Aug. 2, 1949. E. R. COE ET AL 2,477,722

ACCOUNTING MACHINE

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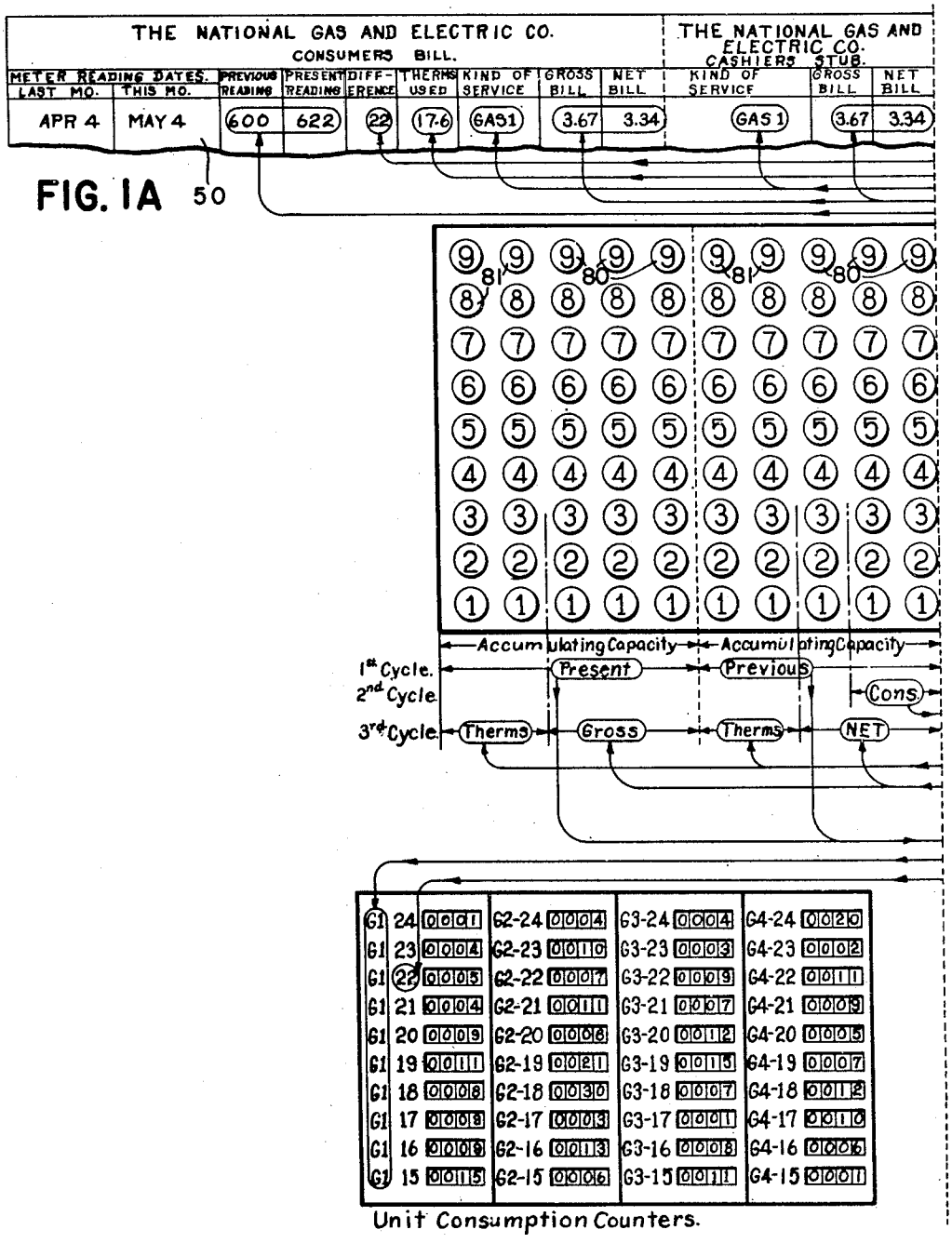

FIG. 1A

Unit Consumption Counters.

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ACCOUNTING MACHINE

Filed Nov. 3, 1943

19 Sheets-Sheet 2

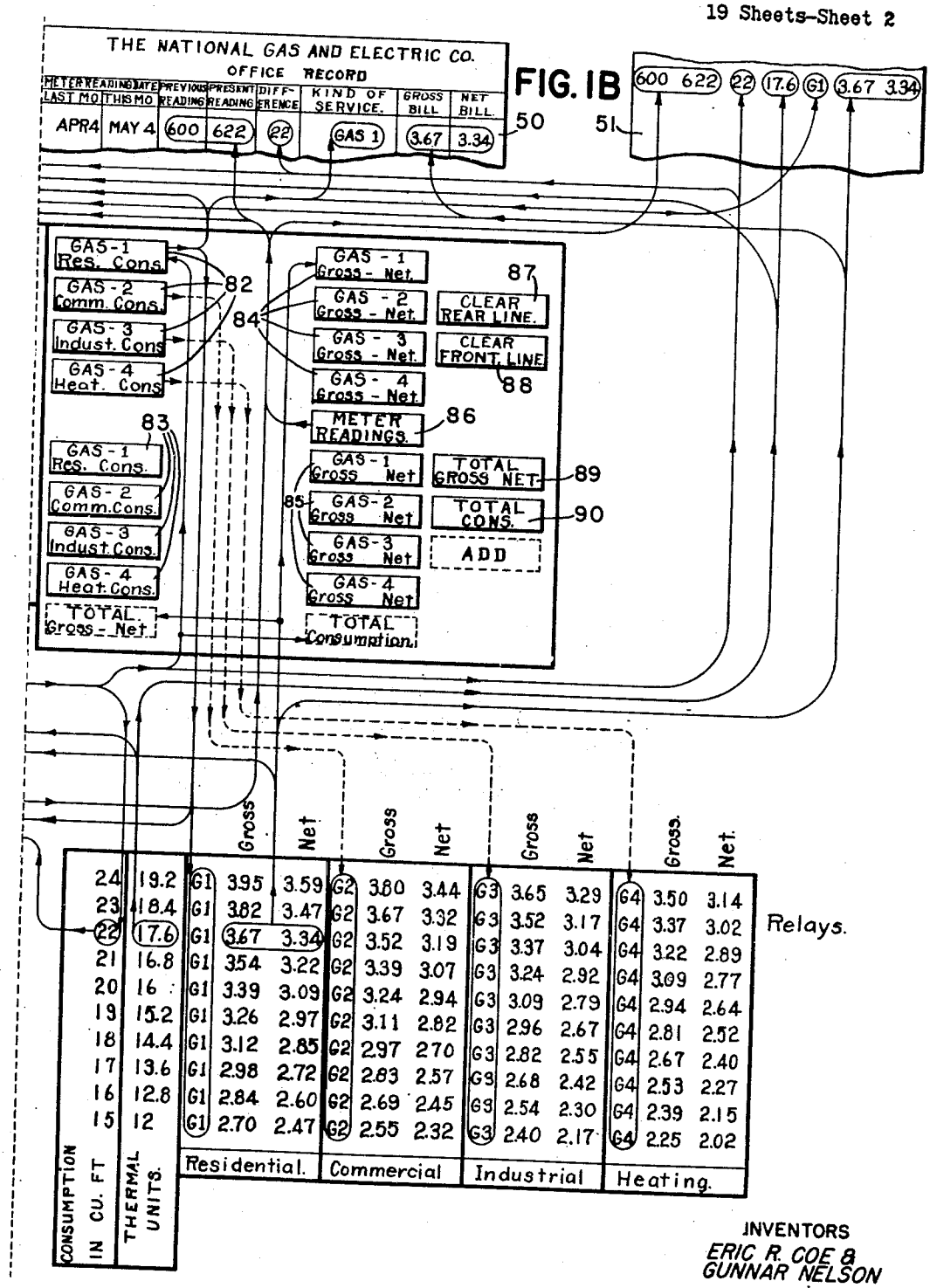

FIG. 1B

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FIG. 2

THE NATIONAL GAS AND ELECTRIC CO. CONSUMERS BILL									THE NATIONAL GAS AND ELECTRIC CO. CASHIERS STUB			THE NATIONAL GAS AND ELETRIC CO. OFFICE RECORD.							
METER READING DATES LAST MO.	METER READING DATES THIS MO.	PREVIOUS READING	PRESENT READING	DIFFERENCE	THERMS USED	KIND OF SERVICE.	GROSS BILL.	NET BILL	KIND OF SERVICE.	GROSS BILL.	NET BILL	METER READING DATES LAST MO.	METER READING DATES THIS MO.	PREVIOUS READING	PRESENT READING	DIFFERENCE	KIND OF SERVICE	GROSS BILL.	NET BILL.
APR4	MAY4	600	622	22	17.6	GAS1	3.67	3.34	GAS 1	3.67	3.34	APR4	MAY4	600	622	22	GAS 1	3.67	3.34
JOHN DOE. 10 MAIN ST. ANYWHERE, OHIO.									JOHN DOE. 10 MAIN ST. ANYWHERE, OHIO			JOHN DOE. 10 MAIN ST. ANYWHERE. OHIO.							

50

FIG. 3

51

836	851	15	12	G1	2.70	2.47
600	622	22	17.6	G1	3.67	3.34
123	146	23	18.4	G1	3.82	3.47
546	569	23	18.4	G2	3.67	3.32
334	357	23	18.4	G3	3.52	3.17
950	973	23	18.4	G4	3.37	3.02
121	138	17	13.6	G1	2.98	2.72
709	725	16	12.8	G1	2.84	2.60
546	564	18	14.4	G1	3.12	2.85

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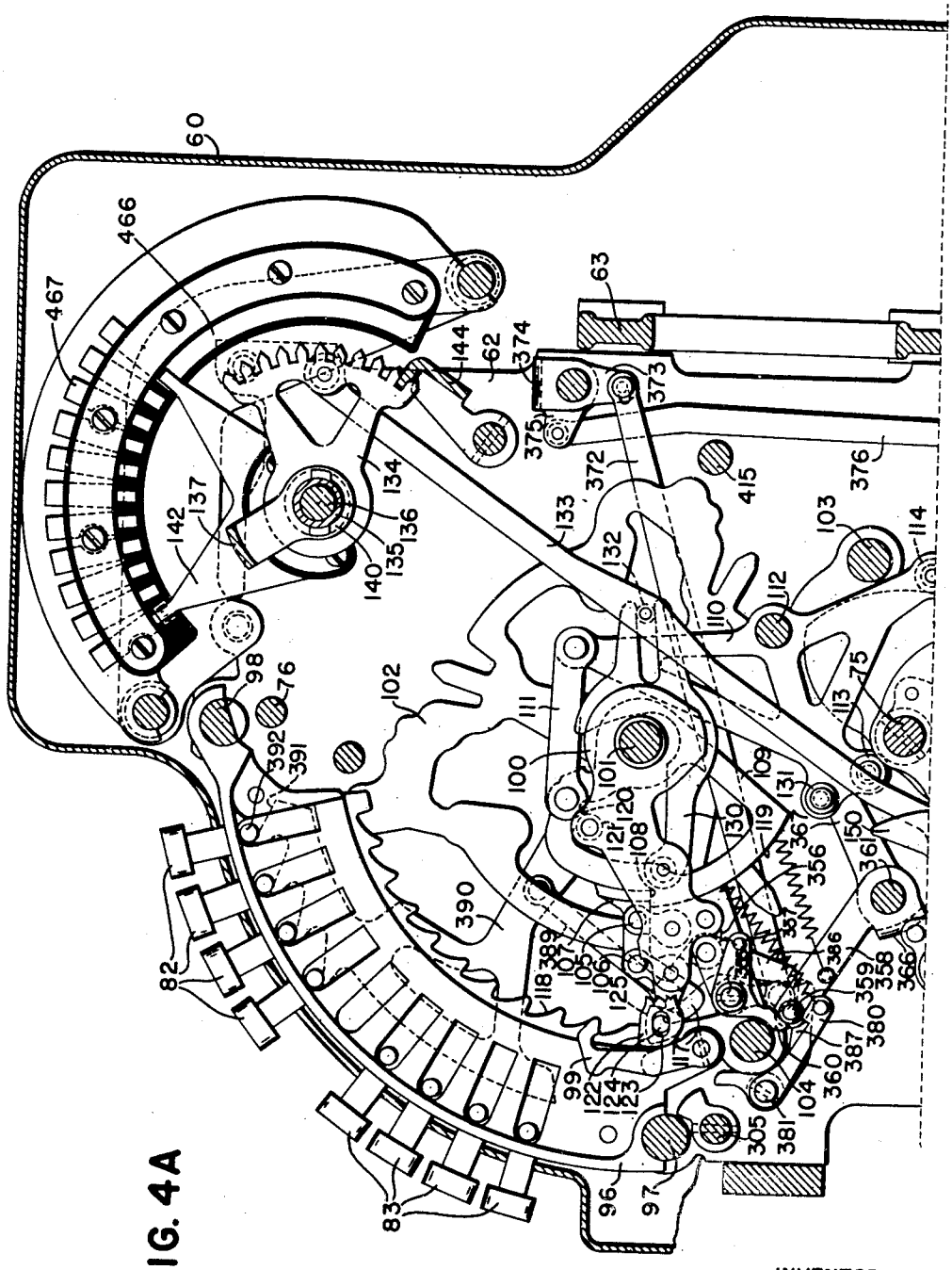

FIG. 4A

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ACCOUNTING MACHINE

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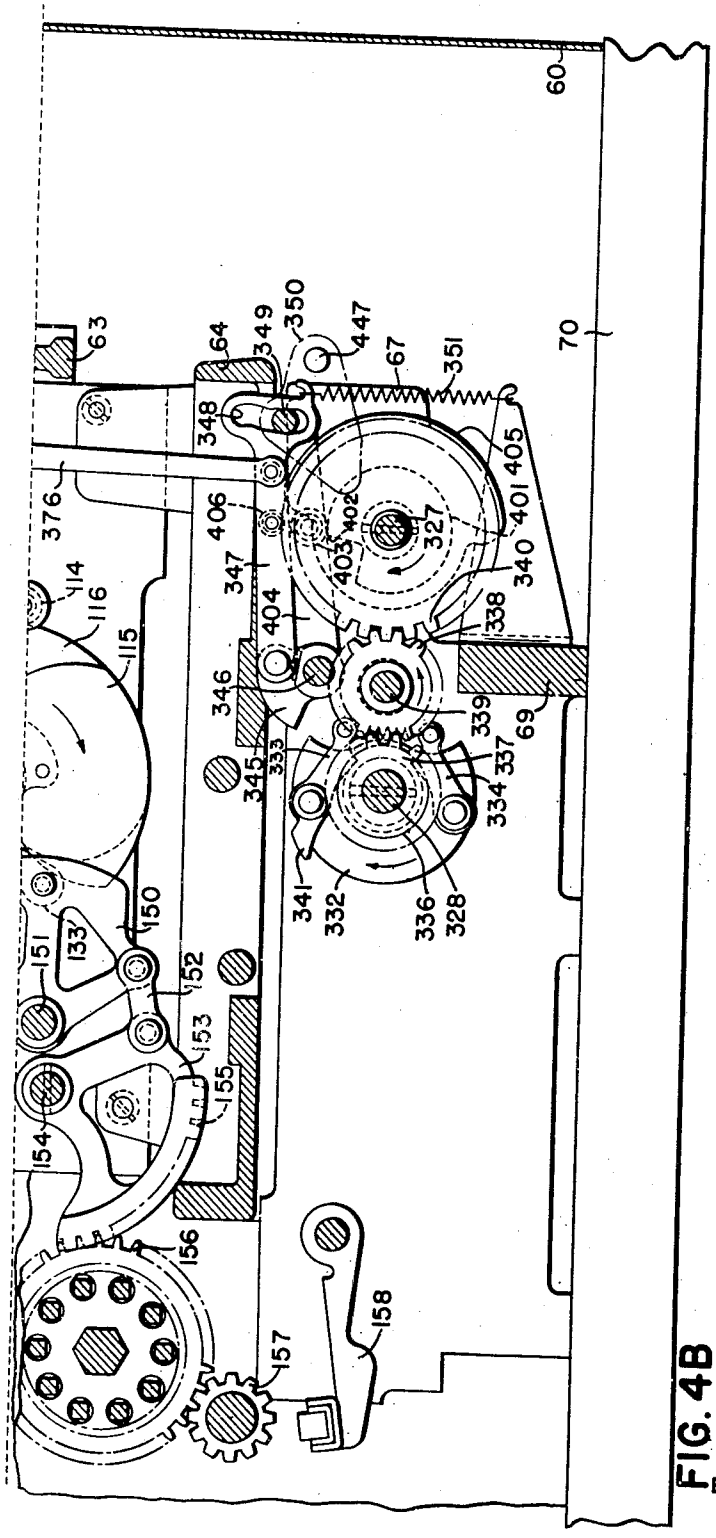

