown in Fig. 17 without pulling the wiper contacts to the left from the position they were set in by the counterclockwise rotation of the sector gear 188 and the consequent right-hand thrust of the connecting rod 4024. It will be seen therefore that the wiper contacts 4004, 4063, 4064, 4065, 4066, 4067, 4068, 4069, 4070, 4071 and 4072, are thrust outwardly along and in parallel relation with the conducting strips 4051, 4052, 4053, 4054, 4055, 4056, 4057, 4058, 4059, 4060 and 4061, respectively, the extent of outward thrust being, in each case, in accordance with the extent of counter-clockwise

rotation of a sector gear such, for example, as the sector gear 188 shown in Fig. 17. It will also be seen that the wiper contacts 4005, 4073, 4074, 4075, 4076, 4077, 4078, 4079, 4080, 4081 and 4082 are thrust outwardly to the same extent as the corresponding wiper contacts 4004, 4063, 4064, 4065, 4066, 4067, 4068, 4069, 4070, 4071 and 4072. The wiper contacts 4005, 4073 to 4082, inclusive, however, are thrust transversely of the relatively fixed conducting strips 4030 to 4039, inclusive, so that when the supporting plate 4002 is raised to bring the conducting strips into engagement with the lower set of wiper contacts and to bring the upper set of wiper contacts into engagement with the conducting strips on the supporting plate 4001, the readout switch 4000 will be in a closed condition and operating to electrically connect selected conducting strips on the upper supporting plate 4001 with selected conducting strips on the lower supporting plate 4002, the electrical connections being by way of the wiper contacts of the switch 4000 and the selection being in accordance with amounts accumulated in the computing apparatus 1.

The lower supporting plate 4002 as shown in Figs. 17, 18 and 19 is supported on a base portion 4116 of a movable support 4117 comprising spaced upright arms 4118 and 4119 which extend upwardly from the base portion 4116. The upright arms 4118 and 4119 are arranged in parallel spaced relation and provide, in effect, supporting arms for the base portion 4116 which is disposed between spaced intermediate frame plates 4120 and 4121 extending lengthwise of the apparatus and which occupy the same relative positions and perform the same functions as the intermediate frame plates 186 and 187 found in the ten-key adding machine described in the aforementioned application, Serial No. 407,016, Patent No. 2,832,530. The frame plates 4120 and 4121 in addition to their other supporting functions, serve as supports for the readout switch 4000, the lower portion of the readout switch 4000 and involving the movable support 4117 having rollers 4122 and 4123 supported on pins 4124 and 4125 extending outwardly from the upright arms 4118 and 4119, respectively. The rollers 4122 and 4123 extend into rectangular apertures 4126 and 4127 formed in the intermediate frame plates 4120 and 4121, respectively. The rollers 4122 and 4123 extend also into rectangular apertures 4128 and 4129 formed in the bellcrank levers 4130 and 4131, respectively, which are pivotally supported on a rod 4132 mounted in and cooperatively supported by the intermediate frame plates 4120 and 4121. Ends of the rod 4132 extend beyond the frame plates to serve as supports for groups of levers comprising the levers 4130, 4133 and 4134 on the right-hand side of Fig. 18, and the levers 4131, 4135 and 4136 shown on the left side of Fig. 18 and in Fig. 19.

4. Closing of the contacts in the switch

The levers 4130 and 4131 are operable through their springs 4137 to raise the movable support 4117 in the switch 4000 at required times so that the upper and lower contacts of the switch will be selectively in electrical connection through the wiper contacts of the switch.

The lever 4131 is normally latched against operation, the latch structure involving, as shown in Fig. 19, the latch lever 4138 having its lower right-hand corner 4139 extending into a notch 4140 formed in the lower portion of an arm 4141 of the lever 4131. When the latch lever 4138 is withdrawn from engagement with the notch 4140, the lever 4131 is rotated on its pivotal point of support on the rod 4132 in a clockwise direction by means of its spring 4137, the spring being normally under tension and having one of its ends secured to the lever 4131 as shown at 4142, while the other end of the spring is secured to the frame plate 4121 as shown at 4143. The spring 4137 shown in Fig. 19 and a like spring on the other side of the switch structure and attached to the lever 4130 are tensioned at all times and are strong enough to lift the

movable support 4117 when the latch lever 4138 is removed from engagement with the arm 4141 and when the cams 4144 and 4192 are in position to permit closing of the switch 4000. Lifting of the movable support 4117 will bring the conducting strips on the lower plate 4002 into engagement with the movable contacts on the lower portions of the insulating members supported on the carriages, such for example, as the carriage 4008. The lifting of the lower supporting plate 4002 will also be sufficient to bring the wiper contact 4003 into engagement with the contact supporting plate 4001 and so that the wiper contact 4003 will be in contact with a selected one of the conducting strips 4030 to 4039, inclusive.

It will be seen that by suitable operation of the sector gears 188, the carriages 4008 may be selectively moved along the link blocks 4009 to required positions relative to the required contacts on the contact supporting plates 4001 and 4002, and that the movable plate 4002 may be upwardly moved to bring the contacts on the lower plate 4002 into engagement with the lower wiper contacts carried by the carriages, and that the upper contacts on the carriages may be brought upwardly into engagement with the conducting strips on the contact supporting plate 4001. Also that the carriages may be uncoupled from the connecting rods to leave the carriages in adjusted positions along the link blocks when the wiper contacts are pressed against the contact supporting plates 4001 and 4002.

5. Opening of the contacts in the switch

The switch 4000 is operated to an open condition by means of cams 4144 and 4192 mounted on a rotatable power shaft 4245. Each cam 4144 and 4192 has a high spot thereon operable to engage an associated bellcrank lever, the cam 4144 being operable to engage the bellcrank lever 4131 simultaneously with the engagement of the bellcrank lever 4130 by the cam 4192. For example, the cam 4144 has a high spot 4145 operable to engage a roller 4146 supported on a pin 4147 mounted on and extending from a right-hand arm portion 4148 of the lever 4131. The cam 4192 has a high spot in register with the high spot 4145 and operable to engage the roller 4206 on the bellcrank lever 4130. When the power shaft 4245 is rotated to bring the high spots on the cams 4144 and 4192 into engagement with the rollers 4146 and 4206, respectively, the levers 4131 and 4130 are rotated counter-clockwise on their common pivotal support, as viewed in Figs. 18 and 19, to make the upper portions of the apertures 4129 bear downwardly on the rollers 4122 and 4123 to force the movable support 4117 and the lower contact supporting plate 4002 downwardly against the action of the springs 4137 until the lower corner 4139 of the latch lever 4138 moves in a counterclockwise direction under the urgency of spring 4215 into the notch 4140 of the lever 4131. At this stage of the operation the high spot 4145 of the cam 4144 passes beyond the position of the roller 4146 and will not affect the position of the lever 4131 until the latch lever 4138 is again operated to release the lever 4131 for upward movement under the force of the spring 4137.

6. Restoring of the movable contacts and carriages

The carriages 4008, as shown in Fig. 17, are normally in the left-hand portion of the switch 4000 and this is the home position for the movable wiper contacts of the switch. When the wiper contacts are moved to the right from the position shown in Fig. 17, and for example to the position shown in Fig. 19, the wiper contacts, upon opening of the switch, may be restored to home position by operation of a bail 4149, which is cyclically operated to insure that the wiper contacts are restored to home position after the amounts computed in the computer apparatus have been electrically represented in the positioning of the movable contacts in the switch, and the electrical record in the switch 4000 has been, in effect, read out of the switch.

The bail 4149 comprises two bow-shaped arms 4150 and 4151 curving rearwardly and upwardly from and mounted on a shaft 4152 supported by and extending through apertured plates 4153 and 4154, end portions of which are riveted or otherwise secured to the frame plates 4120 and 4121, respectively. The apertured plates 4153 and 4154 are additionally apertured to accommodate the power shaft 4245. The shaft 4152 is rotatable and has pinion gears 4155 and 4156 secured to its ends to facilitate its rotation by means of the levers 4133 and 4135, respectively, having toothed end portions 4157 and 4158 in engagement with the respective pinions 4155 and 4156. The levers 4133 and 4135 are pivotally supported on the rod 4132 and are operable by means of their return springs 4159 and 4160, respectively, to return the bail 4149 to the position shown in Fig. 19 subsequent to operation of the bail 4149 to a position to the left of that shown in the figure. The return springs 4159 and 4160 extend from anchorage posts 4161 and 4162 supported in the frame plates 4120 and 4121 to the hook-shaped upper end portions 4163 and 4164 of the respective levers 4133 and 4135.

Extending between the bow-shaped arms 4150 and 4151 and completing the bail structure 4149, is a bar 4165 as shown in Fig. 18. The bar 4165 has reduced diameter end portions 4166 and 4167 extending into elongated slots 4168 and 4169 formed in the upper end portions 4170 and 4171 of the respective bow-shaped arms 4150 and 4151. The bar 4165 extends transversely through the elongated apertures 4172 formed in the link blocks 4009 so that when the bail 4149 is operated, the bar 4165 will move back and forth in each link block 4009 as required. The function of the bail 4149 is to restore the wiper contacts in the switch 4000 to the home position as shown in Fig. 17, when the wiper contacts have been previously moved to a position to the right of the position shown in Fig. 17 such, for example, as the position of the wiper contact 4003 shown in Fig. 19. The restoring of the wiper contacts to the home position is accomplished by operating the bail 4149 so that the bar 4165 is moved to the left of the position shown in Figs. 17 and 19, and until all the carriages 4008 have been engaged by the bar 4165 and are in the position shown in Fig. 17.

The bellcrank levers 4134 and 4136 are pivotally supported on the rod 4132 and are attached at their body portions 4173 and 4174 to, and overlie the levers 4133 and 4135, respectively. The leftwardly extending arm portion 4175 of each bellcrank lever 4134 and 4136 terminating at its free portion in a downwardly directed end 4176, as shown in Fig. 19 in the case of the lever 4136, is engageable by a roller 4177 mounted on an eccentrically positioned pin 4190 extending from the major plane surface of the cam 4144. A like roller 4191 on the cam 4192 is operable to engage an arm portion 4193, on the bellcrank lever 4134, the cams 4144 and 4192 being cooperable with the bellcrank levers 4134 and 4136 to operate the levers 4133 and 4135 to rotate the pinions 4155 and 4156, respectively, counter-clockwise as viewed in Fig. 19, and thus cause the bail 4149 to thrust the bar 4165 toward the left from the position shown in Fig. 19 to push any carriages 4008 back to the position shown in Fig. 17. The return of the carriages 4008 to the position shown in Fig. 17, is accomplished at a time when the contact supporting plate 4002 is in its relatively low position and the upper wiper contacts such, for example, as the wiper contact 4003, are not in contact with the upper contact supporting plate 4001.

Return of the bail 4149 to the position shown in Fig. 19 occurs immediately following the restoration of the carriages 4008 to the home position, and is accomplished through the operation of the springs 4159 and 4160 which are constantly urging the lower ends of the rack levers 4133 and 4135 toward the right, as viewed in Fig. 19. When the cams 4192 and 4144 are rotating and the rollers 4191 and 4177 thereon pass beyond the free ends of

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the respective bellcrank levers 4134 and 4136, the springs 4159 and 4160 are free to move the lower ends of the rack levers 4133 and 4135, respectively, toward the right as viewed in Fig. 19, to rotate the pinions 4155 and 4156 in a clockwise direction to operate the arms 4150 and 4151 outwardly to restore the bar 4165 to the position shown in Fig. 19.

The bellcrank lever 4136 is adjustably secured to the pivoted rack lever 4135 by virtue of the common mounting involving the rod 4132 upon which the levers are pivotally supported and around which both levers can turn and by set screws 4207 and 4208 and an underlying cam 4209. The set screw 4207 is a conventional machine screw having its shank portion extending through an elongated aperture formed in the arm portion 4648 of the lever 4136, the threaded shank of the screw 4207 having screw-threaded engagement in a tapped hole provided in the lever 4135 at a point offset from the pivotal point of support of the lever 4135 on the rod 4132. The set screw 4207 and the elongated aperture in the lever 4136 limit the extent of relative rotation between the pivoted rack lever 4135 and the bellcrank lever 4136. Spaced beyond the position of the set screw 4207 and nearer the outer end of the arm portion 4648 of the bellcrank lever 4136, an elongated aperture 4210 is formed to accommodate a hexagon topped circular cam 4209 eccentrically mounted on a set screw 4208, the threaded shank of the set screw 4208 being in screw-threaded engagement with a tapped hole formed in the rack lever 4135. The enlarged hexagon head portion 4213 on the hexagon topped circular cam 4209 is larger than the width of the elongated aperture 4210 which is formed in the bellcrank lever 4136 and disposed longitudinally of the rack lever 4135. The hexagon head portion 4213 therefore, overlaps portions of the outer flat surface of the bellcrank lever 4136, while the circular cam portion 4214 fits into the elongated slot 4210. The set screw 4208 extends through an eccentrically positioned aperture in the hexagon topped circular cam 4209 and into screw-threaded engagement with a tapped hole formed in the rack lever 4135. By rotating the hexagon topped cam 4209 the bellcrank lever 4136 may be rotated relative to the rack lever 4135 to the extent permitted by the set screw 4207. By tightening the set screw 4208, to bind against the hexagon topped circular cam 4209, the levers 4136 and 4135 may be held in their relatively adjusted positions. The adjustable mounting of the lever 4136 on the lever 4135 is the same as the adjustable mounting provided for the levers 4134 and 4133 on the right side of the structure shown in Fig. 18, the adjustable mounting arrangements permitting some adjustments in the span between the free ends of the bellcrank levers and the toothed ends of the associated rack levers and permitting some adjustment in the time of operation of these relatively operating parts.

7. Recoupling of connecting rods to carriages

When the carriages 4008 are being moved to the position shown in Fig. 17, the nose portions 4028 on the carriages 4008 come into engagement with the nose portions 4027 such that the back of the nose portion 4028 comes into contact with the back of the nose portion 4027 on the connecting rod 4024, and under the thrust of the bail 4149 and the rod 4165 the nose portions 4027 and 4028 cooperate to cam the conducting portion 4006 of the carriage 4008 upwardly to permit the carriage to be moved to the left so that the carriage can again slightly drop to bring the nose portions 4027 and 4028 into the positions shown in Fig. 17 with the nose portions cooperating to couple the carriage 4008 to the connecting rod 4024.

The main support for the switch 4000 comprises, as shown in Figs. 17 and 18, a U-shaped bracket 4194 having apertured upwardly extending arms 4195 and 4196 and an apertured body portion 4197 through which cap screws 4198 or other suitable fastening means extend into

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the insulating sheet 4029 to hold the insulating sheet 4029 to the bracket 4194, the apertured arm portions 4195 and 4196 of which are secured to the frame plates 4120 and 4121 by means of bolts 4199 or other suitable fastening means.

The movable support 4117 is supported by means of the levers 4130 and 4131 in which are respectively formed apertures 4128 and 4129 to receive the respective rollers 4122 and 4123 which extend from the upright arms 4118 and 4119, respectively, and through apertures 4126 and 4127 formed in the respective frame plates 4120 and 4121. On the upper ends of the arms 4118 and 4119 rollers 4200 and 4201 are supported on pins 4202 and 4203 extending from the respective arms 4118 and 4119. The rollers 4200 and 4201 fit into open ended slots 4204 and 4205 formed in the frame plates 4120 and 4121, respectively. By virtue of the rollers 4200 and 4201 on the upper portions of the movable support 4117 and operating in the slots 4204 and 4205, the upper portion of the movable support 4117 is steadied and guided in excursions of the movable support 4117 in the frame structure of the computing apparatus.

When the latch lever 4138 is in the position shown in Figs. 12 and 19, the bellcrank levers 4130 and 4131 which are supported on the shaft 4132, are held in such position that the cams 4192 and 4144 are ineffective to rotate the levers 4130 and 4131, respectively. Under this condition the levers 4130 and 4131 are held down against the action of the spring 4137 and the movable support 4117 will be kept down to maintain the switch 4000 in an open condition.

At the end of each cycle the latch lever 4138 is normally held in latching position as shown in Fig. 12, to hold the lever 4131 down and thus prevent raising of the lower portion of the switch 4000, the lever 4138 being urged to the position indicated by means of the spring 4215, one end of which is attached to the lever 4138 while the other end is attached to a pin 4216 mounted in, and extending from, the frame plate 4121. The latch lever 4138 is pinned to a rotatable shaft 4016 which is supported in, and extends through, the apertured frame plates 4120 and 4121. The shaft 4016 is operable to be rotated by means of a lever system 4217 extending between the rotatable shaft 4016 and a manually operable void key 4218. The lever system 4217 comprises a lever 4219 having one end portion pinned to the shaft 4016 and the other end portion pivotally connected at 4220 to a link 4221, the far end of which is pivotally connected at 4222 to one arm 4223 of a bellcrank lever 4224 having a bifurcated end portion 4225 on an arm 4226 engageable by a pin 4227 extending from a stem 4228 of a manually operable void key 4218, the stem 4228 being apertured at 4229 to accommodate a supporting pin 4230 extending from the frame plate 4120. The bellcrank lever 4224 is centrally pivoted on a supporting screw 4231 mounted in and extending from the frame plate 4120. Depression of the void key 4218 from the position shown in Fig. 12, will operate to cause the latch lever 4138 to swing away from the lever 4131. In this operation the downwardly thrust pin 4227 operates the bellcrank lever 4224 in a clockwise direction to pull the link 4221 toward the right to rotate the shaft 4016 counter-clockwise by virtue of the attached lever 4219. Counter-clockwise rotation of the shaft 4016 releases the latch lever 4138 from engagement with the lever 4131, the latch lever 4138 being moved against the action of the restoring spring 4215. Upon release of the latch lever 4138 from engagement with the lever 4131, the springs 4137 will operate to move the movable support 4117 of the read-out switch 4000 upwardly from the position shown in Fig. 17 to close the switch so that the wiper contacts will be in engagement with the contact supporting plates 4001 and 4002 as required.

Pivotally supported on the upper portion of the latch lever 4138, as shown in Fig. 12, together with Fig. 29, is

a releasing lever 4236 carrying a pin 4237 which is secured at 4238 and projects from the lever 4236. The lever 4236 is pivotally supported on a pin 4239 which is supported at 4240 and projects from an enlargement 4241 formed on the lever 4138. From its pivotal point of support the lever 4236 extends crosswise of the lever 4138 and has a curved upwardly extending portion 4242 extending in spaced relation with an upwardly extending portion 4243 of the lever 4138 and into engagement with a pin 4244 which is mounted in and extends from a lever 4246 shown in Fig. 29. The lower end of the lever 4236 terminates in an angularly bent portion 4247 which is normally maintained in the path of movement of a pin 4248 extending from a plate 4249 shown in Fig. 41 as being mounted on a cam 820 mounted on the actuator bail shaft 185. A lever 825 is mounted on the shaft 807 and has angularly spaced-apart arms including a forwardly directed arm 826, and a rearwardly directed arm 827, carrying near its distal end a cam following roller 829 riding on the edge of the cam lobe 821.

Whenever the actuator bail 192 is moved, the shaft 185 is rotated and the cam 820 is rocked, as shown in Fig. 41, to obtain, in one direction, a clockwise rotational movement of the lever 825 and in the other direction a counter-clockwise movement of the lever 825 which is equipped with a tension spring 830 connected between a stud near the distal end of the arm 826 of the lever 825 and the guide stud 814 extending transversely of the machine above and rearwardly of the actuator bail shaft 185.

