

Sept. 21, 1937.

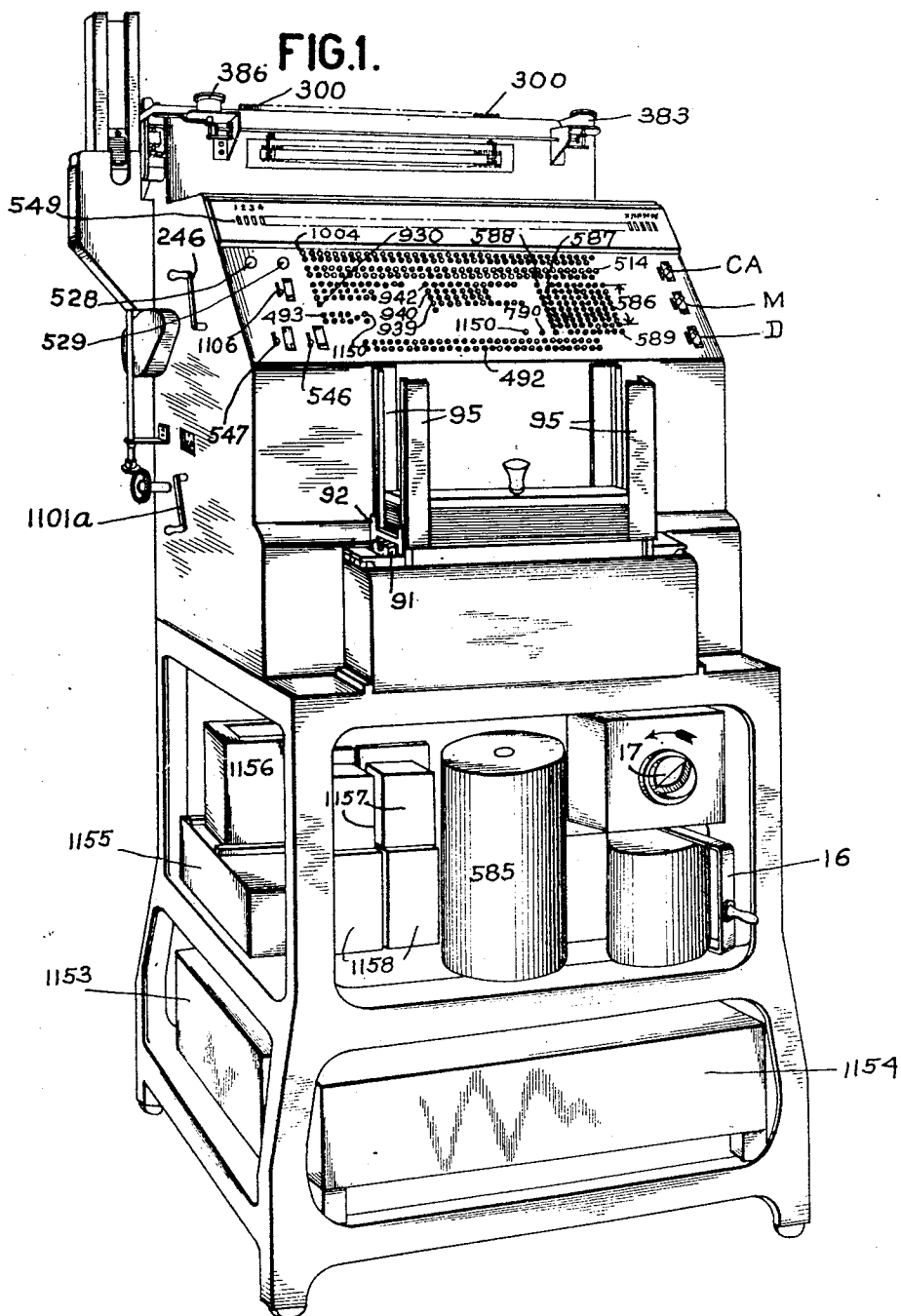
G. TAUSCHEK

2,093,529

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INVENTOR

Gustav Tauschek

BY *his* ATTORNEY

W. M. Wilson

Sept. 21, 1937.

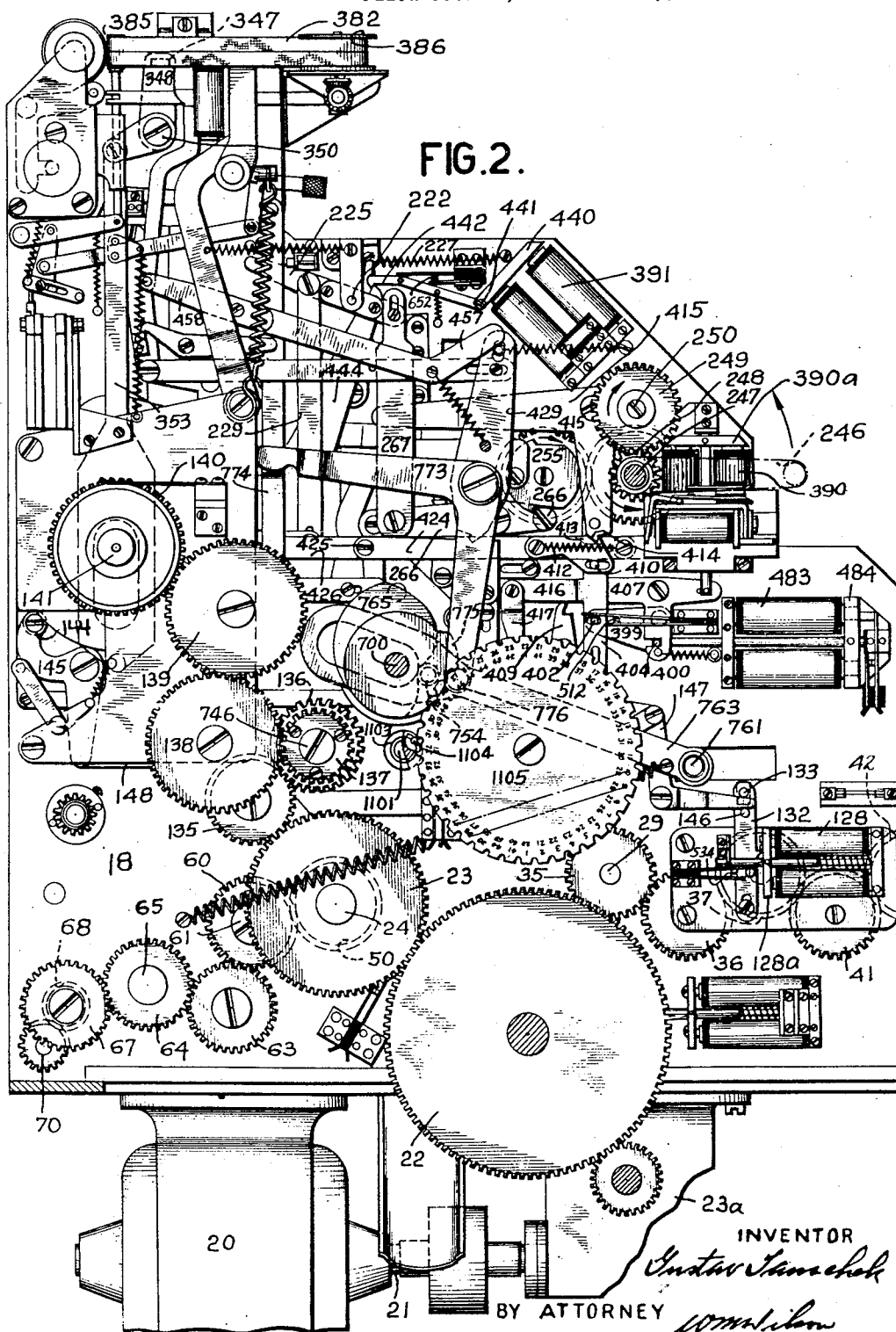
G. TAUSCHEK

2,093,529

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Sept. 21, 1937.