FIG. 4B

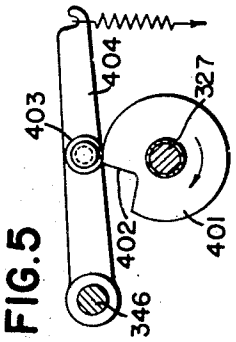

FIG. 5

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ACCOUNTING MACHINE

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19 Sheets-Sheet 6

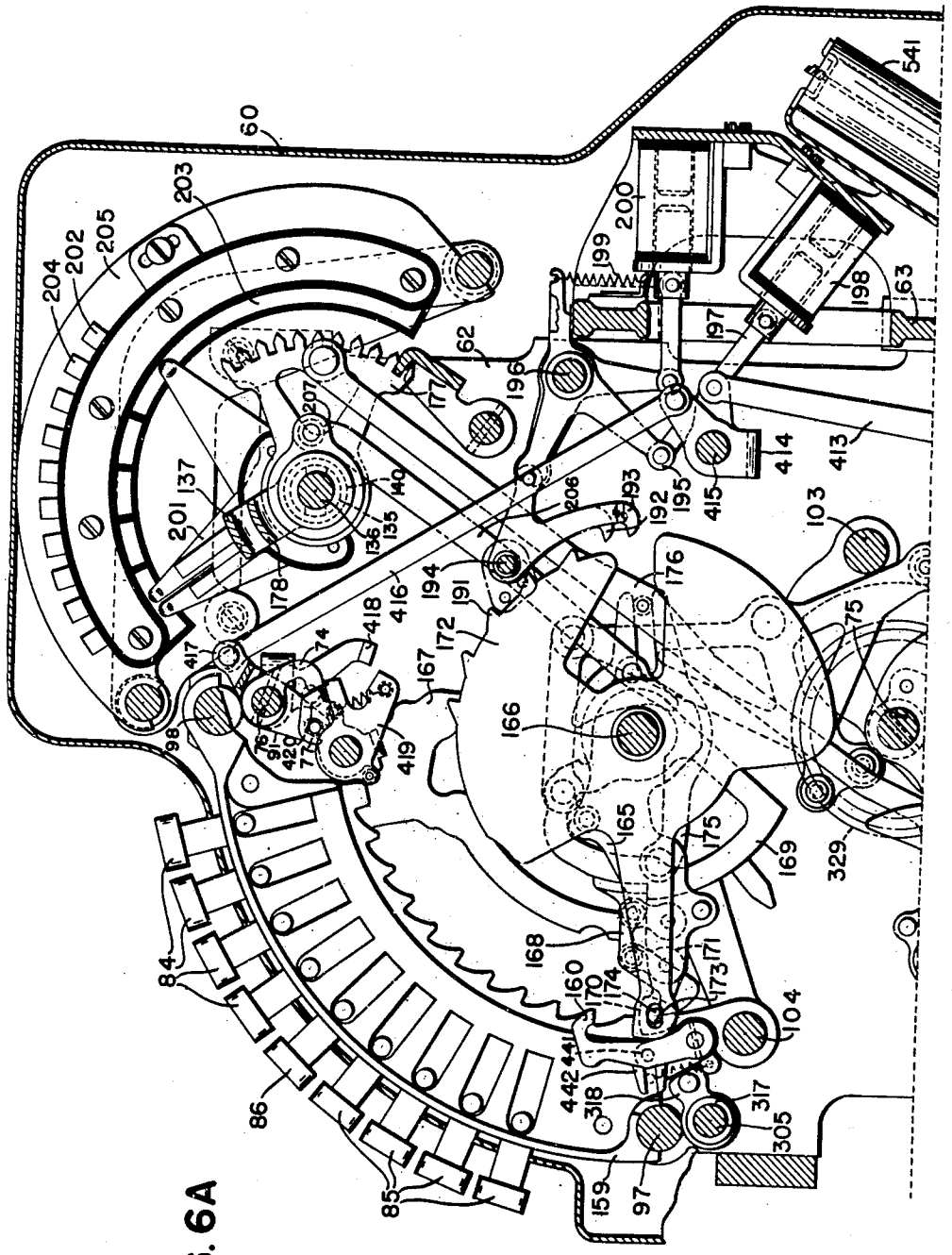

FIG. 6A

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ACCOUNTING MACHINE

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19 Sheets-Sheet 7

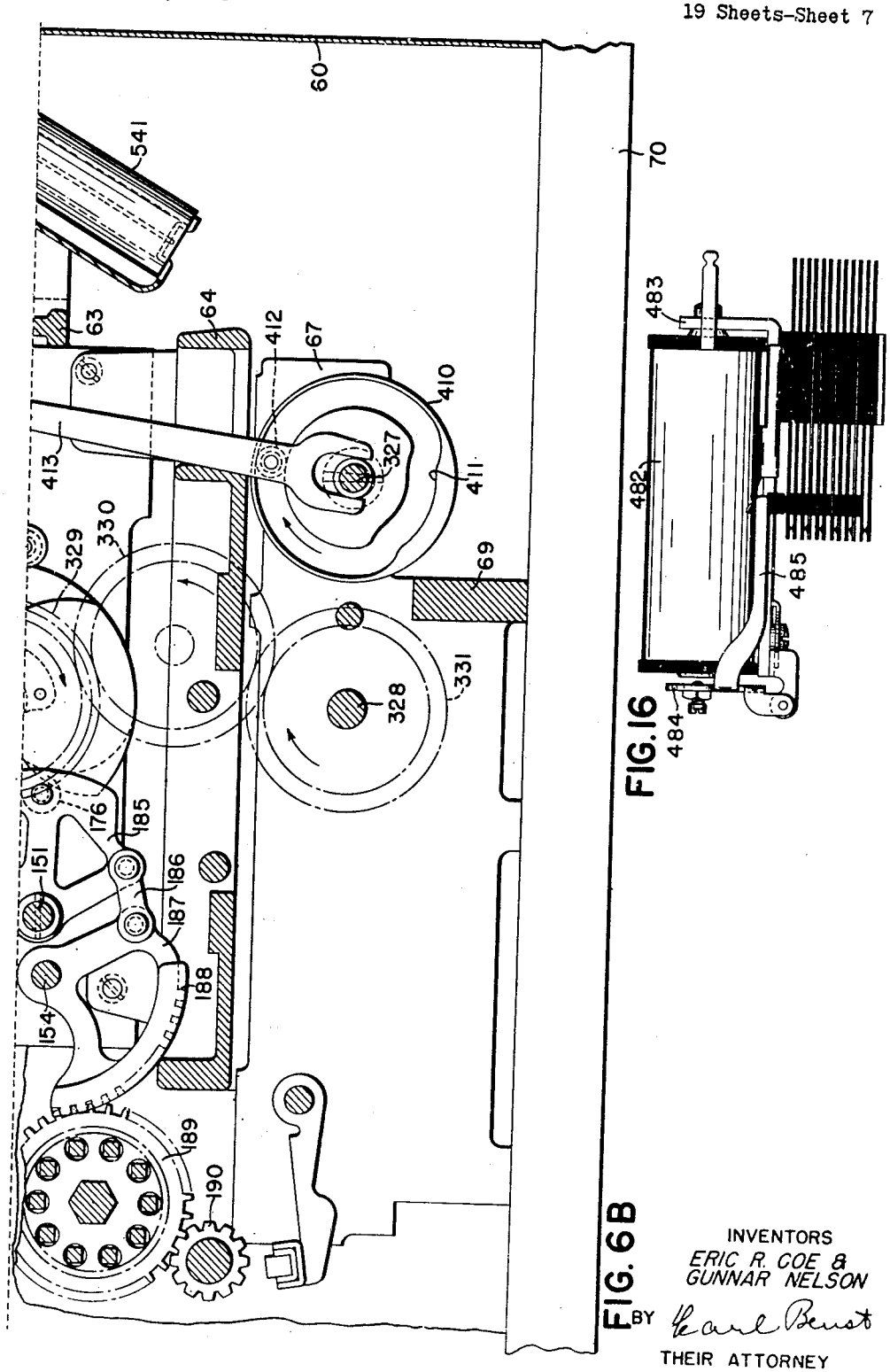

FIG. 16

FIG. 6B

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ACCOUNTING MACHINE

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FIG. 7

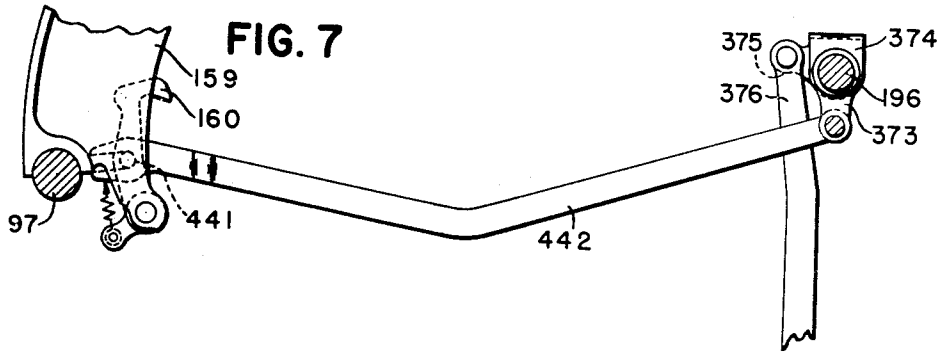
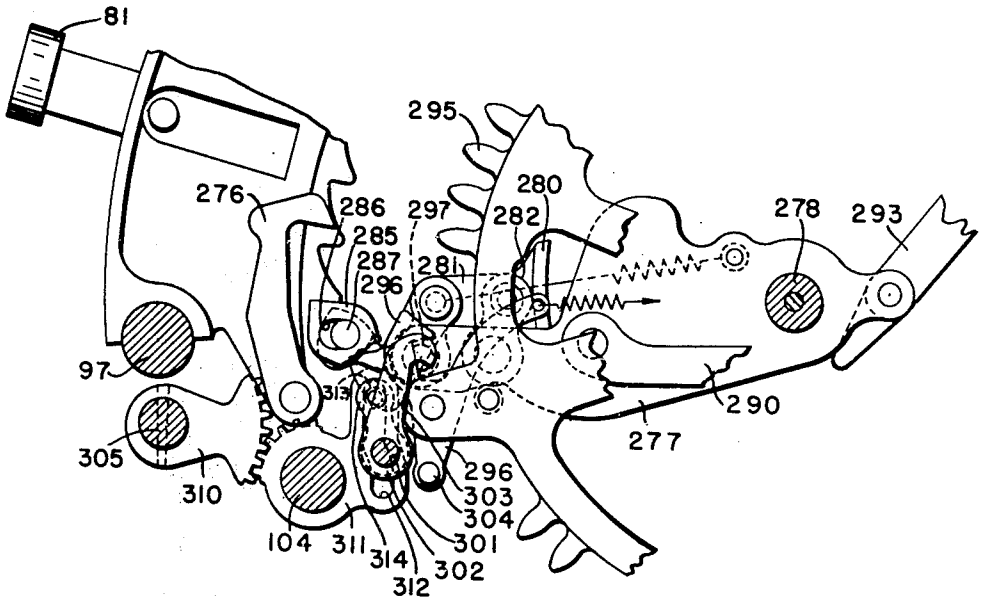


FIG. 9



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ACCOUNTING MACHINE

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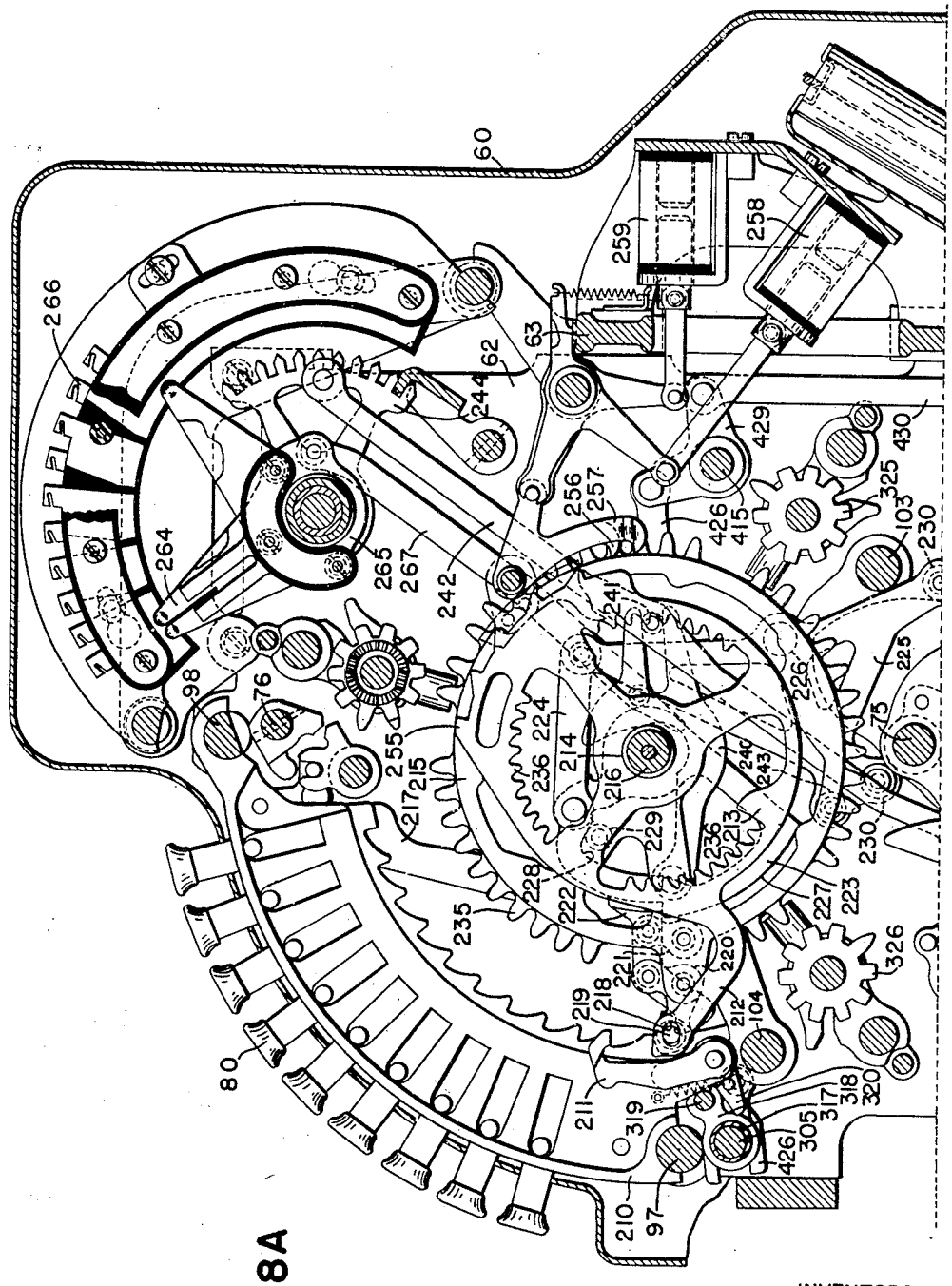

FIG. 8A

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ACCOUNTING MACHINE

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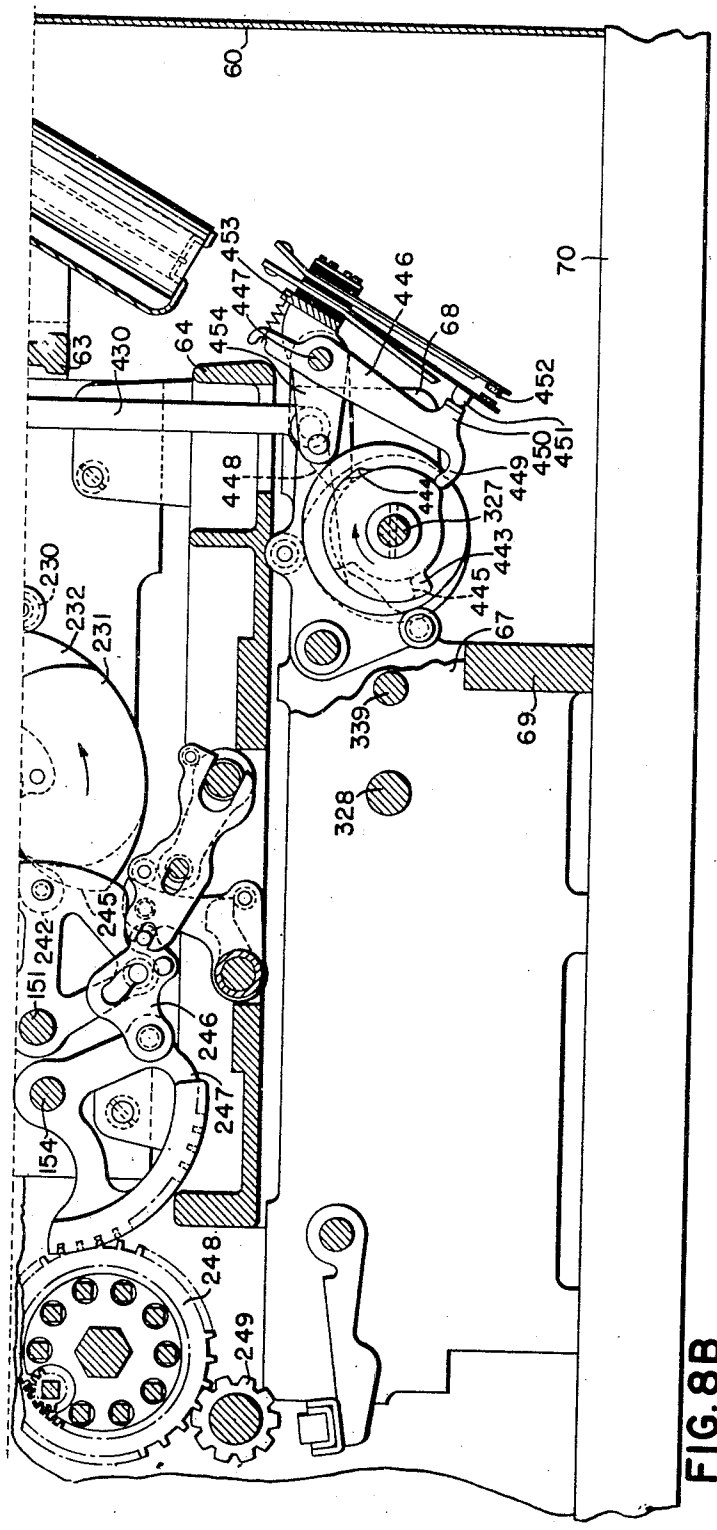

FIG. 8B

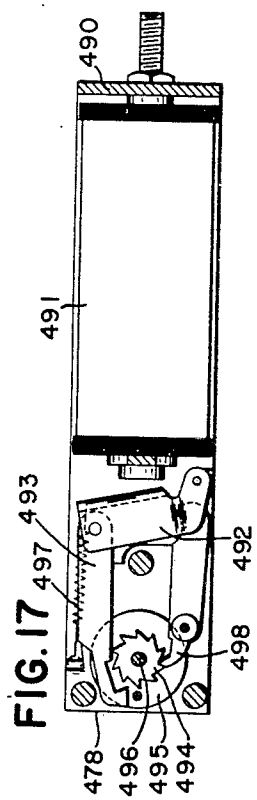

FIG. 17

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Aug. 2, 1949. E. R. COE ET AL 2,477,722

ACCOUNTING MACHINE

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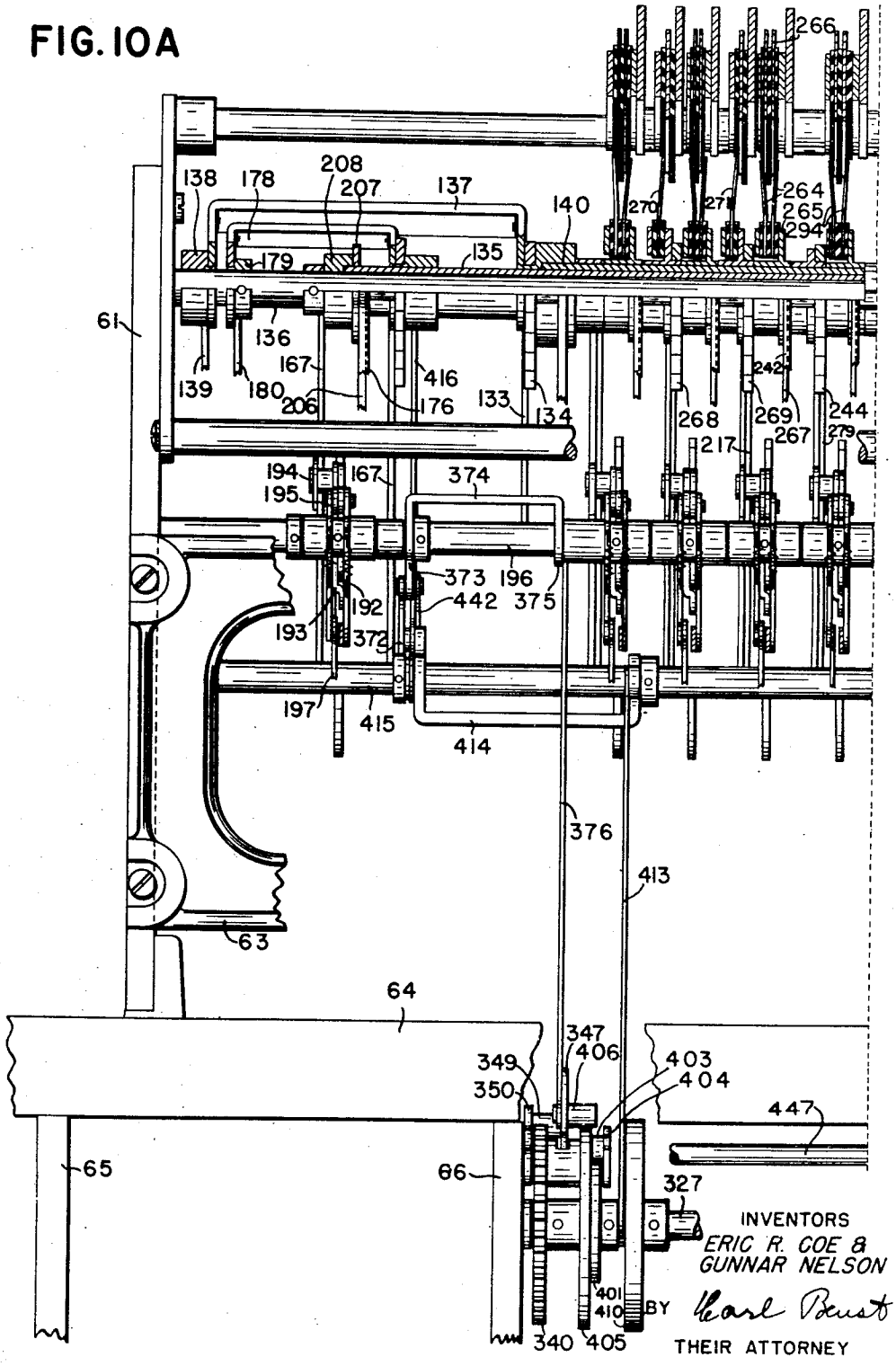
FIG. 10A