With this arrangement, whenever the actuator bail 192 is moved downwardly permitting, through the cam 820, a clockwise rotational movement to the lever 825, the spring 830 resiliently urges the lever arm 826 to move the ribbon-shifting arm 809 upwardly to bring the lower half of the ribbon to printing position.

An elongated lever 837 is pivotally mounted intermediate its length on the right-hand end portion of the mounting shaft 427 of the negative transmission gear mechanism 420, and is longitudinally bent so that its portion above the shaft 427 is substantially upwardly directed and its portion below the shaft 427 is downwardly and forwardly directed. At its upper end the lever 837 is disposed alongside the lever arm 826 and is provided at its upper end with a forwardly directed hook formation 838 which overlies a stud 839 mounted on and extending laterally from the lever arm 826, near the distal end of this lever arm. The hook 838 engages the stud 839 and holds the ribbon-shifting mechanism against upward movement whenever a quantity is additively entered into the machine whenever a positive total or subtotal is taken or whenever a repeat addition cycle, a print only cycle or a clearing cycle is performed by the machine.

When the shaft 185, as shown in Fig. 41, is rotated counter-clockwise to bring the pin 4248 into engagement with the bent portion 4247 of the lever 4236, shown in Figs. 12 and 29, the lever 4236 and the lever 4138 are moved clockwise as viewed in Fig. 29, and counter-clockwise as viewed in Fig. 12 to release the latching lever 4138 from latching engagement with lever 4131 and to move the pin 4239 to the right, as viewed in Fig. 29, to rock the lever 4250 in a clockwise direction. The lever 4250 is pivotally supported on shaft 4016 and has an upper body portion 4251 and a leg portion 4252. The body portion 4251 is notched as shown at 4253 for engagement by the pin 4239 extending from the lever 4236. The leg portion 4252 extends downwardly from the body portion 4251 and into engagement with a clutch 4254 through operation of which the power from a power-driven wheel 4255 operated from a gear train 4256, Fig. 7, from a power-driven gear 146, is transmitted to a rotatable shaft 4245, secured to which are the cams 4257, 4144 and 4192. The clutch 4254 comprises a toothed ratchet 4260 secured to the power-driven wheel 4255, a toothed pawl 4261 pivotally supported at 4262 on a plate 4263 having a hub 4264 secured to the shaft 4245. The

pawl 4261 is a C-shaped member pivotally supported at one end and is equipped with a tooth 4265 arranged to engage in the teeth of the ratchet 4260. A spring 4266 secured at one end to the pawl 4261 and at the other end to a pin 4267 supported in and extending from the plate 4263, constantly urges the pawl 4261 toward engagement with the ratchet 4260. The pawl 4261 is at times held against engagement with the ratchet 4260 by the lever 4250, the lower end 4267 of which is arranged to enter a notch 4268 formed in the pawl 4261. A large-headed pin 4269 supported in the plate 4263 extends through an enlarged aperture 4270 to movably support the pawl 4261 on the plate 4263. When the lever 4252 is operated in a clockwise direction, as viewed in Fig. 29, and to remove the lower end portion 4267 from engagement in the notch 4268, the pawl 4261 is operated by its spring 4266 to move into engagement with the ratchet 4260 so that clockwise rotational movements of the ratchet 4260 will be transmitted to the plate 4263. Since the ratchet 4260 is driven by means of the wheel 4255, engagement of the pawl 4261 with the ratchet 4260 will operate to transmit rotation of the wheel 4255 to the shaft 4245. The lever 4250 is operated against the action of a return spring 4271, one end of which is anchored to the body portion 4251, the other end of the spring 4271 being secured to a pin 4272 extending from the frame plate 4121. The lever 4250 serves as a means for controlling the operations of the switches 4273 and 4274 which are the SW6A and the SW6B Off-Normal contract switches shown in Fig. 32. The switches 4273 and 4274 are single pole, single throw switches and comprise in each case a movable contact and a relatively fixed contact. For example, as shown in Fig. 29, the switch 4273 (SW6A) comprises the movable contact 4275 and the relatively fixed contact 4276. The switch 4274, as shown in Fig. 32, comprises the movable contact 4277 and the relatively fixed contact 4278, the switches being normally open as shown in Figs. 29 and 32. The movable contacts 4275 and 4277 of the respective switches 4273 and 4274 are spring supported and are carried on the body portion 4251 of the lever 4250. The relatively fixed contacts 4276 and 4278 of the respective switches 4273 and 4274 are supported on a bracket 4279 supported on the frame plate 4121, the arrangement of the movable and relatively fixed contacts being such that operation of the lever 4250 in a clockwise direction will bring the movable contacts 4275 and 4277 into engagement with the respective relatively fixed contacts 4276 and 4278 and thus close the switches 4273 and 4274 each time the lever 4250 is operated to release the clutch 4254 to transmit power to the shaft 4245.

8. Interlock for functional keys during readout

The plate 4263, as shown in Fig. 7, of the clutch 4254 is provided with an outwardly extending pin 4280 to control the operation of a latch 4281 controlling the operation of the functional keys of the adding machine. The functional keys of the adding machine such as the Void key, Clear Keyboard, Total, Plus, Minus and Print Only, are all operable to control the application of power to the adding machine in the same manner as covered in the aforementioned application, S. N. 407,016, Patent No. 2,832,530, the control being by virtue of a link 169 which is moved forwardly to close a switch 139 (SW4), shown in Fig. 32, the function of which is to control the application of power to the motor 4282. The source of current supply, not shown, may be any suitable supply such, for example, as an alternating current supply line of about 115 volts, the supply conductors 4283 and 4284, as shown in Fig. 32, being operable for connection to the commercial supply lines. When the functional keys of the adding machine are operated, the switch 139 is closed by forward movement of link 169. The initial supply of current for the motor may be traced as follows: Conductor 4283, motor 4282, conductor 4285,

centrifugally operated speed governor switch 4286, conductor 4287, conductor 4288, conductor 4289, movable contact 4290 and fixed contact 4291 of switch 139 (SW4), conductor 4292, conductor 4284, to the commercial source of current supply, not shown. A spark-arresting circuit 4293 involving the condenser 4294 and resistance 4295, is provided around the contacts in the speed governor switch 4286. The initial operation of the motor 4282, each time a functional key in the adding machine is depressed, is sufficient for operation of the adding machine 1 in a complete cycle of entering and computing amounts, there being a one rotation or single cycle clutch 150, Fig. 8, provided between the cam shaft gear 142 which is driven through a suitable shaft and gear train means extending from the motor to the clutch 150 and through the disk 157 to the cam shaft 135. After the initial energization of the motor 4282 over the above-described circuit, the motor 4282 is at times energized over a second circuit when a readout operation is occurring from the switch 4000. The second circuit involves contacts in the switch 4274 and may be traced as follows: Source of current supply, not shown, conductor 4283, motor 4282, conductor 4285, speed governor switch 4286, conductor 4287, conductor 4288, fixed contact 4278 and movable contact 4277 of switch 4274 (SW6B), conductor 4296, conductor 4297, conductor 4284 to source of current supply, not shown.

A third motor supply circuit is provided which is manually brought into operation through the manual operation of switch 4298 (SW7A). The third circuit may be traced as follows: Source of current supply, not shown, conductor 4283, motor 4282, conductor 4285, speed governor switch 4286, conductor 4287, conductor 4288, conductor 4299, fixed contact 4300 and movable contact 4301 of switch 4298 (SW7A), conductor 4302, conductor 4297, conductor 4284 to source of current supply, not shown.

III.—TAPE PERFORATOR

The tape perforator 2, and which will hereinafter be referred to as the tape perforator 3000, may be, so far as this invention is concerned, a conventional record-making machine operable to make reproducible records of the amounts entered and accumulated in a computing machine.

For the purpose of illustrating the invention and not in the sense of a limitation thereof, the record-making machine is shown and described herein as a conventional tape perforator 3000, operable to make a five channel perforated tape record representative of amounts entered and accumulated in the computing apparatus 1, and electrically represented in the readout switch 4000 contained therein.

As shown in Figs. 1, 2, 3, 4 and 6, the tape perforator 3000 comprises a base member 3001 which may be common with or separated from the base of the computing apparatus 1. Extending upwardly from the base 3001 is an apertured wall 3002 supporting a laterally extending tubular bearing 3003 forming the main support for a main operating shaft 3004 carrying a plurality of cams, the control one 3005 of which is operable to control the operation of a feed wheel 3006, the teeth 3007 being operable to engage in apertures formed in a tape 3008 of paper fed through the tape perforator 3000 from a source of supply, not shown, the tape 3008 in its passage through the tape perforator 3000 passing from the left end of the apparatus shown in Figs. 3 and 4 to the right, the left end of the tape being not as yet perforated while that emerging from the right end being perforated in accordance with a suitable code such, for example, as the Baudot or the telegraph codes commonly employed in making perforated records, such as can be subsequently used to control a printing machine operable to make printed records of information stored in perforated tapes.

The perforations are made in the tape 3008 by operation of a set of punches 3009 which, as shown in Fig. 3, extend upwardly in the tape perforator and may be selectively thrust upwardly from the position shown in Fig. 3, so that the upper reduced diameter end 3010 of the punch may be forced to penetrate the tape 3008. The tape perforator shown in the drawings is of a type in which nine punches may be employed, the punches being arranged in a row so that nine perforations may be made in a row extending transversely of the tape. In an actual setup of the tape perforator for use in connection with the above-mentioned adding machine, and for use in the system shown in Fig. 31, only six punches are required, one of the punches being operable to make a series of equally spaced feed holes in the tape extending along the length of the tape while the other punches are selectively operable to make perforations in the tape, the locations and arrangements of the perforations being representative of information it is required to store in the tape. The selective operation of the punches is accomplished by means of electromagnetic means provided to selectively control the effectiveness or ineffectiveness of levers in mechanical connection with the punches. In accordance with the present invention, and as will be subsequently explained, the electromagnetic means above-mentioned are controlled in accordance with the settings of movable contacts in a switch means, the movable contacts being controlled by means of actuators in a computing apparatus, the actuators being operable in accordance with value registering means in the computing apparatus.

IV.—CODE ILLUSTRATED

For the purpose of explaining this invention and not in the sense of a limitation thereof, a five position code is employed as shown in Fig. 5. The code is arranged to represent values in numbers from "0" to "9," inclusive, to represent letters of the alphabet, CR (carriage return), LF (line feed), Figs, Stop and Space signals. The column to the left in Fig. 5 indicates the value and character of the signal represented by each line of perforations and the squares to the right of the first column are the positions of the perforations to be made in the tape, the 1st and 2nd positions being followed by a feed hole position while the 3rd, 4th and 5th positions are used in combination with the 1st and 2nd positions to indicate the value represented by the arrangement and relative positions of the perforations.

The value "1," according to the illustration in Fig. 5, would be represented by a perforation in each of the first two positions followed by the feed hole and a perforation in the 3rd position followed by a blank space and then a perforation in the 5th position. The value "3" would be represented by a perforation in the 1st position only. This single perforation may be also used to represent the letter "E," if the single perforation in the 1st position is preceded by a set of perforations representing the designation LTRS (letters) which calls for a perforation in each of the five value positions.

A Void key 4218 is provided to operate the void switch 4232 (SW2), Fig. 12, which is, in effect, a single pole, double throw switch and operable to switch over the control of the electromagnetic means in the tape perforator to a rotary commutator switch 4102 to make the perforator operate to punch designations representing LTRS, E, CR, LF, Figs, Stop and Space as required. The switch 4232 comprises a central spring contact 4233 normally spring biased to engage the left-hand or upper contact 4234 until the Void key 4218 is depressed, whereupon the central contact 4233 is moved away from the contact 4234 and into engagement with the right-hand or lower contact 4235.

A Print Only (PO) key 4304 is provided to make the apparatus print the amounts or other information entered, without accumulating for a total. The Print Only

(PO) key 4304 is provided on its stem 4305, as shown in Fig. 28, with a tab 4306 operable upon depression of the key, to close a switch 4307 (SW5); the tab 4306 being operable to engage a finger 4308 attached to and extending from a contact 4309 and to press the contact 4309 into engagement with a contact 4310. When the Print Only key 4304 is depressed, the finger 4308 is moved downwardly to engage under a latch 4311, pivotally supported at 4312 and having a hook-shaped end portion 4313 operable to hold the switch 4307 closed, the latch 4311 being normally urged to a latching condition by means of a spring 4314, one end of which is attached to the latch lever 4311 while the other end is secured to the frame plate 4121. The Print Only switch 4307 (SW5) is normally open as shown in Fig. 32, and when closed to the position shown in Fig. 28, partially prepares a circuit for a portion 4315 of a collector ring 4316 of a commutator switch 4101 shown in Figs. 7, 9 and 10. The main portion 4317 of the collector ring 4316 of the switch 4101 is electrically connected to the left-hand fixed contact 4234 of the switch 4232 (SW2) by way of the conductor 4318. The smaller portion 4315 of the collector ring 4316 is in electrical connection with the movable contact 4309 of the Print Only switch 4307 (SW5) by way of the conductor 4319. A line of segmental contacts 4320 to 4333, inclusive, provided in switch 4101 makes the switch operable to serve as a commutator for the readout switch 400, the segmental contacts 4322 to 4332, inclusive, being separately connected by electrical conductors 4334 to 4344, inclusive, respectively, to the conducting strips 4051 to 4061, inclusive, of the readout switch 4000, which operates to provide a means for selectively controlling the operation of the set of electromagnetic devices 3011, five of which, namely, 3012, 3013, 3014, 3015 and 3016, shown in Fig. 31, are used in selectively controlling the operation of the corresponding number of punch members 3009 in the tape perforator 3000.

The segmental contact 4320 in the switch 4101 is at the stop position of a wiper contact 3017 in the commutator switch 4101. The stop position segmental contact 4320 is in electrical connection with the winding of the electromagnetic device 3012 by way of conductor 3018, diode 3019, conductor 3020 and conductor 3021. The segmental contact 4321 also is in electrical connection with the electromagnetic device 3012 by way of conductor 3022, conductor 3023, diode 3024, conductor 3025, conductor 3020 and conductor 3021. The segmental contact 4321 represents the designation "FIGS" in this apparatus and is in electrical connection with a corresponding "FIGS" segmental contact 3026 in the commutator switch 4102 by way of conductor 3027, which is in electrical connection with conductor 3022. The wiper contacts 3017 and 3028 of the respective switches 4101 and 4102 are Y-shaped conducting members as shown in Fig. 10, and are secured in each case to respective arm portions 3029 and 3030 of an insulating support 3031, which is supported on a rotatable power shaft 4245. The wiper contact 3017, of the switch 4101, is arranged to have one of its arms 3032 make contact with the collector ring 4316 while the arm 3033 travels in a path to successively make contact with the segmental contacts 4320 to 4333, inclusive. The wiper contact 3028, of the switch 4102, is arranged to have one of its arms 3034 make contact with collector ring 3036 while its other arm 3035 moves in a path to successively engage the segmental contacts 3037, 3038, 3039, 3040 and 3026.

The switch 4102 is employed as a commutator switch for controlling the operations of the electromagnetic devices 3012 to 3016, inclusive, in the tape perforator 3000 when the electromagnetic devices are to be operated to control the punches to make sets of perforations in the tape representing directional and operational signals to be given the machine operating under control of the tape. For example, when the wiper contact 3035 is on the seg-

mental contact 3037, the electromagnetic devices 3011 will be selectively operated to selectively control the punches 3009 to make perforations in the tape representing a code signal for the word "letters" or abbreviation thereof (LTRS). When the wiper contact 3035 is on the segmental contact 3038, the electromagnetic device 3012 would be operated to control the punch associated therewith to perforate the tape in such position as to indicate that the signal stands for the letter "E" rather than the numeral "3." A signal indicating "carriage return" (CR), will be formed in the tape when the wiper contact reaches the segmental contact 3039. A signal representing "line feed" (LF) will be formed in the tape when the wiper reaches segmental contact 3040. When the segmental contact 3026 is reached, the resulting signal will indicate that the following perforations made in the tape are to be interpreted as representing numerical values. The commutator switch 4102 may be brought into or out of control with respect to the electromagnetic devices 3011 by operation of the Void switch 4232 (SW2). When the movable contact 4233 of the single pole, double throw switch 4232 is operated, by operation of the Void key 4218 to operate the switch 4232 to make the movable contact 4233 engage the fixed contact 4235, a circuit is extended from the switch 4232 to the collector ring 3036 of the commutator switch 4102 by way of the conductor 4345. It will be seen, therefore, as shown in Figs. 31 and 32, arranged as indicated in Fig. 33, that when the switch 4232 (SW2) has its movable contact 4233 in engagement with the left-hand fixed contact 4234, the circuit extends to the switch 4101 which serves as a commutator for the readout switch 4000, and that the readout switch 4000 is in condition to act as a control for the set of electromagnetic devices 3011 in the tape perforator 3000. Also, that when the switch 4232 has its movable contact 4233 in engagement with the right-hand fixed contact 4235 the circuit is extended to the commutator switch 4102 and this switch is in condition to control the operation of the electromagnetic devices 3011 in the tape perforator 3000.