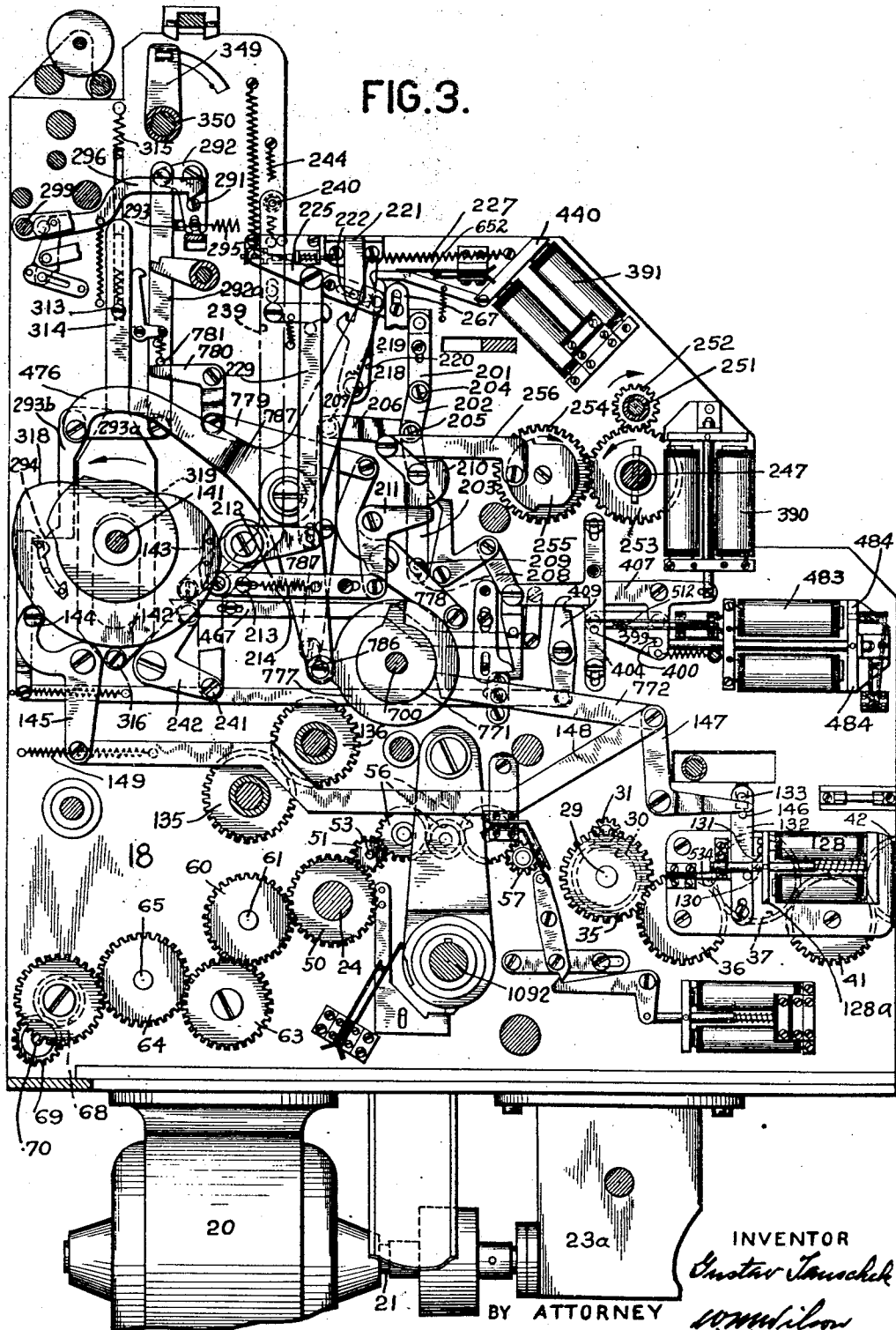
G. TAUSCHEK

2,093,529

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INVENTOR

Ernst Tausch

BY ATTORNEY

condition

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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FIG. 4.

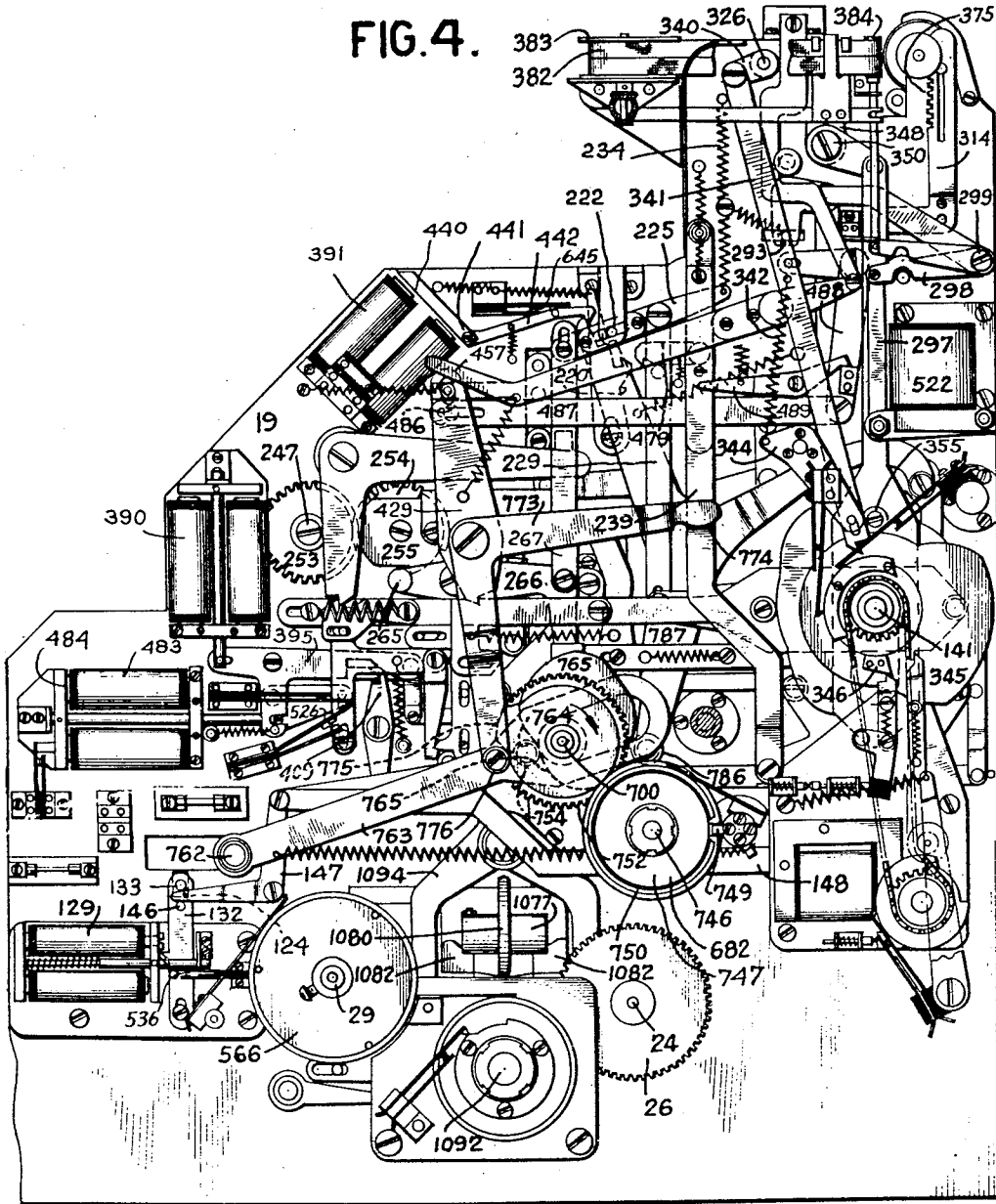
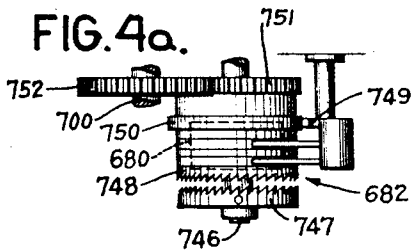


FIG. 4a.



INVENTOR
Gustav Tauschek

BY *h* ATTORNEY

Wm. H. Wilson

Sept. 21, 1937.