ACCOUNTING MACHINE

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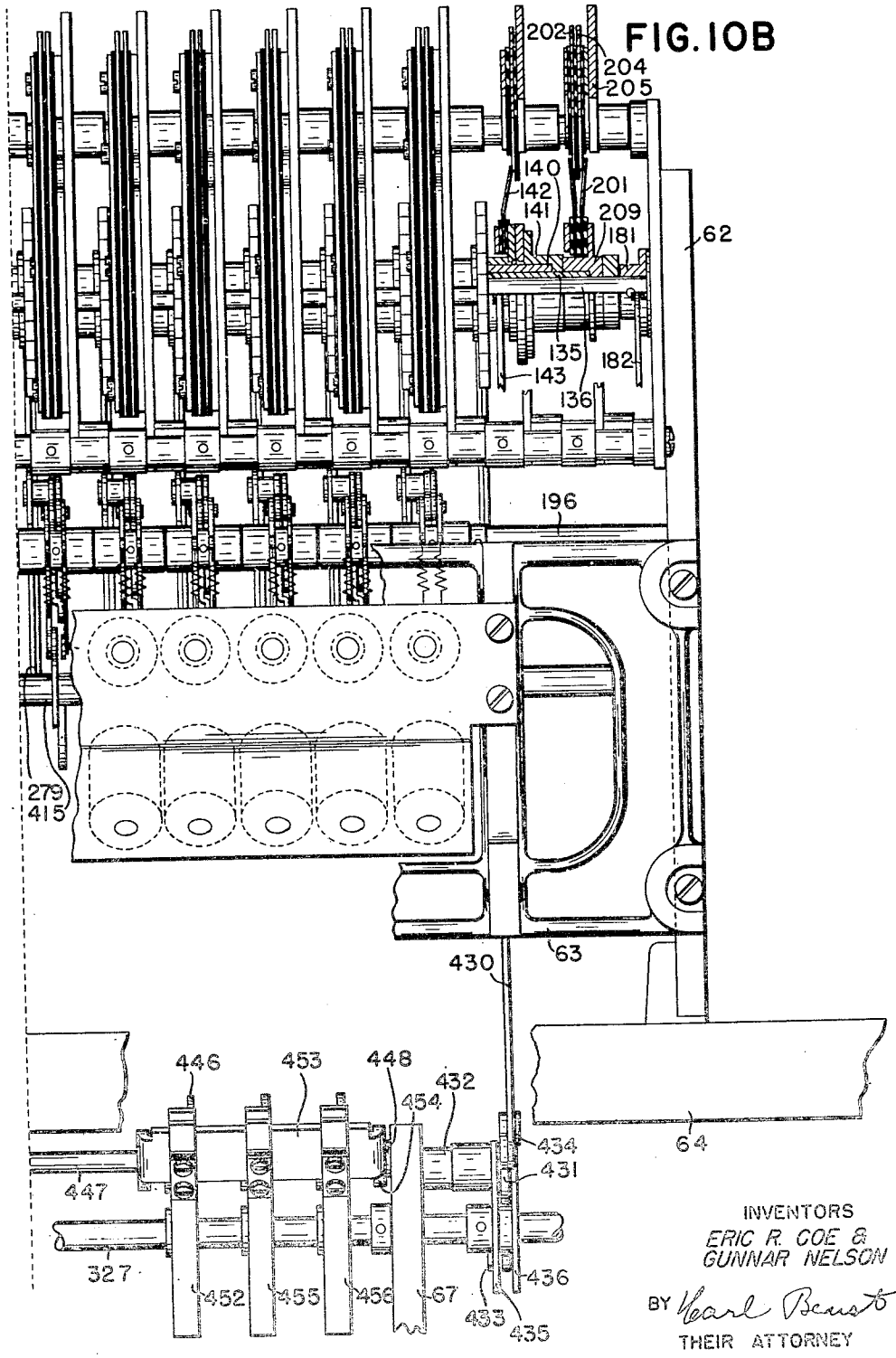
FIG. 10B



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Aug. 2, 1949. E. R. COE ET AL 2,477,722

ACCOUNTING MACHINE

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FIG. 11

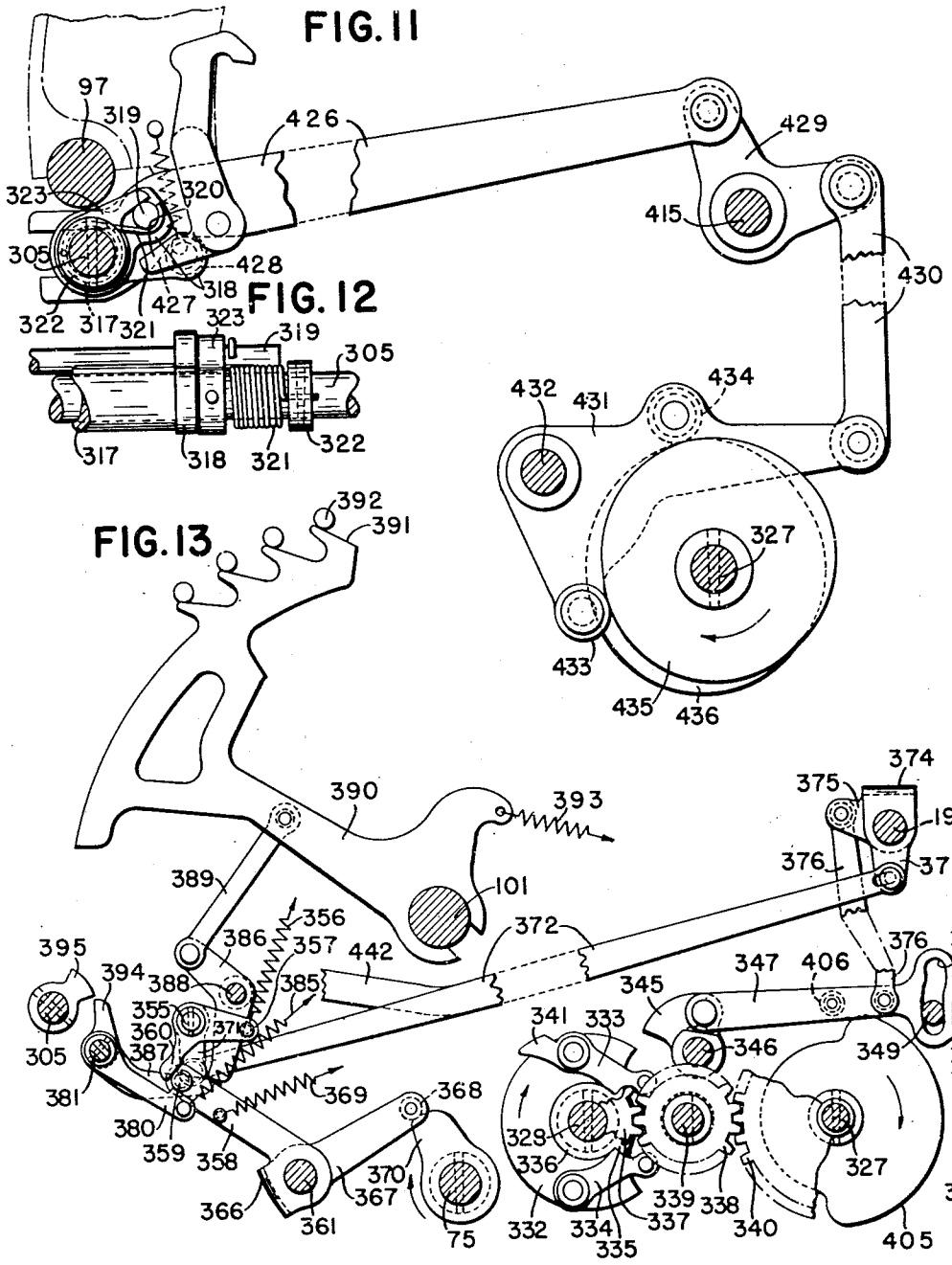

FIG. 12

FIG. 13

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ACCOUNTING MACHINE

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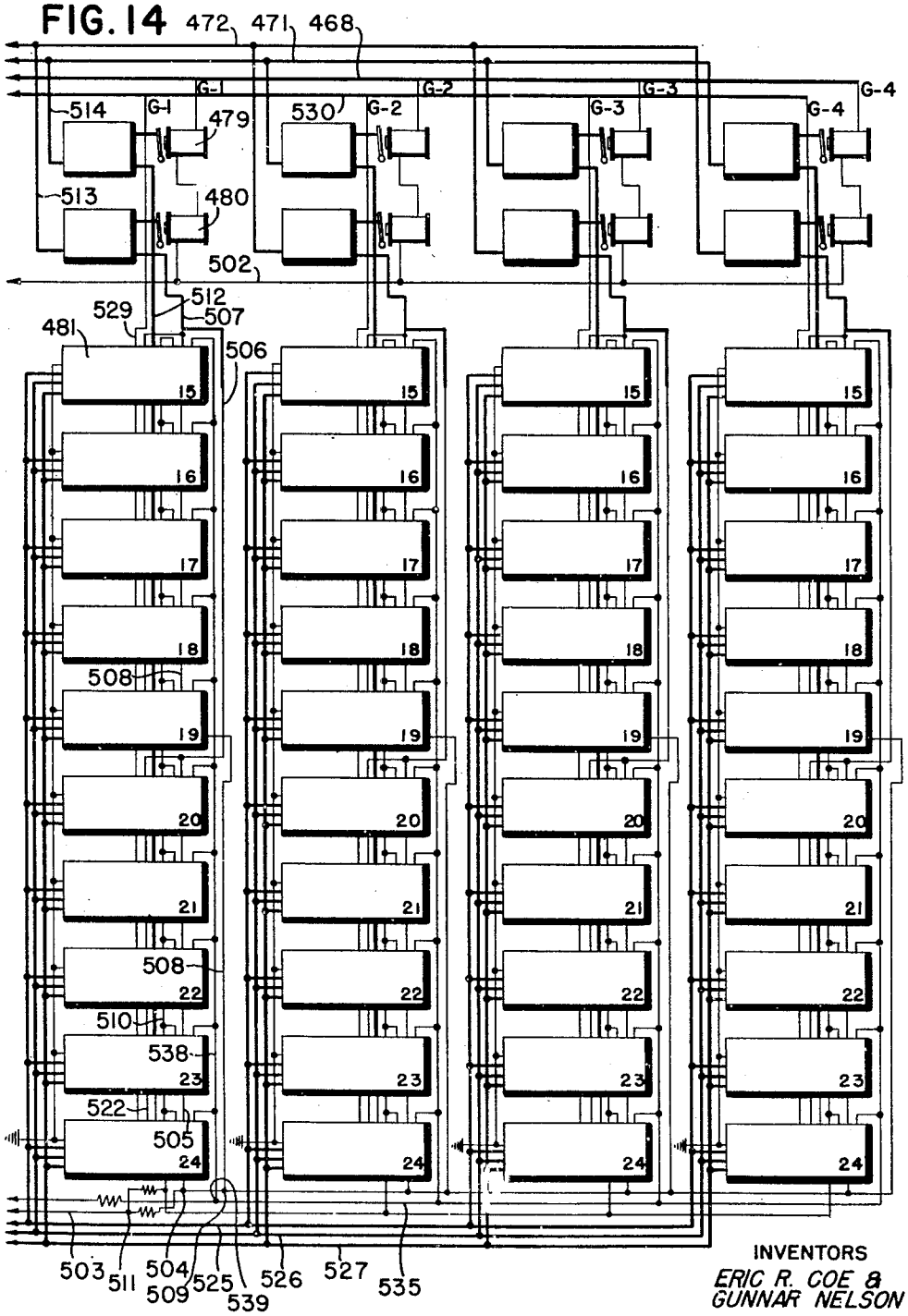
FIG. 14



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ACCOUNTING MACHINE

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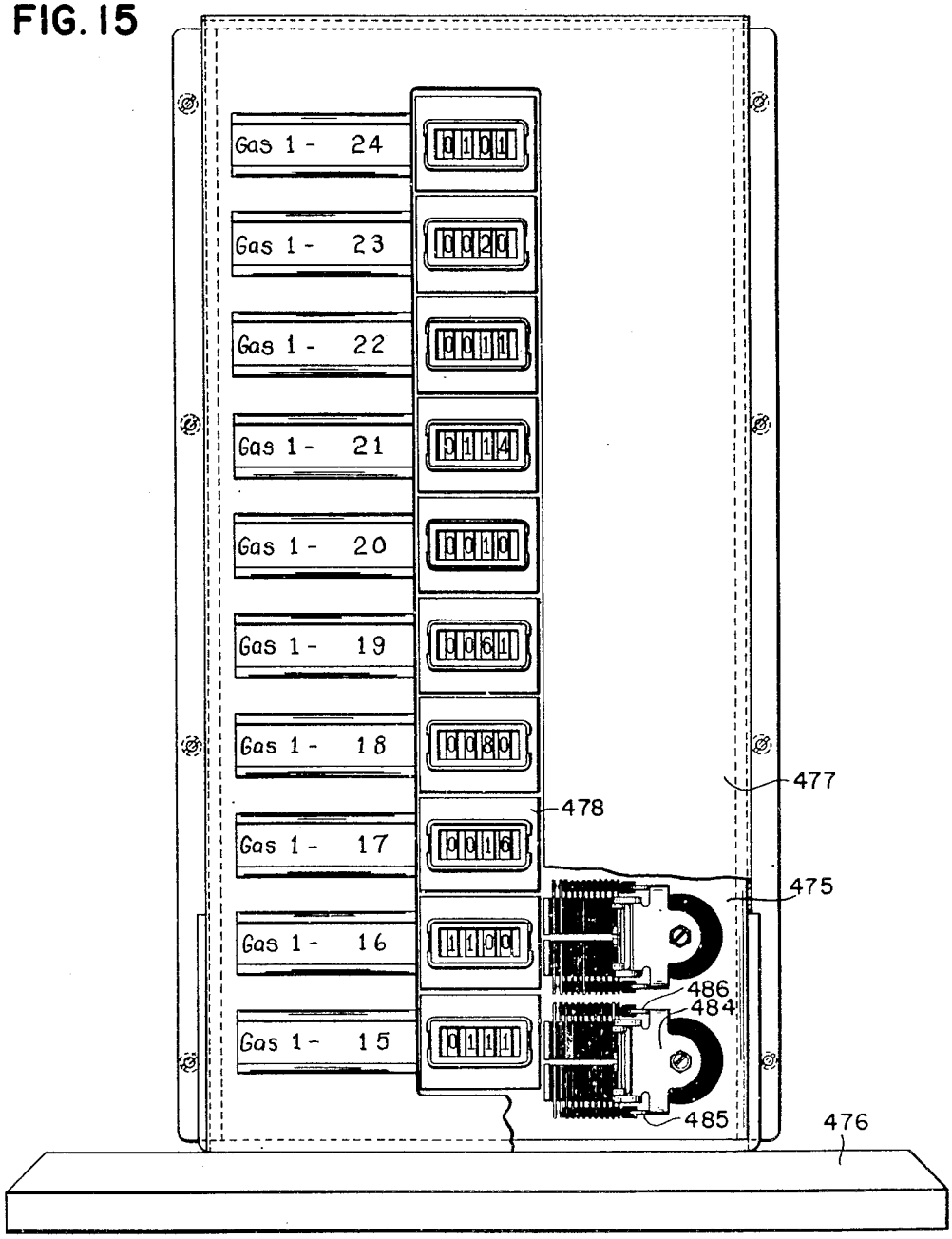
FIG. 15



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Aug. 2, 1949. E. R. COE ET AL 2,477,722

ACCOUNTING MACHINE

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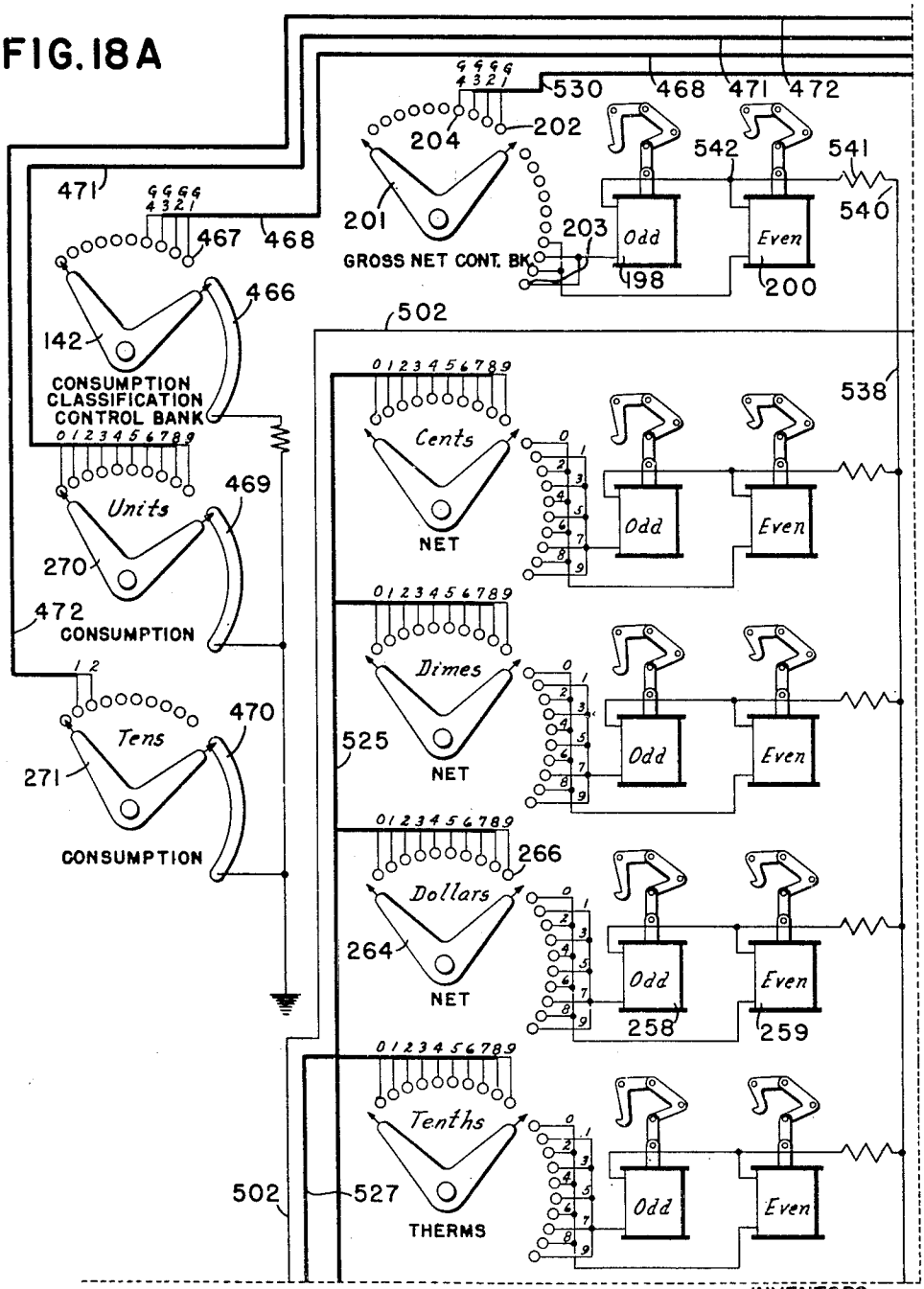
FIG. 18A



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ACCOUNTING MACHINE

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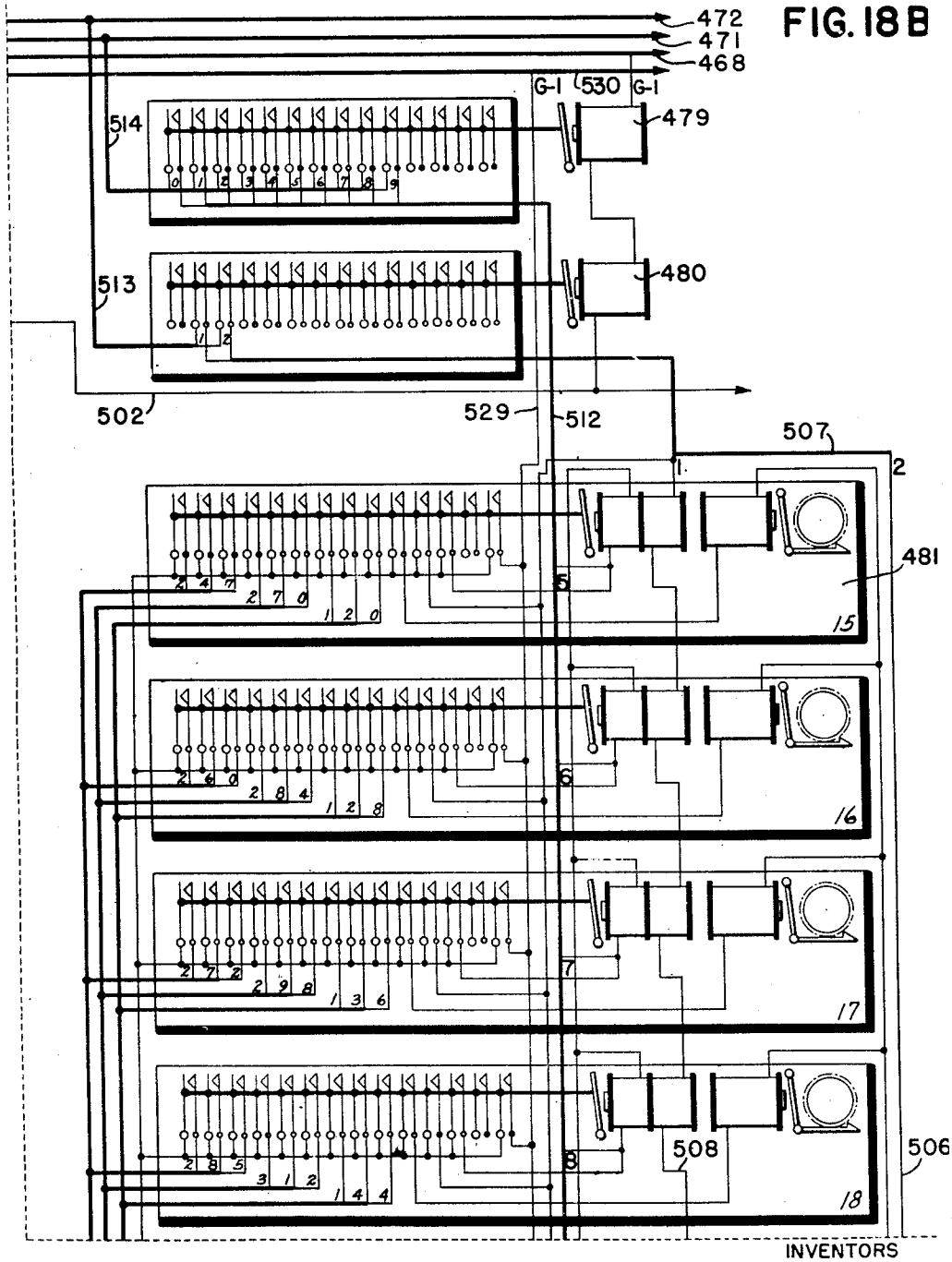
FIG. 18B