The punch pins 3009 are arranged in side-by-side spaced relation and are operable to be thrust upwardly from the position shown in Fig. 3 to make the reduced end portions 3010 pass through the paper tape 3008. Each punch pin 3009 is provided with an operating bar 3041 which is pivotally connected at one end 3042 to the lower end portion of a punch pin 3009. The number of punch pins 3009 provided in the tape perforator 2 illustrated is greater than necessary for a five space code system and the number of operating bars 3041 is also greater than required for the five space code system employed. The extra punch pins 3009 and extra operating bars 3041 provided permit ready conversion of the tape perforator apparatus to a system requiring more perforations to a line than the presently employed five space code system. For example, as shown in Fig. 2, there are eight operating bars 3041, 3043, 3044, 3045, 3046, 3047, 3048 and 3049 to control the same number of punch pins 3009, only one of which is visible and that being in Fig. 3. The operating bars 3041 and 3043 to 3049, inclusive, are pivotally supported on a rod 3050 which extends between and is supported in two spaced beams 3051 which are pivotally supported at their left-end portions on a bar 3052 extending from, and mounted in, a side wall 3002. The beams 3051 are spaced apart a sufficient distance to accommodate the spaced operating bars 3041 and 3043 to 3049, inclusive, and are equipped with rollers 3053 operable for engagement with cams 3054 mounted on a rotatable shaft 3004. The roller 3053 for each beam 3051 is rotatably supported on a pin 4303 secured in an upwardly extending arm portion 3055 of the beam 3051. A curved lower arm portion 3056 serves as a support for the rod 3050 on which the operating bars 3041 and 3043 to 3049, inclusive, are supported. When the shaft 3004 is rotated and

the high spot 3057 on each cam 3054 bears against its associated roller 3053, the beams 3051 are lifted on their unsecured end portions and operate to lift the operating bars 3041 and 3043 to 3049, inclusive, to apply an upward pressure to the perforator pins 3009. The left ends 3058 of the operating bars 3041 and 3043 to 3049, inclusive, are normally free to move upwardly as shown in Fig. 3. The free ends 3058, however, may be selectively held against upward movement by means of bellcrank levers 3059 which on their upper arm portions 3060 are formed to provide hooks 3061 operable to extend over the free ends 3058 of the operating bars 3041 and 3043 to 3049, inclusive, under the urge of springs 3062. Controlling the operations of the bellcrank levers 3059 are the electromagnetic devices 3011, the armatures 3063 of which are operable under the pull of their springs 3064, 3065 to normally hold the bellcrank levers 3059, as viewed in Fig. 3, against operation in a clockwise direction under the urge of springs 3062. The upper end of the arm 3060 of each bellcrank lever 3059 is dimensioned to fit into a notch 3066 formed in the under surface of the armature 3063 of the associated electromagnetic device 3011. When the operating coil 3067 of the electromagnetic device 3011 is energized, the armature 3063 is attracted to move away from the upper end portion of the arm 3060 of the bellcrank lever 3059 to, in effect, unlatch the bellcrank lever 3059 for operation to move its hook portion 3061 over the left-hand free end portion 3058 of the operating bar 3041. When the free end portion 3058 of an operating bar 3041 and 3043 to 3049, inclusive, is held against rising by the associated bellcrank lever 3059, the perforator pin 3009 associated with the held operating bar is thrust upwardly through the paper tape 3008. The perforator pins associated with operating bars not held against rising at their left ends 3058 will not perforate the paper tape 3008 when the beams 3051 are lifted by the cams 3054 since the paper tape 3008 is strong enough to resist perforation unless the operating bar is held at its left-end portion. When the operating bar is not held at its left-end portion 3058, most of the lifting force applied to the operating bar is taken up and dissipated in the portion of the operating bar to the left of the pivotal point of support 3050. By holding the left-end portion 3058 down, the upward thrust of the beams 3051 is concentrated in the right-hand ends of the selected operating bars 3041 and 3043 to 3049, inclusive. It will be seen that in Fig. 3, the operating bar 3041 is in effect in a full floating condition and the upward thrust of the beams 3051 is not concentrated at either end of the operating bar and that the reduced diameter upper end portion 3010 of the perforator pin 3009 has not penetrated the paper tape 3008 even though the beams 3051 are at their highest positions, having been moved thereto by the cams 3054. When the high spots 3057 of the cams 3054 pass beyond the rollers 3053, the operating bars 3041 and 3043 to 3049, inclusive, and the beams 3051 are moved downwardly under the thrust of a suitable cam, not shown, but carried on the shaft 3004 alongside the cam 3054. Springs 3068 secured at one end to the operating bars 3041 and 3043 to 3049, inclusive, and at the other end to fingers 3069 of a secured comb 3070 are provided to insure withdrawal of the punches 3009 to normal position.

The punches 3009 may be selectively brought into operation to perforate the paper tape 3008 by selectively operating the electromagnetic devices 3011, each of which, upon energization, will attract its armature 3063 away from the upper end of a leg portion 3060 of a bellcrank 3059 to unlatch the bellcrank. Unlatching of the bellcrank 3059 permits the hook portion 3061 to extend over the left end 3058 of an operating bar 3041 to hold the left end of the operating bar 3041 against upward movement. Under this condition, the perforator pin 3009 associated with that operating bar will pene-

trate the paper tape 3008 when the beams 3051 are lifted by the high spots 3057 on the cams 3054 since the held operating bar cannot rise at its left-hand held end 3058 and the corresponding right end of the operating bar receives and responds to the full lifting effects of the cams 3054 and overcomes the resistance of the paper tape 3008 and makes a perforation in the tape 3008. The displaced pieces of the tape formed by operation of the punches pass upward from the tape 3008 and into a receptacle 3071 which has an outlet tube 3072 connected thereto for leading the tape punchings away from the tape perforating apparatus.

One of the operating bars 3041 and 3043 to 3049, inclusive, is arranged to have its left end 3058 permanently held against floating in order that the perforating pin 3009 associated with that particular operating bar will operate to punch feed holes in the tape 3008. In this particular illustrative setup of the apparatus, the operating bar 3046 is made effective to make its punch 3009 operate to punch the feed holes in the tape 3008. The operating bar 3046 is held down at its left end by means of a fixed bracket 3075. It will be seen, therefore, that for each cyclic rotation of the shaft 3004 the tape 3008 is perforated at a point in register with an aperture 3074, as shown in Figs. 1 and 2, in a perforated laminated punch block 3076. This provides the feed hole in the tape 3008. Other perforations are made in the tape at the same time as the feed hole is formed. These other perforations are arranged in a line across the tape and are selectively formed in the tape at positions in register with the apertures 3077, 3078, 3079, 3080 and 3081 in the perforated laminated punch block 3076.

The bellcrank levers 3059 selectively unlatched by operation of the electromagnetic devices 3011 are controlled for simultaneous movement by virtue of a gang latch 3082 which normally extends across the path of movement of pointed end portions 3083 of the arms 3084 of the bellcrank levers 3059. The latch 3082 extends from a lever 2085 pivotally supported at 3086 and having a cam follower roller 3087 cyclically operated for each rotation of the cam shaft 3004 and operating to move the lever 3085 against the action of a restoring spring 3088. When the gang latch 3082 is moved to the right from the position shown in Fig. 3, the bellcrank levers 3059 selectively released by the electromagnetic devices 3011, are rotated clockwise to engage and hold the left ends of their associated operating bars 3041 which in this particular illustrated setup of the apparatus, would be among the operating bars 3044, 3045, 3047, 3048 and 3049. Subsequent to the clockwise rotational movement of the bellcrank levers 3059, the gang latch 3082 is moved to the left under urge of the spring 3088 to extend over the upper portions of the pointed ends 3083 of the bellcrank lever 3059. It will be seen, therefore, that the gang latch 3082 is operable to hold the bellcrank levers in selectively operated positions and is cyclically operated to permit movement of the bellcrank levers to normal position. Restoration of the bellcrank levers 3059 is obtained under control of a cam on cam shaft 3004 by operation of the lever 4602 which is in mechanical connection with the comb 3089. When the lever 4602 is operated to rotate the comb 3089 counter-clockwise against the action of the restoring spring 3090, the bellcrank levers 3059 are rotated by means of the comb 3089 counter-clockwise until the upper ends of the left-hand arms 3060 of the bellcrank levers 3059 are latchingly engaged by armatures 3063 of the electromagnetic devices 3011. A bail 3091 pivotally supported at 3092 and extending across the path of clockwise movement of the bellcrank levers 3059 is operable to close a normally open switch 3093 (PCC) shown in Fig. 32, when any of the electromagnetic devices 3011 is operated. The switch 3093 is not shown in Fig. 3, but is located directly back of the switch 3094 (PLC) which, as shown in Fig. 32, is normally closed,

but which opens in mid cycle to release the clutch magnet 3095 (PCM) from energization. The clutch magnet 3095 (PCM), as shown in Fig. 2, is supported on a bracket 3096 secured to the wall 3002. The clutch magnet 3095 is operable to control the operation of a clutch 3097, the function of which is to control the application of power from a belt-driven pulley 3098 to the cam shaft 3004 of the tape perforator 3000. The pulley 3098 is driven by means of a belt 3099 extending from a pulley 3100 secured to a shaft 4, Fig. 1, extending from a gear system 3101 driven by means of a shaft 3102 extending from the motor 4282 of the computing apparatus 1. The clutch 3097 is an expansion clutch and is provided with a rotatable clutch member 3104 operable to transmit rotations from the pulley 3098 to a shaft 3004 which extends through the clutch 3104 and into the interior of the tape perforator 3000 and serves as the cam shaft of the tape perforator. The clutch member 3104 is provided with a lug 3105 operable to engage an armature 3106 of the electromagnetic device 3095 (PCM) unless the electromagnetic device 3095 is energized. When the armature 3106 is engaged by the lug on the clutch member 3104, the clutch member 3104 is held against rotation and the cam shaft 3004 of the tape perforator 3000 is not operated. When the electromagnetic device 3095 (PCM) is energized to remove its armature 3106 from the path of movement of the lug 3105, the clutch 3097 operates to transmit power from the pulley 3098 to the cam shaft 3004 of the tape perforator. A back lash stop arrangement comprising a pivotally supported arm 3107 engaging in a notch, not shown, but formed in a collar 3108 secured to the shaft 3004 prevents reverse rotations of the cam shaft 3004.

V. TAPE FEED

As shown in Fig. 3, the tape 3008 is fed over a roller 3109 at the left in Fig. 3 and from thence toward the right of the figure. The tape passes under a guide portion 3110 and between the apertured pin blocks 3111, 3076 and 3112 in the lower two of which the upper ends of the tape perforator pins 3009 are arranged to operate. After passing over the location of the perforator pins, the tape extends over the feed wheel 3006 and thence between a curved guide plate 3113 and a frame bracket 3114 and outwardly of the apparatus. The tape 3008 is fed along in step-by-step movements under the drive of the tape feed wheel 3006 which is secured to a shaft 3115 equipped with a detent wheel 3116 and a ratchet wheel 3117, shown in Fig. 2, the detent being completed by means of a spring-equipped lever 3118 pressing a roller 3119 between the teeth of the wheel 3116. The ratchet wheel 3117 is operated by means of a pawl 3120 forming part of a system of levers involving the bellcrank lever 3121, Fig. 4 having a follower 3122 engaged by a cam 3123 secured to the cam shaft 3004. In the operation of the tape perforator 3000 all perforations to be made in a single row extending across the width of the tape 3008 are made simultaneously. The number of the perforations, other than the feed hole, appearing in a row is controlled by the selective operation of the electromagnetic devices 3011. If the tape 3008 breaks during the operation of the apparatus, a pivotally supported lever 3124 supporting the guide 3110, will be allowed to rotate counter-clockwise under the pull of a spring 3125 to operate a lever system involving the levers 3126, 3127 and 3128 to open a switch 3129 (PTC) to stop operation of the tape perforator until the tape is again made taut under the guide 3110. Undue tightening of the tape 3008 in its span from the source of supply to the tape feed wheel 3006 will also cause opening of the switch 3129 since the tape passes over a roller 3109 supported on a pivotally supported lever 3130 having an arm portion 3131 operable to engage and operate the lever 3127 toward the right of the position shown in Fig. 4, and against the action of a spring 3134 when the tape is tightened sufficient to pull the lever 3130 toward the right of the

position shown. The guide 3113 which normally operates to hold the tape close to the feed wheel 3006, extends from a pivotally supported lever 3132 which is mechanically connected through a link 3133 with the lever 3124. The guide 3113 may be moved outwardly from the feed wheel 3006 to facilitate insertion of the tape 3008 between the guide 3113 and the feed wheel 3006. When the guide 3113 is moved fully outward from the feed wheel 3006, the link 3133 will operate to rotate the lever 3124 in a clockwise direction and over dead center of its supporting point sufficient to pull the lever 3126 to the right and operate the levers 3127 and 3128 to open the switch 3129. The guide 3113 is provided with a knife edge portion 3135 to permit ready severing of data-bearing portions of the tape 3008 from unused portions of the tape.

VI.—ACTUATOR MECHANISM

(Fig. 14 and part of 17)

The actuator mechanism with the exception of its connection with the readout switch 4000, is substantially the same as the actuator employed in the ten-key adding machine described in the aforementioned application, S. N. 407,016, Patent No. 2,832,530, and comprises an axle shaft 185 journaled at its ends in intermediate frame plates of the machine and extends transversely of the machine above and substantially parallel to the cam shaft 135. Actuator sectors 188 equal in number to the number of selector sectors 33, plus two, are journaled in side-by-side or ordinal arrangement on the axle shaft 185 and extend from the axle shaft toward the shiftable selector unit 11 constituting a portion of the digitation mechanism A.

Each actuator sector 188 is substantially the shape of a section of a circle and the axis of the axle shaft 185 extends through the centers of the hypothetical circles of which the corresponding sectors constitute sections. Gear teeth 189 are provided on the arcuate edges of the actuator sectors 188 and each sector is provided with an elongated opening 190 having a longitudinal curvature centered on the axis of the shaft 185. The sectors may also be provided with weight reducing openings as shown in Fig. 17 if desired.

A rod or bail 192 extends through the openings 190 in the several actuator sectors and arms 193 and 194 not visible in Fig. 17, but connected, as shown in Fig. 35, between the corresponding ends of the bail 192 and the shaft 185, near the correspondingly opposite ends of the shaft, support the bail 192 in spaced and parallel relationship to the axle shaft 185.

As shown in Fig. 35 a yoke 195 of somewhat elliptical shape surrounds the cam shaft 135 and the actuator trail and lead cams 174 and 175, and has an upwardly and forwardly projecting extension pivotally mounted on a fixed cam follower shaft 196, which extends transversely of the machine above and forwardly of the cam shaft 135, and is supported in the side and intermediate plates of the machine frame. An arm 197 extends forwardly from the extension 195 and is pivotally connected by a spacing pin 198 to the distal end of one leg 199 of a ribbon feed actuating bellcrank lever 200 rockably mounted on the cam follower supporting shaft 196. The other leg 201 of bellcrank lever 200 extends upwardly from shaft 196 and is connected at its upper end to the forward end of a link 202 which drives the ribbon feed of the printing mechanism presently to be described.

An arm extends rearwardly from the rearward end of the yoke 203 and is pivotally connected at its rearward or distal end to the lower end of the link 204, the upper end of which is connected to the actuator bail 192.

The yoke 203 carries on its upper side a cam following roller 205 riding on the peripheral edge of the actuator trail cam 174 and on its lower side a cam following roller 206 riding on the peripheral edge of the actuator lead cam 175, the yoke being disposed between the cams

174 and 175 and the roller 205 projecting from the right-hand side of the yoke while the roller 206 projects from the left-hand side of the yoke.

With this arrangement the bail 192 is positively moved both downwardly and upwardly, and during an operating cycle of the machine is first moved to its lower position, is maintained in its lower position for a predetermined time interval and is then restored to its upper position.

A corresponding latch lever 208, shown in Fig. 17, is disposed adjacent one side of each actuator sector gear 188 and is pivoted at its upper end to the sector near the upper radial edge of the sector by a pivotal connection 209 and extends from the pivotal connection along the opening 190 in the actuator sector gear 188 and past the side of the bail 192 remote from the axle shaft 185. The latch lever is angularly bent intermediate its length to provide at the side thereof, adjacent the bail 192, a concave seat 210 which receives a roller 210' rotatably mounted on the bail 192, the roller 210' being received in the corresponding seat 210 when the bail is in its upper limiting position relative to the corresponding sector 188. The latch lever is resiliently held in engagement with the bail by a spring 211 connected between the sector 188 and the distal end of an arm 212 projecting angularly from the pivoted end of the lever 208. The portion of the lever 208 between the seat 210 and the free end of the latch lever, constitutes a longitudinally curved tail portion 213 directed from the bail 192 toward the shaft 185.

When the bail 192 is pulled downwardly by the action of the lead cam 175, shown in Fig. 35, on the cam follower 206, engagement of the bail in the latch lever seat 210, shown in Fig. 17, holds the sector 188 down until the sector is positively stopped at an angular position predetermined by the setting of a corresponding selector sector 33 at which time the bail moves out of the seat 210 and along the concave edge of the tail portion 213 of the latch lever to complete the downward movement of the bail. As the bail moves along the tail portion 213 it maintains downward pressure on the sector 188 and the angularity of the tail portion to the remainder of the latch lever is such that this pressure is sustained by the force of spring 211 when the bail starts up again and until the bail positively engages the sector and returns it upwardly to its home or full-cycle position, the bail being moved upwardly by the action of cam 174, shown in Fig. 35, on follower roller 205.

When, as shown in Fig. 34, the bail 192 moves upwardly relative to the actuator sector gears 188, it comes into engagement with abutment formations 214 at the upper ends of the openings 190 in the sectors, simultaneously moving into the seats 210 of the latch lever 208 and then moves the actuator sectors upwardly until the upper radial edges of the sectors abut against the stop bar 215 in the upper or full-cycle position of the actuator sectors.

VII.—PRINTING MECHANISM

1. Print wheels and gear mechanism

The printing mechanism generally indicated at 216, in Fig. 34, is disposed above the actuator mechanism with its orders in alignment with corresponding orders of the actuator mechanism; a plurality of print wheel drive gears 217 are journaled on a drive gear shaft 218 which extends transversely of the machine above-mentioned and parallel to the cam shaft 135, and is mounted at its ends in the intermediate frame plates 186 and 187. The gears 217 are disposed in side-by-side or ordinal arrangement along the shaft 218 and the number of the gears is equal to the number of actuator sectors 188. Each gear 217 includes a central hub portion 219 of cylindrical shape provided with a peripheral notch 220, the purpose of which will be later explained.

A plurality of print wheel carriers 221 are rockably mounted intermediate their length on a fixed shaft 222

which extends transversely of the machine in spaced and parallel relationship to the shaft 218. Each carrier 221 includes a pair of parallel arms 223 and 224 with the pairs of arms arranged in side-by-side or ordinal arrangement along the shaft 222 and in alignment with corresponding drive gears 217 and actuator sectors 188. Both arms 223 and 224 extend upwardly from the shaft 222, and near the upper end of the arm 224 a pivot pin or axle 225 extends transversely through the two arms of each pair and carries an idler gear 226 which meshes with a corresponding drive gear 217. The arm 223 of the carrier pair 221 is extended upwardly and forwardly beyond the upper end of the arm 224 and carries an axle pin 227 spaced above the axle pin 225. Print wheel gear 230 is journaled on the axle pin 227 and includes a spur gear portion 231, the teeth of which mesh with the teeth of the idler gear 226 mounted in the same carrier, and which is formed on one side of the print wheel portion 232 having printing bosses 233 projecting from the periphery thereof at uniformly spaced angular intervals therearound. It will be noted that the printing bosses 233 are spaced apart and that the outer surfaces of these bosses are made concave in a direction circumferentially of the printing wheel so that the outer surfaces of the bosses will fit against the cylindrical surface of a printing platen 242.

2. Zero foil latch mechanism

Each of the arms 223, as shown in Fig. 34, is provided with an extension 235 directed forwardly from the pivot shaft 222 and overlying one side of the outer portion of the corresponding drive gear 217 to serve as a guide for maintaining the corresponding drive gears 217 and idler gears 226 in meshing alignment with each other. The arm 223 is also extended forwardly of the print wheel axle pin 227 as indicated at 236, and this forward extension is notched out to provide at its lower portion, a latch shoulder 237 facing upwardly and forwardly. A plurality of irregularly shaped zero foil latch levers 238 equal in number to the number of print wheel drive gears 217 and print wheel carriers 221, are pivotally mounted intermediate their length on a fixed shaft 239 which extends transversely of the machine in spaced and parallel relationship to shafts 218 and 222. Each of these zero foil latch levers 238 has an upwardly directed arm 240 provided at its upper end with a detent formation 241 which engages the shoulder 237 on the corresponding print wheel carrier arm 223, to releasably latch the corresponding print wheel in nonprinting position in which it is spaced from the associated printing platen 242. The latch levers 238 are received in corresponding transverse notches or recesses in a comb bar 243 which extends transversely of the machine above and parallel to the shaft 239 to maintain these latch levers in properly spaced relationship to each other, and each lever has a forwardly directed lever arm 244 and a rearwardly directed arm 245, and the rear end portion of which is disposed against the same side of the corresponding drive gear 217 against which the forward extension 235 of the carrier arm 223 is disposed. A spring 246 is connected between the distal end of each forwardly directed latch lever arm 244 and a fixed spring attaching bar 247 extending transversely of the machine above, and substantially parallel to the shaft 239, these springs urging the corresponding latch levers to rock in a clockwise direction as illustrated in Fig. 34. Each rearwardly directed latch bar arm 245 has on its rearward end a downwardly directed detent 248 which drops into the notch 220 in the corresponding print drive gear wheel hub 219 to free the latch arm for clockwise rocking movement by the associated spring 246 to a position in which the latching detent 241 at the upper end of the upwardly directed arm 240 of the latch lever engages over the corresponding shoulder 237 on the carrier arm 223.