G. TAUSCHEK

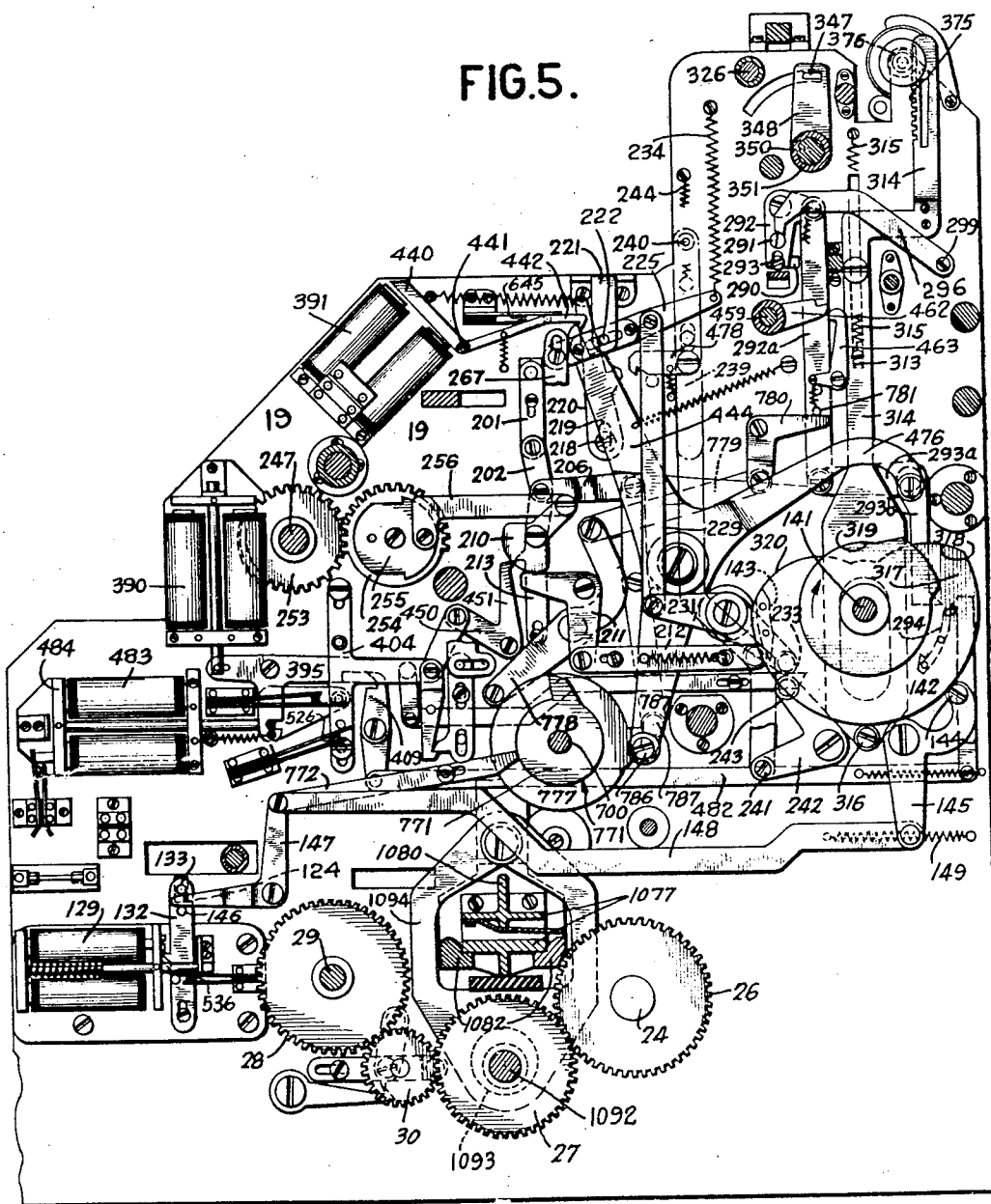
2,093,529

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FIG. 5.



INVENTOR

Gustav Tauschek

BY *his* ATTORNEY

W. M. Wilson

Sept. 21, 1937.

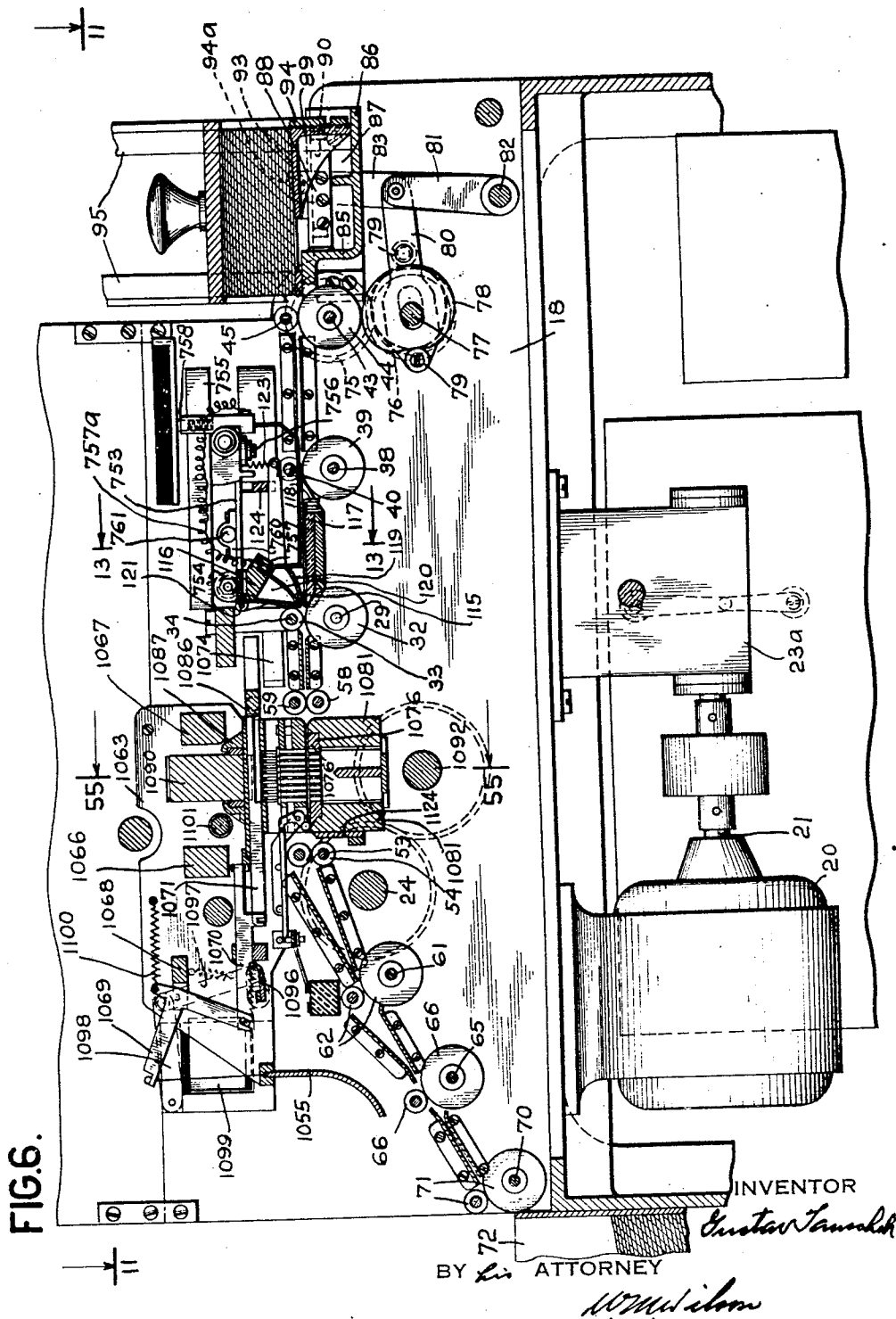
G. TAUSCHEK

2,093,529

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G. TAUSCHEK

TABULATING MACHINE

Filed Oct. 11, 1932

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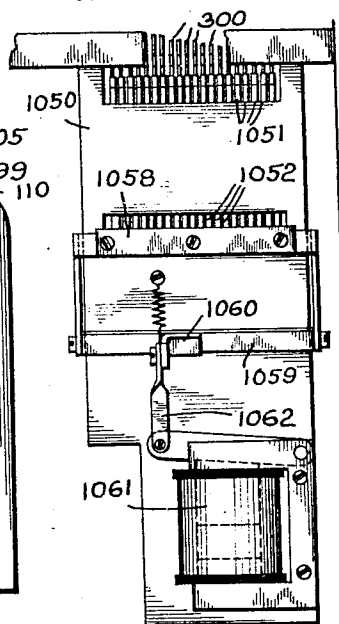
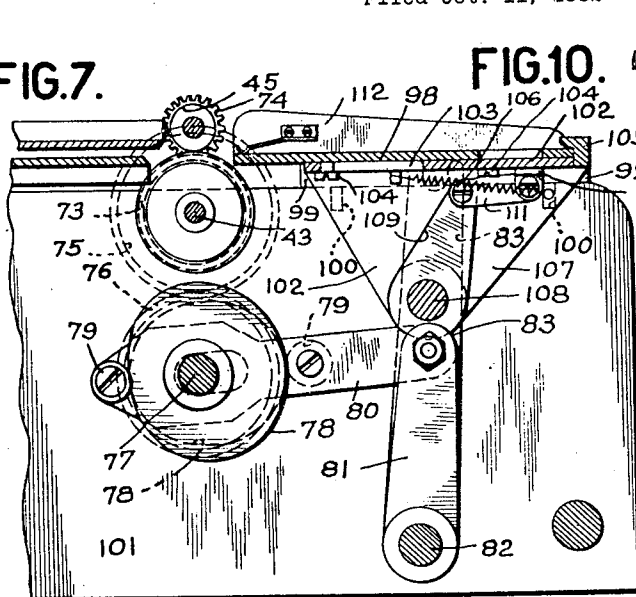


FIG.8.