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Aug. 2, 1949. E. R. COE ET AL 2,477,722

ACCOUNTING MACHINE

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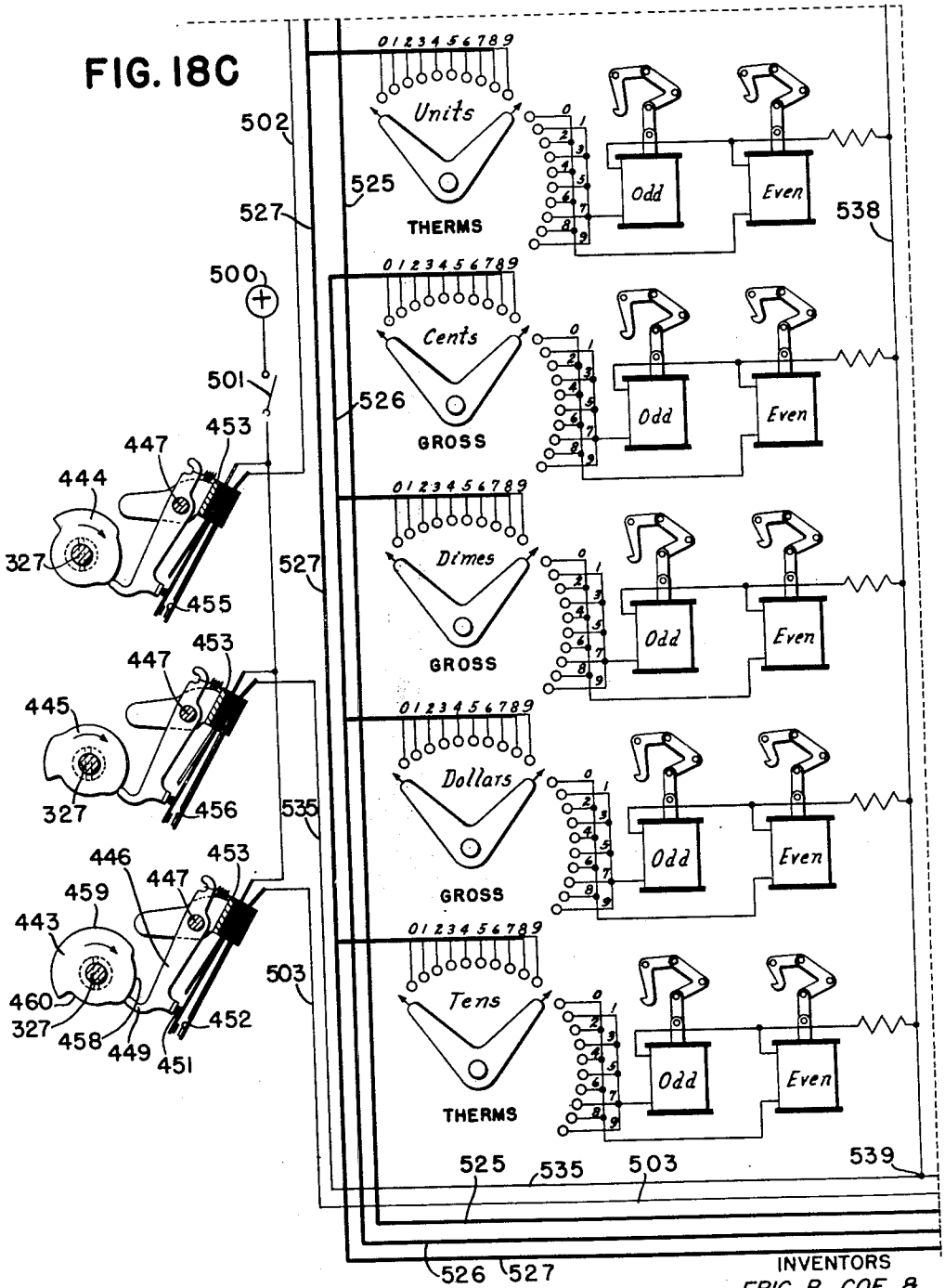
FIG. 18C



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ACCOUNTING MACHINE

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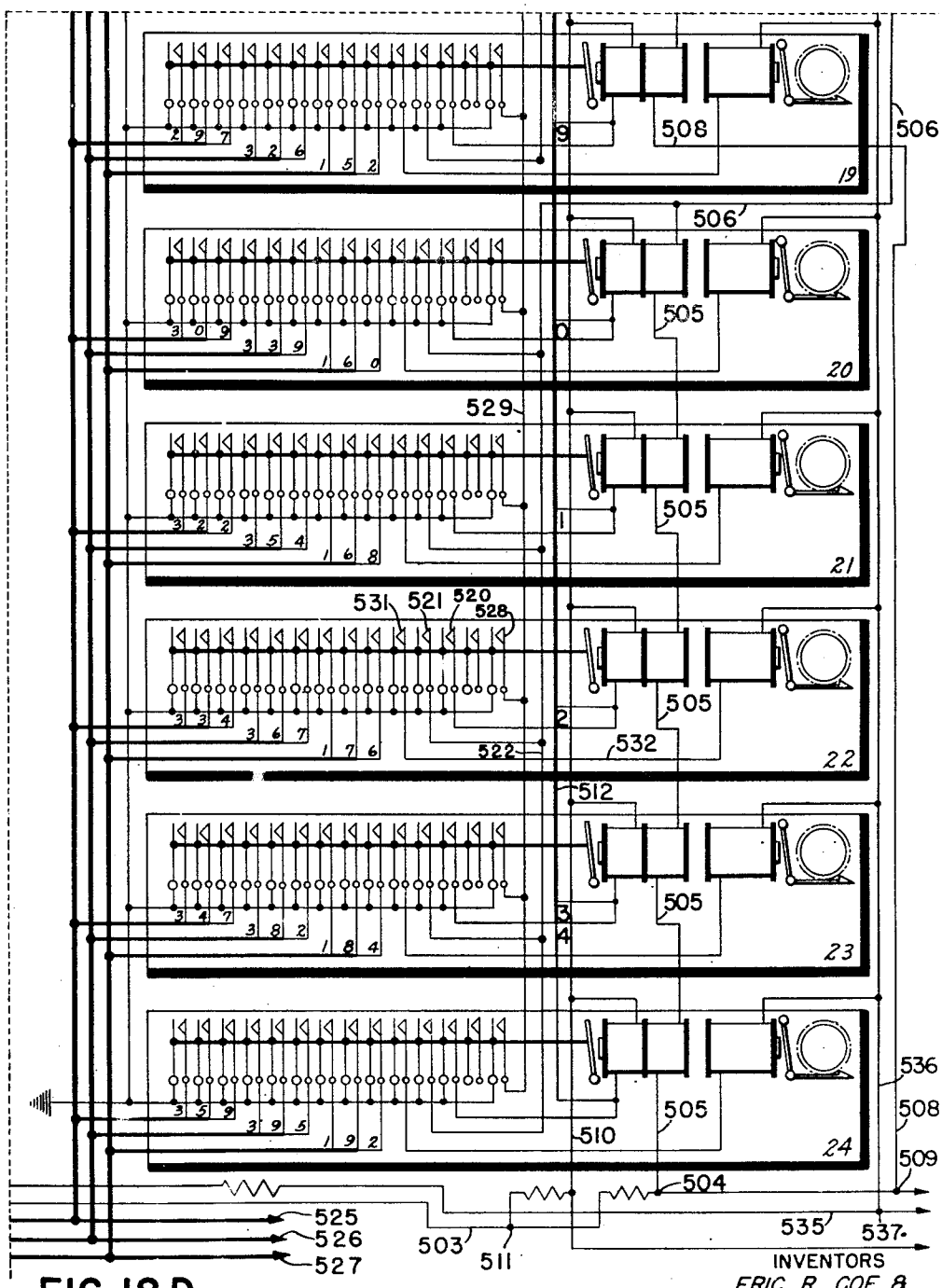

FIG. 18 D

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Patented Aug. 2, 1949

2,477,722

UNITED STATES PATENT OFFICE

2,477,722

ACCOUNTING MACHINE

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Application November 3, 1943, Serial No. 508,810

16 Claims. (Cl. 235—61)

1

This invention relates to accounting machines and is directed particularly to novel controls for a machine which is used to prepare statements for utility services.

This invention is shown applied to a utility billing machine of the class illustrated and described in United States Letters Patent No. 2,141,332, which issued on December 27, 1938, to Charles H. Arnold.

When making up utility statements such as those for gas and electric service, it is customary to include on the statement, the present and previous meter readings, the amount of consumption, and a plurality of amounts which are related to and are based on the amount of the consumption. The present invention enables the machine, when operated to record a consumption amount, to render the novel controls effective to cause another operation of the machine to take place automatically and to cause a preset amount control device corresponding to the consumption amount to be effective to control the operation of the machine during the automatic operation to make the proper entries of the related amounts, such as the gross and net amounts to be charged for the particular amount of gas or electricity consumed, and, in the case of gas, the quantity of heat in the gas consumed.

Several advantages are derived from the automatic operation of the machine under control of the novel control means; for example, the time required to set up the related data on the keys is eliminated, and the possibility of error arising from the incorrect selection or setting up of the related amounts and controls is avoided.

It is an object of the invention, therefore, to provide novel controlling means whereby certain data related to other data may be entered into the machine automatically as a consequence of entering said other data.

A further object of the invention is to provide novel controls which are effective in an operation in which a consumption amount is entered into the machine, to cause another operation of the machine to occur automatically and to cause the entry of a plurality of amounts related to the consumption amount, which related plurality of amounts are automatically selected according to the consumption amount.

Another object of the invention is to provide a plurality of groups of relays, the different groups corresponding to different kinds of service and the different relays within the groups corresponding to particular consumption amounts, each of said relays, when selected according to the consumption amount and service, being effective to prepare circuits for controlling the entry of amounts and for providing other controls related to that particular consumption amount and service.

2

With these and incidental objects in view, the invention includes certain novel features of construction and combinations of parts, the essential elements of which are set forth in appended claims and a preferred form or embodiment of which is hereinafter described with reference to the drawings which accompany and form a part of this specification.

In the drawings:

Figs. 1A and 1B taken together form a diagrammatic showing of the keyboard, a fragment of a statement and audit strip, and the related preset amount control devices, and also show the manner in which various controls are effective in a typical operation.

Fig. 2 is a facsimile of a statement printed by the machine utilizing the novel controls.

Fig. 3 is a facsimile of a portion of an audit strip printed by the machine utilizing the novel controls.

Figs. 4A and 4B, combined, provide a side elevation of the bank of consumption classification control keys and their related differential mechanism, certain parts being omitted to show more clearly the selector switch operated by the differential mechanism and to show the control means for causing the automatic operation of the machine to enter the related amounts.

Fig. 5 is a detail of a locating means for the automatic operation control shaft.

Figs. 6A and 6B, combined, provide a side elevation of the bank of gross-net and meter reading control keys and their related differential mechanism, certain parts being omitted to show the translator switch operated by the differential mechanism.

Fig. 7 is a detail of means for moving the zero stop pawl for the gross-net and meter reading differential mechanism during an automatic operation of the machine.

Figs. 8A and 8B, combined, provide a side elevation of the hundreds denominational order bank of "Previous" amount keys and their associated differential mechanism.

Fig. 9 is a detail of a portion of a combinational type of differential mechanism and shows the manner in which it can be controlled to produce the various results in amount entering and amount withdrawing operations.

Figs. 10A and 10B, combined, provide a rear elevation of the machine with certain parts

omitted and others broken away to show the novel controls more clearly.

Fig. 11 is a detail of the mechanism which is operative during an automatic operation of the machine to release the zero stop pawls associated with the amount differential mechanisms.

Fig. 12 is a further detail of a portion of the mechanism for releasing the zero stop pawls.

Fig. 13 is a detail of the mechanism controlled by certain of the consumption classification control keys for causing an automatic operation of the machine to enable the preset related amounts to be entered therein.

Fig. 14 is a wiring diagram showing the relation between the different classification groups of preset amount relay-and-counter units and between the units of a group.

Fig. 15 shows relay and counter units related to one of the classifications.

Fig. 16 is a detail of one of the relays used in the device to provide preset amounts and controls.

Fig. 17 shows one of the counters which are used to count the number of times a particular relay is operated.

Figs. 18A, 18B, 18C, and 18D together form a wiring diagram illustrating the circuits by which the relays are selected and the circuits by which the relays can control the entry of preset amounts and other controls in the machine, showing in particular the circuits associated with the relays of one of the classification groups.

General description

The invention is shown applied to an accounting machine having a plurality of totalizers which may be selected to receive entries of various amounts and also having a column printing mechanism for selectively printing on various zones of a statement and on an audit strip in different operations of the machine.

Throughout this description, the expression "cycle of operation of the machine" refers to that operation which occurs during a single rotation of the main operating shaft.

When the machine is operated according to the invention, the present and previous meter readings are set up in the appropriate sections of the amount keyboard, as shown in Figs. 1A and 1B, and the meter reading key is depressed to initiate the first cycle of operation of the machine.

The meter reading key controls means which select printing hammers for operation to print the amounts of the meter readings in the proper zones on the statement **50** (Figs. 1A, 1B, 2 and 3) and also on the audit strip **51**.

Next, the amount of the consumption, which has been computed from the meter readings, is set up on the amount keyboard, as indicated in Fig. 1A, and if the consumption is within the range for which the preset amount relays have been provided, that key of the upper four keys in the consumption classification control bank (Fig. 1B) which corresponds to the type of service involved on the statement is depressed to initiate the second cycle of operation of the machine.

During this operation of the machine, the control key controls means which select printing hammers for operation to print the amount of the consumption is proper zones of the statement **50** and on the audit strip **51** and also controls means to select a totalizer corresponding to this classification so that the consumption amount may be entered therein by means under control of the amount keys.

In machines of the prior art, it was next necessary to select from a precomputed chart the amounts of gross and net charges corresponding to the particular consumption and classification and set these amounts up on the amount keyboard in one or more operations of the machine so that they might be entered into the proper totalizers and be printed on the statement and audit strip. These operations of selecting data related to consumption amounts and setting this data in the machine were time-consuming and often were the source of errors.

Applicants eliminate these time-consuming operations and possible sources of error by their novel controls, which automatically select the related amounts and cause these amounts to be entered into the machine without any intervention of the operator of the machine.

In order to obtain these novel controls, applicants provide a group of relays for each possible consumption classification, each group of relays containing relays corresponding to various ones of the most frequently occurring consumption amounts, and, when any selected one of these relays is operated, it will close contacts to prepare circuits which will be rendered effective in a third or automatic cycle of operation of the machine to control the machine to enter certain of these related amounts into proper totalizers and to control the recording of the related amounts in proper zones on the statement and audit strip.

The consumption classification control key which is operated to initiate the second cycle of operation of the machine is also operative to render a control means effective to cause the machine automatically to perform the third or automatic cycle of operation in which these amounts are entered.

During the second cycle of operation of the machine, a selector switch is set according to the classification of the consumption amount and is effective to select the group of relays corresponding to that classification, and, at the same time, selector switches are set according to the consumption amount to pick out, from the selected group of relays, that relay which corresponds to the consumption amount. The selected relay will be energized after the differential mechanisms have been positioned in the second cycle of operation and will be effective to prepare circuits which control the entries in the machine during the third or automatic cycle of operation of the machine, as indicated in Figs. 1A and 1B. In this manner, the amounts related to the particular consumption amount are selected automatically without any intervention on the part of the operator of the machine.

Near the end of the second cycle of operation of the machine, the keys which were set to control the entry of the consumption amount are released in the manner which is customary in this type of machine, so that the circuits which have been prepared can be effective to control the machine in the third or automatic cycle to cause the proper entries of the related amounts into totalizers and the recording of these amounts in proper zones on the statement **50** and the audit strip **51**.

Accordingly, it is seen that, upon the entry of the consumption amount, the novel controls will be effective, without any further action on the part of the operator of the machine, to cause the selection of the gross and net charges for this consumption and the selection of other amounts and controls related to this consumption, and will be effective to cause the machine to be con-

trolled according to the selected amounts and controls in the operation of the machine which automatically follows the operation in which the consumption amount was entered. With these novel controls, therefore, it is seen that the possibility of error arising during the selection of the related amounts and the setting of these amounts is eliminated, as is the loss of time which would be required actually to set up these related amounts and controls on the various keys of the keyboard.

The novel controls in the disclosed embodiment are shown in connection with the selection of amounts related to ten selected consumption amounts in four classifications of gas service. It is not intended, however, that the invention be limited to the use of the controls only in connection with gas service, or to the specific number of classification groups of relays, or to the specific number of relays in the groups, as the invention may be practiced in connection with other types of service, using smaller or larger numbers of classification groups of relays and larger or smaller numbers of relays in the groups as the particular circumstances require. Further, the invention is not limited to the use of the same range of consumption amounts in all classifications, but rather, the range for each classification may be chosen to include the consumption amounts which occur most frequently in that particular classification. The particular groups of relays for gas service in the four classifications have been used because it is believed that an understanding of the invention may be had from an explanation of the selection from these groups and that the expansion of the novel controls to include other types of service, classifications, or consumption ranges will be obvious from an understanding of the manner in which the relays of these groups are selected and are rendered effective to exert their controls.

The means by which the novel controls are obtained and the manner in which these means operate will now be described.

Detailed description

The novel control means are shown applied to a machine of the type illustrated and described in the United States Patent No. 2,141,332, which issued on December 27, 1938, to Charles H. Arnold, and contains features which are well known and are shown clearly in the United States Patents Nos. 1,242,170 and 1,394,256 which issued respectively on October 9, 1917, and October 18, 1921, to F. L. Fuller; Nos. 1,761,542 and 1,977,094 which issued respectively on June 3, 1930, and October 16, 1934, to B. M. Shipley; No. 2,229,791 which issued on January 28, 1941, to P. Sburlino et al.; and No. 2,262,258 which issued on November 11, 1941, to B. M. Shipley et al.

Those mechanisms of the instant machine which are of conventional construction, having been used in prior machines, and which are necessary for an understanding of the invention, will be but briefly described herein. Reference may be had to the patents referred to above for a more detailed description of these mechanisms.

The various mechanisms of the machine are enclosed in a suitable cabinet **60** (Figs. 4A, 4B, 6A, 6B, 8A, 8B, 10A, and 10B) and are supported by means of a framework which includes main side frames **61** and **62**, which are connected by a rear cross bar **63** and other rods and cross bars, and are fastened to a machine base **64** carried by printer supporting frames such as **65**, **66**, **67**, and **68**, which are maintained in proper spaced relation by cross bars such as **69** and are carried by a machine supporting means **70**.

The machine is preferably operated by an electrically operated driving means of the type which is usually provided in this type of machine. This electrically operated driving means consists of a motor which may be rendered operable and which may be connected by a clutch to the main drive shaft **75** of the machine.

As is usual in this type of machine, the machine drive is controlled from a shaft **76** (Figs. 4A, 6A, and 8A), which is normally spring-urged in a clockwise direction but is blocked from such movement by a blocking pawl **77** engaging an arm **74** thereon. The blocking pawl **77** may be moved from blocking position relative to the arm **74** by certain of the control keys and by an automatic control means to be described more fully later, and the blocking pawl **77**, when so moved, will release the shaft **76** for clockwise movement to cause the motor circuit to be closed and the clutch to be effective to connect the motor to the main drive shaft **75**. Near the end of the operation of the machine, the shaft **76** is restored counter-clockwise, at which time it is effective to release any depressed keys and will allow the blocking pawl **77** to return to blocking position in front of the arm **74**. The details of the means by which the shaft **76** closes the switch and causes the clutch to be operable, and the means for imparting counter-clockwise movement to the shaft **76**, are not necessary for an understanding of the invention and are not shown herein but are shown and described in the Shipley Patent No. 1,761,542, referred to above.

If desired, the machine may be operated manually by a crank in the manner also shown and described in the Shipley Patent No. 1,761,542.

Keyboard

As shown diagrammatically in Figs. 1A and 1B, the keyboard contains ten banks of amount keys; however, the keyboard having this capacity is used merely to illustrate the invention, and it is not intended that the invention be limited to a machine having but ten banks of amount keys, as it may be applied readily to machines having larger capacity keyboards. In the instant embodiment of the invention, the keyboard is divided into two five-bank groups, each group containing three banks of amount keys **80** for controlling conventional differential mechanisms to enter amounts into and withdraw amounts from totalizers and to set type wheels according to these amounts, and also containing two banks of keys **81** for controlling combinational type of amount differential mechanisms which are capable of operating to withdraw amounts from totalizers in certain operations and to set type wheels according to these amounts and are capable of operating in other operations merely to set the type wheels without causing any entry into the totalizers.