A latch releasing bail 250 extends through slots as indicated at 251 in the intermediate frame plates 186 and

187, and across the upper edges of the forwardly directed arms 244 of the latch levers 238. The bail 250 is supported at its ends in the upper ends of a pair of arms, one of which is illustrated in Fig. 36, and designated at 252, pivotally mounted at locations spaced below the bail 250 on the intermediate frame plates 186 and 187 as indicated at 253 of the arm 252 so that the bail 250 can swing forwardly and downwardly, and upwardly and rearwardly in the slots 251.

The arm 252 as shown in Fig. 36, is extended downwardly beyond its pivotal mounting 253 upon the intermediate frame plate 187, and is provided at its lower end with a face which abuts a pin 254 located on cam follower lever 255. The cam follower lever 255 is pivotally mounted intermediate its length on the transverse shaft 196, and at its upper end is in engagement with the forward side of the face of arm 252. At its lower end the lever 255 carries a cam following roller 257 which rides on the peripheral edge of the zero foil cam 171 mounted on the cam shaft 135. The zero foil cam 171 is so shaped that during approximately the first 180 degrees of a machine cycle during which time the actuator sectors 188 are undergoing their downward stroke, as shown in Fig. 34, the bail 250 is held down on the forwardly directed arms 244 of the latch levers 238, holding the latch lever detents 241 out of engagement with the latching shoulders 237 on the print wheel carrier arms 223. This maintains the latch lever detents 248 out of the notches 220 in the print wheel drive gear hubs 219 and frees the drive gears for rotational movement. Near the end of the first half and beginning of the second half of the machine cycle, while the actuator sectors are being held in their limiting downward positions, the cam follower roller 257, Fig. 36, rides into a dwell of the cam 171 and a tension spring 260 connected between the upper end of the bail supporting arm 252 and the machine frame, raises the latch lever bail 250, Fig. 34, away from the latch lever arms 244 and thereby conditions the latch levers to move into engagement with the corresponding shoulders 237 under the actuation of the corresponding latch lever springs 246.

During the downward stroke of the actuator sectors and while the latch levers 238 are held out of engagement with the notches 220 in the drive gear hubs 219 by the bail 250, those drive gears in alignment with selector sectors which have been manually set to numeral values will be rotated away from their "0" positions in a manner presently to be described, so that, when the actuator bail 192 approaches the end of its downward movement and the bail 250 is moved to release the latch levers 238, the notches in the drive gears, which have been rotated from their "0" positions will be moved out of registry with the corresponding zero foil latch lever detents 248 and these detents will not be able to re-enter the corresponding notches 220 and will be held on the cylindrical peripheral surfaces of the corresponding hub formations 219 so that the corresponding latch lever detents 241 will be held out of engagement with the shoulders 237 of the corresponding print wheel carriers 221 leaving these carriers free to rock the print wheels 230 carried thereby toward the platen 242 during the printing operation, presently to be described.

The upwardly directed arm 240 of each latch lever 238 has near its upward end a forwardly directed projection 261 the outer end portion 261' of which is laterally directed to the left, as viewed from the front of the machine, and overlies the like outer end portion 261' of the projection 261 on the next latch lever to the left, these forward extensions being omitted from the upwardly projecting arms of the first two latch levers at the right-hand end of the assembly. The arrangement is such that if any print wheel drive gear to the left of the first two gears at the right-hand end of the assembly is moved away from its "0" position, all of the latch levers to the right of such drive gear will be held by the zero foil projections

261 out of latching engagement with the corresponding shoulders 237 on the print wheel carrier arms 223 and the print wheels to the right of the indicated drive gear will be free to move in a printing operation. Since the drive gears to the left of the indicated drive gear have not been moved and still have their hub notches 220 in registry with the zero foil latch lever detents 248 and since the latch levers to the left are not restrained by the projections 261, these latch levers to the left of the indicated drive gear will be moved by their springs 246 into latching engagement with the corresponding shoulders 237 to hold the corresponding print wheels against printing movement so that the printing mechanism will not print zeros to the left of the highest order of the numeral entry made into the machine by the keyboard and selection mechanism as previously explained.

When the actuator sectors have been returned to their upward position at the end of the machine cycle, the bail 250 will have been moved downwardly by the cam 171 to raise all of the latch lever detents 248 out of the corresponding notches 220 in the print drive gear hubs 219 thereby freeing the print wheel drive gears for rotational movement by the downward stroke of the actuator sectors during the first portion of the next operating cycle of the machine.

The manner in which a driving connection is provided between the actuator sectors 188, the print wheel drive gears 217 and the selector sectors 33 will be described in detail in the next following section dealing with the positive, pendant gear transmission mechanism.

3. Printing operation—Fig. 34

The lever arm 224 of each print wheel carrier 221 is provided with a rearwardly directed extension or tail portion 263 and a tension spring 264 is connected between the rear end of each rearward extension 263 and the machine frame, and is effective, when released, to rock the corresponding print wheel carrier 221 about the shaft 222 in a direction such that the associated print wheel 230 is moved rearwardly to strike the adjacent, forward portion of the cylindrical surface of the platen 242.

A bail cross member in the form of a rod 265 extends transversely of the machine below the rearward extensions 263 of the carrier levers 224 and is supported at its ends in the rearward ends of a pair of bail supporting arms 266 and 267, as shown in Figs. 34, 37 and 43. At their forward ends the arms 266 and 267 are pivotally mounted on the carrier supporting shaft 222 and the arm 266 is provided at a location spaced somewhat above and forwardly of the bail 265 with a laterally projecting stud 268 which preferably carries a sleeve or roller 269.

A bellcrank lever 270 is pivotally mounted at its knee on the axle shaft 218 of the print wheel drive gears 217 and has the rearward or distal end of one of its arms 271 underlying the stud carried roller 269. The other arm 272 of this bellcrank lever extends downwardly and rearwardly from the shaft 218 and to a location opposite the cam shaft 135 and carries on its lower or distal end a cam following roller 273 which rides on the peripheral edge of the print cam 172.

The print cam 172 is so shaped that during the major portion of a machine cycle the bail 265 is supported in its upper limiting position in which it holds the lever extensions 263 upwardly, and renders the springs 264 ineffective to move the print wheels 230 toward the platen 242. The cam 172 is provided with a low portion 274 of restricted angular extent into which the cam follower 273 drops during a time interval in which the actuator sectors 188 are retained at the end of their downward stroke, as described above, momentarily moving the bail 265 downwardly away from the bottom edges of the carrier lever extensions 263 and conditioning the springs 264 to rock the carriers 221 which have been freed from their associated latch levers 238 in a direction to strike

the print wheels 230 against the platen 242. After the free print wheels have been moved to strike the platen 242, they are immediately returned to their home or full-cycle position by reason of the limited angular extent of the dwell 274 in the printing cam 172.

A portion of the arm 223 of each print wheel carrier 221 is perpendicularly offset from the edge of the arm and arcuately curved longitudinally to overlie the portion of the corresponding idler gear 226 nearest the platen 242 to provide a dust shield 275 for the idler gear.

When a print wheel carriage 221 is rocked about the shaft 222 to move the corresponding print wheel 230 from its home or full-cycle position to its platen engaging position, the teeth of the corresponding idler gear 226 are moved out of mesh with the teeth of the associated print wheel drive gear 217, although they remain in mesh with the teeth of the associated print wheel gear 231. This unmeshing of the idler gear 226 and the drive gear 217 would leave the print wheel free to turn while it is positioned near the platen 242 if some means were not provided to lock the print wheel in its rotational position during this printing movement of the print wheel.

A print wheel locking pawl 278 is pivotally mounted intermediate its length on each print wheel carrier arm 221 by a pivotal connection 279 disposed forwardly of and somewhat below the corresponding print wheel axle pin 227. The locking pawl 278 is disposed in substantially upright position at the forward side of the associated print wheel and has on its upper end a hook formation 280 the end of which is double beveled to fit between any two adjacent teeth of the associated print wheel. A tension spring 281 is connected between the lower end of the locking pawl 278 and the forward extension 236 of the arm 223 below the shoulder 237 and resiliently urges the locking pawl to rock about the pivotal mounting 279 in a direction to engage the end of the hook formation 280 thereof between adjacent teeth on the print wheel. At its lower end the pawl 278 is provided with a notch 282 of inverted V-shape and an actuating bar 283 extends transversely of the machine through the notches in the lower ends of all of the print wheel locking pawls 278.

The pawl actuating bar 283, as shown in Fig. 35, is disposed in spaced parallel relationship to the drive gear axle 218 and is carried at its ends on the distal ends of the legs 284 and 285 of a rectangularly shaped bail 286 pivotally mounted on the axle shaft 218 and near the intermediate or cross portion 287 of the bail.

A cam following rocker arm 290 is pivotally mounted intermediate its length on the drive gear axle shaft 218 at the outer side of the intermediate frame member 186 and is disposed in substantially upright position. A cam following roller 291 on the bottom end of the arm 290 rides on the peripheral edge of the tens-transfer cam 173 at the forward side of this cam and a tension spring 292 connected between the upper end of the rocker arm 290 and the machine frame resiliently holds the cam following roller against the associated cam 173. A spacing pin 293 extending through a slot in the intermediate frame plate 186 connects the rocker arm 290 above the shaft 218 to the leg 285 of the bail 286 and a second spacing pin 294 connects a forward extension of the rocker arm 290 to the forward portion of the leg 285 of the bail 286.

The shape of the tens-transfer control cam 173 is such that the spring 292, which holds roller 291 against the peripheral edge of this cam, will hold the actuating bar 283 in such position, as illustrated in Fig. 34, relative to the lower ends of the locking pawls 278, that the pawls will be held out of engagement with the corresponding printing wheels until the actuator bail 192 nears the end of its downward stroke. At this time the roller 291 rides off the lobe 295 of the cam 173 and frees the spring 292 to move the bar 283 in a direction to free the springs 281 to force the ends of the hook formations at the outer

ends of the locking pawls 278 into engagement between the angularly spaced-apart teeth of the associated printing wheels. At the same time the actuator sectors are aligned and latched in position by means presently described, and immediately afterward the print control bail 265 is moved to free the springs 264 to swing the released print wheel carrying arms 221. As the print wheel carrying arms are swung, the print wheel idler gears 226 are moved out of mesh with the print wheel drive gears 217, but, as the idler gears are held against rotation by engagement of the pawls 278 with the print wheels and the actuator sectors and print wheel drive gears are latched against rotation, no relative rotation between the idler gears 226 and drive gears 217 takes place during printing. The print wheels are also held firmly against rotational movement during the printing movement of the print wheel carrying arms.

When the printing operation has been completed and the print control bail 265 moved upwardly to restore the print wheel carrying arms 221 to their full-cycle position, a pin 296 on the actuator lead cam 175 engages an offset shoulder 297 near the lower end of arm 290 and rocks this arm back to the full-cycle position shown in Fig. 35, thereby moving the pawls 278 out of engagement with the print wheels and restoring the rotational freedom of the print wheels so that the print wheels which have been moved away from their "0" position can be restored to their "0" position on the upward stroke of the actuator bail 192. Shortly after the pin 296 has restored the arm 290 the roller 291 again rides onto the lobe of cam 173 and the arm holds the bar 283 in position to maintain the pawls 278 clear of the print wheels 230 until the next printing operation.

4. Actuator sector aligning and latching mechanism

While the idler gears 226 are out of mesh with the drive gears 217 it is also necessary to hold the drive gears against accidental rotation so that the idler gears will re-mesh smoothly with the associated drive gears when the print wheels are returned from their printing to their full-cycle, or home, position. Locking of the drive gears 217 is accomplished by aligning and temporarily locking the actuator sectors 188 during the time that these sectors are retained at the bottom end of their downward stroke, and suitable mechanism for this purpose is illustrated in Fig. 40.

A plurality of bell crank shaped, sector locking pawls 298 are pivotally mounted in side-by-side or ordinal arrangement on a pawl supporting shaft 299 which extends transversely of the machine rearwardly of and below the cam shaft 135 and is mounted at its ends in the intermediate frame plates 186 and 187. Each of the locking pawls 298 comprises an arm 300 extending forwardly from the mounting shaft 299 and having on its distal end an upwardly projecting detent 301, and an arm 302 extending downwardly from the shaft 299. A spring 303 is connected between the lower end of each pawl leg 302 and a bail mounting shaft 511 of the symbol printing mechanism, to be described later, and resiliently urges the pawl to rock about the shaft 299 in a direction to insert the corresponding pawl detent 301 between two adjacent teeth 189 of the actuator sector 188 in alignment with the particular pawl. A comb bar 304 of right-angular cross-sectional shape is disposed below and transversely of the shaft 299 and is mounted on the shaft for pivotal movement by arms, as indicated at 305, positioned one at each end of the comb. The comb has an upwardly extending leg 306 provided with spaced-apart notches or slots respectively receiving the arms 300 of the locking pawls 298 and a substantially horizontally disposed leg 307 having spaced-apart slots or notches receiving the downwardly extending arms 302 of the locking pawls. A cam follower lever 310 is mounted at one end on the shaft 299 at one end of the shaft and is driv-

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ingly connected to the comb 304. A cam following roller 311 is mounted on the forward end of the lever 310 and rides on the peripheral edge of the total taking cam 178.

When the roller 311 is disposed on the lobe of the cam 178, as shown in Fig. 40, the comb 304 is held in such position that the forward edges of the locking pawl legs 302 engage the inner edges of the corresponding notches in the bottom or horizontal leg 307 of the comb and the detents 301 of the locking pawls are held by the comb out of engagement with the teeth of the actuator sectors 188. The locking pawls are held out of engagement with the actuator sectors until the end of the downward stroke of the actuator sectors and are brought into engagement with the sector gear teeth at the end of the downward movement of the sectors by riding of the cam follower 311 off the lobe of cam 178 to hold the sectors against movement below the positions determined by the corresponding selector sectors 33. In the upward movement of the actuator sectors the sector teeth ratchet over the pawl detents 301, the cam follower 311 riding up on the lobe of cam 178 to withdraw the pawls from the actuator sectors near the end of the operating cycle of the machine. The locking pawls 300 are made separately, one for each actuator sector, so that the detents 301 thereof can drop into interdental spaces of the corresponding actuator sectors as the sectors are brought into alignment at the positions in which they are stopped at the end of the downward stroke of the actuator bail 192, as described above.

When the movable selector sectors have been brought back to their home position and stopped, the latches between the actuator bail 192 and the corresponding actuator sectors will be released so that the bail can complete its downward movement with no further movement of the actuator sectors.

Just prior to the locking of the actuator sectors by the detents 301 of the pawls 300, the actuator sectors are brought into alignment at the end of their downward stroke by suitable aligning mechanism also shown in Fig. 40. This is necessary because the stop bar 27, shown in Fig. 14, for the home position of the selector sectors is so positioned that these sectors can move slightly beyond their normal home or full-cycle position in order to re-engage the noses 53 of the pawls 45 with the rearward ends of the zero latch dogs 50 when the selector sectors are returned to their "0" position by the downward stroke of the corresponding actuator sectors. This puts the actuator sectors and the print wheels driven thereby slightly out of their proper printing position and may leave the print wheels which have been released for printing out of accurate alignment across the print wheel orders.

The mechanism for accurately aligning the actuator sectors and the print wheels, when the sectors reach the end of their downward stroke and just before printing occurs, comprises a cam following rocker 312, shown in Fig. 40, pivotally mounted intermediate its length on a cam rocker pivot shaft 313 positioned below the actuator sectors 188 and substantially parallel to the cam shaft 135. At its forward end the rocker 312 carries a cam following roller 314 which rides on the peripheral edge of the actuator aligning cam 176 and a spring 315 extends downwardly from the rearward end of the rocker or lever 312 and is connected at its lower end to the machine frame to resiliently maintain the roller 314 in engagement with the periphery of the cam 176. A bail 316 of right-angular shape has substantially parallel legs, as indicated at 317 in Fig. 40, spaced apart a distance slightly greater than the length of the actuator mechanism and disposed at the inner sides of the intermediate frame plates 186 and 187. At the open end of the bail these legs 317 are pivotally mounted on a shaft 319 carried by the actuator frame and extend downwardly and forwardly so that the intermediate or cross mem-

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ber 318 of the bail is disposed immediately below the actuator sectors. The cross member 318 carries at its front edge an upwardly and forwardly directed stop rib 320 so positioned that its edge, remote from the cross member 318, will engage in approximately aligned interdental spaces of the actuator sectors 188 and bring these sectors into accurate angular or rotational alignment when the bail 316 is swung forwardly and upwardly about its pivotal mounting on the stop shaft 319.

An arm 321 of the rocker or lever 312 extends upwardly and rearwardly from the pivotal mounting of the lever 312 on the shaft 313 and is provided in its upper end with a notch 322. The lever 312 is positioned at the outer side of the intermediate frame plate 187 and this plate is provided with an aperture 323 at the upward end of the lever arm 321. A pin 324 extends from the bail leg 317 adjacent the plate 187 through the aperture 323 in this plate and is engaged in the notch 322 at the upper end of the lever arm 321 so that, when the forward end of the rocker arm 312 is forced downwardly by engagement of the lobe 325 of the cam 176 with the cam following roller 314, the bail 316 will be swung forwardly and upwardly to engage the leading edge of the rib 320 in interdental spaces of the actuator sectors and bring these sectors into accurate alignment. As is apparent from the shape and relative position of the cams 176 and 178 in Fig. 40, the cam 176 acts first to bring the actuator sectors into alignment and immediately after the sectors have been aligned the rocker arm 310 is released to move the comb bar 304 in a direction to release the locking pawls 300 so that these pawls may be actuated by their springs 303 into locking engagement with the actuator sectors.

VIII.—POSITIVE TRANSMISSION GEAR MECHANISM

The mechanism as mentioned above, which drivingly connects the actuator sectors 188 to the selector sectors 33, comprises a positive transmission gear mechanism disposed between the actuator and selector sectors and generally indicated at 330 in Fig. 14. This gear mechanism 330 comprises a bail including parallel legs as indicated at 331 in Fig. 14, spaced apart a distance somewhat greater than the length of the actuator mechanism and interconnected by a suitable cross-member 332 and gear shafts 334, 335 and 336. A top cross-member or transmission shifting member 333 which extends from the outside of the leg 331, extends perpendicularly from the upper end of the structure and is used to shift the positive gear transmission mechanism.

The bail provides a rigid cage or carriage for the transmission gears and the three gear shafts or axles 334, 335 and 336, extend transversely of the space between the bail legs 331 in spaced-apart and parallel relation to each other and are mounted at their ends in the corresponding bail legs at locations spaced apart longitudinally of the legs. A plurality of transmission gears 337 are journaled on the upper gear shaft 334 in side-by-side or ordinal arrangement, the number of these gears being equal to the number of actuator sectors 188 and the gears being constantly in mesh with the corresponding actuator sectors 188 and with the corresponding print wheel drive gears 217 as shown in Fig. 34. A plurality of intermediate or reversing gears 338 are journaled in side-by-side or ordinal arrangement on the intermediate gear shaft 335, and these gears mesh respectively with the gears 337. A plurality of gears 340 are journaled on the gear shaft 336 in side-by-side or ordinal arrangement, the number of these gears also being the same as the number of selector sectors 33, and the gears 340 being in mesh with the corresponding intermediate or reversing gears 338. The transmission gears 337, 338 and 340 are preferably all ten-tooth gears of the same size with teeth of the size of the teeth on the selector sectors 33 and on the actuator sectors 188.