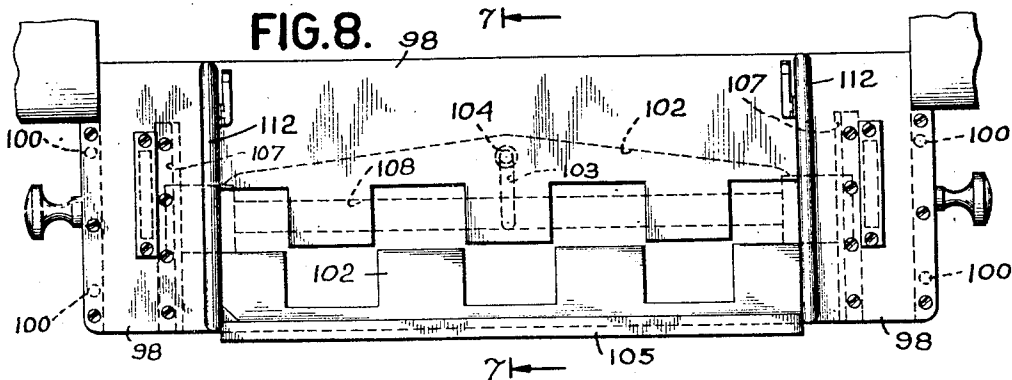
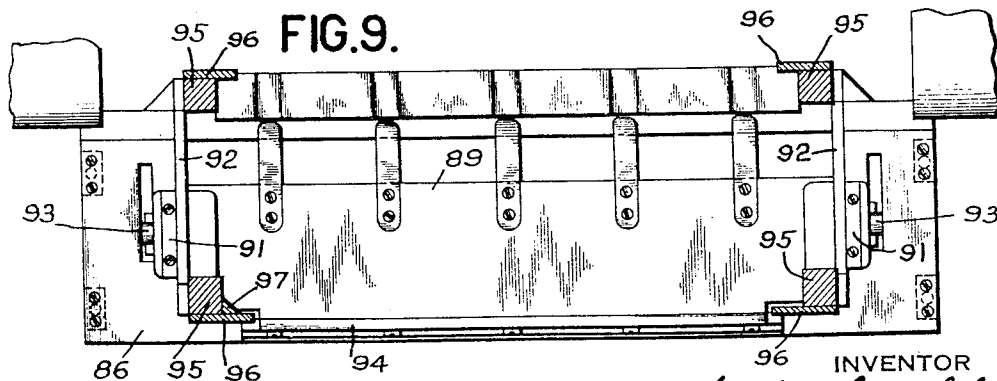


FIG.9.



INVENTOR

Gustav Tanchek

BY *his* ATTORNEY

Wormilow

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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35 Sheets-Sheet 8

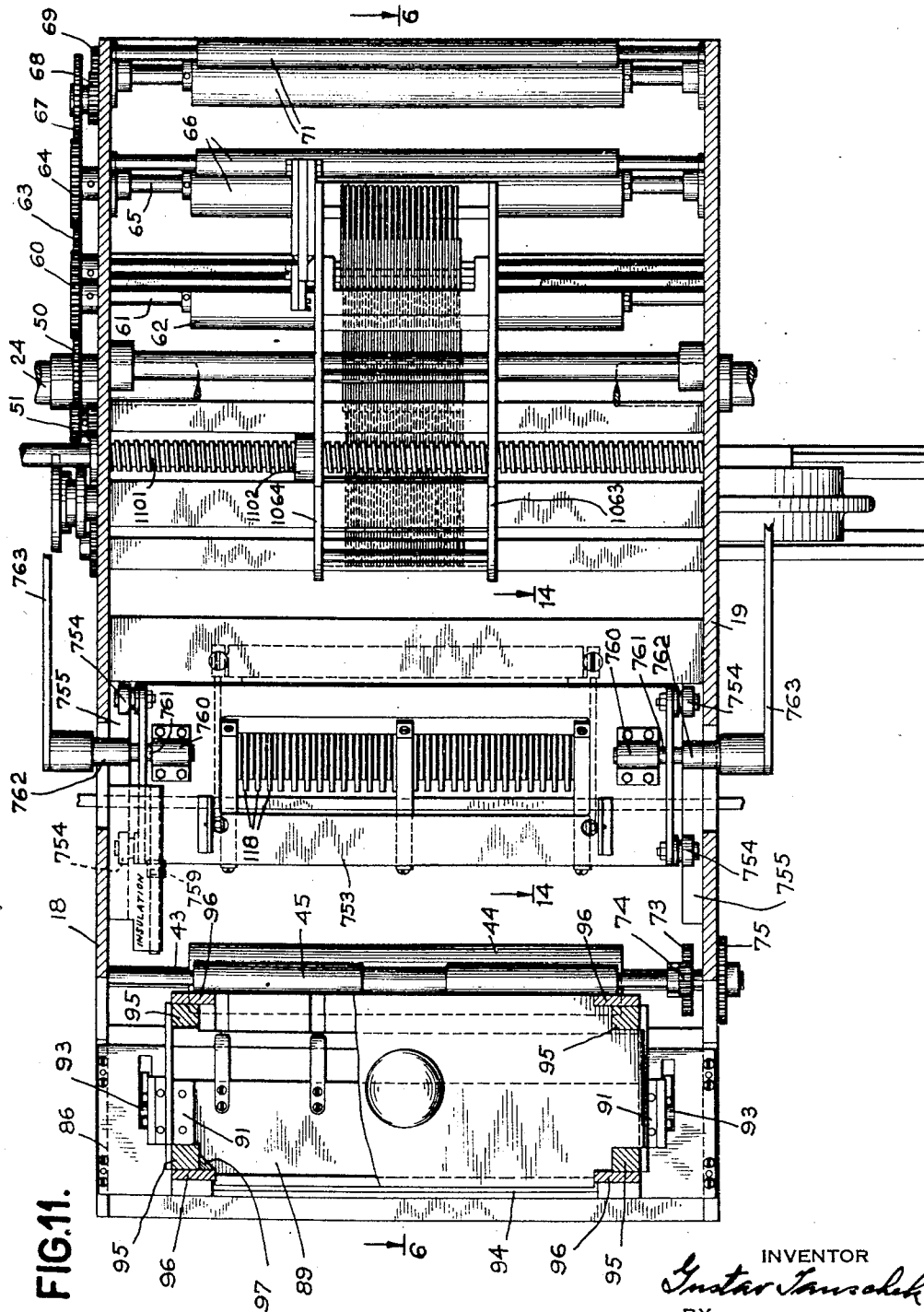


FIG. 11.

INVENTOR
Gustav Tauschek
BY
W. M. Wilson
ATTORNEY

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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FIG.13.