In addition to the banks of amount keys, the keyboard is provided with three banks of control keys; namely, a consumption classification control bank, another control bank used in connection with the entries of meter readings and the entries of gross and net amounts related to the consumption amounts, and a total operation control bank which controls the machine in total-recording operations.

The consumption classification bank of control keys controls operations in which consumption

amounts are set up on the amount keys and are entered to their respective totalizers and are printed. This bank contains four keys 82, which are related to the different classifications of service, as "residential," "commercial," "industrial," and "heating" and are used to control an amount-entering operation of the machine when the consumption amount is related to one of these classifications and is within the range for which preset amount relays are provided. These keys are also used in connection with the total control keys to enable totals of these consumption amounts in different classifications to be recorded. This bank contains another set of four keys 83, which are related to the different classifications but do not cause an automatic operation, and are used to control amount-entering operations when the consumption amount is above or below the range for which preset-amount relays are provided. The keys 83 are also used in conjunction with total control keys to control operations for recording totals of these consumption amounts.

The other control bank contains a set of gross-net keys 84, which correspond to the keys 82 and which are used in conjunction with the total control keys to cause the totals of the gross and net amounts related to the various classifications to be recorded; a set of gross-net keys 85, which correspond to the keys 83 and which are used to control non-automatic operations in which gross and net amounts are manually set up on the keys and are entered, and are also used in connection with the total keys to control the recording of the totals of these gross and net amounts in different classifications; and a meter reading key 86, which is operated to control the machine in an operation in which the meter readings are entered therein.

The bank of total operation control keys contains a key 87, which is operated in conjunction with either the keys 82 or 83 to cause totals of the consumption amounts, which have been accumulated on the various totalizers of the rear or third totalizer line according to these various classifications, to be recorded. A key 88 in this bank is operated in conjunction with the keys 84 and 85 in said other control bank to cause the totals of gross and net amounts which have been accumulated on the various totalizers of the front, or second, totalizer line corresponding to these keys, to be recorded. Keys 89 and 90, respectively, in the total control bank, when operated alone, are effective to cause the totals of all gross and net amounts and the total of all consumption amounts to be recorded.

The control keys 82, 83, 84, 85, 86, 89, and 90 are also effective, as is well known in this type of machine, to withdraw the blocking pawl 77 from blocking engagement with arm 74 to release the shaft 76 and initiate an operation of the machine.

Total control means

The total control keys control the differential positioning of a well-known type of total control plate which is effective to condition certain elements of the machine to cause a total recording operation to take place and which is effective to select from which row of totalizers the total will be recorded. Keys 89 and 90 in this bank are operable to rock a yoke 91 (Fig. 6A), which is connected to the blocking pawl 77, and remove this pawl to initiate a machine operation. The means for positioning the total control plate and the means controlled by these means and by the plate are well known and are not disclosed herein. Reference may be had to the United States Patent No. 2,262,258, which issued to Shipley et al., for the details of these means, if desired. The total plate also sets control disks in the printing means in a manner similar to that shown in the patent to Arnold, No. 2,141,332, cited above, to control the selective operation of various mechanisms in the printing mechanism.

Control differential mechanisms

The differential mechanisms used in the consumption classification bank and the gross-net and meter-reading bank in the instant machine are similar to the transaction differential mechanisms usually provided in this type of machine, as shown by the patents referred to earlier herein, but have been modified slightly in order that certain of the novel controls may be used.

The differential mechanism controlled by the consumption classification control keys 82 and 83 is shown in Figs. 4A and 4B.

The keys 82 and 83 are mounted in the usual key frame 96, which is removably mounted on rods 97 and 98 extending between the main side frames 61 and 62. As is well known and shown in the patents cited above, the key frame 96 carries a zero stop pawl 99 pivotally mounted thereon and also carries the usual control slides and a retaining means. Any key, when depressed, will cooperate with the control slides to remove the zero stop pawl 99 from effective position and also remove the blocking pawl 77 (Fig. 6A) from blocking engagement with arm 74 to release the shaft 76 and initiate an operation of the machine. The depressed key will be retained in depressed position by the retaining means until near the end of the operation and, while in depressed position, will be operable to control the extent of movement of the differential mechanism.

The differential mechanism includes a differentially positionable latch-supporting arm 100, which is pivotally mounted on a hub 101 carried by a pair of hanger plates 102, only one of which is shown in Fig. 4A, which plates are in turn supported by a pair of rods 103 and 104 extending between the side frames 61 and 62.

A link 105 and a bell crank 106 are pivoted on the arm 100 and support a latch 107 for movement relative to the arm 100. The latch is normally spring-urged toward the hub 101 and engages a shoulder 108 on a driving segment 109, which also may pivot about the hub 101. The driving segment 109 is given first a clockwise movement and then a counter-clockwise movement during each cycle of operation of the machine by means of a cam lever 110, which is connected to the driving segment by a link 111. The cam lever 110 is pivoted on a stud 112 on the hanger plate 102 and is operated through a pair of rollers 113 and 114, which engage companion plate cams 115 and 116 secured to the main shaft 75. The arm 100 is accordingly connected to the driving segment 109 by the latch 107 and will be driven clockwise thereby until the latch is withdrawn from the shoulder 108.

An auxiliary arm 122, also pivoted on the hub 101, is connected for movement with the arm 100 by means of a slot 123 engaging a pin 124 on the bell crank 106.

When the differential mechanism is operated with a key depressed in the bank, the zero stop pawl 99 will be in ineffective position and the arm 100 and the latch 107 will move with the driving segment until an arm 125 of the bell crank 106 engages the depressed key. Continued movement

of the arm 100 and the latch 107 will cause the bell crank 106 to pivot and withdraw the latch from the shoulder 108 to disconnect the arm 100 from the driving segment 109 at a position corresponding to the key depressed. As the latch 107 is withdrawn from the shoulder 108, an extension 117 on the latch will engage a notch 118 in an arcuate plate secured to the key frame 96, and, at the same time, the arcuate portion 119 of the driving segment 109 will pass under the latch to maintain the extension 117 in engagement with the notch 118 to lock the arm 100 in its set position until the return or counter-clockwise movement of the driving segment 109. During this counter-clockwise movement of the driving segment, just as the shoulder 108 has passed the latch 107, and the latch can move out of the notch 118 and reengage the shoulder on the driving segment, a surface 120 of the driving segment 109 will engage a stud 121 on the arm 100, so that continued counter-clockwise movement of the driving segment 109 will cause the arm 100 and the latch 107 to be moved counter-clockwise therewith to their home position.

If no key in the bank is depressed, the zero stop pawl 99 will engage the arm 122 and arrest it and, through the pin-and-slot connection with the bell crank 106, will cause the latch 107 to be disengaged from the driving segment 109 to position the arm 100 in zero position.

The usual beam 130, which has one of its ends pivotally connected to the arm 100 and which is engaged by a roller 131 on the cam lever 110 near the end of the clockwise movement thereof, is bifurcated at its other end to engage a stud 132 on a link 133 and is operable through this connection to transmit the differential positioning of the arm 100 to the link 133. Link 133 is pivotally connected at its upper end to an aliner segment 134 mounted on a sleeve 135 on a shaft 136 extending between the side frames 61 and 62.

A yoke 137 (Figs. 4A and 10A) connects the aliner segment 134 to an arm 138 loose on shaft 136 and transmits the movement of the aliner segment 134 to the arm, so that a link 139 connected to the arm 138 can operate to set the usual notched control disk which controls the selective engagement of the totalizer lines. The movement of the aliner segment 134 is also transmitted through the sleeve 140 (Figs. 10A and 10B) to a member 141 loose on the sleeve 135, which member 141 is effective to set a selector switch wiper contact arm 142 and operate a link 143, which drives the usual totalizer shifting cam for shifting the totalizers on the rear totalizer line relative to their actuators. The notched disk and shifting cam for controlling the selective engagement of the totalizers are well known in this type of machine.

The usual aliner 144 is moved into engagement with notches in the periphery of the aliner segment 134 at proper times, during an operation of the machine, to aline the segment 134 and the link 133 and the parts set thereby accurately in position and to retain these parts in their set position during certain parts of the operation. This operation of the aliner 144 is usual in machines of the type to which the invention is applied, as shown by the patents cited earlier herein.

The link 133 (Fig. 4B) is pivotally connected at its lower end to a segment 150 loose on shaft 151 journaled in the side frames 61 and 62. The segment 150 is connected by a link 152 to a segment 153, which is secured to shaft 154 also journaled in the side frames 61 and 62. The segment 153 contains a series of teeth 155, which cooperate with the external teeth of an external-internal ring gear 156 capable of driving shafts and gears to set up type wheels as 157 to enable printing to take place in various columns on the statement and audit strip in a manner similar to that shown in the Arnold Patent No. 2,141,332. As also shown in this patent, the shaft 154 can cause the differential positioning of control discs in the printing mechanism to control the selection of hammers, as 158, to determine in which column printing will take place and to provide other controls for the printing mechanism.

The consumption classification control differential mechanism therefore, controls the totalizer selecting and engaging means and the printing mechanism in a well-known manner and, in addition to these controls, is also effective to set a selector switch to control the selection of a group of preset amount relays in accordance with the particular classification to which the consumption amount is related. The control by the selector switch will be explained in detail later herein.

The differential mechanism controlled by the bank of control keys which contains the groups of gross-net keys 84 and 85 and the meter reading key 86 is shown in Figs. 6A and 6B and is also generally similar to the transaction differential mechanism usually employed in this type of machine, but has been modified in several respects, in order that the novel controls may be associated therewith.

The keys 84, 85, and 86 are mounted in a key frame 159 removably supported by the rods 97 and 98 and carrying the zero stop pawl 160 and the usual control slides and retaining means. Any of these keys, when depressed, will be effective, through the control slides, to remove the zero stop pawl 160 from its normal controlling position and will be effective to remove the blocking pawl 77 from blocking relation with the arm 74 on the shaft 76 to initiate an operation of the machine. The depressed key will be retained in depressed position until near the end of the cycle of operation which was initiated by the key, and, while depressed, the key will be operable to control the extent of movement of the differential mechanism.

The differential mechanism contains the usual differentially positionable latch supporting arm 165 pivotally carried by a hub 166 supported by the hanger plates, as 167, for this bank. The usual latch 168 connects the arm 165 to a driving segment 169 until an arm 170 of a bell crank 171 is arrested to cause the latch 168 to be withdrawn from the driving segment 169. An auxiliary control member 172, rotatable about the hub 166, has a slot 173 engaging a pin 174 on the arm 170 of the bell crank, so that, when the auxiliary control member 172 is arrested, as by the zero stop pawl 160, it will be effective to withdraw the latch 168 and disconnect the arm 165 from the driving segment 169.

The usual beam 175 is pivoted on the differentially positionable arm 165 and is coupled to the link 176 to transmit the differential positioning of the arm 165 to the link 176. The upper end of link 176 is pivotally connected to an aliner segment 177 (Figs. 6A, 10A, and 10B) free on the sleeve 135. The segment 177 is connected by a yoke 178 to an arm 179 pinned to the shaft 136. A link 180 connects the arm 179 to the usual totalizer engaging control disk to enable this disk to

be positioned by the differential mechanism for this bank. Also fastened to the shaft 136 at the right-hand end thereof, as viewed in Figs. 10A and 10B, is an arm 181, to which is pivotally connected a link 182, which operates the totalizer line shifting cam which is usually provided to shift the totalizers on the front line relatively to the amount actuators.

As indicated earlier herein, the operation of the engaging control disks and the totalizer line shifting cams to cause the selective engagement of the totalizers and the amount actuators is old and well known, and reference may be had to the patents listed above, and particularly to the patent to Fuller, No. 1,394,256, for details of these means and their operation, if desired.

The lower end of link 176 is pivoted to a sector 185 (Fig. 6B), which is secured to the shaft 151 and is connected by a link 186 to a sector 187 loose on shaft 154 and having teeth 188, which engage the external teeth of an external-internal ring gear 189. The ring gear 189 operates gears and shafts to cause the setting of type wheels, as 190, in a manner similar to that shown in the Arnold Patent No. 2,141,332, cited. Shaft 151, to which the sector 185 is secured, will be differentially positioned by this control differential mechanism and will be effective, through means similar to those shown in the Arnold Patent No. 2,141,332, to set control disks in the printing mechanism to select printing hammers for operation and to provide other controls for the printing mechanism.

In order that the novel control means may control the operation of this differential mechanism, the auxiliary control member 172 is provided with a plurality of projections 191 along its upper rear edge, which projections can be engaged selectively by the pawls 192 and 193 pivotally mounted on a stud 194 carried by a bracket fastened to one of the hanger plates 167. As will be clear from Fig. 6A, pawl 193 is longer than pawl 192, and, when pawl 193 is moved to engaging position, the auxiliary control member 172 will be allowed to move farther by one increment of movement than it would if pawl 192 were in position to engage the same projection 191. By this arrangement, the engagement of one or the other of the pawls 192 or 193 selectively with the different ones of the five projections 191 enables the auxiliary control member 172 to be arrested in any one of ten positions to cause the differentially positionable arm 165 to be disconnected from the driving segment 169 and set in any one of ten positions.

Pawl 193 is connected by a pin-and-slot connection to a bell crank 195 pivotally supported by a cross rod 196 extending between the side frames 61 and 62. A link 197 connects the bell crank 195 to the movable core of a control magnet 198, which magnet, when energized, will be effective, through the link 197 and the bell crank 195, to move the pawl 193 into engaging position against the action of a spring 199. As soon as the magnet 198 becomes de-energized, the spring 199 will return the pawl 193 to ineffective position.

A linkage similar to the one described above enables the pawl 192 to be moved into engaging position when a control magnet 200 is energized.

Pawl 192, engaging the first projection 191, will be effective to stop the arm 165 in the same position as will the zero stop pawl. Through its engagement with the other projections, the pawl 192 will be effective to arrest the arm in positions which may be designated 2, 4, 6, and 8, and, since the pawl 193 allows the member 172 to move one step farther than the pawl 192, it will be effective, when cooperating with the same set of projections, to stop the arm in positions which may be designated 1, 3, 5, 7, and 9. The pawl 192 and the control magnet 200, therefore, will be designated as being related to "even" values, and the pawl 193 and the control magnet 198 will be designated as being related to "odd" values.

The control magnets 198 and 200 will be selectively energized by circuits prepared by any selected preset amount relay and closed at the proper time in a cycle of operation of the machine by a translator switch mechanism.

The translator switch mechanism consists of a pair of wiper contact arms 201, which can cooperate with two arcuate sets of stationary contacts, one set of which is engageable by one of the wiper contact arms 201 to complete the circuit to the "odd" control magnet 198 to arrest the control member in the "odd" positions, and the other set of which is engageable by the other wiper contact arm 201 to complete the circuit to the "even" control magnet 200 to arrest the control member in the "even" positions.

The arcuate set of contacts, which complete the circuit to the "odd" control magnet 198, contains an individual contact as 202 in each of the "odd" positions of the differential mechanism and a contact 203, which is common to all the individual "odd" position contacts and is connected to the "odd" control magnet 198. In Fig. 18A, the contact 203 is shown diagrammatically as plurality of separate contacts connected together. Similarly, the arcuate set of contacts, which complete the circuit to the "even" control magnet 200 contains an individual contact 204 in each of the "even" positions of the differential mechanism and a common contact which is similar to contact 203 and is connected to the "even" control magnet 200. In Fig. 18A, this common contact is shown diagrammatically as a series of separate contacts electrically connected together. The two sets of stationary contacts are insulated from each other and are adjustably supported on a plate 205 carried on rods extending between brackets fastened to the side frames 61 and 62.

The wiper contact arms 201 of the translator switch mechanism are driven by the differential mechanism and move with the arm 165 in its clockwise and return movements. The drive for the wiper contact arms 201 is obtained through a link 206, which connects the differentially settable arm 165 with an arm 207 (Figs. 6A, 10A, and 10B), which is fastened to a collar 208 loose on shaft 136. The collar 208 is connected by the sleeve 135 to a collar 209 also carried by the shaft 136. The collar 209 has fastened thereto the plurality of wiper contact arms 201, which, together with the arcuate banks of contacts, make up the translator switch mechanism.

The use of two sets of individual contacts and two wiper contact arms in the translator switch mechanism enables an overlapping of the time in which the wiper contact arms engage adjacent individual contacts of the different sets and enables a longer period of contact to be established between any individual contact and its related wiper contact arm to insure that the circuit to the selected control magnet will be closed sufficiently early to cause the magnet to operate properly during the movement of the contact arm into the position corresponding to that individual contact. Note in Figs. 6A and 8A that the forward or left-hand edge of an individual contact of one set over-

laps the rear or right-hand portion of the preceding individual contact of the other set.

The operation of these controls is as follows:

Near the end of a consumption registering operation, a preset amount relay will be selected and will be operated to connect ground to the individual contact corresponding to the position in which the differential mechanism is to be arrested in the automatic operation which follows the consumption registering operation. As the differential mechanism is operated in the automatic operation, the wiper contact arms **201** will be driven over the individual contacts, as **202** and **204**, in succession until one or the other of the contact arms engages the individual contact which is grounded by the operated relay, at which time potential will have been applied to the "odd" and "even" control magnets and the circuit through the "odd" or 'even" control magnet **198** or **200** will be completed to ground, enabling the magnet to be energized to rock its related pawl **192** or **193** into the path of one of the projections **191** on the auxiliary control member **172** and prevent further movement of this member. The member **172** will be effective, through its pin-and-slot connection with the arm **170** of the bell crank **171**, to cause the latch **168** to be disengaged from the driving segment **169** and arrest the arm **165** and the control means settable thereby in the desired differential position.

In this manner, the totalizer selection and the control of the printing mechanism can be obtained in the automatic cycles in which the gross and net amounts and therms related to the particular consumption amount which has been entered into the machine, are entered into the machine and are printed in the proper columns on the statement and on the audit strip.

The details of the manner in which the circuits are prepared will be described hereinafter.

Amount differential mechanisms

As previously stated, the banks of amount keys **80** control conventional type of amount differential mechanisms, and the banks of amount keys **81** control combinational type of amount differential mechanisms.

The conventional type of amount differential mechanism which is controlled by the hundreds denominational order bank of "Previous" amount keys **80** is shown in Figs. 8A and 8B and will be considered first; however, since most of this mechanism is old and well known, only that portion of the mechanism which is necessary for an understanding of the manner in which the new control mechanism is applied will be described.

As shown in Fig. 8A, the amount keys **80** for this bank are mounted in a key frame **210** supported on the rods **97** and **98**. Pivotally supported on the lower end of the key frame **210** is the usual zero stop pawl **211** having a right-angled projection located in the path of movement of an extension **212** of an auxiliary member **213** pivoted on a hub **214** of an amount differential actuator **215**. The actuator **215** is loosely mounted on a hub **216** extending between hanger plates **217** supported by the pair of rods **103** and **104**. The auxiliary member **213** has a slot **218** in the extension **212** thereof, through which extends a stud **219** in one arm of a bell crank **220** pivoted on the actuator **215**. The bell crank **220** and a link **221**, also pivoted on the actuator, support a latch **222** for movement relative to the actuator. The latch **222** is normally spring-urged to engage a shoulder on a driving segment **223** pivoted on the hub **216** and connected by a link **224** to a lever **225** journaled on a stud **226** secured in one of the plates **217**. The lever **225** carries a pair of rollers **230**, which cooperate with the peripheries of companion cams **231** and **232** secured on the main drive shaft **75** and cause the lever **225** to be operated to drive the driving segment **223** clockwise from home or normal position and then return the segment counter-clockwise to this position. As long as the latch **222** engages the shoulder on the driving segment **223**, it will be effective to drive the actuator.

The actuator **215** is provided with three sets of teeth, as **235**, with which the totalizers may be engaged and be actuated thereby to enter amounts in amount entering operations or to withdraw amounts in total recording operations. The operation of the actuator **215** to enter or withdraw amounts into or from the totalizer is well known in the art, and reference may be had to the patents referred to above for details of these operations if desired.

If an amount key **80** in this bank has been depressed, the zero stop pawl **211** will have been moved to ineffective position and the driving segment **223** will be effective, through the latch **222**, to drive the actuator **215** until the arm of the bell crank **220** engages the depressed key and causes the latch **222** to be disengaged from the shoulder on the driving segment **223**. After the latch has been withdrawn, the arcuate surface **227** on the driving segment will cooperate with the latch to retain the actuator **215** in its set position. When the actuator has been set, the selected totalizer or totalizers will be engaged with the appropriate teeth on the actuator **215**, and, upon the return movement of the driving segment **223**, the surface **228** thereon will engage the stud **229** on the actuator **215** to return the actuator to home position and thereby cause the entry of the amount into the totalizer or totalizers engaged therewith.

When no amount key **80** has been depressed, the zero stop pawl **211** will engage the extension **212** of the auxiliary control member **213** and arrest the member against further movement. The member **213** will be effective, through the connection including the pin **219** and the slot **218**, to withdraw the latch **222** from the shoulder on the driving segment **223** and stop the actuator **215** in its zero position.