The upper gear shaft 334 is extended beyond the legs of the gear carrying cage and is mounted at its ends in the intermediate frame plates of the machine so that the entire cage can swing about the axis of the shaft 334, carrying with it the gear shafts 335 and 336 and the corresponding gears 338 and 340.

In the addition and subtraction cycles of the machine the cage of the positive transmission mechanism 330, shown in Fig. 14, is rocked by the cam 179, shown in Fig. 8, in a manner to bring the transmission gears 340, shown in Fig. 14, corresponding in number to the number of activated selector sectors, into mesh with the corresponding selector sectors 33 during the first portion of the machine cycle in which the actuator sector bail 192, Fig. 34, is given its downward stroke. During the downward stroke of the actuator bail 192, the actuator sectors 188 in alignment with the selector sectors 33, Fig. 14, which have been manually set and which are engaged or meshed with the corresponding positive transmission gears 340, will be returned to their home or "0" position, at which time they are stopped by the stop bar 27. On the downward movement of the corresponding actuator sectors 188 the print wheels 230, Fig. 34, in alignment with the sectors, are rotated by the corresponding gears 337, 217 and 226 to bring the numerals embossed on the print wheels which correspond to the numbers for which the corresponding selector sectors are set into position to impinge the platen 242 during the printing movement of the print wheels.

1. Shifting mechanism for positive transmission gear mechanism

The positive or add gear mechanism 330, Fig. 14, is moved into and out of operative engagement with the selector sectors 33 during the addition, subtraction, repeat addition and print only cycles of the machine, and is releasably latched in operative engagement with the selector sectors during the downward stroke of the actuator sectors 188 by mechanism particularly illustrated in Figs. 34, 35 and 38.

Referring first to Fig. 28, a V-shaped bellcrank arm 342 is pivotally mounted at its knee on the rocker arm pivot shaft 313 and has arms 343 and 344 extending from the pivotally mounted knee portion of the arm divergently relative to each other. A cam following roller 345 on the distal end of the arm 343 of this lever rides on the peripheral surface of the pendent gear operating cam 179 and the distal end of the other arm 344 of the lever 342, is pivotally connected to one end of the link 346. The link 346 extends upwardly and forwardly from its pivotal connection with the distal end of the bellcrank lever leg 344 and has on its upper end a hook formation 347 positioned to engage the upper edge of the shifting member 333 of the transmission gear mechanism 330. An extension 348 is forwardly directed from the link 346, intermediate the length of this link, and a spring 349 is connected between the distal end of the extension 348 and bellcrank lever leg 344 intermediate the length of this leg and resiliently urges the hooked upper end of the link 346 forwardly and out of position to engage the shifting element 333 of the gear mechanism 330. At a location spaced from the hook formation 347, the link 346 is provided with a shoulder formation 350 projecting in the same direction as the hook formation with the distance between the opposed edges of the hook formation 347 and the shoulder formation 350 slightly greater than the width of the shifting element 333 so that this element can be received between these opposed edges.

A second link 351 is disposed alongside the link 346 and is pivotally connected at its lower end to the distal end of the bellcrank lever leg 344, this second link 351 having at its upper end a hook formation 352, but having no shoulder formation thereon corresponding to the shoulder formation 350 on the link 346.

Whenever the machine goes through an operative cycle,

the cam 179 will, of course, be rotated through an angular distance of 360 degrees or one complete rotation and brought to a stop, and the bellcrank lever 342 will be rocked about its pivotal mounting on the shaft 313 each time the cam 179 is rotated, the cam follower 345 being resiliently maintained in engagement with the peripheral edge of the cam 179 by a suitable spring 357 connected to the bellcrank rocker arm 342.

A lever 353 pivotally mounted intermediate its length on the print mechanism drive gear shaft 218 extends upwardly and forwardly, and downwardly and rearwardly from the shaft 218 and has its upper end engaged by an abutment pin 354 on the rearward end of a link connected to the mechanism operated by the addition control key of the machine, so that forward movement of the pin 354 in response to a depression of the addition control key, as will be later explained, swings the lever 353 about its pivotal mounting on the shaft 218 to move the lower end of this lever rearwardly. At its lower end the lever is provided with an elongated slot or notch 355 which receives a pin 356 projecting laterally from the link 346 near the shoulder formation 350 on this link.

A second lever 358, also pivotally mounted intermediate its length on the shaft 218, is disposed alongside the lever 353 and is engaged at its upper end by an abutment pin corresponding to the abutment pin 354 projecting laterally from a link 359 extending rearwardly from the subtraction key mechanism so that the link 359 will be moved forwardly when the subtraction key is depressed, this link being also moved forwardly when the print only control key of the machine is depressed. At its lower end the lever 358 is provided with a notch similar to the notch 355 slidably receiving a pin projecting laterally from the link 351.

When the addition control key of the machine is depressed, the link 346 is swung by the lever 353 to a position in which the transmission shifting element 333 of the gear mechanism 330 is received between the hook formation 347 and shoulder formation 350 on this link. With the element 333 engaged by the link 346, as the cam 179 is rotated, the link 346 is pulled downwardly to swing the transmission gear mechanism, 330 in Fig. 14, in a direction to mesh its gears 340 with the gear teeth of the selector sectors when the lobe portion of the cam 179, Fig. 38, passes under the cam following roller 345. This movement of the gear mechanism 330, Fig. 14, gear connects the actuator sectors 188 with the corresponding selector sectors 33 for the downward stroke of the actuator sectors and limits the downward movement of the actuator sectors to the digital positions of the corresponding selector sectors.

After the actuator sectors have been moved downwardly to their terminal position, aligned and locked in position, as described above, the dwell portion of the cam 179, Fig. 38, comes opposite the roller 345 and the retracting spring 357 connected to the bellcrank lever 342 rocks the lever in a direction to move the link 346 upwardly thereby swing the shifting element 333 of the gear mechanism 330, Fig. 14, upwardly to move the gears 340 out of mesh with the teeth of the selector sectors, back to a neutral position, and from the neutral position into mesh with the drive gears of an accumulator mechanism, presently to be described, so that the entry value read out from the selector sectors by the actuator sectors on the downward movement of the actuator sectors and transmitted to the print wheels, will be transmitted to the accumulator on the upward, return stroke, of the actuator sectors.

In a similar manner the lever 358, Fig. 38, moves the link 351 to position such that the hook formation 352 of this link engages the upper edge of the transmission shifting element 333 of the positive gear transmission mechanism 330 and, when the cam 179 is rotated, the transmission mechanism 330 is first swung to bring the gears 340 thereof into mesh with the selector sectors before

the downward stroke of the actuator sectors 188 of the machine. However, since the link 351 has no shoulder formation corresponding to the shoulder formation 350 on the link 346, the link 351 is not effective to move the gears 340 of the transmission mechanism 330 into mesh with the accumulator drive gears but only frees the transmission for a return to its neutral position when the cam following roller 345 rides onto the dwell portion of the cam 179. In addition to the cams 173 and 179 shown in Fig. 8, there are other cams and parts assembled in connection with the shaft 135. These additional parts numbered 14, 134, 137, 138, 142, 151, 152, 170, 171, 172, 174, 175, 176, 178, 205 and 206 are not pertinent to the description of the present invention but are conventional parts of the ten-key adding machine described in the above-mentioned H. J. Chall application S. N. 407,016, Patent No. 2,832,530.

2. Locking mechanism for positive gear transmission— Fig. 37

The mechanism for locking the positive gear transmission mechanism 330 in each one of its three positions, that is, its position in which its gears 340, Fig. 14, are in mesh with the selector sector gear teeth, its neutral position and its position in which its gears 340 are in mesh with the accumulator drive gears, is shown in Fig. 37 and comprises a T-shaped locking bar 362 which inclines downwardly and forwardly from the cam shaft 135. The upper end of the bar 362 is notched out to slidably receive the cam shaft and this notch is continued longitudinally of the bar at a reduced width to receive a guide pin 363 which insures rectilinear movement of the locking bar. A crosshead 364 on the lower end of the bar extends perpendicularly to opposite sides of the bar 362 and carries at its ends detents 365 and 366 which are directed from the crosshead back along the bar 362 toward the cam shaft 135. The leg 331 of the cage of the transmission gear mechanism is provided at its free end with a formation 367 of increased width and spaced-apart notches 368, 369 and 370 are provided in the end of the formation 367, the portions of the formation between and at the outer sides of these notches being provided with inclined edges for camming the detent 365 into the notches.

A cam following rocker arm 372 is mounted at its lower end on the rocker arm pivot shaft 511 and carries on its upper end a cam following roller 373 which rides on the peripheral edge of the transmission locking cam 170. A second lever arm 375 disposed in spaced and almost parallel relationship to the lever arm 372 is also pivotally mounted at its lower end on the shaft 511 and is pivotally connected at its upper end to the slide or locking bar 362 by a suitable pivotal connection 376. The lever arm 372 is drivingly connected to the lever arm 375 in a manner to permit the upper end of the lever 375 to follow the rectilinear movement of the locking bar 362 and a suitable spring, not illustrated, connected between the machine frame and the lever 372 maintains the cam following roller 373 against the peripheral edge of the cam 170.

The cam 170 has lobe portions 377 and 378 of restricted angular extent disposed in substantially diametrically opposite relationship to each other and effective, when in engagement with the cam following roller 373 to move the locking bar 362 outwardly to retract the detent 365 from the end of the formation 367 on the end of the leg of the transmission cage.

While the transmission 330 is being swung by the cam 179 to mesh the transmission gears 340 with the selector mechanism sectors, the lobe 378 of the cam 170 holds the detent 365 out of engagement with the end of the cage formation 367 and, as soon as the shifting of the transmission mechanism is complete the roller 373 rides off the cam lobe 378 permitting the detent 365 to

engage in the notch 370 and hold the transmission gears 340 firmly in mesh with the gear teeth of the selector sectors. Near the end of the dwell of the actuator sectors 188 at the end of their downward stroke, the roller 373 rides up on the cam lobe 377 forcing the detent 365 out of the notch 370 and the transmission gear unit, 330, Fig. 14, is then returned to its neutral position both by the cam 179, Fig. 38, and by resilient centering means connected to the gear unit and presently to be described. If the transmission gear mechanism is stopped at its neutral position, when the roller 373, Fig. 37, rides off the cam lobe 377, the detent 365 is engaged in the center notch 369 in the free end of the leg 331 of the transmission cage. However, if the transmission gear mechanism is moved past its neutral position by the link 346, as described above, to engage its gears 340 with the drive gears of the accumulator mechanism 390, Figs. 14 and 15, the detent 365, Fig. 37, when released by the riding of the roller 373 off the cam lobe 377, engages in the notches 368 to hold the gears 340 of the transmission mechanism firmly in mesh with the accumulator drive gears during the upward stroke of the actuator sectors.

The detent 366 on the end of the crossbar 364 remote from the detent 365 operates in a similar manner to lock a negative transmission mechanism in either its neutral, or its operative, position but this negative transmission is reserved for a later description in connection with the subtraction cycle and total taking cycles of the machine.

The mechanism which resiliently urges the pendant, transmission gear mechanism 330, Fig. 14, to its neutral position in which its gears 340 are clear of both the selector sectors 33 and the accumulator drive gears is illustrated in Fig. 44 and generally indicated at 380. This mechanism comprises a pair of opposed jaws 381 and 382 pivotally mounted at corresponding ends on one end of the positive transmission gear shaft 334 and extending from the shaft 334 past the respectively opposite edges of the transmission shifting element 333 of the positive transmission cage. A stop pin 383 is disposed between the free ends of the jaws 381 and 382 and a tension spring 384 connected between the jaws at a location between the gear shaft 334 and the element 333 resiliently urges the jaws toward each other and the free ends of the jaws against the stop pin 383 to hold the element 333 in its centered or neutral position. When the shifting element 333 is moved to one side or the other in consequence of rocking movement of the positive gear transmission mechanism in one direction or the other from its neutral position, the corresponding jaw 381 or 382 is forced away from the stop pin 383 tensioning the spring 384 which then resiliently urges the jaw back to its position at rest against the stop pin 383 and urges the shifting element 333 back to its position corresponding to the neutral position of the transmission gear mechanism.

In order to prevent incidental angular movements of those positive transmission gears and actuator sectors which are not being used to transmit a value entered into the selector unit of the digitation mechanism to the printing mechanism and the accumulator, a locking bar 385, as indicated in Fig. 14, is secured at one end to the left-hand end of the carriage of the shiftable selector unit and extends to the left from this unit parallel to the axis of the selector sector shaft 32. This bar has its outer edge in alignment with the outer ends of the second gear teeth of the selector sectors from the zero latch ends of the sectors and, when the transmission gears 340 are moved into meshing engagement with those selector sectors which have been stepped to the left of the right-hand side of the positive transmission mechanism, the locking bar 385 enters into interdenal spaces of all of the gears 340 to the left of the left-hand end of the shiftable selector mechanism and holds these gears

340 against any rotational movement during the downward stroke of the corresponding actuator sectors 188. This insures that any print wheel which is not moved from its "0" position in response to the transmission of an entry value from the digitation mechanism to the printing mechanism will be retained in its "0" position.

IX.—ACCUMULATOR MECHANISM

Figs. 14, 15 and 16

The accumulator mechanism of the adding machine is generally indicated at 390 and particularly illustrated in Figs. 14, 15 and 16. This mechanism is provided as a unitary structure which is installed in the machine through an opening 391 in the machine base 392 and has a rigid frame including brackets 393 and 394 which are disposed one along each side of the opening 391 and extend upwardly through the opening, these brackets having perpendicularly offset apertured lugs, which extend into recesses in the base at the corresponding sides of the opening 391 and are secured to the base by screw fasteners, as indicated at 395. The frame also includes left and right end plates disposed in spaced-apart and parallel relationship to each other, and a plurality of separator plates 398 uniformly spaced apart between the end plates and disposed in parallel relationship to each other and to the end plates. The end plates and the separator plates are provided with aligned apertures including one series of aligned apertures near the bottom edges and the front ends of these plates and one set of aligned apertures near the bottom edges and the rear ends of the plates and a supporting bar 400 of rectangular cross-sectional shape extends through the series of apertures near the front edges of the plates while a similar bar 401 extends through the series of apertures near the rear edges of the plates. The bars 400 and 401 are secured to the upstanding portions of the brackets 393 and 394 by suitable means, such as the screw fasteners 402 extended through apertures in the brackets and threaded into tapped holes in the corresponding ends of the bars.

Suitable clamping means such as a base plate 403, as illustrated in Fig. 14, or clamping strips, underlie the bottom edges of the plates 396, 397 and 398 parallel to the supporting bars 400 and 401 and screw fasteners 402 extend through apertures in the clamping means and are threaded into tapped holes extending transversely of the bars 400 and 401 to clamp the end plates and spacer plates rigidly in their position on the supporting bars. The plates are also reinforced in their spaced and parallel relationship to each other by various shafts and through pins as will become apparent during the following description of the accumulator mechanism.

A main axle shaft 405 extends transversely through the plate assembly intermediate the height of the plates and is secured at its ends in the end plates 396 and 397, projecting at its ends beyond the outer sides of these end plates shown in Fig. 16. A plurality of accumulator gears 406 are mounted in side-by-side or ordinal relationship on the shaft 405 and are disposed one gear in each space between the adjacent spacer plates 398 and one gear between each outside spacer plate 396' and 397' and the adjacent side plate, there being eleven of these accumulator gears or one more than the ten selector sectors, as described above. Each accumulator gear 406 has twenty gear teeth 407 uniformly spaced apart around its periphery and a tens-transfer cam structure 408 is disposed against one side of each accumulator gear and rigidly secured to the gear for rotation therewith.

Each tens-transfer cam structure 408 comprises a bar extending diametrically of the associated accumulator gear and having an enlarged and apertured center portion through which the shaft 405 extends and double beveled end portions terminating in blunted points disposed in alignment with interdental spaces at diametrically opposite sides of the gear.

A drive gear shaft 410 extends transversely through the plate assembly above and parallel to the shaft 405 and this shaft 410 also extends at its ends outwardly of the outer sides of the end plates 396 and 397 of the plate assembly. Accumulator drive gears 411 are journaled in side-by-side or ordinal arrangement on the shaft 410, there being eleven of these gears disposed one in each space between adjacent plates of the plate assembly and meshing with the corresponding accumulator gear 406. Each drive gear has ten gear teeth 412 so that it requires two rotations of a drive gear to complete one rotation of the associated accumulator gear.

A detent shaft 414 extends transversely through the plate assembly at the upper, width reduced end of the assembly and detent pawls 415 are rockably mounted on the shaft 414 in ordinal arrangement along the shaft, there being one detent pawl for each of the accumulator drive gears 411 and each pawl having at one end a bearing portion 416 receiving the shaft 414 and at its other end a V-shaped detent formation 417 which engages in the interdental space at the upper side of the associated drive gear 411 to hold the drive gear and corresponding accumulator gear against accidental rotation. Each pawl is resiliently held in movement resisting engagement with its associated drive gear by a tension spring 418 connected between the pawl at a location intermediate the length of the pawl and a tie rod 419 which extends transversely of the plate assembly below and parallel to the detent shaft 414.

With the above-described arrangement it will be apparent, that when the positive gear transmission 330 is rocked, as described above, to mesh its gears 340 with the accumulator drive gears 411 during the upward or return stroke of the actuator sectors 188, the drive gears 411 will be rotated in an additive or clockwise direction and will impart an opposite or counter-clockwise rotation to the associated accumulator gears 406.

X.—NEGATIVE TRANSMISSION GEAR MECHANISM

Means are also provided for rotating the accumulator gears in a negative or subtractive direction during the upward stroke of the actuator sectors and this means includes a negative or subtractive gear transmission assembly, generally indicated at 420 in Figs. 14 and 37.

The gear assembly 420 comprises a bail having parallel legs 421 spaced apart a distance at least as great as the length of the actuator mechanism and the accumulator mechanism and connected by a cross portion 422 extending transversely across the space between and joined at its ends to the legs 421. Spaced-apart and parallel gear shafts 423 and 424 are mounted at their ends in the bail legs 421 and extend across the space between these legs. A plurality of ten-tooth transmission gears 425 are mounted in side-by-side or ordinal arrangement on the shaft 423 while a plurality of similar, ten-tooth transmission gears 426 are mounted in side-by-side or ordinal arrangement on the shaft 424 and mesh with corresponding gears 425.

It will be noted that the positive gear transmission 330 has an odd number of gear sets, three such sets being shown in the accompanying drawings, while the negative gear transmission 420 has an even number of gear sets, two such gear sets being illustrated. This provides an arrangement wherein the positive gear transmission will rotate the accumulator drive gear 411 in one direction to add a positive or additive value to the accumulator while the negative transmission 420 will rotate the drive gears in the opposite direction to apply a subtractive or negative value to the accumulator.