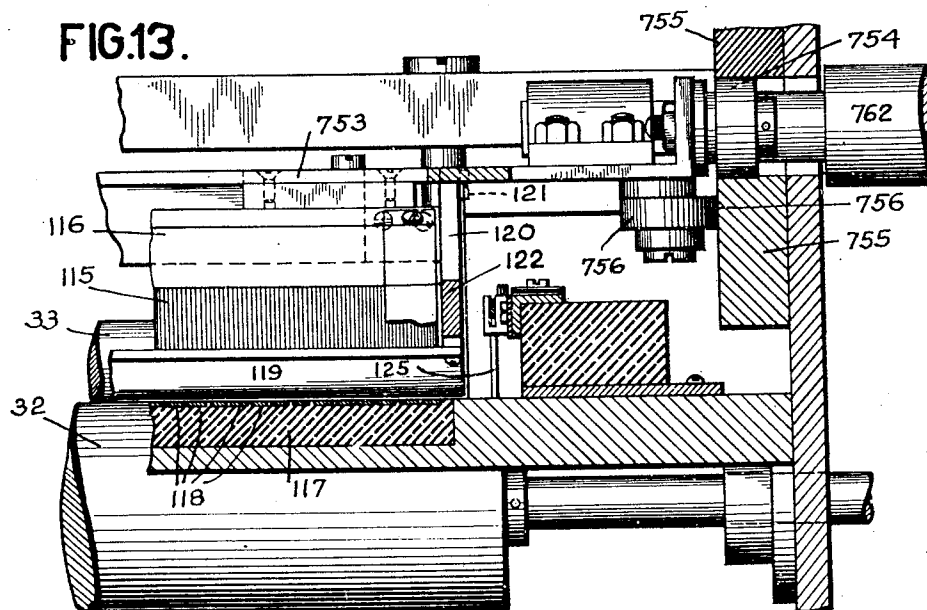


FIG.12.

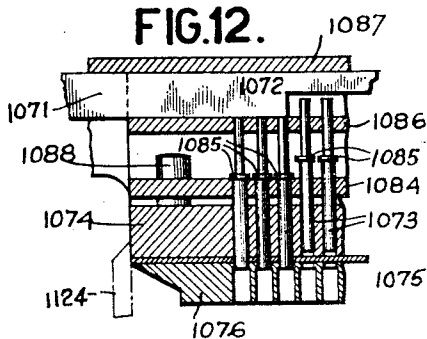


FIG.14.

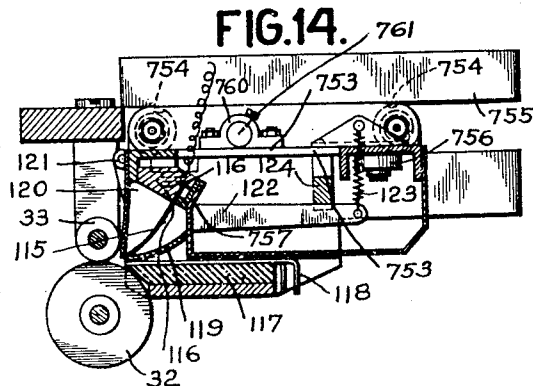


FIG.15.

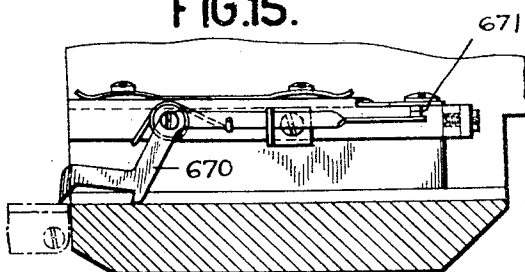
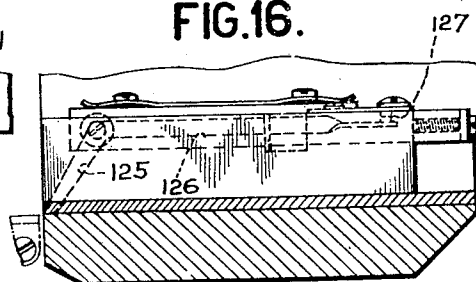


FIG.16.



INVENTOR

Gustav Tauschek

BY *his* ATTORNEY

W. M. Wilson

Sept. 21, 1937.

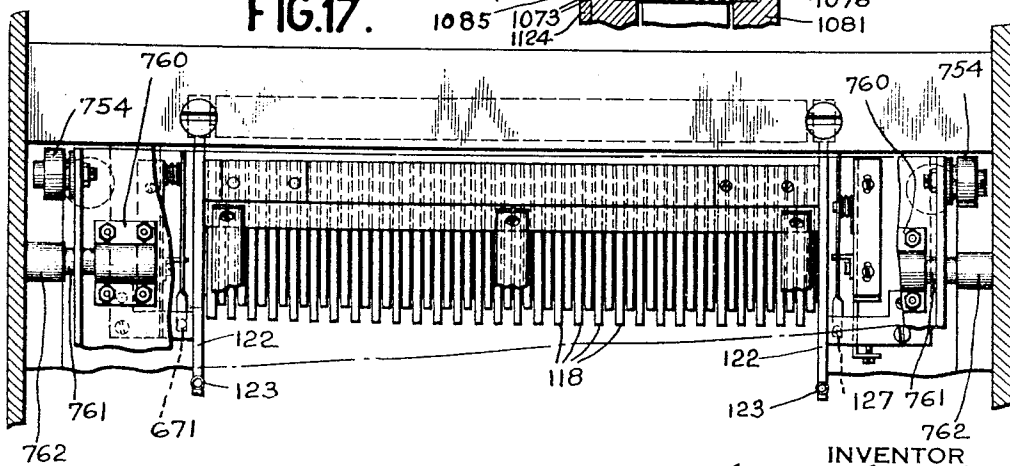
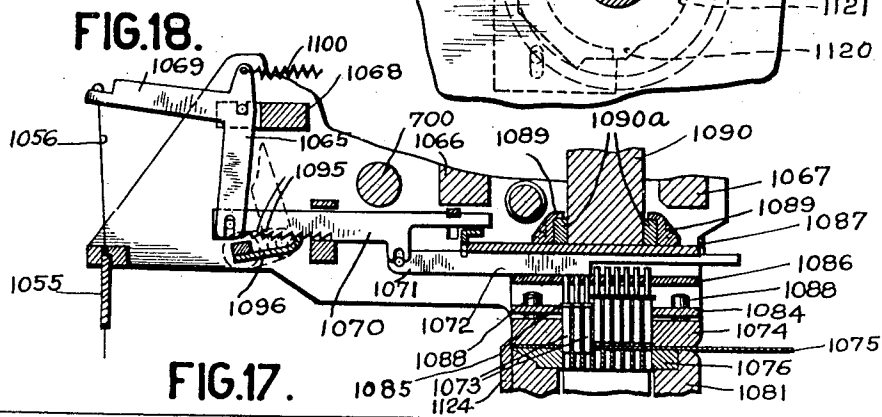
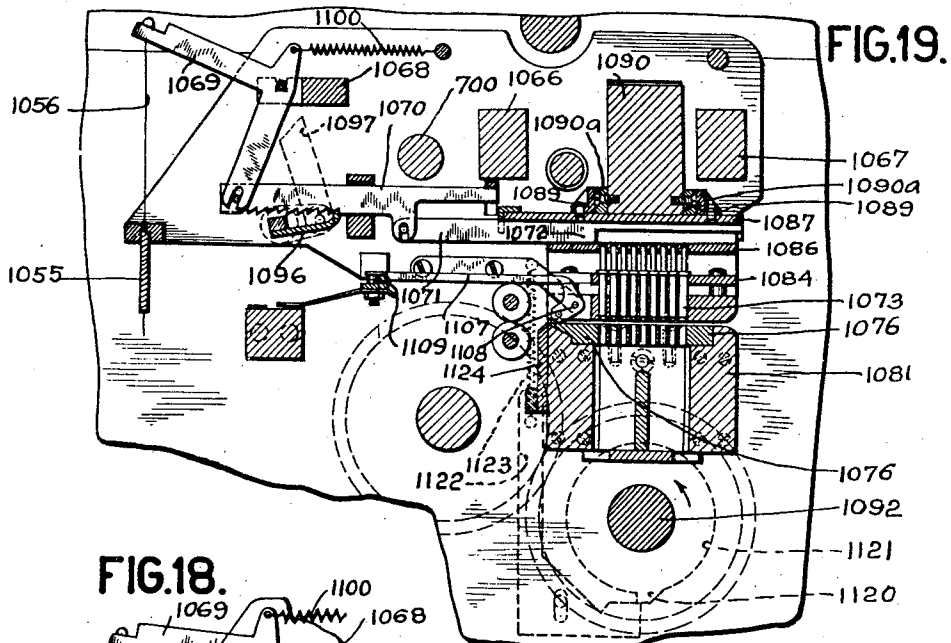
G. TAUSCHEK

2,093,529

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Sept. 21, 1937.