The auxiliary control member **213** also contains the usual sets of teeth **236**, which are used to enable the totalizers to control the positioning of the actuators **215** in total recording operations. This control is fully explained in the Shipley Patent No. 1,977,094, referred to earlier herein.

The usual beam **240** is pivoted at one end to the actuator **215** and has its other end bifurcated to engage a stud **241** in a link **242**. After the actuator **215** has been set in any of its positions of adjustment, a roller **243** on the lever **225** engages the beam **240** and causes the beam to transmit the differential setting of the actuator to the link **242**, which link is pivoted at its upper end to an aliner segment **244**, loose on sleeve **140**, and at its lower end to a segment **245** (Fig. 8B), loose on shaft **151** and connected by the usual zero elimination link **246** to a segment **247** loose on shaft **154**. The segment **247** has a series of teeth engaging external teeth on an external-internal ring gear **248**, which is effective through shafts and gears to set type wheels, as **249**, in various columns to positions corresponding to the setting of the

actuator in order that the value of the setting of the actuator may be recorded.

The amount differential mechanism is provided with novel control means similar to those provided in the gross-net amount and meter reading control differential mechanism, by which its differential actuation may be controlled from any selected preset amount relay according to the predetermined amount.

The auxiliary control member 213 is provided with a series of projections 255 along its upper rear edge, which projections can be selectively engaged by either of a pair of pawls 256 and 257 when the pawl is moved into engaging position by the related "odd" or "even" control magnet 258 or 259.

A translator switching mechanism is provided to complete a circuit through the proper "odd" or "even" control magnet at the proper time in the cycle of operation. The wiper contact arms 264 (Figs. 8A and 10A) of this switching mechanism are carried by a collar 265 loose on the sleeve 140 and are driven past the two arcuate sets of contacts 266 by a link 267, which is pivotally connected to the actuator 215 and the collar 265. As the wiper contact arms 264 are driven by the actuator 215, they will engage a contact 266 determined by a circuit prepared in the previously operated preset amount relay and will complete the circuit through the "odd" or "even" control magnet 258 or 259 and cause the energization of the magnet. The control magnet will move its related pawl into the path of one of the projections 255 and will arrest the auxiliary control member 213, which will be effective through the pin-and-slot connection to disengage the latch 222 and cause the actuator to be set in proper position.

The translator switching mechanism and the magnet-operated pawls are provided for each of the banks of amount differential mechanisms to enable preset amounts to be entered therein during the automatic cycle of operation of the machine.

As shown in Fig. 10A, the aliner segments 268 and 269 for the banks upon which consumption amounts are set up are used to set wiper contact arms 270 and 271, respectively, of selector switching mechanisms which are similar to the switching mechanism shown in Fig. 4A, and enable these differential mechanisms to select a preset amount relay corresponding to the amount of the consumption. The manner in which this selection is accomplished will be explained fully hereinafter.

As mentioned earlier herein, combinational type of amount differential mechanisms are associated with the banks of keys 81. This form of differential mechanism is capable of two types of operation—in total recording operations, the mechanism is operable to withdraw amounts from totalizers and to set type wheels according to these amounts; and in amount entering operations, the mechanism is operable to set type wheels according to amounts but does not actuate any totalizer.

The reason why the combinational type of amount differential mechanism is used will be clear from Figs. 1A and 1B, in which it is seen that in the first cycle of operation of the machine, the amount keyboard is "split" into two five-bank groups in order that the present and previous meter readings may be entered into the machine. During this operation, the differential mechanisms controlled by both the keys 80 and 81 must set the printing wheels according to these amounts, but no totalizer is selected to receive these amounts. However, in the third or automatic cycle, the differential mechanisms related to the keys 80 are controlled according to the gross and net amounts which are printed and entered into totalizers which are selected to receive these amounts, while those differential mechanisms related to the keys 81 are controlled according to the amount or quantity of the therms, which amount is printed only and is not entered into any of the selected totalizers.

The combinational type differential mechanisms are rendered effective in total recording operations to withdraw any overflow amounts from their related totalizer wheels which are used in the well-known manner to receive entries of overflow amounts through the tens transfer mechanism.

The combinational type of amount differential mechanism shown herein is substantially like the one shown in the Sburlino et al. Patent No. 2,229,771 and will be but briefly described.

Fig. 9 shows that portion of the combinational type of amount differential mechanism which differs from the conventional type of amount differential mechanism and enables its different modes of operation to be obtained. The mechanism shown in this figure is representative of the differential mechanisms in the various denominations controlled by keys 81. The mechanism shown in Fig. 9 may be considered as that differential mechanism which is used to enter the digit of the thousands denominational order of the amount of the previous reading and the digit of the lowest denominational order of the amount of the therms and is representative of all of the differential mechanisms of this type.

The differential mechanism is controlled by the bank of amount keys 81, which are mounted in the same kind of key frame and control a zero stop pawl 276, just as the amount keys 80 do.

This type of amount differential mechanism includes a differentially positionable latch-supporting arm 277, which is pivotally mounted on a hub 278 carried by a pair of hanger plates 279 (Figs. 10A and 10B), supported by the rods 103 and 104.

The arm 277 carries a latch 280 supported thereon by the usual bell crank 281 and link 282, which latch engages a shoulder on a driving segment in a manner similar to the conventional differential mechanisms and enables the arm 277 to be driven by the segment until the bell crank 281 is rocked to withdraw the latch 280.

Also pivoted on the hub 278 is an auxiliary control member 285, similar in all respects to the auxiliary control member 213 described above in connection with the conventional amount differential mechanism.

The auxiliary control member 285 has a slot 286 engaging a stud 287 on the bell crank 281 to cause the operation of the bell crank 281 to withdraw the latch 280 when the auxiliary control member 285 is arrested by the zero stop pawl 276, by means operated under control of the totalizers in total recording operations, or by a pair of pawls which can be selectively operated by control magnets under control of circuits prepared in the preset amount relays in automatic operations.

The usual beam 290, with one end pivoted to the differentially positionable latch-supporting arm 277 and the other end bifurcated to engage a stud on a link similar to the link 242 of the conventional type of amount differential mecha-

nism, transmits the setting of the arm **277** to the link in order that the link can set type wheels to corresponding different positions in the same manner as explained above in connection with the conventional type of amount differential mechanism.

Also pivoted on the latch-supporting arm **277** is a link **293**, which drives the wiper contact arm **294** (Fig. 10A) of the translator switching mechanism of this bank in synchronism with the movement of the arm **277** to complete the prepared circuit to one or the other of the pawl-operating control magnets at the proper time during the operation of the differential mechanism.

The totalizer actuator **295** provided for this differential mechanism is pivoted on the hub **278** and has the usual three sets of teeth for actuating the various totalizers. This actuator **295** is connected to the latch-supporting arm **277** for operation thereby, said connection including a coupling pawl **296** pivoted on the actuator **295** and spring-urged to engage a stud **297** on the latch-supporting arm **277**. As the arm **277** is driven to different positions, it will be effective to drive the actuator if the pawl **296** is in engagement with the stud **297**, and such movement of the actuator **295** will enable it to withdraw amounts from its related wheel in any selected totalizer. If the pawl **296** is not in engagement with the stud **297**, the arm **277** will not drive the actuator **295**, and in such an operation only the setting of the type wheels takes place.

Control means are provided to control whether or not the actuators, as **295**, will be coupled to the differentially settable arms, as **277**, to be driven thereby. These control means will now be described.

A shaft **301** (Fig. 9) is journaled in the hanger plates which support the seven banks of amount differential mechanisms at the left of the keyboard (Fig. 1A) and has pinned thereon an uncoupling arm **302** (Fig. 9) for each of the combinational type of amount differential mechanisms. The controls for the bank shown in Fig. 9 are typical, so that an understanding of the controls for the four banks can be obtained from a description of the controls shown in Fig. 9.

The uncoupling arm **302** is normally positioned so that, in all amount-entering operations, a cam surface **303** thereon lies in the path of movement of a stud **304** in the end of the coupling pawl **296** and can cause the pawl to be rocked counter-clockwise out of engagement with the stud **297** on the differentially settable arm **277** during the early part of the movement of the differential mechanism to thereby uncouple the actuator **295** from the differentially settable arm **277**.

As explained in the cited patents and particularly in the Sburlino et al. patent, a zero stop pawl throwout shaft **305** is rocked clockwise during total recording operations to move the zero stop pawls of the amount differential mechanisms from effective position. This movement of the shaft **305** is used to move the uncoupling arm **302** out of the path of movement of the stud **304** on the coupling pawl **296**, so that the coupling pawl will remain effective to cause the actuator **295** to be moved by the differentially settable arm **277** to withdraw and print an amount from the overflow wheels of a totalizer.

Secured to the shaft **305** is a gear segment **310**, which meshes with a gear portion of a cam member **311** loose on the rod **104**. The cam member **311** contains a cam slot **312**, into which extends a stud **313** on an arm fastened to the end of a shaft **301**. When shaft **305** is rocked clockwise, the gear segment **310** will cause the cam member **311** to rock counter-clockwise and, through the cam slot **312** and the stud **313**, will cause the shaft **301** to rock counter-clockwise to move the uncoupling arms **302** out of the path of movement of the studs **304** and prevent the uncoupling of the actuator **295** from the settable arm **277**. Near the end of a total recording operation, the uncoupling arm **302** is moved back to its normal effective position.

It is seen, therefore, that in amount-entering operations, the actuator **295** will be uncoupled from the differentially settable arm **277**, which operates alone to set only the type wheels to enable the amount of the entry to be printed, while in total-recording operations, the actuator **295** and the arm **277** remained coupled to enable amounts to be withdrawn from a totalizer and the type wheels to be set according to these amounts so that the amount of the total can be printed.

The means whereby the clockwise operation of the shaft **305** will be effective to withdraw the zero stop pawls in both the conventional and combinational types of amount differential mechanisms from effective position is substantially like that shown in the patents cited earlier herein. Referring to Figs. 8A, 11, and 12, it will be seen that the shaft **305** has thereon a sleeve **317**, to which are secured arms **318** supporting a rod **319**, which is positioned above arms **320** fastened to the zero stop pawls for the various amount differential mechanisms. The sleeve **317** is yieldingly connected to the shaft **305** by means of a spring **321** (Figs. 11 and 12), which has one end secured to a collar **322** pinned to the shaft **305** and has the other end engaging an extension of the rod **319** to urge the extension of the rod into engagement with an arm **323** pinned to the shaft **305**. Through this connection, the sleeve **317** can be operated by the arm **323** when the shaft **305** is rocked clockwise, and also can be operated independently of the shaft, in a manner to be explained more fully hereinafter, to move the zero stop pawls and allow the differential mechanisms to be positioned under control of the preset amount relays in the automatic operation which follows the consumption amount entering operation.

Totalizers

The instant machine is provided with the usual three lines of totalizers (Fig. 8A), but in the novel controls for the rather limited classification and service being described to illustrate the invention, only the totalizers on the front and rear lines will be considered. Since the totalizers, their selection, and their operation are old and well known, it is obvious that the upper totalizer line could also be used, if desired, and that variations in the selection of the totalizers on the several lines could be made without departing from the invention.

The totalizers used in the instant machine are old and well known in the art, and therefore no detailed description will be given herein. If such a description is desired, reference may be had to the Fuller Patent No. 1,242,170, mentioned earlier herein.

The front and rear lines of totalizers are each provided with ten totalizers, one totalizer on a line for each possible position of its related controlling differential mechanism, although in the

instant embodiment only nine of the totalizers are used.

The totalizers, as 325 (Fig. 8A), on the rear line are related to the consumption classification control differential mechanism and are shifted laterally by the usual cam (not shown) operated by the link 143 (Fig. 10B) to bring any desired totalizer opposite the amount actuators for operation thereby to accumulate the totals of the various consumptions classified according to the keys 82 and 83. A grand total of all gross and net amounts is accumulated in the totalizer located in the zero position on this line of totalizers.

The totalizers, as 326, on the front line are selected to accumulate the gross and net amounts and the grand total of all consumption amounts, and are shifted by their related differential mechanism, which is controlled by the keys 84, 85, and 86 (Figs. 1B and 6A) and drive the link 182 (Fig. 10B) to operate the usual shifting cam. The totalizer which is selected when this control differential mechanism is stopped in zero position is used to accumulate the grand total of all the consumption amounts which were accumulated separately in the totalizers on the rear line according to classifications. All the other totalizers on the front line are "split" totalizers; that is, the tens transfer is interrupted between the lower five denominational orders and the higher five denominational orders, enabling each half totalizer to serve as a separate totalizer to allow separate totals to be accumulated simultaneously, such as gross and net amounts (cycle 3, Fig. 1A).

The totalizer located on the rear line in the position corresponding to the zero position of the classification control differential mechanism is also a "split" totalizer and accumulates separately all the gross amounts and the net amounts which were entered into the various gross-net totalizers on the front line.

The well-known totalizer engaging means, which is controlled by the usual notched disks set by the links 139 and 180 (Fig. 10A) and by the usual total control plate set under control of the keys 87, 88, 89, and 90, causes the engagement and disengagement of the selected totalizer or totalizers with and from the amount actuators to cause entries to be made therein in adding operations, and amounts to be withdrawn therefrom in total recording operations. Since the totalizer engaging means forms no part of the instant invention, it will not be described in detail herein. Reference may be had to the patents listed at the beginning of this specification, and particularly to the Fuller Patent No. 1,394,256, if details of the selecting and engaging means are desired.

Printing mechanism

The printing mechanism in the instant machine is of the column printing type similar to the one shown in the Arnold Patent No. 2,141,332. Since the invention is concerned with novel controls for the printing mechanism and is not concerned with the details of the printing mechanism, only so much of the printing mechanism as is necessary for an understanding of the invention will be described herein.

The printing mechanism is located between the various ones of the printer supporting frames 65, 66, 67, and 68 (Figs. 10A and 10B) and is adapted to print in different zones or columns on an inserted statement 50 and on an audit strip 51 which is retained in the machine. Column printing is obtained by having groups of type wheels located opposite the various columns on the statement and the audit strip, which type wheels are connected by the well-known internal gear drive to their related differential mechanisms to be positioned thereby. For instance, the differential mechanism associated with the right-hand bank of keys on the keyboard is connected to position the units order type wheels opposite the various "previous reading," "consumption," and "net bill" columns on the statement and the audit strip, and, by rendering the impression hammers as 158 (Fig. 4B) selectively operable in different operations of the machine, the proper values will be printed in their correct columns.

Through selected connections in the internal gear drive, the combinational type differential mechanisms associated with the four banks of keys 81 are arranged to set adjacent type wheels opposite the "therms" columns on the statement and the audit strip as well as set the two higher orders of type wheels in the sets opposite the "previous" and "present" columns.

Date printing type wheels may be provided and may be set directly by suitable manual means to print the dates of the meter readings in the proper columns of the statement.

The various impression hammers may be selectively coupled to their actuating means under control of a plurality of notched disks which may be differentially positioned by the differential mechanisms of the three control banks. The disks may be notched so that a cooperating feeler for each hammer can operate and render the necessary hammers operable in each of the several machine operations.

The feeding and ejecting means for the statement and the audit strip also can be controlled from the differentially settable notched disks.

For further details of the manner in which the internal gear drive enables different type wheels to be set from the differential mechanism and the manner in which the notched control disks are effective to control the hammer selection and provide other controls for the printing means, reference may be had to the Arnold Patent No. 2,141,332.

Automatic operation control means

Upon the entry of any consumption amount within the range for which preset amount relays are provided, the machine, with applicants' novel control means, is caused to perform another cycle of operation automatically to cause the gross and net amounts and the amount of the therms related to the consumption amount to be entered therein.

A control shaft 327 (Figs. 4B, 5, 6B, 8B, 10A, 10B, 11, and 13), journaled in the printer supporting frames 66, 67, and 68, is provided with means to control certain parts of the machine in the automatic cycle of operation and is driven to make one revolution during the two cycles of operation of the machine in which the consumption amount and the related amounts are entered.

The drive for the control shaft 327 is obtained from the main drive shaft 75, to which a shaft 328 may be connected by any suitable means, such as a train of gears 329, 330, and 331, shown schematically in Figs. 6A and 6B. A clutch mechanism of a type which is well known in this type of machine releasably connects the control shaft 327 to the shaft 328 to be driven thereby. The connection includes a disk 332 (Figs. 4B and

13) fastened to shaft 328 and carrying a driving pawl 333 and a retaining pawl 334, which pawls are urged to engage opposite edges of a boss 335 on a disk 336 loose on the shaft 328 and connected by a hub to a gear 337 also loose on the shaft 328. Gear 337 is effective, through an intermediate gear 338 mounted on a stud 339 on the printer supporting frame 66, to drive a gear 340 secured to the control shaft 327. The gear ratio between the gears of this train is so chosen that the control shaft 327 will be driven one revolution for two revolutions of the shaft 328. This connection will be effective to drive the control shaft as long as the driving pawl 333 engages the boss 335 on the disk 336. The driving pawl 333, however, may be rocked out of driving relation with the boss on the disk when an extension 341 of the pawl 333 engages a control member 345 which is pivoted on a stud 346 in the frame 66 and is movable into the path of movement of the extension 341.

In the instant embodiment of the invention, the control member 345 is normally out of position to engage the extension 341 on the driving pawl, but is moved to intercepting position in all operations of the machine except those in which the control shaft 327 is to operate. The control member 345 can be moved to and from blocking position by a shifting member 347, which is pivoted at one of its ends to the control member 345 and has a cam slot 348 in its other end cooperable with a stud 349 mounted on a bracket 350 secured to the printer supporting frame 66. When the stud 349 is in an intermediate position slightly below the middle portion of the cam slot 348, as shown in Figs. 4B and 13, the control member 345 is located in a position out of the path of movement of the extension 341, but, when the rearward end of the shifting member 347 is moved downwardly so that the stud 349 occupies the upper end of the slot 348, the shifting member will move to the left and shift the member 345 counter-clockwise about the stud 346 and into the path of the extension 341 of the driving pawl 333 to interrupt the drive for the control shaft 327. The rear end of the shifting member 347 is normally urged downwardly by a spring 351 extending between the member and a bracket 352 secured to the cross bar 69.

Means is provided to control whether the rear end of the shifting member 347 will be in its intermediate or lower position. This means is shown in Figs. 4B and 13 and includes a shaft 355 journaled in the hanger plates 102 and 167 for the control differential mechanisms. A spring 356, connected to one arm 357 of a bell crank secured to shaft 355, normally urges the bell crank and the shaft 355 to move in a counter-clockwise direction, but, in the normal or home position of the machine, this movement is blocked by a lever 358, which has a stud 359 engaging the other arm 360 of the bell crank. The lever 358 is pivoted on a shaft 361 extending between the main side frames 61 and 62 and is connected by yoke 366 to a cam lever 367 also pivoted on the shaft 361 and having a roller 368, which is urged by a spring 369 into engagement with a cam 370 secured to the main drive shaft 75. Shortly after the main drive shaft 75 begins to operate, the high portion of the cam 370 will move from beneath the roller 368 and will allow the spring 369 to rock the levers 358 and 367 clockwise about the shaft 361. This movement of lever 358 will cause the stud 359 to move from blocking engagement with the arm 360 of the bell crank and will allow the bell crank and the shaft 355 to rock counter-clockwise. A link 372 is pivoted to an arm 371 secured to the shaft 355 and is connected by a pin-and-slot-connection to one arm 373 of a yoke 374 pivoted on the shaft 196, the other arm 375 of the yoke being connected to a link 376 pivoted to the shifting member 347.

When the shaft 355 is blocked against movement, link 372 will prevent the yoke 374 from being rocked clockwise by the spring 351 and will maintain the shifting arm in the intermediate position, where it positions the control member 345 out of intercepting relation with the extension 341 and allows the drive for shaft 327 to be effective.

In an operation in which the shaft 355 is not blocked against movement, the shaft 355, as it rocks counter-clockwise, will be effective, through the arm 371 and the above linkage, to allow the rear end of the shifting member 347 to be moved downwardly by the spring 351 to position the stud 349 in the upper end of the cam slot 348 and shift the control member 345 into intercepting relation with the extension 341 of the driving pawl 333 to disable the drive for the shaft 327.

Near the end of the machine operation, the cam 370 will restore the lever 358 counter-clockwise, and the stud 359 on the lever in turn will engage the arm 360 and rock the bell crank and the shaft 355 and shift the connected linkage back to its starting position to restore the shifting member 347 toward the right (Fig. 13) and return the control member 345 from intercepting relation with the extension 341 of the driving pawl 333.

Accordingly, unless the shaft 355 is blocked against movement, the shifting member 347 will be moved to the left near the beginning of each operation of the machine to disable the drive for the control shaft 327, and, if moved, will be returned to the right near the end of the operation.

The consumption classification control keys 82, which are operated when the consumption is within the range for which preset amount relays are provided, are operable to control means which can block the movement of the shaft 355 and connected linkage and allow the shifting member 347 and the control member 345 to remain in normal position, where the control member is out of intercepting relation with the extension 341. These means are shown in Figs. 4A and 13.