The bail legs 421 of the negative transmission bail extends beyond the gear shaft 423 in a direction away from the gear shaft 424, and a pivot shaft 427 (Fig. 37) extends through the bail legs at the ends thereof at the side of the shaft 424 remote from the shaft 423 and is

mounted at its ends in the intermediate frame plates 186 and 187 of the machine to provide a pivotal mounting for the negative gear transmission parallel to but spaced from both of the gear shafts 423 and 424. The negative transmission mechanism is rocked about its pivot shaft 427 by mechanism shown in Fig. 38 and comprising an arm 428 which projects perpendicularly from the subtraction control link 351 alongside of and beyond the extension 348 of the addition control link 346, the arm 428 having its distal end disposed in alignment with a projecting end of the gear shaft 423 of the negative transmission mechanism.

With this arrangement, after the negative control key has been depressed to engage the hook formation 352 of the link 351 with the top cross member 333 of the positive gear transmission to rock this transmission in a direction to bring its gears 340 into mesh with the selector sectors before the downward stroke of the actuator sectors 188 by rotation of the cam 179 and permit return of the positive gear transmission to its neutral position when the cam follower 345 on the rocker arm 342 rolls off the lobe of the cam 179, movement of the rocker arm 342 by its retracting spring 357, while ineffective to move the shifting element 333 of the positive gear transmission cage in a direction to mesh the gears 340 of the positive transmission with the accumulator drive gears because of the absence of a shoulder formation on the link 351, moves the arm 428 so that the distal end portion 429 of this arm engages the projecting end portion of the gear shaft 423 and rocks the negative gear transmission 420 in a direction to mesh the gears 425 with the actuator sectors 188 and the gears 426 for the accumulator drive gears 411.

One leg 421 of the negative gear transmission cage is provided on its free end with a terminal formation 480, Fig. 37, of increased width and this formation is provided in its distal end with spaced-apart notches 481 and 482, the ends of the portions of the formation 480 at the sides of these notches being beveled to provide cam edges leading into the open, outer ends of the notches. During the cycling of the machine while a positive entry is being made into the accumulator or a positive total abstracted therefrom, the negative transmission unit remains in its neutral position and the detent 366 on the crosshead 364 of the locking bar 362 is moved into the notch 481 to hold the negative gear transmission against movement at the times the positive gear transmission is held in mesh with the selector sectors, in mesh with the accumulator drive gears or in its neutral position. However, when a negative value is being entered into the accumulator or a negative total being taken therefrom and the negative gear unit is swung into meshing engagement with the accumulator drive gears, the detent 366 is entered into the notch 482 in the formation 480 to hold the negative transmission gears in mesh with the actuator sectors and the accumulator drive gears during the upward or return stroke of the accumulator sectors.

The finger 428, Fig. 38, is provided at its distal end with a laterally offset nose formation 429 which engages the adjacent end of the shaft 423 when the link 351 is moved by the cam following rocker 342 when the link 351 has been raised by operation of the subtract key but which misses the end of the shaft 423 when the link 351 is moved by the rocker arm without first having been raised by operation of the subtraction key so that the negative gear transmission mechanism will not be rocked to operative position except when the subtraction key is operated or when a negative balance is to be read out of the accumulator, as will be later described.

The link shifting levers 353 and 358 are provided near their lower ends with forwardly directed nose or lug formations, as indicated at 430 for the lever 353, which lug formations rest at their distal ends on the upper surface of a fixed guide plate 431 which extends transversely of the machine immediately above the cam 179

and constitutes a portion of a bracket 434 which carries the shafts 196 and 218, to limit the movement of the lever arms 353 and 358 in a link retracting direction, and the links 346 and 351 are provided near their upper ends with downwardly and forwardly extending guide fingers 435 and 436, respectively, which are guided in corresponding slots extending transversely of the plate 431.

From the above description it will be observed that the actuator sectors while undergoing their upward (return) strokes are effective to rotate the accumulator drive gears 411 in either a positive direction or a negative direction depending upon whether the positive transmission gear mechanism 330 or the negative transmission gear mechanism 420 is moved into driving engagement with the accumulator drive gears 411.

For a more convenient understanding of the subsequent description, it will be noted that, when looking at the accumulator mechanism from the right-hand side of the machine as in Fig. 14, the positive rotational direction of the accumulator drive gears 411 is clockwise and that of the associated accumulator gears 406 counter-clockwise and that the direction of negative rotation of the drive gears 411 is counter-clockwise and the direction of negative rotation of the negative accumulator gears 406 clockwise.

XI.—TENS-CARRYING MECHANISM OF THE ACCUMULATOR

As in all mechanical accumulators, it is necessary to provide mechanism which becomes effective when any particular accumulator gear advances past its "9" and through its "0" position to advance the accumulator gear of the next highest order an angular extent corresponding to one gear tooth or a single unit space. This is a tens-transfer mechanism and in the accumulator of the calculator shown in connection with the present invention, this mechanism is provided in two symmetrical parts located at diametrically opposite sides of the accumulator gears so that it can accomplish its tens-transfer function in either a positive or negative rotational direction of the corresponding accumulator gears depending upon whether a positive or a negative entry is being stored in the accumulator.

Shafts 438 and 439 extend transversely of the accumulator plate assembly below the accumulator gears 406 and in spaced and parallel relationship to each other and the accumulator gear shaft 405. A number of bellcrank levers 440 equal in number to the number of accumulator gears 406 are pivotally or rockably mounted at their knees on the shaft 438 in side-by-side or ordinal arrangement and each of these bellcrank levers has one arm 441 extending downwardly and rearwardly toward the complementary shaft 439 and terminating substantially midway between the shafts 438 and 439 and has an arm 442 projecting upwardly and forwardly from the shaft 438 and provided near its upper end with a rearwardly directed hook formation 443. Bellcrank levers 444 are rockably mounted at their knees on the shaft 439 in side-by-side or ordinal arrangement relative to each other and are also equal in number to the number of accumulator gears 406. Each lever 444 has a leg 445 extending upwardly and forwardly toward the shaft 438 and terminating medially of the distance between the shafts 438 and 439, it being noted that the distal ends of the lever arms 441 and 445 overlap between the lever supporting shafts 438 and 439. Each lever 444 also has a rearwardly directed leg 446 provided near its distal end and on its upper edge with an upwardly directed hook formation 447. Tension springs 448 extend between the hook formation 443 and 447, each spring being connected at one end to the hook formation 443 on a bellcrank lever 440 and at its other end to the hook formation 447 on the opposite bellcrank lever 444 and tending to resiliently rock the two bellcrank levers toward each

other about their pivotal mountings on the shafts 438 and 439.

A detent pawl 450 is pivotally mounted by a pivot connection 451 on the upper end of each bellcrank leg 442 and has an angularly shaped arm 452 directed toward the aligned accumulator gear 406 and terminating at its distal end in a detent formation 453 which will engage a tooth of the aligned accumulator gear and rotate the corresponding gear through one unit space in a positive entry direction when the bellcrank lever 440 is rocked about the shaft 438 by the spring 448 in a direction such that the hook formation 443 moves toward the hook formation 447 of the opposite bellcrank lever 444. Adjacent the detent 453, the arm 452 is provided with a terminal shoulder 454 which engages a stop bar 455 extending transversely through the accumulator plate assembly and limits the rotational movement imparted to the accumulator gear by the detent 453 to a single unit space.

The axis of the stop bar 455 is in or adjacent to a plane including the axes of the accumulator gear shaft 405 and the bellcrank pivot shaft 438 intermediate the distance between the shaft 405 and the shaft 438 and this stop bar also serves as a tie rod to reinforce the accumulator plate assembly.

The pawl 450 in addition to the arm 452 includes a hook formation 456 which projects from the pawl radially of the pivotal connection 451 and in a forward direction and which is connected by tension spring 457 to a lug 458 projecting radially from the forward edge of the bellcrank arm 442 adjacent the shaft 438. The spring 457 resiliently urges the pawl 450 to rotate in a direction to raise the detent 453 into engagement with the teeth of the aligned accumulator gear when the bellcrank 440 is rocked in a rearward direction by the spring 448 and the pawl is also provided with a radially directed stop arm 459 the distal end of which engages a stop pin or stud 460 carried by the bellcrank arm 442 to limit rotational movement of the pawl 450 by the spring 457 and the arm 452 of the pawl is provided intermediate the length of its upper edge with a latching shoulder 461.

Shafts 462 and 463 extend transversely of the accumulator plate assembly above the accumulator gear shaft 405 and near the front and rear edges, respectively, of the plate assembly. These shafts 462 and 463 are disposed in spaced and parallel relationship to each other and to the shaft 405 and the shaft 462 is above the shaft 438 while the shaft 463 is above the shaft 439.

A plurality of latch levers 465 are rockably mounted each at its upper end on the shaft 462 in side-by-side or ordinal arrangement relative to each other and these latch levers depend from the shaft 462 and each carries at its lower end an abutment formation 466 which engages the shoulder 461 on the corresponding detent pawl 450 and holds the pawl in retracted position with its detent 453 spaced from the corresponding accumulator gear 406. Each latch lever 465 has intermediate the length thereof and at the side thereof nearest the accumulator gears 406 a rearwardly extending nose formation 467 which abuts against a stop bar 468 when the lever is in latching engagement with its associated pawl 450 to limit rocking movement of the lever about the shaft 462 in a direction toward the accumulator gears, and a tension spring 469 connected between the lower end portion of the latch lever 465 and a tie rod 470, Fig. 15, extending transversely through the accumulator plate assembly between the lower end of the latch lever 465 and the accumulator gear assembly, resiliently urges the latch lever to rock toward the gear assembly.

A live pawl or actuating dog 472 is disposed against one side of each of the latch levers 464 and pivotally connected to the corresponding latch lever by a pivotal connection 473 located medially of the length of the latch lever. The actuating dog 472 is provided with an abutment formation 474 which projects radially from the

pivotally mounted portion of the dog into the path of the outer end portions of the tens-transfer cam 408 carried by the corresponding accumulator gear and is also provided with a forwardly directed arm 475 connected near its distal end by a spring 476 to the upper end portion of the latch lever 465. The spring 476 resiliently urges the actuating dog 472 to rotate relative to the associated latch lever 465 until a stop arm 477 on the actuating dog is brought to bear against a stud 478 projecting laterally from the corresponding latch lever 465. The stop arm 477 bears against the side of the stud 478 remote from the accumulator gear assembly so that, when the accumulator gear 406 is rotating in a positive or counterclockwise direction, as viewed in Fig. 14, and an end of the tens-transfer cam member 408 engages the abutment formation 474 applying pressure in a downward direction to this abutment formation, the actuating dog will not rock relative to the associated latch lever 465 but, the latch lever will be forced to swing away from the accumulator gear assembly releasing the abutment formation 466 on the lower end of the latch lever from the latching shoulder 461 on the associated detent pawl 450 to free the detent pawl for rocking movement of this pawl and the associated bellcrank 440 about the shaft 438 in a direction to move the pawl detent 453 against a tooth of an aligned accumulator gear and rotate the gear one unit space in the positive or counterclockwise direction.

The spring-biased pivotal connection between the detent pawl 450 and the associated bellcrank 440 permits the bellcrank lever and the pawl carried thereby to be returned from a gear moving position to their home or full-cycle position, as illustrated in Fig. 14, without imparting any rotation in a reverse or negative direction to the associated accumulator gear and the spring-biased, pivotal connection between the actuating dog 472 and the associated latch lever 465 permits the end portions of the corresponding tens-transfer cam 408 to move past the abutment formation 474 of the actuating dog in a negative or clockwise direction without moving the associated latch lever 465 to release the corresponding detent pawl 450.

The terminal detent 453 on each detent pawl 450 is off-set laterally to the left from the abutment formation 474 of the actuating dog 472 mounted on the latch lever 465 holding the particular detent pawl so that, when the latch lever is released from its associated detent pawl by engagement of the tens-transfer cam 408 on the accumulator gear in alignment with the latch lever 465, the detent 453 will engage a tooth of the accumulator gear of the next higher order, that is, the accumulator gear immediately to the left of the gear carrying the tens-transfer cam which released the latch so that the gear of the next higher order will be advanced one unit space in the positive or additive direction.

A detent pawl 485 is pivotally mounted on each of the negative bellcrank levers 444 and urged by a tension spring 486 connected between a hook formation on the pawl and a lug on the bellcrank lever to a rotational position in which the stop arm 487 on the pawl engages the stop stud 488 on the arm 446 of the lever 444. Each detent pawl 485 carries a terminal detent formation 489 effective when the arm 444 is rocked by the spring 448 toward the corresponding accumulator gear 406 to move the accumulator gear engaged by the particular detent 489 one unit space in a negative or clockwise direction, as viewed in Fig. 14. Each detent pawl 485 is also provided with a terminal shoulder 490 which engages a stop bar 491 extending transversely of the accumulator plate assembly in spaced and parallel relationship to the stop bar 455 to limit swinging movements of the pawl 485 under the influence of spring 448 to an extent such that the detent 489 will move the corresponding accumulator gear one unit space only. The assembly of each negative bellcrank 444 and corresponding detent pawl

485 is identical with the corresponding positive assembly including a bellcrank lever 440 and detent pawl 450, and the spring-biased pivotal connection between the pawl 485 and the bellcrank 444 permits the pawl and bellcrank assembly to be returned to its home or full-cycle position after a gear rotating movement without imparting any rotational movement to the associated accumulator gear.

Negative latch levers 492 are pivotally mounted at their upper ends on the shaft 463 in side-by-side or ordinal relationship to each other and depend from the shaft 463 toward the corresponding detent pawls 485. Each latch lever 492 carries on its lower end an abutment formation 493 which engages with the latching shoulder on the upper edge of the corresponding detent pawl 485 to releasably hold the pawl in its home or full-cycle position retracted from the corresponding accumulator gear, and a tension spring 494 connected between each latch lever 492 near the lower end of the lever and a tie rod 495 extending transversely of the accumulator plate assembly resiliently urges the latch lever to swing about the shaft 463 to its pawl latching position. A nose formation 496 directed forwardly from the forward edge of the lever 492 medially of the length of the lever engages a stop bar 497 extending transversely of the accumulator plate assembly to stop the spring induced swinging movement of the latch lever 492 when the lever has been brought by the spring to its latching position.

A latch lever actuating pawl 498 is pivotally mounted on each latch lever 492 medially of the length of the latch lever by a pivotal mounting 499 and a tension spring 500 connected between one end of the dog 498 and the upper end portion of the lever 492 resiliently urges the dog to rotate relative to the associated lever 492 until the stop arm 501 on the dog is brought to bear against the outer side of the stop lug 502 extending laterally from the upper portion of the latch lever 492.

The dog 498 carries an abutment formation 503 disposed in the path of the end portions of the tens-transfer cam member 408 carried by the corresponding actuator gear 406 and the spring tension on the dog 498 is such that when the gear 406 is rotating in a positive or counter-clockwise direction, as viewed in Fig. 14, the ends of the tens-transfer cam will pass the abutment formation 503 and rock the dog relative to the associated latch lever 492 without moving the latch lever out of latching engagement with the corresponding detent pawl 485. However, when the accumulator gear is rotated in a negative, or clockwise direction, as viewed in Fig. 14, engagement of an end of the tens-transfer cam 408 with the corresponding abutment formation 503 will tend to move the actuating dog 498 relative to the latch lever 492 in a direction in which movement is precluded by the stop arm 501 and stud 502 thereby swinging the latch lever about the shaft 463 in a direction to release the associated detent pawl 485 and free this pawl to impart a single step or unit space rotational movement to a corresponding accumulator gear. The terminal detent 489 of the negative gear moving assembly is laterally offset to the left from the position of its associated abutment formation 503, in the same manner as in the positive gear rotating assembly, so that, when the tens-transfer cam on one accumulator gear moves the aligned latching lever 492 to release the corresponding detent pawl 485 and bellcrank lever 446, the detent 489 will engage and impart a one step or unit space rotational movement to the accumulator gear of the next higher order.

With the above-described arrangement the tens-transfer operation will be carried forward in either a positive or a negative direction, but in each case the tens-transfer operation will be made from an accumulator gear passing through its "0" position to the accumulator gear of the next higher order immediately to the left of the gear passing through its "0" position.

The operation of the tens-transfer mechanism, as described above, is controlled by a bail, generally indicated at 505, the cross or intermediate portion 506 of which constitutes an actuating rack extending transversely of the accumulator plate assembly below the distal ends of the legs 441 and 445 of the bellcrank levers 440 and 444. The legs 507 and 508 of the bail 505 are pivotally mounted at the open end of the bail on a shaft 509 which is supported on the end plates 396 and 397 of the accumulator plate assembly parallel to and forwardly of the shaft 438. A bellcrank lever 510 (Fig. 45) is pivotally mounted at one end on the intermediate frame plate 187 of the machine by a pivotal mounting 511 disposed rearwardly of and below the cam shaft 135. One arm 512 of this bellcrank lever 510 extends forwardly from the pivotal connection 511 and is connected at its forward end to the adjacent end of the bail 506 by a link 513.

A second arm 514 of the bellcrank lever extends upwardly from the leg 512 near the free or distal end of the latter and terminates at a location above the tens-transfer actuating cam 173. A cam following roller 515 is carried on the upper end of the bellcrank arm 514 and rides on the peripheral edge of the cam 173 and a tension spring 516 connected to the leg 512 and depending therefrom is connected at its lower end to the machine frame and resiliently urges the bellcrank lever 510 downwardly and the cam following roller 515 into engagement with the edge of the cam 173.

The bail 506 has three operative positions including an intermediate position in which it is slightly below the distal end portions of the bellcrank lever arms 441 and 445 so that, when any one of the detent pawls 450 or 485 is unlatched, the corresponding spring 448 will swing such detent pawl and its associated bellcrank lever about the supporting shaft 438 or 439 an angular extent such that the detent pawl cannot be relatched by the corresponding latch lever when the tens-transfer cam 408 moves past the abutment formation 474 or 503 which occasioned the unlatching of the detent pawl, a top position in which it is raised sufficiently above its intermediate position to restore any detent pawl which has been unlatched, and a home or full-cycle position in which it is disposed below its intermediate position a distance sufficient to permit the tens-transfer action to take place.

After being unlatched and moved to a position at which it cannot be relatched, the movement of the detent pawl and its carrying bellcrank lever is arrested by the engagement of the distal end portion of the corresponding bellcrank lever arm 441 or 445 with the bail rod 506 with the latter in its intermediate position, so that the tens-carrying operation is delayed until after the entry has been made into the accumulator and the actuator sectors have returned to their home or full-cycle position.

The shape of the cam 173, Fig. 45, and its rotational position on the cam shaft 135 is such that the bail 506 is held up in its intermediate position during the portion of the machine cycle in which the actuator sectors accomplish their downward and upward strokes and completely enter the selected value into the accumulator.

Immediately after the actuator sectors have returned to their full-cycle position the cam following roller 515 drops from the lobe portion 295 into the low portion 517 of the cam 173 moving the bail cross-member 506 downwardly away from the bellcrank lever arms 441 and 445, Fig. 14, to its full-cycle position, thereby freeing those bellcranks and detent pawl assemblies which have been unlatched to simultaneously complete their tens-carrying operation under the power of the associated springs 448.

Cam following roller 515, Fig. 45, does not ride out of the low portion 517 of the cam 173 before the end of the operating cycle so that the bail 506 is left in its lowered or full-cycle position when the operating cycle terminates. At the beginning of the next operating cycle

of the machine, the cam following roller 515 rides up on the lobe portion 295 of the cam 173 first raising the bail rod or cross-member 506 to its top position somewhat above its intermediate position to restore all of the released bellcrank and detent pawl assemblies to their latched condition and to then lower the bail slightly to its intermediate position, as described above.