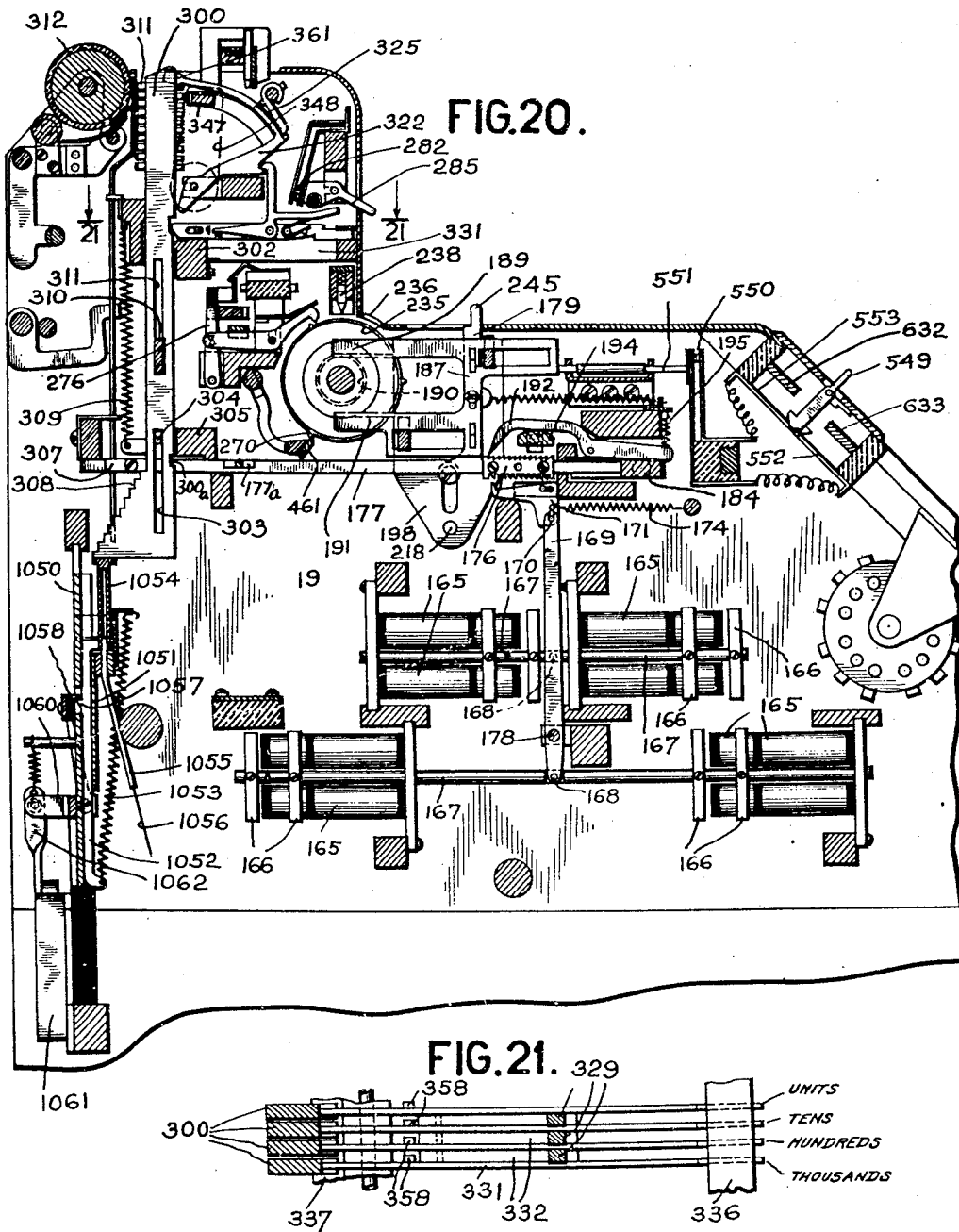
G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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INVENTOR
Gustav Tauschek
BY *hi* ATTORNEY
W. M. Wilson

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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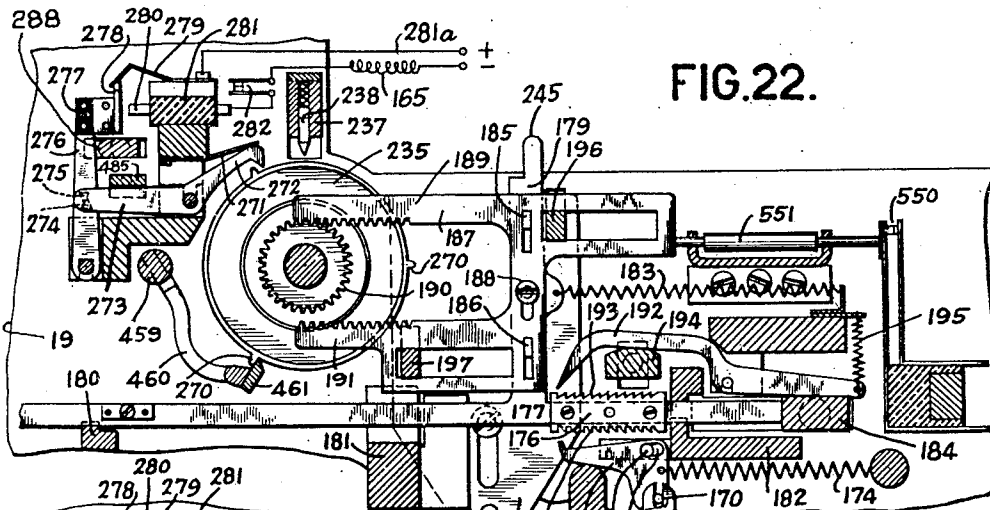


FIG.22.

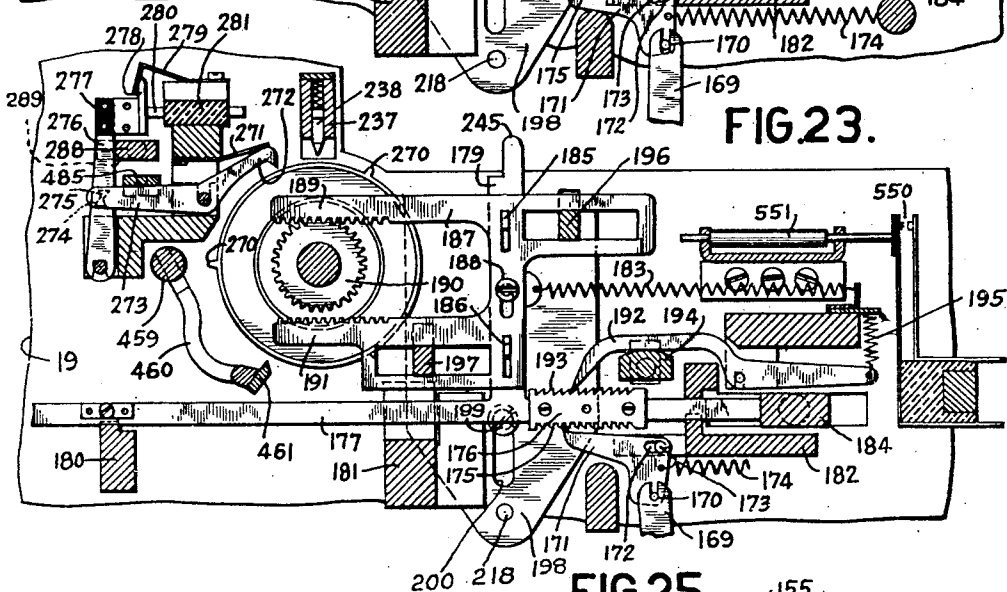


FIG.23.