A latch 380, fastened to a stub shaft 381 journaled in extensions of the hanger plates for the consumption classification and gross-net control differential mechanisms, is located adjacent the arm 360 of the bell crank. A spring 385, fastened to the latch 380, normally urges the latch 380 toward the arm 360, but this movement is prevented by a blocking member 386, which engages the end of an arm 387 also secured to the stub shaft 381. Accordingly, as long as the latch 380 is prevented from moving toward the arm 360 of the bell crank, the bell crank, the shaft 355, and the linkage can be operated to disable the drive for the control shaft 327.

The blocking member 386 is pivoted on a stud 388 on the hanger plate 102 and is connected by a link 389 to a control detent 390, pivoted on the hub 101 and provided with camming surfaces 391 which can be engaged by pins 392 on the stems of the keys 82 when the keys are depressed. When one of the keys 82 is depressed to control the entry of a consumption amount, the pin 392

engaging the cam surface 391 will rock the control detent 390 counter-clockwise against the action of a spring 393 and will cause the blocking member 386 to rock counter-clockwise to move its lower end out of engagement with the arm 387. As the lever 358 moves clockwise near the beginning of a machine operation, the latch 380 can move in front of the arm 360 of the bell crank and prevent the operation of the shaft 355 and linkage whereby the control shaft 327 will remain coupled to and be driven by the shaft 328.

Means is provided to block the operation of the latch 380 in total recording operations to allow the shaft 355 and linkage to operate and disable the drive for the control shaft 327, even though one of the keys 82 has been operated. This means includes an arm 394 secured to the stub shaft 381 and a blocking member 395 on the zero stop pawl throwout shaft 305, which is rocked clockwise in a well-known manner in total recording operations. When the shaft 305 is rocked clockwise, the member 395 will move in front of the arm 394 and will prevent the latch 380 from moving into engagement with the arm 360 of the bell crank, even though one of the keys 82 has been depressed and has moved the member 386 out of blocking engagement with the arm 387 on the shaft 381.

In operations in which the latch 380 has been allowed to move to arrest the arm 360, the return movement of the arm 358 and the stud 359 counter-clockwise will also restore the latch 380 and the arm 387, so that the blocking member 386 may move into blocking relation therewith.

The drive for the control shaft 327, therefore, will be interrupted in all operations of the machine except operations in which consumption amounts are entered under control of the keys 82 and automatic operations consequent thereon. When the drive for the shaft 327 is not disabled, the shaft 327 will be driven to make a complete revolution during the consumption amount entering operation and the following automatic operation, in which the amounts related to the consumption amount are entered into the machine.

Means is provided to prevent the unintentional movement of the control shaft 327 when the driving connection between the shaft 328 and the control shaft 327 is interrupted. This means includes a locating element 401 (Figs. 4B, 5 and 10A) secured to the shaft 327 and having a notch 402, which will be positioned to receive a roller 403 on a spring-urged lever 404 when the shaft 327 has been driven by the driving pawl 333 during the time the driving pawl was being disengaged from the boss 335. After the control shaft 327 has been disconnected from its driving means, the retaining means will maintain it in its moved position until an operation in which the drive for the shaft is not disabled, during which operation the driving pawl will engage the boss 335 in its moved position and will complete the movement of the shaft.

It will be recalled that the control keys 82, when depressed, operate control means which prevent the rear end of the shifting member 347 from being lowered to cause the drive for the shaft 327 to be disabled. However, the control shaft 327 makes one revolution during two cycles of operation of the machine, and the control keys 82 will be released at the end of the first cycle or consumption entering operation, which means that, unless other means are provided to prevent the lowering of the rear end of the member 347, the shaft 355 and linkage will allow it to drop at the beginning of the second cycle of operation and disable the drive for the shaft 327 after the shaft has moved but half the necessary distance. In order to prevent the drive for the control shaft 327 from being thus disabled, the control shaft 327 has secured thereon a cam member 405, which cooperates with a roller 406 on the side of the shifting member 347 near the end of the consumption entering operation and raises the member 347 a slight distance upwardly so that the stud 349 occupies the lowest position in the slot 348. This movement of the shifting member 347 serves to prevent the lowering of the end of the shifting member 347 and the disabling of the drive for the shaft 327 during the cycle of operation of the machine which follows the cycle of operation initiated by the control keys 82, so that, when the drive for the shaft 327 has been rendered effective, it will remain effective until the shaft has made a complete rotation and has caused the operation of the necessary controls in the automatic operation. This movement of the member 347 is also utilized to remove the zero stop pawl 160 (Fig. 6A) in the gross-net control differential mechanism in a manner to be described later.

In order that the machine drive will be operable to cause the automatic operation of the machine in which the gross and net amounts and the amount of the therms related to a consumption amount may be entered into the machine, a disk 410 (Figs. 6B and 10A) is provided on the control shaft 327 to operate means which allow the shaft 76 to be released again after the consumption amount has been entered.

The disk 410 has therein a cam race 411, into which extends a roller 412 on a link 413 (Figs. 6A and 6B) pivoted to one arm of a yoke 414 loosely mounted on a cross-rod 415 extending between the main side frames 61 and 62. The other arm of the yoke 414 is connected by a link 416 to a member 417 loose on the shaft 76. The member 417 has an extension which is formed with a bentover ear 418, which can engage the usual non-repeat pawl 419 and prevent it from moving to effective position, and also has a stud 420, which can engage the yoke 91 and can move the yoke which, through the pin-and-slot connection of the yoke 91 with the blocking pawl 77, is effective to move the pawl out of blocking relation with the arm 74 on the shaft 76 to release the shaft 76 for clockwise movement to cause an operation of the machine to occur.

The cam race 411 is so shaped that near the end of the consumption amount entering operation the link 413 will be drawn downwardly, and, through the yoke 414 and the link 416, will rock the member 417 clockwise to a position where the ear 418 on the extension blocks the movement of the non-repeat pawl 419 and the stud 420 moves the blocking pawl 77 out of blocking relation with the arm 74. When the usual counter-clockwise movement is given to the shaft 76 near the end of the operation, therefore, the blocking pawl 77 will have been moved out of blocking relation with the arm 74 and the non-repeat pawl will be retained out of engagement with the arm 74, so that these pawls will be ineffective to block the clockwise movement of the shaft 76, which follows the counter-clockwise movement of the shaft and initiates the automatic cycle of operation.

When the shaft 76 is rocked counter-clockwise near the end of the consumption amount entering operation, it will be effective in the usual manner to release the keys which have been depressed in the various banks, and this release of the keys will cause the zero stop pawls to be restored to

effective position. In order that the operation of the machine may be controlled by the relay-controlled means in the automatic cycle of operation, means must be provided to withdraw the zero stop pawls for the differential mechanisms in the amount banks and the gross and net control bank at the beginning of the automatic cycle of operation, so that these differential mechanisms can operate until stopped by the magnetically-operated pawls under control of the preset amount relay which has been selected according to the consumption amount.

The zero stop pawls, as **211** and **276** (Figs. 8A and 9), for the various amount differential mechanisms are withdrawn at the beginning of the automatic cycle of operation by mechanism shown in Figs. 8A, 8B, 10B, and 11. A link **426**, which is bifurcated at one end to straddle the shaft **305**, has a cam surface **427**, which can cooperate with a roller **428** on the arm **318** attached to the end of the sleeve **317**. The other end of the link **426** is connected to one arm of a bell crank **429** loose on the shaft **415**. The other arm of the bell crank **429** is connected by a link **430** to a cam lever **431**, pivoted on a stud **432** on the printer supporting frame **67**, and carrying a pair of rollers **433** and **434**, which cooperate with the peripheries of a pair of cams **435** and **436**, respectively, secured to the control shaft **327**. The cams **435** and **436** will be effective, at the beginning of the automatic cycle of operation, to rock the cam lever **431**, which, through the connecting linkage, will shift the link **426** toward the right (Fig. 11) so that the cam surface **427** thereon can cause the sleeve **317** to be rocked clockwise independently of the shaft **305** to withdraw the zero stop pawls, as **211** and **276**, from blocking relation with their amount differential mechanisms.

The zero stop pawl **160** for the differential mechanism of the gross-net control bank will also be withdrawn from effective position at the beginning of the automatic cycle of operation. The means for accomplishing this are shown in Figs. 6A, 7, and 10A.

The zero stop pawl **160** is provided with a stud **441**, which is engaged by the forward bifurcated end of a link **442**. The rear end of the link **442** is pivoted to the arm **373** of the yoke **374**, and, when the cam **405** raises the shifting member **347** near the end of the consumption entering operation, as explained earlier herein, the link **376** will rock the yoke **374** clockwise to shift the link **442** forwardly to move the zero stop pawl **160** to ineffective position, so that the control differential mechanism can be arrested by the magnetically-operated pawls under control of the selected preset amount relay.

The control shaft **327** also has secured thereon three cams **443**, **444**, and **445** (Figs. 8B and 18C), which respectively, control the closing and opening of switches **452**, **455** and **456** in the electrical portion of the control means at the proper time in the consumption amount entering operation and the automatic operation which follows.

Since the switches controlled by the cams are similar, their construction and operation will be clear from a description of the means controlled by the cam **443**. An arm **446** (Figs. 8B, 10B, and 18C) is pivoted opposite the cam **443** on a rod **447** carried by brackets **350** and **448** (Figs. 4B, 8B, 10A, and 10B) fastened to the printer supporting frames **66** and **67**. A forward extension **449** of the arm **446** is spring-urged to engage the periphery of the cam **443**, and a rearward extension **450** of the arm **446** has a bent-over edge to engage an insulating member **451** on the movable contact of the circuit-controlling switch **452**. Each switch consists of a pair of resilient contact members (Figs. 8B and 18C), which are mounted on the yoke **453** and are normally urged to open condition but can be closed by their related cam and lever at the proper time during the rotation of the control shaft **327**. The yoke **453** is supported on the rod **447** and has one arm **454** connected to the bracket **448**.

As shown in Figs. 8B and 18C, the control cams **443**, **444**, and **445** are provided with three control levels. As seen on cam **443**, there is a normal level, as indicated at **458** (Fig. 18C), which positions the arm **446** so that the movable contact of switch **452** is just short of closed circuit condition. The cam **443** also has a high level, as indicated at **459**, which causes the arm **446** to be rocked counter-clockwise to close the contacts of the switch, and a low level **460**, which follows the high level and allows the movable contact to move a maximum amount to insure that the circuit will be opened completely after it has served its purpose.

The circuits controlled by these switches and the means included in the circuits whereby the novel controls are obtained will now be described.

Circuits

In the illustrative embodiment of the invention, four groups of relays are provided—one group, G—1, for residential gas service; a second group, G—2, for commercial gas service; a third group, G—3, for industrial gas service; and a fourth group, G—4, for heating gas service. As shown in Figs. 14, 18A, 18B, 18C, and 18D, each group of relays includes two group-selector relays and ten preset amount relay and counter units corresponding to the consumption amounts between **15** and **24** units.

The groups of relays are selected according to the differential positioning of the wiper contact arm **142** (Figs. 4A and 18A) of the selector switch for the consumption classification control bank. When the wiper contact arm **142** is positioned by the differential mechanism under control of one of the keys **82**, it will connnect the common contact **466** to the individual contact **467** corresponding to the key depressed. The individual contacts **467** are connected to corresponding conductors in the cable **468** (Figs. 14, 18A, and 18B), from which the conductors extend to various ones of the group-selector relays. The circuit, which has been selectively prepared by the differential position of the wiper contact arm **142**, is completed by the cam-controlled switch **455** at the proper time in the operation of the machine and causes the selected group selector relays to be energized.

The wiper contact arms **270** and **271** (Fig. 10A) for the selector switches in units and tens denominational orders of the consumption amounts, respectively, similarly connect common contacts **469** and **470** (Fig. 18A) to various individual digit value contacts in these orders, which digit value contacts are connected to corresponding digit conductors in the cables **471** and **472** for the units and tens digits of the consumption amounts. Conductors extend from the digit conductors in cable **471** to the normally open contacts in one of the group selector relays in each of the groups of contacts, and in a like manner conductors extend from the digit conductors of cable **472** to normally open contacts in the other of the group selector relays in the various groups.

Digit circuits extend from the normally open contacts of the group selector relays to various ones of the preset amount relays according to the consumption amounts, so that, when the group selector relays of a group are energized, they will close their normally open contacts and will extend the control from the selector switches in the consumption blanks to the various preset-amount relays of the group. The circuits thus prepared will be completed through the cam-controlled switch 452 at the proper time in the operation of the machine, to cause the preset-amount relay corresponding to the consumption amount to be operated and prepare control circuits corresponding to amounts related to the consumption amount, which circuits can control the machine in the automatic cycle of operation to enable the proper entry of these related amounts to be made therein. The preset-amount relay which is operated will close holding circuits to both of its windings to maintain it operated after the group selector relays have been de-energized and until the switch 452 is opened after the preset-amount relay has controlled the machine in the automatic cycle of operation.

Since the groups of relays are substantially alike, it is believed that the construction and operation of the various groups will be clear from the following description of the relays of group G—1 and their selection and operation.

The relay group corresponding to residential consumption, or G—1, is shown in the left-hand group of Fig. 14; in Fig. 15; and in detail in Figs. 18B and 18D.

The several relays of this group are mounted on a panel 475 (Fig. 15) supported by a base 476 and enclosed by a suitable cabinet 477. Also mounted on the panel are a plurality of counters 478, one for each preset-amount relay, which are operated from the preset-amount relays to count the number of times these relays have operated.

The selector relays 479 and 480 (Figs. 14 and 18B) are of the single winding type and will close their contacts whenever their winding is energized. The preset-amount relay in a relay-and-counter unit 481 is of the double winding type and will operate to close its contacts only if both windings are energized at the same time. A representative relay is shown in Figs. 15 and 16. The relay consists of a winding 482, which may be of the single or double type, carried by a supporting bracket 483, to which is pivoted an armature 484. The armature 484 is provided with a pair of extensions 485 and 486 (Fig. 15), each of which is effective, when the armature 484 is rocked clockwise (Fig. 16) about its pivot against the tension of the contacts, to cause a plurality of pairs of the contacts to be closed to prepare circuits to the preset amount relays or to control the machine according to related values, as the case may be.

The counters, which are provided to count the number of times any preset amount relay is operated, are of conventional construction and will be but briefly described herein. Each counter is supported in a U-shaped frame 490 (Fig. 17), to which an operating magnet 491 is secured. An armature 492 is pivotally mounted between the sides of the frame 490 and carries an actuating pawl 493, which cooperates with a ratchet 494 on a units denominational order numeral wheel 495 rotatable on a shaft 496 extending between the sides of the frame 490. A spring 497, secured to one side of the frame 490 and to the armature 492, normally retains the actuating pawl 493 in the position shown in Fig. 17; however, when the magnet 491 is energized, it will attract the armature 492 against the action of the spring 497 and will move the actuating pawl 493 to the right to impart an increment of movement to the wheel. As soon as the magnet 491 is de-energized, the spring 497 will restore the armature 492 and the actuating pawl 493 to the left to the position shown in Fig. 17, and during this return movement a pawl 498 will cooperate with the ratchet 494 to prevent any improper reverse rotation of the wheel 495. Numeral wheels in the higher orders are operated by the usual tens transfer mechanisms, which are operable to enter a unit in a higher order wheel each time the next lower order wheel exceeds its capacity.

While the group of relays and counters for the single classification have been shown mounted in a unitary panel construction in Fig. 15, it is not intended that the invention be limited to this construction, as the several groups of relays may equally well be mounted in a single panel instead of in individual panels, if desired.

It is believed that the selection and operation of the various relays will be clear from the following description of the selection and operation of the relay corresponding to a consumption of twenty-two units of gas used in residential service.

The amount of the consumption, or 22, is set up on the consumption amount keys 80 at the right of the amount keyboard (Fig. 1A), and the consumption classification control key 82 related to residential service is depressed to initiate the consumption amount entering operation and to render the control shaft 327 operable to cause an automatic operation to follow the consumption amount entering operation.

The differential mechanisms related to the two right-hand amount banks will be stopped by the "2" keys to set the wiper contact arms 270 and 271 (Fig. 18A) to connect the individual contacts corresponding to the digit "2" to the common contacts 469 and 470, respectively, which are connected to ground.

The consumption classification differential mechanism will be stopped by the depressed key 82 and will set the wiper contact arm 142 to connect the common contact 466 to the contact 467, which is connected to the conductor G—1 in the cable 468.

After the differential mechanisms have completed their forward movement, the cam-controlled switch 455 is closed to complete a circuit from the source of potential 500 over a manually operable enabling switch 501 which is closed at this time, switch 455, and conductor 502, which extends to the selector relays in all the groups; however, in this particular operation the selector switch has been set for the classification "G—1," so the circuit will continue over the windings of the group selector relays 480 and 479 in series, the conductor G—1 in cable 468, contact 467, wiper contact arm 142, common contact 466, and to ground over a resistor. The completion of this circuit will cause the group selector relays 479 and 480 to be energized. If the selector switch had been set to another classification, the circuit from conductor 502 would have been extended over the selector relays of that classification group instead of over the selector relays 479 and 480. The switch 455 will remain closed until just before the end of the consumption entering operation, when it will open to release the selector relays 479 and 480

and prevent any further energization of selector relays during the automatic cycle of operation which follows.

The selector switches which are set according to the consumption amount will now be effective to select the preset amount relay which corresponds to the consumption amount in the selected group of relays. Before considering the manner in which the selection of a preset amount relay in a group is effected, the circuits including the various windings of the preset amount relays will be explained.

In the present embodiment, the preset amount relays are provided for the consumption amounts from 15 to 24 units, and each relay consists of two windings, the left one of which, as seen in Figs. 18B and 18D, is energized according to the units denominational order digit of the consumption amount and the other of which is energized according to the tens digit of the consumption amount. When the circuits are completed through the selector switches, only that preset amount relay which corresponds to the consumption amount will have both of its windings energized at the same time and will operate to close its contacts.

After the differential mechanisms have finished their forward movement and shortly before switch **455** is closed, switch **452** is closed to connect the source of potential **500** to the conductor **503**. From point **504** on the conductor **503**, a conductor **505** extends over the right-hand windings of the preset amount relays whose tens value is "2," in series, and then over the conductor **506** to the "2" conductor in cable **507**, which extends to the normally open contact in the selector relay **480** for tens value of the consumption amount. Similarly, a conductor **508** extends from the point **509** on the conductor **503**, over the right-hand windings of the preset amount relays whose tens value is "1," in series, and then over the "1" conductor in cable **507** to the normally open contact in the selector relay **480**.

A conductor **510** extends from the point **511** on the conductor **503** and is connected to all the left-hand windings of the preset amount relays to supply potential thereto. The circuits through the left-hand windings of the various relays extend to the cable **512** and are connected to digit conductors therein which correspond to the units digit of the consumption amount to which the preset amount relay is related. The digit conductors in the cable **512** extend to the normally open contacts in the selector relay **479**.

When the selector relay **480** is energized and operates to close its normally open contacts, the digit conductors of cable **507** will be connected to conductors of like digit value in the cable **513**, which extend from conductors in cable **472**, to which the individual contacts of the selector switch for the tens digit of the consumption amount are connected, and then over the wiper contact arm **271** and common contact **470** to ground. Similarly, when selector relay **479** is energized and operates to close its normally open contacts, the digit conductors of cable **512** will be connected to corresponding digit conductors in cable **514**, which extend from conductors in the cable **471**, to which the individual contacts in the selector switch for the units digit of the consumption amount are connected, and then over the wiper contact arm **270** and common contact **469** to ground.

With the consumption amount selector switches set at "22," therefore, the circuit through the right-hand windings of the preset amount relays for the values "20" through "24" will be completed when the selector relay **480** closes its contacts, and these windings will be energized, and the circuit through the left-hand winding of the relay whose units digit value is "2" will be completed when the relay **479** closes its contacts, and this winding will be energized. The preset amount relay for the value "22" will be the only relay to have both windings energized at this time and will operate to close its contacts.

When the preset amount relay for the value "22" operates, contact **520** therein will close a holding circuit to ground for the left-hand winding of the relay and contact **521** will close a holding circuit to ground for the right-hand winding of the relay over conductor **522**. These holding circuits maintain the relay operated after the group selector relays have been released and until the switch **452** is opened to remove positive potential from the winding after the control of the machine in the differential operation has been effected.

The operation of the preset amount relay is also effective to ground certain of the individual contacts in the translator switches to enable the actuators to be differentially positioned in the automatic operation.

Three cables, which are common to all the classification groups of relays, are provided to enable the relays to control the differential positioning of the amount differential actuators in the automatic cycle of operation. Cable **525** contains three sets of ten conductors, one of which sets extends to the individual contacts of the translator switch for the "cents" of the net amount; another of which sets extends to the individual contacts of the translator switch for the "dimes" of the net amount; and the third of the sets of conductors extends to the individual contacts of the translator switch for the "dollars" of the net amount. The contacts in the preset amount relay **22**, by connecting one conductor in each set of conductors to ground, are effective to ground the proper individual contacts to provide a control for a three-digit net amount, which is, in this instance, $3.34. Similarly, a cable **526** contains three sets of ten conductors, which sets of conductors are connected to the three sets of individual contacts in the differential mechanisms for the gross amount, and enable the relay to ground the individual contacts according to a three-digit gross amount, which is, in this instance, $3.67.