XII.—ACCUMULATOR CONDITIONING MECHANISM FOR TOTAL PRINTING

The accumulator gear blocking means operated by the total sign sensing mechanism comprises, as shown in Fig. 15, a positive blocking bail generally indicated at 568, the legs of which are pivotally mounted at their distal ends on the ends of the shaft 462, and the cross or intermediate portion 569 of which extends across the length of the accumulator immediately above the abutment formations 474 of the latch lever actuating dogs 472; and a negative blocking bail generally indicated at 570, the legs of which are pivotally mounted at their distal ends on the shaft 463 near the ends of this shaft, and the intermediate portion 571 of which extends across the length of the accumulator mechanism immediately above the abutment formations 503 on the actuator dogs 498 for the negative latch levers 492.

XIII.—THE ELECTRICAL SYSTEM

The electrical system for the Add-Punch apparatus involving this invention may be as shown in Figs. 31 and 32, when placed in the relative positions shown in Fig. 33.

As heretofore mentioned, the motor 4282 of the computing apparatus may be operated from a suitable source of current supply such, for example, as an A. C. source delivered at approximately 115 volts.

As shown in Fig. 31, the readout switch 4000 in the computing apparatus 1 and the electromagnetic devices 3011 in the tape perforator apparatus 2, are constructed and arranged for operation on a direct current system. To obtain the direct current supply for the electrical system, the conductors 3136 and 3137 leading from a suitable source of alternating current supply may include the primary winding 3138 of an alternating current transformer 3139 and in this primary circuit there may be a cover interlock switch 3140 and a protective fuse 3141. The cover interlock switch 3140 (SW3) is operable to close its contacts when the cover of the apparatus is applied and will open its contacts when the cover is removed. The transformer 3139 through its secondary 3142, supplies alternating current at the desired voltage to a full wave rectifier 3143 which may be a suitable set of selenium rectifiers arranged in a bridge 3144, the conjugate arms 3145 and 3146 of which are connected to conductors 3147 and 3148 which form the main conductors of the switching system. The conductors 3147 and 3148 are provided with the usual condenser 3149 and resistor 3150 in shunt of the bridge 3144. The system is provided with a pulsing switch 3151 (SW8) comprising, as shown in Fig. 11, a pair of normally open contacts 3152 and 3153 controlled by a toothed wheel 3154 secured to the rotatable shaft 4245, the teeth 3155 of the wheel 3154 being operable to engage an impact pin 3156 mounted on a spring-biased arm 3157 bearing the contact 3153, the arrangement being such that the contacts 3152 and 3153 will be closed for each engagement of a tooth 3155 with the impact pin 3156.

When the apparatus of this invention is in use for computing and making perforated tape records of the amount accumulated in the computing apparatus, the conductors 3136, 3137, of Fig. 31, and 4283 and 4284, of Fig. 2, are connected to a suitable source of current supply (C. S.), the cover of the apparatus being in required position to close the switch 3140.

By operating the digital keys 17, Fig. 1, the "0" key, and required control keys such as the Plus or Minus keys, values may be set in the computing apparatus 1. Operation of the Plus or Minus key, the Total, Clear, Void

and Print Only key will result in closing of the movable contact 4290, in Fig. 32, against the fixed contact 4291 of the switch 139 (SW4) as above mentioned. The closing of switch 139 (SW4) will permit power to flow from the source of supply, not shown, over the conductors 4283, 4284, 4292, 4289, 4288, 4287, and 4285 to supply the motor 4282, the normally closed contact in the centrifugal governor 4286 being in the current supply circuit for the motor 4282. Under this condition the switch 139 will remain closed for one complete cyclic operation of the computing apparatus. The readout switch 4000, however, shown in Figs. 17 and 19 is normally open and cannot close due to the latched condition thereof by virtue of the engagement of the lever 4138 with the lever 4131. Under this condition the tape perforator apparatus 3000, shown in Fig. 1, will therefore not operate to record values accumulated in the computing apparatus.

When the Plus (+) key is operated, the pin 4605 on the stem of the Plus (+) key operates to move the lever system 4604 toward the left in Figs. 27, 28 and 29 which operates to pull lever 4236 in a counter-clockwise direction to swing the end portion 4247 out of the path of movement of the pin 4248 on the cam 4249.

When the Keyboard Clear key is operated the shaft 894 is rotated clockwise to operate lever 4606 to also operate lever 4236 to swing the end portion 4247 out of the path of movement of the pin 4248 on the cam 4249.

The lever system 4603 is automatically operated toward the left by the cam 4257 on shaft 4245 shown in Fig. 29, to operate the bellcrank lever 4607 to rotate the shaft 4608 to release the latch 4609 from its holding engagement on closed switch SW1.

To make the tape perforator apparatus 3000 come under the control of the readout switch 4000, the lever 4246 should be manually operated by pulling its handle 4346 toward the front of the computing apparatus and which would be to the position shown in Fig. 29, in which the notch 4347 in the detent portion 4348 of the lever is in engagement with the pin 4349 extending from a pivotally supported link 4350 which may be mounted on a pin, not shown, extending from the frame 4121. When the lever 4246 is in the position shown, the bent portion 4247 of the lever 4236 is in the path of movement of the pin 4248 on the plate 4249 supported on the cam 820, Fig. 41, on the actuator shaft 185 and during the rotation of the actuator shaft the latch lever 4138 shown in Figs. 19 and 29, will be rotated clockwise on its pivotal point of support 4016 to move the pin 4239 to operate to close the "Off-Normal" switches 4273 and 4274 (SW6A and SW6B, respectively). Operation of the handle 4346 of the lever 4246 toward the rear of the computing apparatus will move the detent portion 4348 of the lever so that the notch 4351 will engage the pin 4349 and the pin 4244 on the lower portion of the lever will operate the release lever 4236 to move its bent portion 4247 out of the path of movement of the pin 4248 on the plate 4249 supported on the cam 820 on the actuator shaft 185.

Closing of the "Off-Normal" switches 4273 and 4274 (SW6A and SW6B, respectively) will therefore occur if the handle 4346 of the lever 4246 is in the position shown in Fig. 29 and the computing apparatus is operated to go through its cycle of operation.

Assuming that the readout switch 4000 has been released for operation by the proper setting of the handle 4346 controlling the operation of the latch lever 4138 and also assuming that the tape is properly in position in the tape perforator 3000, with the tape operating to close the switch 3129 (PTC), Fig. 32, and with the motor initially started, readout of whatever values are represented in the readout switch 4000 will take place to operate the electromagnets in the tape perforator over circuits that can be traced, in Figs. 31 and 32, as follows: Conductor 3147, fixed contact 3158 and movable contact 3159 of switch 3129 (PTC), conductor 3160, fixed contact 3161

and movable contact 3162 of switch 3094 (PLC), conductor 3163, fixed contact 3153 and movable contact 3152 of switch 3151 (SW8), conductor 3164, movable contact 4233 and left-hand fixed contact 4234 of switch 4232 (SW2), conductor 4318, collector ring 4316 and wiper contacts 3032 and 3033 of switch 4101. Assuming that the value "111" were in the computing apparatus and that the wiper contacts of the readout switch were in the required positions for that value and were engaging the required contacts in the upper and lower contact plates 4001 and 4002, Fig. 18, respectively, the circuits could be traced out of the readout switch 4000 as follows: For the "hundreds" position, wiper contact 3033, Fig. 31, and segmental contact 4330 of readout switch 4000, conducting strip 4059 of lower contact supporting plate 4002, wiper contact 4064, wiper contact 4074, conducting strip 4031 of upper contact supporting plate 4001, conductor 4352, diode 4353, conductor 4354, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358, conductor 3148 to rectifier 3144 for the 1st position hole. For the 2nd position hole the circuit would extend from conductor 4352 from the readout switch to conductor 4359, conductor 4360, diode 4361, conductor 4362, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358, and conductor 3148 to rectifier 3144. For the 3rd position hole the circuit would extend from conductor 4359 to conductor 4366, diode 4367, conductor 4368, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358, and conductor 3148 to rectifier 3144. For the 5th position hole the circuit would extend from conductor 4359 to conductor 4372, diode 4373, conductor 4374, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to rectifier 3144. It will be seen from the code layout shown in Fig. 5, that for the value "1" the value must be represented on the tape 3008 by perforations in the 1st, 2nd, 3rd and 5th positions, and that with the arrangement shown in Fig. 31, this requires energization of the electromagnetic devices 3012, 3013, 3014 and 3016 in the order recited, in order that the required operating bars of the tape perforator will be held at their normally free ends and the tape perforating pins for the 1st, 2nd, 3rd and 5th positions will be forced through the paper tape.

Since, in the number "111," the value of "1" is also shown in the tens position, the electromagnetic devices 3012, 3013, 3014, and 3016 must be again operated in the order mentioned and it will be seen that this will occur when the wiper contact 3033 of the commutator switch 4101 reaches the segmental contact 4331 while the wiper contacts 4063 and 4073 of the readout switch 4000 are on the respective conducting strips 4060 and 4031 of the respective lower and upper contact supporting plates 4002 and 4001.

Since the value "1" is also shown in the units position, the electromagnetic devices 3012, 3013, 3014 and 3016 must be again operated in the order mentioned and it will be seen that this will occur when the wiper contact 3033 of the commutator switch 4101 reaches the segmental contact 4332 while the wiper contacts 4004 and 4005 are on the respective conducting strips 4061 and 4031 of the respective lower and upper contact supporting plates 4002 and 4001 of the readout switch 4000.

If the value computed in the computing apparatus were "2," the wiper contacts in the readout switch 4000 would be in the 2nd value position for operating to serve as a conducting means between the conducting strip in the required ordinal position in the lower contact supporting plate 4002 and the conducting strip 4032.

Assuming that the value "2" in the computing apparatus were in the 2nd ordinal position, or in other words, in the tens position, the wiper contacts for the 2nd ordinal

position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4060 and 4032. When the lower contact supporting plate 4002 is moved upwardly to bring the upper wiper contacts into engagement with the upper contact supporting plate 4001, the crossover points of the conducting strips 4060 and 4032 would be in electrical connection through the wiper contacts in the 2nd ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3012, 3013 and 3016 will be energized to bring their associated perforator pins into operation, the electromagnetic devices being energized over circuits that may be traced from the commutator switch 4101 as follows:

For the electromagnetic device 3012, wiper contact 3033, segmental contact 4331, conductor 4343, conducting strip 4060, wiper contact 4063, wiper contact 4073, conducting strip 4032, conductor 4378, diode 4379, conductor 4380, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3013, wiper contact 3033, segmental contact 4331, conductor 4343, conducting strip 4060, wiper contact 4063, wiper contact 4073, conducting strip 4032, conductor 4378, conductor 4381, conductor 4382, diode 4383, conductor 4384, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3016, wiper contact 3033, segmental contact 4331, conductor 4343, conducting strip 4060, wiper contact 4063, wiper contact 4073, conducting strip 4032, conductor 4378, conductor 4381, conductor 4385, diode 4386, conductor 4387, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "3" in the computing apparatus were in the 3rd ordinal position or in other words, in the hundreds position, the wiper contacts for the 3rd ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4059 and 4033. When the lower contact supporting plate 4002 is moved upwardly to bring the upper wiper contacts into engagement with the upper contacts supporting plate 4001, the crossover points of the conducting strips 4059 and 4033 would be in electrical connection through the wiper contacts in the 3rd ordinal position in the readout switch 4000. Under this condition the electromagnetic device 3012 will be energized to bring its associated perforator pin into operation, the electromagnetic device 3012 being energized over a circuit that may be traced from the commutator switch 4101 as follows: Wiper contact 3033, segmental contact 4330, conductor 4342, conducting strip 4059, lower wiper contact 4064, upper wiper contact 4074, conducting strip 4033, conductor 4388, conductor 4389, diode 4390, conductor 4391, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "4" in the computing apparatus were in the 4th ordinal position (the thousands position), the wiper contacts for the 4th ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4058 and 4034. When the lower contact supporting plate 4002 is moved upwardly the crossover points of the conducting strips 4058 and 4034 would be in electrical connection through the wiper contacts 4065 and 4075 in the 4th ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3013 and 3015 will be energized to bring their associated perforator pins into operation to make perforations in the tape at the 2nd and 4th positions across the tape, the electromagnetic devices being

energized over circuits that may be traced from the commutating switch 4101 as follows:

For the electromagnetic device 3013, wiper contact 3033, segmental contact 4329, conductor 4341, conducting strip 4058, wiper contact 4065, wiper contact 4075, conductor 4034, conductor 4392, conductor 4393, diode 4394, conductor 4395, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358, and conductor 3148 to the bridge 3144.

For the electromagnetic device 3015, wiper contact 3033, segmental contact 4329, conductor 4341, conducting strip 4058, wiper contact 4065, wiper contact 4075, conductor 4034, conductor 4392, conductor 4396, diode 4397, conductor 4398, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "5" in the computing apparatus were in the 5th ordinal position (the ten thousand position) the wiper contacts for the 5th ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4057 and 4035. When the readout switch is operated to close, the conducting strips 4057 and 4035 are in electrical connection through the wiper contacts 4066 and 4076 in the 5th ordinal position in the readout switch 4000. Under this condition the electromagnetic device 3016 is energized to bring its associated perforator pin into operation to make a single perforation in the tape at the 5th position across the tape, the electromagnetic device 3016 being energized over a circuit traceable from the commutator switch 4101 as follows: Wiper contact 3033, segmental contact 4328, conductor 4340, conducting strip 4057, wiper contact 4066, wiper contact 4076, conducting strip 4035, conductor 4402, conductor 4403, diode 4404, conductor 4405, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "6" in the computing apparatus were in the 6th ordinal position (the hundred thousand position), the wiper contacts for the 6th ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4056 and 4036. When the readout switch is closed the conducting strips 4056 and 4036 are in electrical connection through the wiper contacts 4067 and 4077 in the 6th ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3012, 3014 and 3016 will be energized to bring their associated perforator pins into operation to make perforations in the tape 3008 at the 1st, 3rd and 5th positions across the tape, the electromagnetic devices being energized over circuits that may be traced from the commutating switch 4101 as follows:

For the electromagnetic device 3012, wiper contact 3033, segmental contact 4327, conductor 4339, conducting strip 4056, wiper contact 4067, wiper contact 4077, conducting strip 4036, conductor 4406, diode 4407, conductor 4408, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3014 and starting to trace at the conductor 4406, conductor 4409, diode 4410, conductor 4411, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3016, conductor 4409, conductor 4412, diode 4413, conductor 4414, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "7" in the computing apparatus were in the 7th ordinal position (the million position) the wiper contacts for the 7th ordinal position in the read-

out switch 4000 would be in position at the crossover points of the conducting strips 4055 and 4037. When the readout switch is operated to close, the conducting strips 4055 and 4037 are in electrical connection through the wiper contacts 4068 and 4078 in the 7th ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3012, 3013 and 3014 will be energized to bring their associated perforator pins into condition for operation to make perforations in the tape 3008 at the 1st, 2nd and 3rd positions across the tape, the electromagnetic devices being energized over circuits that may be traced from the commutating switch 4101 as follows:

For the electromagnetic device 3012—wiper contact 3033, segmental contact 4326, conductor 4338, conducting strip 4055, wiper contact 4068, wiper contact 4078, conducting strip 4037, conductor 4415, conductor 4416, diode 4417, conductor 4418, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3013 and starting to trace at the conductor 4415—conductor 4419, diode 4420, conductor 4421, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358, and conductor 3148 to the bridge 3144.

For the electromagnetic device 3014—conductor 4419, conductor 4422, diode 4423, conductor 4424, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "8" in the computing apparatus were in the 8th ordinal position (ten million position) the wiper contacts for the 8th ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4054 and 4038. When the readout switch is operated to close, the conducting strips 4054 and 4038 are in electrical connection through the wiper contacts 4069 and 4079 in the 8th ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3013 and 3014 will be energized to bring their associated perforator pins into operation to make perforations in the tape 3008 at the 2nd and 3rd positions across the tape 3008, the electromagnetic devices being energized over circuits that may be traced from the commutator switch 4101 as follows:

For the electromagnetic device 3013—wiper contact 3033, segmental contact 4325, conductor 4337, conducting strip 4054, wiper contact 4069, wiper contact 4079, conducting strip 4038, conductor 4425, conductor 4426, diode 4427, conductor 4428, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3014 and starting to trace at the conductor 4425—conductor 4429, diode 4430, conductor 4431, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358 and conductor 3148 to the bridge 3144.

Assuming that the value "9" in the computing apparatus were in the 9th ordinal position (the hundred million position) the wiper contacts for the 9th ordinal position in the readout switch 4000 would be in position at the crossover points of the conducting strips 4053 and 4039. When the readout switch is operated to close, the conducting strips 4053 and 4039 are in electrical connection through the wiper contacts 4070 and 4080 in the 9th ordinal position in the readout switch 4000. Under this condition the electromagnetic devices 3015 and 3016 will be energized to bring their associated perforator pins into condition for operation to make perforations in the tape 3008 at the 4th and 5th positions across the tape, the electromagnetic devices being energized over circuits that

may be traced from the commutating switch 4101 as follows:

For the electromagnetic device 3015—wiper contact 3033, segmental contact 4324, conductor 4336, conducting strip 4053, wiper contacts 4070 and 4080, conducting strip 4039, conductor 4432, conductor 4433, diode 4434, conductor 4435, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the electromagnetic device 3016 and starting to trace at the conductor 4432—conductor 4436, conductor 4437, diode 4438, conductor 4439, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

1. Zero suppression and recording

Records are made in the tape 3008 when "0" values in the computing apparatus are preceded by some value from "1" to "9," inclusive. When the wiper contacts of the readout switch 4000 are in the fully retracted position, they will be in position to form electrical connections between the conducting strips 4051 to 4061 on the lower contact supporting plate 4002, and the conducting strip 4030 on the upper contact supporting plate 4001 when the readout switch 4000 is closed. However, there will be no operation of the electromagnets 3013, 3014 and 3016 under this condition to operate the tape perforator to record a "0," unless the "0" value has been preceded by some value from "1" to "9," inclusive.

In the event that the "0" value is preceded by a numerical value, a relay 4440 (R1) is operated to close its left-hand contacts 4441 and to lock up through its right-hand contacts 4448 (R1A).

The circuit for operation of relay 4440 (R1) may be traced as follows: From the positive side of the bridge 3144, conductor 3147, closed switch 3129 (PTC), conductor 3160, closed switch 3094, conductor 3163, closed switch 3151 (SWB), conductor 3164, movable contact 4233 and left-hand fixed contact 4234 of switch 4232 (SW2), conductor 4318, collector ring 4316 of commutator switch 4101, wiper contacts 3032 and 3033 of wiper 3017, a selected one of the segmental contacts 4322 to 4332, inclusive, of switch 4101, for example, segmental contact 4332 for the 1st ordinal position, conductor 4344, conducting strip 4061, wiper contact 4004, wiper contact 4005, conducting strip 4031, conductor 4352, conductor 4359, conductor 4443, diode 4444, conductor 4445, conductor 4446, break contacts 4447 of make-before-break contacts 4448, conductor 4449, winding of relay 4440 (R1) conductor 4450, conductor 4451 and conductor 3148 to the negative side of the bridge 3144.