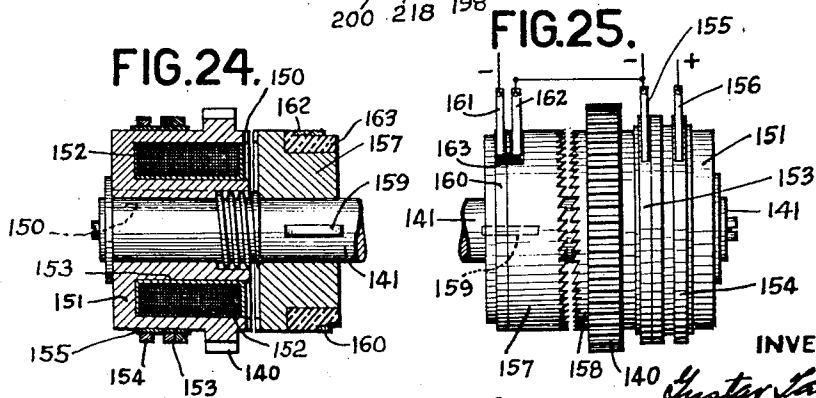


FIG.24.

FIG.25.

INVENTOR

BY *his* ATTORNEY

Wm Wilson

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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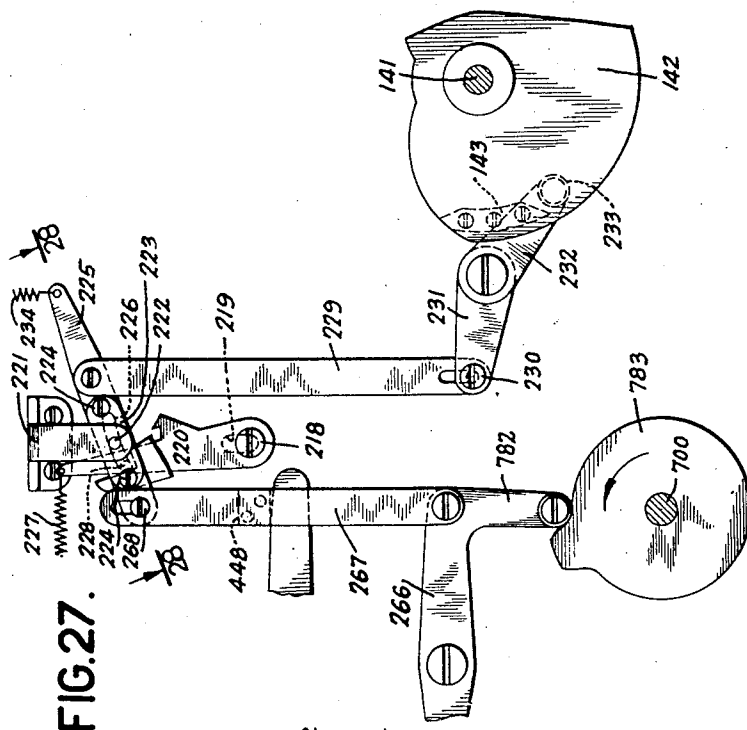


FIG. 27.

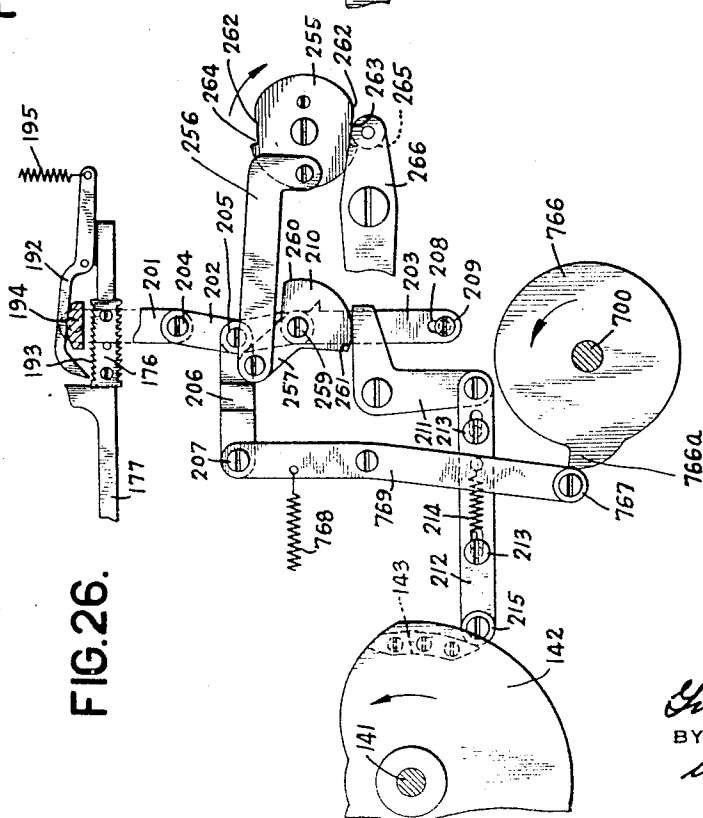


FIG. 26.

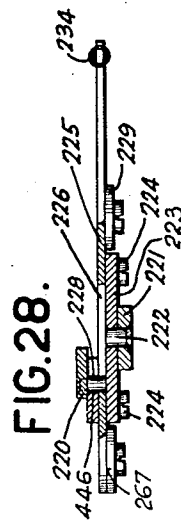


FIG. 28.

INVENTOR
Gustav Tauschek
BY
Wm. M. Wilson
ATTORNEY

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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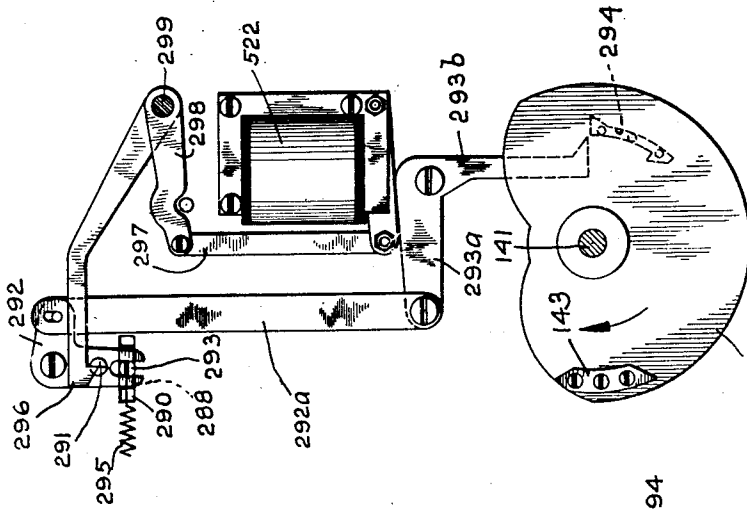
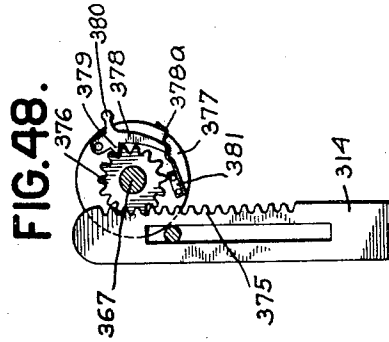
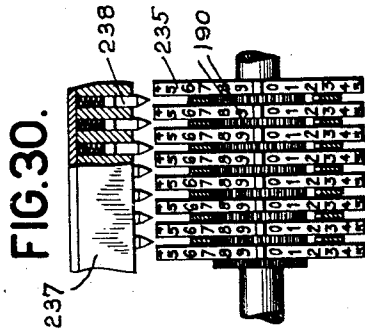


FIG. 31.

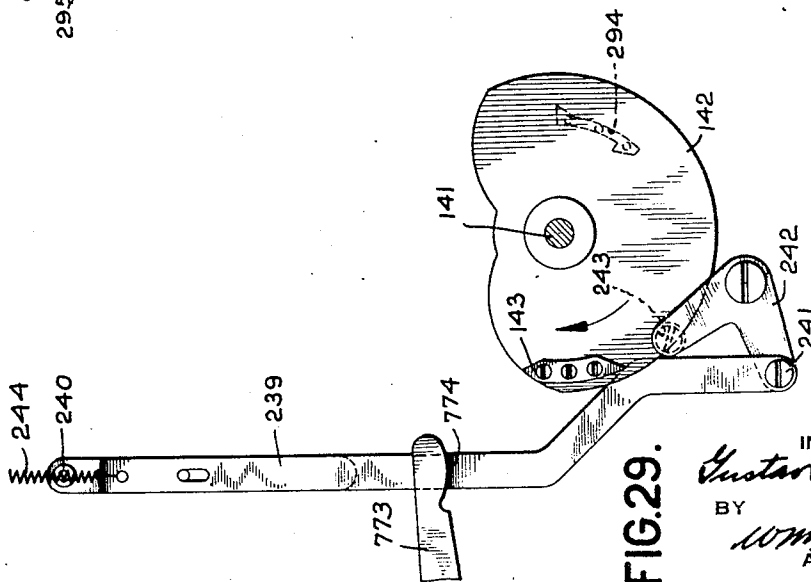


FIG. 29.