It will be recalled that the quantity of the therms is set up by using the two banks of keys **81** at the left of each five-bank group of keys on the keyboard. However, in the instant embodiment, the quantity of the therms never exceeds a three-digit amount, so the translator switch for the bank of keys at the extreme left of the keyboard has its individual contact in the zero position connected directly to ground, and the differential mechanism for this bank will be controlled to stop in its zero position in all the automatic cycles of operation. Cable **527** contains three sets of ten conductors, which extend to the individual contacts of the translator switches for the "tenths" and "units" of therms banks located in the fourth and fifth banks of amount keys from the right-hand side of the keyboard in Fig. 1A and to the individual contacts in the translator switch for the "tens" therms bank, which is located in the second amount bank from the left in the keyboard in Fig. 1A. These conductors in

cable 527 enable the individual contacts in these translator switches to be grounded according to the quantity of therms related to the particular consumption amount, the quantity being 17.6 therms for the 22 units of consumption being considered.

The preset amount relay which is operated grounds two more circuits. Contact 528 applies ground to conductor 529, which is related to residential classification, G—1, and extends through cable 530 to the individual contact which is related to this classification, to the translator switch for the gross-net control bank and enables the differential mechanism to be arrested in position to control the entry of the gross and net amounts into their proper totalizers and to control the printing mechanism to indicate the classification and print it in the proper column on the statement and audit strip. Contact 531 applies ground to conductor 532, which extends to the winding of the counter operating magnet for this relay-and-counter unit.

The preset amount relay which is operated, therefore, will close holding circuits for its windings, will prepare its related counter for operation, and will prepare circuits to the translator switches to enable them to control the differential operation of the differential mechanisms in the automatic cycle of operation.

At the beginning of the automatic cycle of operation before the differential mechanisms begin their clockwise movement the cam-operated switch 456 is closed to apply operating potential to the counter operating magnets for the various relay-and-counter units and also to apply operating potential to the "odd" and "even" control magnets for the various amount and control differential mechanisms.

When the switch 456 is operated, it will close a circuit from the source of potential 500, over the manually operated enabling switch 501, which has been closed, and over the switch 456 to a conductor 535 (Figs. 18C and 18D). A conductor 536 extends from point 537 on the conductor 535 and supplies potential to the actuating magnets for the various counters of this group, but, since the magnet for the counter related to "22" units of consumption is the only one connected to ground by its related relay, this magnet will be the only one which is energized to actuate its counter wheel. Conductors similar to conductor 536 are provided for the counters associated with the other groups of relays, but these counters are not operated at this time because none is connected to ground by an operated relay.

Cam-controlled switch 456 also applies operating potential to the "odd" and "even" control magnets to enable them to be operated during the automatic cycle of operation according to circuits prepared in the operated preset amount relay. Since the circuits prepared by the operated preset amount relay and the manner in which they operate to control the extent of movement of the differential mechanisms are similar for the various differential mechanisms, an understanding of the several circuits will be clear from an explanation of the circuit for controlling the differential mechanism for the gross-net control bank.

A conductor 538 extends from point 539 on the conductor 535 (Fig. 18C) and supplies potential to the "odd" and "even" control magnets for the various differential mechanisms, the circuit for the magnets associated with the gross-net control bank extending from point 540 on the conductor 538 (Fig. 18A), over a suitable current-limiting resistor 541 to point 542, where the circuit branches, with one branch leading over the winding of the "odd" control magnet 198 to the common contact 203 (shown schematically as a plurality of interconnected individual contacts in Fig. 18A) in the translator switch. The common contact 203 may be connected to the various "odd" individual contacts 202 in the translator switch by one of the wiper contact arms 201 as it is driven by the differential mechanism. The other branch of the circuit from point 542 goes over the winding of the "even" control magnet 200 to a common contact similar to contact 203, which may be connected to the "even" individual contacts 204 by the other wiper contact arm 201 of the translator switch. In the circuit diagram, the wiper contact arms are shown schematically as a single contact arm which successively engages both "odd" and "even" individual contacts, but the actual construction of the wiper contact arms is as shown in Figs. 6A, 8A, 10A, and 10B and consists of two wiper contact arms for each switch, one for the "odd" individual contacts and one for the "even" individual contacts. The circuit for the "odd" or "even" control magnet will be completed and the magnet energized to stop the differential mechanism when one or the other of the wiper contact arms connects a grounded individual contact to its related common contact in the translator switch.

The operated preset amount relay corresponding to 22 units of consumption has closed its contact 528 to apply ground to the conductor 529, which extends through cable 530 to the individual contact "G—1" in an "odd" position in the translator switch, so that, when contact 456 has closed, the circuit thus prepared will be completed through the "odd" magnet when one of the wiper contact arms 201 connects this individual contact 202 to the common contact 203, and the differential mechanism will be arrested in the controlling position to enter the amounts according to residential gas service and to control the recording means to print the required data in appropriate zones on the statement 50 and the audit strip 51.

During this automatic operation, the "3," "3," and "4" individual contacts, respectively, in the banks for the dollars, dimes, and cents of the net amount, the "3," "6," and "7" individual contacts, respectively, in the banks for the dollars, dimes, and cents banks of the gross amount, and the "1," "7," and "6" individual contacts, respectively, in the banks for the tens, units, and tenths of therms will have been grounded by the operated preset amount relay for a consumption of 22 units and will have caused their related control magnets to be energized at the proper times to arrest the several amount differentials in positions corresponding to these amounts. The control magnets will remain energized until after all the differential mechanisms have been positioned in the automatic cycle of operation, at which time the switch 452 will open and release the magnets.

The novel control means, therefore, are effective to select a group of relays according to the classification of service being registered and are effective to select from this group of relays the relay corresponding to the amount consumption, and this selected relay is effective to control the machine to enter therein one or more amounts and controls which are related to the particular amount of consumption being considered.

The invention, however, is not limited to the

use of only ten preset-amount relay and counter units for each classification, as it is obvious that conductors for the tens values "3" through "9" could also be included in cables **472**, **513**, and **512** and could be extended over the contacts of relay **480** to cable **507**, from which they could continue over the tens windings of additional preset-amount relays in the same manner as shown for the tens conductors "1" and "2" in Fig. 18B. The circuits including these additional tens value conductors, together with units value circuits extending over units value windings similar to those shown in Fig. 18B, would enable up to ninety-nine relays to be provided in each group and would enable any one of these relays to be selected according to the positioning of the selector switches by the consumption amount differentials.

It is believed that the operation of the machine embodying the novel controls has been made clear in connection with the description of the mechanisms and that a further description of the operation of the machine is not necessary for an understanding of the invention.

While the form of mechanism herein shown and described is admirably adapted to fulfill the objects primarily stated, it is to be understood that it is not intended to confine the invention to the one form or embodiment herein disclosed, for it is susceptible of embodiment in various forms all coming within the scope of the claims which follow.

What is claimed is:

1. In a machine operable to perform single-cycle operations and plural-cycle operations, the combination of a plurality of differentially settable members; means normally retaining the members against differential movement; devices to control the setting of said members in the first cycle of a plural-cycle operation; means to arrest the members after different extents of movement to thereby cause the members to be set in different positions in the second cycle of a plural-cycle operation; a plurality of selectively operable control devices having means therein to control the arresting means to cause the members to be set to various predetermined positions as determined by the selected control device under control of the first cycle setting of said members; means for selecting any of the control devices for operation; sequence of operation control means; means to initiate a plural-cycle operation and to render the sequence of operation control means operative; means operated by the sequence of operation control means in the first cycle of a plural-cycle operation to render the selecting means effective to select one of the control devices and to operate the selected device; means operated by the sequence of operation control means at the beginning of a subsequent cycle of a plural-cycle operation to withdraw the retaining means to free the differentially settable members for control by the arresting means; and means operated by the sequence of operation control means in said subsequent cycle to render the control devices effective to control the arresting means to cause the members to be set in predetermined positions determined by the selected control device.

2. In a machine operable to perform plural-cycle operations, the combination of differentially operable mechanism which operates in each cycle of operation; manipulative means operable to control the differential operation of the mechanism in the first cycle of the plural-cycle operation; electrically operated means to control the differential operation of the mechanism in a subsequent cycle of the plural-cycle operation; a selector switching mechanism differentially settable by the differential mechanism; a timing translator switching mechanism driven by the differential mechanism in synchronism therewith and connected to the electrically operated control means to control the time of operation of the electrically operated control means; means controlled by the selector switching mechanism according to the setting thereof and cooperating with the timing translator switching mechanism to determine at which time in the operation of the differential mechanism the electrically operated control means will operate; and sequence of operation control means to render the selector switching mechanism operable after the differentially operable mechanism has been set under control of the manipulative devices in the first cycle of the plural-cycle operation, and to render the timing translator switching mechanism operable before the differentially operated mechanism begins to operate in said subsequent cycle, whereby the differentially operable mechanism, by its setting in the first cycle of the plural-cycle operation, automatically controls its differential operation in a subsequent cycle of the plural-cycle operation.

3. In a machine operable to perform plural-cycle operations, the combination of a plurality of amount differential mechanisms; amount determining devices to control the differential operation of said mechanisms during the first cycle of a plural-cycle operation; a plurality of preset-amount devices related to different predetermined multi-digit amounts; selector means set by certain of the differential mechanisms according to multi-digit amounts; means operable in the first cycle of a plural-cycle operation, to enable the selector means, when set to one of said predetermined amounts, to select and operate the preset-amount device related to that amount; and means controlled by the operated preset-amount device for controlling the differential operation of the amount differential mechanisms in a subsequent cycle of the plural-cycle operation to control their setting according to other amounts based on the predetermined amount to which the operated device is related.

4. In a machine operable to perform plural-cycle operations, the combination of a plurality of amount differential mechanisms; amount keys to control the setting of amounts in said differential mechanisms in the first cycle of a plural-cycle operation; a plurality of preset-amount relays related to different predetermined multi-digit amounts; means including selector switches which are set by certain of the differential mechanisms according to multi-digit amounts and are operable to control circuits to the relays according to said amounts; means operable in the first cycle of a plural-cycle operation, to complete the control circuits and enable the selector means, when set to one of said predetermined amounts, to select and operate the preset amount relay related to that amount; and means including circuits controlled by the operated preset-amount relay for automatically controlling the differential operation of the amount differential mechanisms in a subsequent cycle of the plural-cycle operation, to control their setting according to other amounts based on the predetermined amount to which the operated device is related.

5. In a machine operable to perform plural-cycle operations, the combination of a plurality

of amount differential mechanisms; a plurality of preset-amount relays related to different predetermined multi-digit amounts and having contacts closable to prepare circuits representing other amounts based on the multi-digit amount; selector means including selector switches which are set by certain of the differential mechanisms according to multi-digit amounts and are operable to selectively control circuits to the relays according to the multi-digit amounts; means operable in the first cycle of a plural-cycle operation to cause the circuits to the relays to be operable to enable the selector switches, when set to one of said predetermined multi-digit amounts, to select and operate the preset-amount relay related to that amount; and means controlled by the prepared circuits in the operated preset-amount relay, and including timing switches operated by the differential mechanisms, for controlling the differential operation of the amount differential mechanisms including said certain differential mechanisms in a subsequent cycle of the plural-cycle operation, to control the setting of the differential mechanisms to be made automatically according to said other amounts based on the predetermined amount to which the operated relay is related.

6. In a machine operable to perform plural-cycle operations, the combination of a plurality of amount differential mechanisms; another differential mechanism; a plurality of groups of preset-amount devices, the devices in the groups being related to different predetermined multi-digit amounts; selector means set by said other differential mechanism; selector means set by certain of said amount differential mechanisms according to multi-digit amounts; means operable in the first cycle of the plural-cycle operation to render the several selector means jointly operable to select a group of preset-amount devices according to the setting of said other differential mechanism and to further select and operate the preset-amount device in the selected group of devices which corresponds to the predetermined multi-digit amount set on the certain amount differential mechanism; and means controlled by the operated device for automatically controlling the differential operation of the amount differential mechanisms including said certain differential mechanisms in a subsequent cycle of the plural-cycle operation, to control their setting according to other amounts based on the predetermined amount to which the operated device is related.

7. In a machine operable to perform plural-cycle operations, the combination of a plurality of amount differential mechanisms; control differential mechanisms; a plurality of groups of preset-amount relays; the relays in the groups being related to different predetermined multi-digit amounts; selector means set by one of said control differential mechanisms; selector means set by certain of said amount differential mechanisms according to multi-digit amounts; means operable in the first cycle of the plural-cycle operation to render the several selector means jointly operable to select a group of preset-amount relays according to the setting of said one of the control differential mechanisms and to further select and operate the preset-amount relay in the selected group of relays which corresponds to the predetermined multi-digit amount set on the certain amount differential mechanism; and means controlled by the operated relay for controlling the differential operation of the amount differential mechanisms including said certain differential mechanisms and another of said control differential mechanisms in a subsequent cycle of the plural-cycle operation, to control the setting of the amount differential mechanisms according to other amounts based on the predetermined amount to which the operated relay is related, and to control the differential movement of said other of the control differential mechanisms to provide a control in accordance with the significance of the group in which the operated relay is included.

8. In a machine of the class described, the combination of a differentially positionable member; a plurality of control surfaces on said member; a first pawl selectively movable into cooperation with any desired one of the control surfaces, to arrest the member in a corresponding one of a plurality of positions; a second pawl displaced relatively to the first pawl and selectively movable into cooperation with the same set of control surfaces to arrest the member in a corresponding one of a plurality of other positions which are displaced relatively to the first-mentioned plurality of positions by an amount equal to the displacement between pawls; and means to selectively move one or the other pawl into cooperation with the desired control surface during the movement of the member, to arrest the member in the desired position.

9. In a machine of the class described, the combination of a differentially positionable member; a plurality of control projections on said member; a first pawl selectively cooperable with any of the control projections during the movement of the member to arrest the member in certain positions; a second pawl displaced relatively to the first pawl and cooperating with the same set of projections to arrest the member in other positions which are displaced relatively to said certain positions an amount equal to the displacement between the pawls; an operating magnet for each pawl; and means to control the magnets including circuits which may be prepared according to the position in which it is desired to arrest the member, and a circuit-closing means movable in synchronism with the member to complete the prepared circuit to the proper magnet at the proper time to arrest the differential mechanism in the desired position.

10. In a machine of the class described, the combination of a differential member settable to any one of a plurality of alternate "odd" and "even" positions; a plurality of control surfaces on said member equal in number to the "odd" or the "even" positions to which the member may be set; a first pawl selectively cooperable with the control surfaces at different times during the operation of the member to arrest the member in any of its "even" positions; a second pawl selectively cooperable with the control surfaces at different times during the operation of the member and so located relatively to the first pawl to arrest the member in its "odd" positions; and means to control which pawl will operate and the time of its operation to thereby control the position to which the differential member will be set.

11. In a machine of the class described, the combination of a differential member settable to any one of a plurality of alternate "odd" and "even" positions; a plurality of projections on said member equal in number to the "odd" or the "even" positions to which the member may be set; a first pawl selectively cooperable with the

projections at different times during the operation of the member to arrest the member in any of its "even" positions; a second pawl selectively cooperable with the projections at different times during the operation of the member and so located relatively to the first pawl to arrest the member in its "odd" positions; an "even" pawl operating magnet; an "odd" pawl operating magnet; and means to control which magnet will operate and the time of its operation to thereby cause the operation of one or the other of the pawls to arrest the differential member in the desired position.

12. In a machine of the class described, the combination of a differential member settable to any one of a plurality of alternate "odd" and "even" positions; a plurality of projections on said member equal in number to the "odd" or the "even" positions to which the member may be set; a first pawl selectively cooperable with the projections at different times during the operation of the member to arrest the member in any of its "even" positions; a second pawl selectively cooperable with the projections at different times during the operation of the member and so located relatively to the first pawl as to arrest the member in its "odd" positions; and means to control which pawl will operate and the time of its operation to thereby control the position to which the differential member will be set, said means including a magnet for operating each pawl, operating circuits for the magnets, control means for preparing the circuits to the magnets according to the position in which it is desired to arrest the member, and a circuit-closing member movable synchronously with the member and operable to complete the prepared circuit to cause the proper magnet to operate at the proper time to cause the member to be arrested in the desired position.

13. In a device of the class described, the combination of a member differentially settable to a plurality of positions; means to arrest the member in any of said positions; switching mechanism including a plurality of contacts, which contacts are located in positions corresponding to the positions to which the member may be set and are so arranged that the contacts corresponding to alternate positions of the member form separate sets, a common contact for each of said sets, and a pair of wiper contact arms movable past the plurality of contacts one after another in succession and operable to connect the contacts in the two sets alternately to their related common contacts; a pair of magnets selectively operable to operate said arresting means, one of said magnets being connected to each of said common contacts; control means for selectively preparing a circuit to the contact in the position corresponding to the one in which it is desired to arrest the member, which circuit will be completed through the proper magnet when the wiper contact arm connects the contact to which the circuit has been prepared, to its common contact to which the magnet is connected; and means to drive the wiper contact arms in synchronism with the member to engage the various contacts as the member approaches their related positions to enable the circuit to the proper magnet to be completed at the proper time in the operation of the member to enable the magnet to operate the arresting means and position the member in the required position.

14. In an apparatus of the class described, the combination of a member movable different distances to different positions; means to arrest the member in different positions and including a pair of magnets for arresting the member in alternate positions; and means to control the arresting means, including a timing switch containing a plurality of contacts which correspond to the different positions to which the member may be moved, the contacts for alternate positions forming separate sets and each contact being wide enough to overlap the preceding contact in the other set, a pair of wiper contact arms, one related to each set and driven in synchronism with the member to engage the various contacts as the member approaches their relative positions, said arms completing, at the proper time in the operation of the member, a prepared circuit from any selected one of the contacts to its related proper magnet, the provision of two sets of contacts which overlap enabling contact to be made early enough and long enough to allow the proper magnet sufficient time to operate and cause the arresting means to stop the member in the desired position, and circuits which may be selectively prepared to any contact according to the position in which the member is to be arrested.

15. In a machine of the class described, the combination of a member movable different extents from a normal position to any of a plurality of alternate "odd" and "even" positions; means, including an operating magnet, to arrest the member in different "odd" positions; means, including an operating magnet, to arrest the member in different "even" positions; and control means for said magnets, including a set of individual contacts located in positions corresponding to the "even" positions of the member, a set of individual contacts located in positions corresponding to the "odd" positions of the member, a common contact for each set of contacts and to which the related magnet is connected, means to prepare a circuit to any individual contact according to the position in which it is desired to arrest the member, a wiper contact arm movable with the member from normal position to engage the "even" individual contacts in succession to connect them to their related common contact to enable a circuit from any prepared "even" individual contact to be completed through its related magnet, and a wiper contact arm movable with the member from a normal position to engage the "odd" individual contacts in succession to connect them to their related common contact as the member reaches related positions and to enable a circuit from any prepared "odd" individual contact to be completed through its related magnet, the individual contacts of the two sets of contacts being sufficiently wide that they overlap, thus enabling a wiper contact arm to make contact with an individual contact in one set before the other wiper contact arm has left the preceding individual contact of the other set, thereby enabling a wiper contact arm to make contact with a prepared individual contact early enough in its movement and long enough to complete the circuit to its related magnet to allow the magnet sufficient time to operate the arresting means and stop the member in the desired position.

16. In a machine of the class described, the combination of a differential member settable to any one of a plurality of alternate "odd" and "even" positions; a plurality of projections on said member equal in number to the "odd" or the "even" positions to which the member may

be set; a first pawl selectively cooperable with the projections at different times during the operation of the member to arrest the member in any of its "even" positions; a second pawl selectively cooperable with the projections at different times during the operation of the member and so located relatively to the first pawl as to arrest the member in its "odd" positions; and means to control which pawl will operate and the time of its operation to thereby control the position to which the differential member will be set, said means including a magnet for operating each pawl, a plurality of contacts which correspond to the different positions to which the member may be set, the contacts for the "even" positions and the contacts for the "odd" positions forming separate sets and each contact being wide enough to overlap the preceding contact in the other set, selectively operable circuit controlling means to prepare a circuit to any one of the individual contacts according to the position to which the member is to be set, a pair of wiper contact arms, one for each set of contacts, for completing the prepared circuit from the individual contact to its related magnet, and means to drive the wiper contact arms in synchronism with the movement of the member so that they will engage the contacts corresponding to the various positions of the member as the member moves toward those positions, the provision of two sets of contacts which overlap enabling the prepared circuit to be completed long enough and early enough to allow the magnet therein sufficient time to move its pawl into engagement with the proper one of the projections on the member to stop the member in the desired position.

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