The lockup circuit for the relay 4440 (R1) is formed when the relay is initially energized and pulls its armature 4451' against contact 4452 before the break contacts 4447 are opened, the armature 4451' and contact 4452 serving as make contacts of the make-before-break contacts 4448. When the armature 4451' engages contact 4452 the relay 4440 (R1) remains energized over its lockup circuit which may be traced as follows: Bridge 3144, conductor 3147, conductor 4453, fixed contact 4276 and movable contact 4275 of switch 4273 (SW6A), conductor 4454, armature 4451' and contact 4452 of make-before-break contacts 4448, conductor 4449, winding of relay 4440 (R1), conductor 4450, conductor 4451, and conductor 3148 to the bridge 3144.

The closing of its left-hand contacts 4441 (R1B) by relay 4440 (R1) prepares a circuit for the operation of the electromagnetic devices 3013, 3014 and 3016 to control the operation of the perforator pins to make a record on the tape indicating a "0." Assuming that the "0" is in the 2nd ordinal position and that the wiper contact 4063 is in engagement with conducting strip 4060, and that the wiper contact 4073 is in contact with conducting

strip 4030, and that contacts 4441 (R1B) are closed, the circuit is continued as follows:

For the operation of electromagnetic device 3013—conductor 4455, conductor 4456, diode 4457, conductor 4458, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the operation of the electromagnetic device 3014—conductor 4455, conductor 4459, diode 4460, conductor 4461, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358, and conductor 3148 to the bridge 3144.

For the operation of the electromagnetic device 3016—conductor 4455, conductor 4456, conductor 4462, diode 4463, conductor 4464, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to the bridge 3144.

For the initial energization of the relay 4440 (R1) when the value "2" is to be recorded, the energizing circuit for the relay is by way of conducting strip 4032, conductor 4378, conductor 4381, conductor 4465, diode 4466, conductor 4467, conductor 4446, break contact 4447, conductor 4449, winding of relay 4440 (R1), conductor 4450, conductor 4451 and conductor 3148 to the bridge 3144.

For the initial energization of the relay 4440 when the value "3" is to be recorded, the circuit would extend from the conducting strip 4033, conductor 4388, conductor 4468, diode 4469, conductor 4470 to conductor 4446. From this point on it will be seen that the circuit follows the same lines as specified for the lower values.

For the initial energization of the relay 4440, when the value "4" is to be recorded, the circuit would extend from the conducting strip 4034, through conductor 4392, conductor 4396, conductor 4471, diode 4472, conductor 4473 to conductor 4446.

For the initial energization of the relay 4440, when the value "5" is to be recorded, the circuit would extend from the conducting strip 4035, through conductor 4402, conductor 4474, diode 4475, conductor 4476 to conductor 4446.

For the initial energization of the relay 4440, when the value "6" is to be recorded, the circuit would extend from the conducting strip 4036 through conductor 4406, conductor 4409, conductor 4477, diode 4478, conductor 4479 to conductor 4446.

For the initial energization of the relay 4440, when the value "7" is to be recorded, the circuit would extend from the conducting strip 4037, through conductor 4415, conductor 4419, conductor 4480, diode 4481, conductor 4482 to conductor 4446.

For the initial energization of the relay 4440 when the value "8" is to be recorded, the circuit would extend from the conducting strip 4038, through conductor 4425, conductor 4429, conductor 4483, diode 4484, conductor 4485 to conductor 4446.

For the initial energization of the relay 4440 when the value "9" is to be recorded, the circuit would extend from the conducting strip 4039, through conductor 4432, conductor 4436, conductor 4486, diode 4487, conductor 4488 to conductor 4446.

2. Letter and word records

Records are made in the tape 3008 to indicate letters and words to direct the operations of a typewriter in transcribing the information recorded in the tape 3008.

The word "stop" is indicated by perforations made in the tape through operation of perforator pins controlled by operation of the electromagnetic devices 3012, 3013 and 3015 under control of the commutator switch 4101, the circuits for operation of the electromagnetic devices in making the "stop" record being traceable as follows:

For the electromagnetic device 3012—point 3145 on the bridge 3144, conductor 3147, fixed contact 3158, and

movable contact 3159 of switch 3129 (PTC), conductor 3160, fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, fixed contact 3153 and movable contact 3152 of switch 3151 (SW8), conductor 3164, conductor 4489, movable contact 4490 and fixed contact 4491 of switch 4492 (SW1), conductor 4493, fixed contact 4310 and movable contact 4309 of switch 4307, conductor 4319, portion 4315 of collector ring 4316 of switch 4101, wiper contact point 3032, wiper contact 3017, wiper contact point 3033, segmental contact 4320 of switch 4101, conductor 3018, diode 3019, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to point 3146 on the bridge 3144.

For operation of the electromagnetic device 3013 in the recording of the "stop" signal, the electromagnetic device 3013 is energized over conductor 3018, conductor 4494, diode 4495, conductor 4496, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to point 3146 on the bridge 3144.

For operation of the electromagnetic device 3015 in the recording of the "stop" signal, the electromagnetic device 3015 is energized over conductor 3018, conductor 4494, conductor 4497, diode 4498, conductor 4499, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to point 3146 on bridge 3144.

The abbreviation "Figs." is indicated by perforations made in the tape through operation of the perforator pins controlled by operation of the electromagnetic devices 3012, 3013, 3015 and 3016 under control of the commutator switch 4101, the circuits for operation of the electromagnetic devices in making the "Figs." record being traceable as follows:

For the electromagnetic device 3012—point 3145 on the bridge 3144, conductor 3147, fixed contact 3158 and movable contact 3159 of switch 3129 (PTC), conductor 3160, fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, fixed contact 3153 and movable contact 3152 of switch 3151 (SW8), conductor 3164, conductor 4489, movable contact 4490 and fixed contact 4491 of switch 4492 (SW1), conductor 4493, fixed contact 4310 and movable contact 4309 of switch 4307, post conductor 4319, portion 4315 of collector ring 4316 of switch 4101, wiper contact point 3032, wiper contact 3017, wiper contact point 3033, segmental contact 4321 of switch 4101, conductor 3022, conductor 3023, diode 3024, conductor 3025, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

For operation of the electromagnetic device 3013 in the recording of the "Figs." signal the electromagnetic device 3013 is energized over conductor 3023, conductor 4500, conductor 4501, diode 4502, conductor 4503, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

For the operation of the electromagnetic device 3015 in the recording of the "Figs." signal, the electromagnetic device 3015 is energized over conductor 3023, conductor 4500, diode 4504, conductor 4505, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

For the operation of the electromagnetic device 3016 in the recording of the "Figs." signal, the electromagnetic device 3016 is energized over conductor 3023, conductor 4500, diode 4506, conductor 4507, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of the bridge 3144.

The word "Space" is indicated by perforations made in

the tape through operation of the perforator pin controlled by operation of the electromagnetic device 3014 under control of the commutator switch 4101, the circuit for operation of the electromagnetic device 3014 being traceable as follows: Point 3145, of bridge 3144, conductor 3147, fixed contact 3158 and movable contact 3159 of switch 3129 (PTC), conductor 3160, fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, fixed contact 3153 and movable contact 3152 of switch 3151 (SW8), conductor 3164, movable contact 4233 and left-hand fixed contact 4234 of switch 4232 (SW2), conductor 4318, portion 4317 of collector ring 4316 of switch 4101, wiper conducting parts 3032, 3017 and 3033, segmental contact 4333 (SP), conductor 4508, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

The word "Letters" is indicated by perforations made in the tape through operation of the perforator pins controlled by operation of the electromagnetic devices 3012, 3013, 3014, 3015 and 3016 under control of the commutator switch 4102, the circuits for operation of the electromagnetic devices 3012, 3013, 3014, 3015 and 3016 being traceable for this operation as follows:

For the electromagnetic device 3012—point 3145 of the bridge 3144, conductor 3147, fixed contact 3158 and movable contact 3159 of switch 3129 (PTC), conductor 3160, fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, fixed contact 3153 and movable contact 3152 of switch 3151 (SW8), conductor 3164, movable contact 4233 and right-hand fixed contact 4235 of switch 4232 (SW2), conductor 4345, collector ring 3036 of switch 4102, wiper conducting parts 3034, 3028 and 3035, segmental contact 3037 of switch 4102, conductor 4509, conductor 4510, conductor 4511, diode 4512, conductor 4513, conductor 3020, conductor 3021, winding of electromagnetic devices 3012, conductor 4356, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of the bridge 3144.

For the electromagnetic device 3013 and tracing only from the segmental contact 3037—conductor 4509, conductor 4510, diode 4514, conductor 4515, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of the bridge 3144.

For the electromagnetic device 3014 and tracing only from the segmental contact 3037—conductor 4509, conductor 4510, conductor 4516, diode 4517, conductor 4518, conductor 4369, conductor 4370, winding of electromagnetic device 3014, conductor 4371, conductor 4358, and conductor 3148 to point 3146 of the bridge 3144.

For the electromagnetic device 3015 and tracing only from the segmental contact 3037—conductor 4509, conductor 4510, conductor 4519, diode 4520, conductor 4521, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

For the electromagnetic device 3016 and tracing only from the segmental contact 3037—conductor 4509, diode 4522, conductor 4523, conductor 4375, conductor 4376, winding of electromagnetic device 3016, conductor 4377, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

The letter "E" is indicated by a single perforation made in the tape 3008 through the operation of the perforator pin controlled by operation of the electromagnetic device 3012 under control of the commutator switch 4102, the circuit for the operation of the electromagnetic device 3012 being by way of the right-hand fixed contact 4235 of switch 4232 and conductor 4345 to switch 4102 and out of switch 4102 by way of segmental contact 3038 and thence over conductor 4524, conductor 3020, conductor 3021, winding of electromagnetic device 3012, conductor

4356, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

The code signal for "Carriage Return" (CR) is indicated by a single perforation made in the tape 3008 through the operation of the perforator pin controlled by operation of the electromagnetic device 3013 under control of the commutator switch 4102. The circuit for the operation of the electromagnetic device 3013 in this case is by way of the right-hand fixed contact 4235 of switch 4232 and conductor 4345 to switch 4102 and by way of segmental contact 3039, conductor 4525, conductor 4363, conductor 4364, winding of electromagnetic device 3013, conductor 4365, conductor 4357, conductor 4358 and conductor 3148 to point 3146 on bridge 3144.

The code signal for the words "Line Feed" (LF) is indicated by a single perforation made in the tape 3008 through the operation of the perforator pin controlled by operation of the electromagnetic device 3015 under control of the commutator switch 4102. The circuit for the operation of the electromagnetic device 3015, in this case, and tracing only from the commutator switch 4102, is by way of segmental contact 3040, conductor 4526, conductor 4399, conductor 4400, winding of electromagnetic device 3015, conductor 4401, conductor 4357, conductor 4358 and conductor 3148 to point 3146 of bridge 3144.

The tape perforator 3000 has a punch clutch magnet 3095 (PCM) which is an electromagnetic device operable to control the operation of a clutch forming a power transmitting device operable to control the transmitting of power to the cam shaft 3004 of the tape perforator 3000. The punch clutch magnet 3095 is brought into operation to permit power to be transmitted to the cam shaft 3004 when an electromagnetic device 3011 is energized to release a bellcrank lever 3059 which, upon release is operable to move a bail 3091 which is in mechanical connection with the switch 3093 (PCC), the switch 3093 being operable to close when the bail 3091 is rotated clockwise as viewed in Fig. 3.

When the switch 3093 (PCC) is closed, the punch clutch magnet 3095 is energized over a circuit as follows: Point 3145 of bridge 3144, conductor 3147, right-hand fixed contact 3158 and movable contact 3159 of closed switch 3129 (PTC), conductor 3160, right-hand fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, conductor 3165, conductor 3166, movable contact 3167 and fixed contact 3168 of switch 3093 (PCC), conductor 3169, winding of electromagnetic device 3095 (PCM), conductor 3170, conductor 4451, and conductor 3148 to point 3146 of the bridge 3144.

The tape perforator 3000 may be operated to run tape through the apparatus without recording code signals thereon when it is desired to visually read the code signals on the tape and when it is desired to remove perforated portions of the tape from the perforator apparatus. The manually operated tape feed switch 4298 (SW7A) provided for control of the apparatus in such cases is mechanically connected to a switch 3171 (SW7B) to control the punch clutch magnet 3095 (PCM). Closing of the switch 3171 completes a circuit to the punch clutch magnet 3095 (PCM), traceable as follows: Point 3145 of bridge 3144, conductor 3147, right-hand fixed contact 3158 and movable contact 3159 of switch 3129, conductor 3160, fixed contact 3161 and movable contact 3162 of switch 3094 (PLC), conductor 3163, conductor 3165, conductor 3172, fixed contact 3173, and movable contact 3174 of switch 3171 (SW7B), conductor 3175, conductor 3169, winding of electromagnetic device 3095 (PCM), conductor 3170, conductor 4451 and conductor 3148 to point 3146 of bridge 3144.

The diodes 3176 and 3177 shown as being connected around the operating coils of the respective electromagnetic devices 4440 (R1) and 3095 (PCM) and the diodes 3178, 3179, 3180, 3181 and 3182 shown as being connected around the operating coils of respective electro-

magnetic devices 3012, 3013, 3014, 3015 and 3016 are included in the electrical system for the purpose of providing, in each case, a low impedance path for the E. M. F. generated by the collapse of the field around the coil and serve to smooth out the operating pulses. The diodes shown in connection with the readout switch 4000, such for example, as the diodes 4353 and 4361 and the diodes 4512, 4514, 4517, 4520 and 4522, are provided to maintain the direction of current flow in the system and prevent back leakage of pulses in the system.

The diodes as shown in Figs. 24 and 25 are cartridge type electrical elements comprising a cylindrical body 3183 and pin type terminals 3184 and 3185. The diodes are removably mounted in spaced spring clip terminals 3186 and 3187 comprising in each case a U-shaped body portion 3188 and spaced finger portions 3189 and 3190. The body portions 3188 are mounted on an insulating board 3192 by means of metal eyelets 3193. The insulating board 3192, as shown in Fig. 22, is equipped with terminals 3194 and 3195 of sheet metal secured in place by eyelets 3196. The terminals 3194 have two finger portions 3197 and 3198 for the connecting of wires thereto, while the terminals 3196 have only one finger portion 3199. Extending across portions of the upper and lower faces of the insulating board 3192 are strips 3200 and 3201 of conducting material arranged in a predetermined pattern and operating to form, in effect, conducting lines from the terminals 3194 and 3195 to the clip terminals 3186 and 3187 and from one spring clip terminal to another. The mounting eyelets 3193 and 3196, in some cases, serve as conducting paths between the conducting strips on one face of the board 3192 and conducting strips on the opposite face of the board. The diodes can be readily mounted in place on the board 3192 simply by pressing the pin type terminals 3184 and 3185 between the fingers 3189 and 3190 of the spaced terminals 3186 and 3187. The terminal board 3202 comprising the insulating board 3192 and the diodes mounted thereon, is secured by screws or other fastening means, not shown, to the under surface of the base 3001.

Directional marks 3203 are formed on one face of the board 3192 in the vicinity of the terminals 3186 and 3187 to indicate the direction and position in which the diode should be placed and to correspond with the directional mark 3204 appearing on the diode.

In explaining the present invention and as illustrative of a suitable computing apparatus for employment therein, some of the drawings used in the above-mentioned Harold J. Chall application, S. N. 407,016, Patent No. 2,832,530, have been used, with some slight modifications, in the present application. For example:

In the present application:

<i>In the present application:</i>	<i>In S. N. 407,016</i>
Fig. 1A is substantially the same as.....	Fig. 1
Fig. 8 is substantially the same as.....	Fig. 8
Fig. 13 is substantially the same as.....	Fig. 3
Fig. 14 is substantially the same as.....	Fig. 16
Fig. 15 is substantially the same as.....	Fig. 22
Fig. 16 is substantially the same as.....	Fig. 20
Fig. 34 is substantially the same as.....	Fig. 9
Fig. 35 is substantially the same as.....	Fig. 11
Fig. 36 is substantially the same as.....	Fig. 12
Fig. 37 is substantially the same as.....	Fig. 14
Fig. 38 is substantially the same as.....	Fig. 17
Fig. 39 is substantially the same as.....	Fig. 18
Fig. 40 is substantially the same as.....	Fig. 15
Fig. 41 is substantially the same as.....	Fig. 13
Fig. 43 is substantially the same as.....	Fig. 36
Fig. 44 is substantially the same as.....	Fig. 19
Fig. 45 is substantially the same as.....	Fig. 23

A full explanation of parts shown in the figures above listed, and in such cases where the parts are common to the present application and the formerly filed application, may, therefore, be found in the formerly filed application S. N. 407,016, Patent No. 2,832,530.

What is claimed is:

1. An electrical switch comprising a set of fixedly supported contacts, a set of movably supported contacts, facing said set of fixedly supported contacts and spaced

¹ (Fig. 13 being enlarged.)

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from said set of fixedly supported contacts, a set of carriages operating in the space between said sets of contacts, wiper contacts supported on said carriages, movable operating rods individual to and engageable with said carriages and operable to move said carriages from a starting position, cooperating nose portions forming latch means on said carriages and on said movable operating rods to detachably latch said operating rods to said carriages, means to move said set of movably supported contacts to relatively lift the nose portions of said latch means to release said operating rods from said carriages, and a restoring bail operable to engage and restore said carriages to the starting position and force said nose portions into latching engagement.

2. An electrical switch comprising a set of fixedly supported spaced contacts, a collector contact common to the contacts in said set of spaced contacts, a movable support for said collector contact, said movable support facing and being spaced from said set of fixedly supported spaced contacts, means to move said movable support relative to said set of fixedly supported spaced contacts, a carriage operable to move in the space between said set of fixedly supported spaced contacts and said collector contact, a conductor member on said carriage, a wiper contact connected to said conductor member and operable to ride on said collector contact, a wiper contact connected to said conductor member and operable to successively engage the contacts in said set of fixedly supported spaced contacts, a movable connecting rod individual to said carriage and releasably connected to said carriage and operable to move said carriage, a nose portion on each carriage and a nose portion on each connecting rod, said nose portions being cooperable to releasably couple said connecting rod to said carriage and a rotatable gear connected to said connecting rod and operable to move said connecting rod.

3. An add-punch apparatus comprising, in combination, an adding machine, movable members operable in accordance with values entered in said adding machine, a tape perforating machine, and a readout switch in said adding machine operable to set up switching conditions representing numerical values put into said adding machine, said readout switch comprising a first set of spaced conducting strips, a second set of spaced conducting strips facing said first set and extending crosswise relative to said first set, spring wiper contacts operable in the

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space between said first and second sets of conducting strips, carriages supporting said spring wiper contacts, connecting rods extending from said movable members to said carriages, releasable lift latch means operating to releasably couple said connecting rods to said carriages and means to relatively move said sets of conducting strips to bring said sets of conducting strips into conducting relation with said wiper contacts and to lift said releasable lift latch means to uncouple said connecting rods from said carriages.

4. An add-punch apparatus comprising, in combination, an adding machine, movable members operable in accordance with values entered in said adding machine, a tape perforating machine, and a readout switch in said adding machine operable to set up switching conditions representing values put into said adding machine, said readout switch comprising a first set of spaced conducting strips, a second set of spaced conducting strips facing said first set and extending crosswise relative to said first set, spring wiper contacts operable in the space between said first and second sets of conducting strips, means to relatively move said sets of conducting strips to bring said sets of conducting strips into conducting condition with said wiper contacts, horizontally movable carriages for carrying said wiper contacts, vertically movable contact carrying members spring supported in said carriages, connecting rods extending from said movable members to said carriages and releasable coupling means comprising nose portions on said connecting rods and on said vertically movable contact carrying members, forming releasable connecting means between said connecting rods and said carriages.

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