INVENTOR
Gustav Tauschek
BY
Wm. Wilson
ATTORNEY

Sept. 21, 1937.

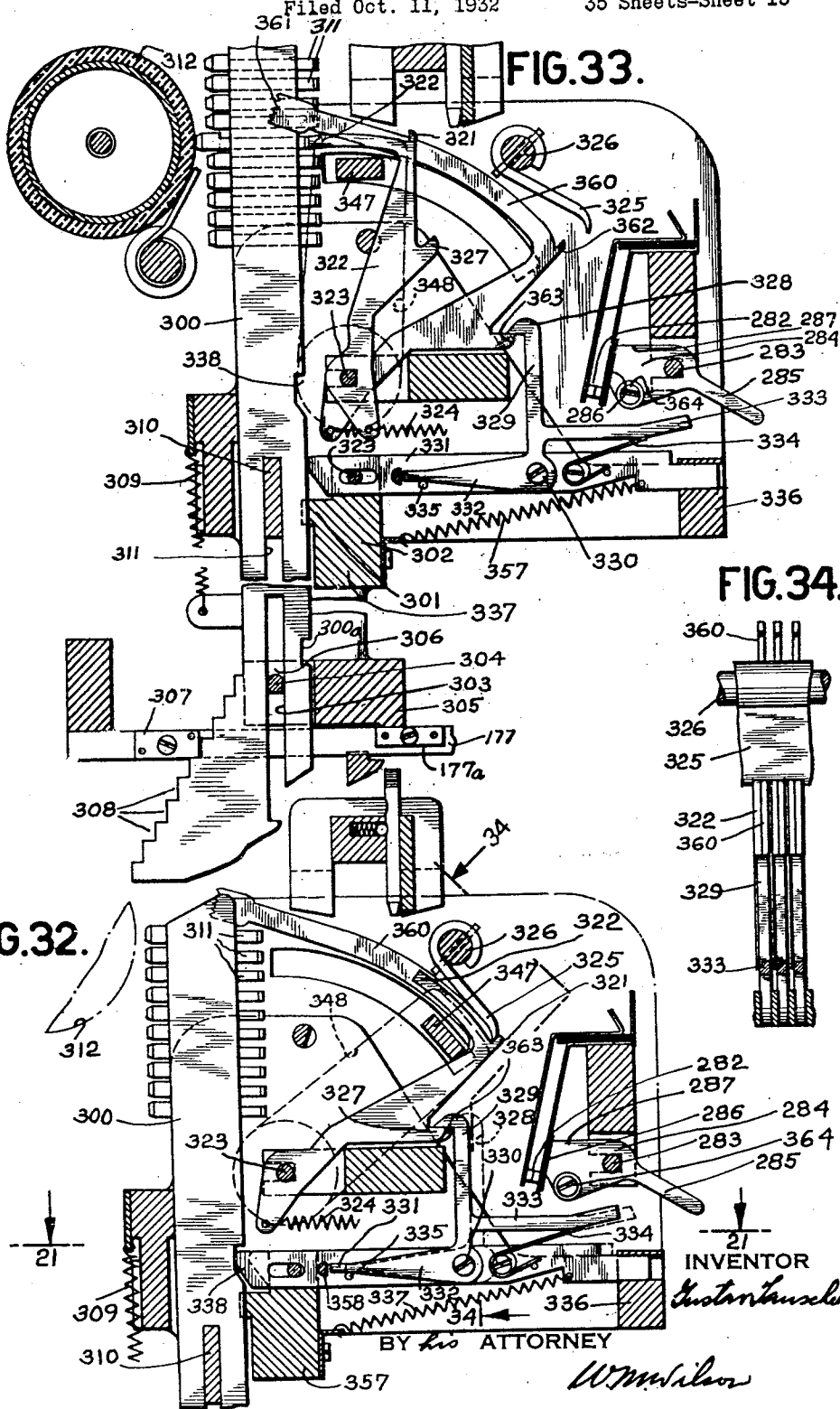
G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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Sept. 21, 1937.

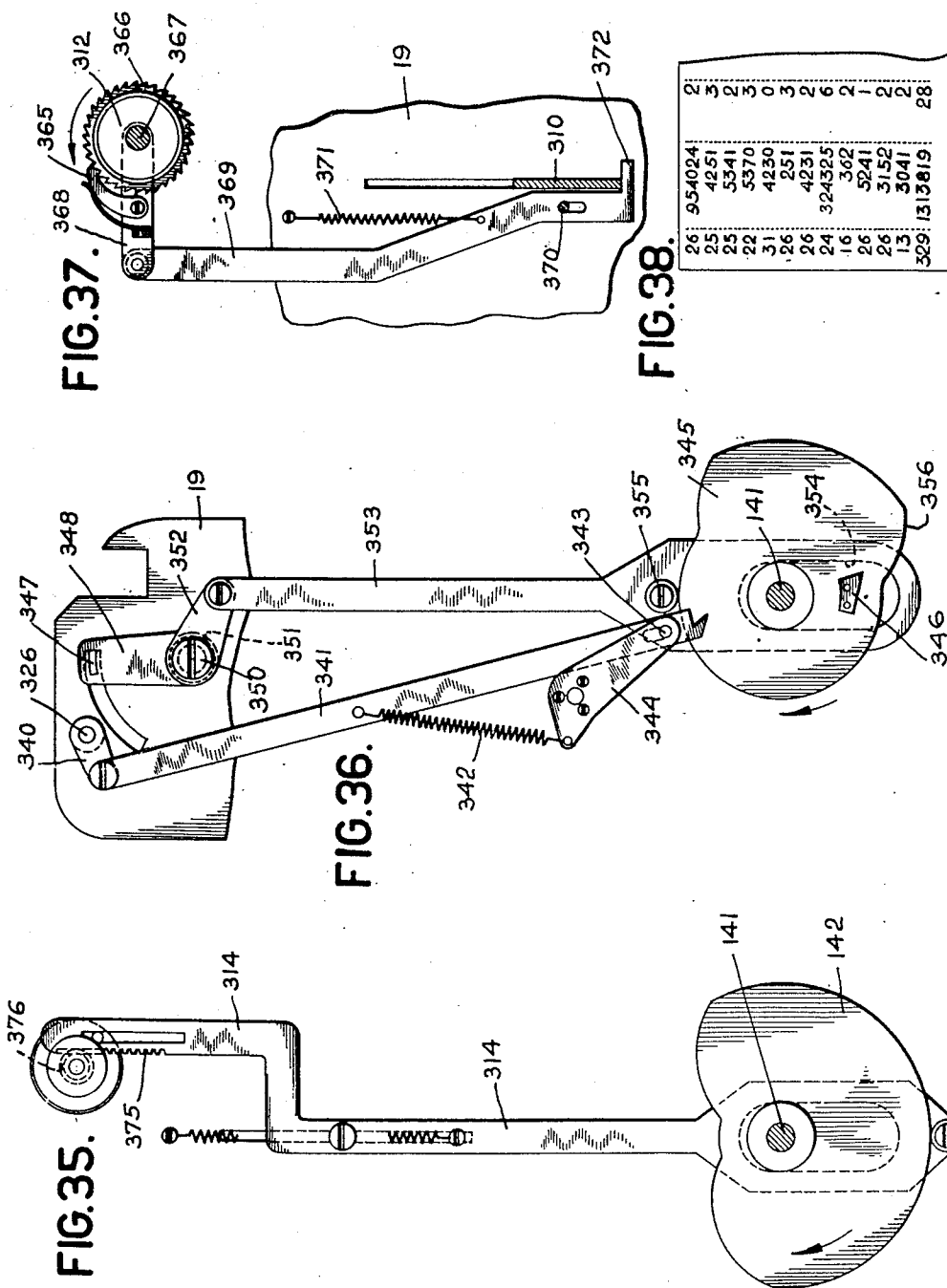
G. TAUSCHEK

2,093,529

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INVENTOR
Gustav Tauschek
BY
William
ATTORNEY

Sept. 21, 1937.

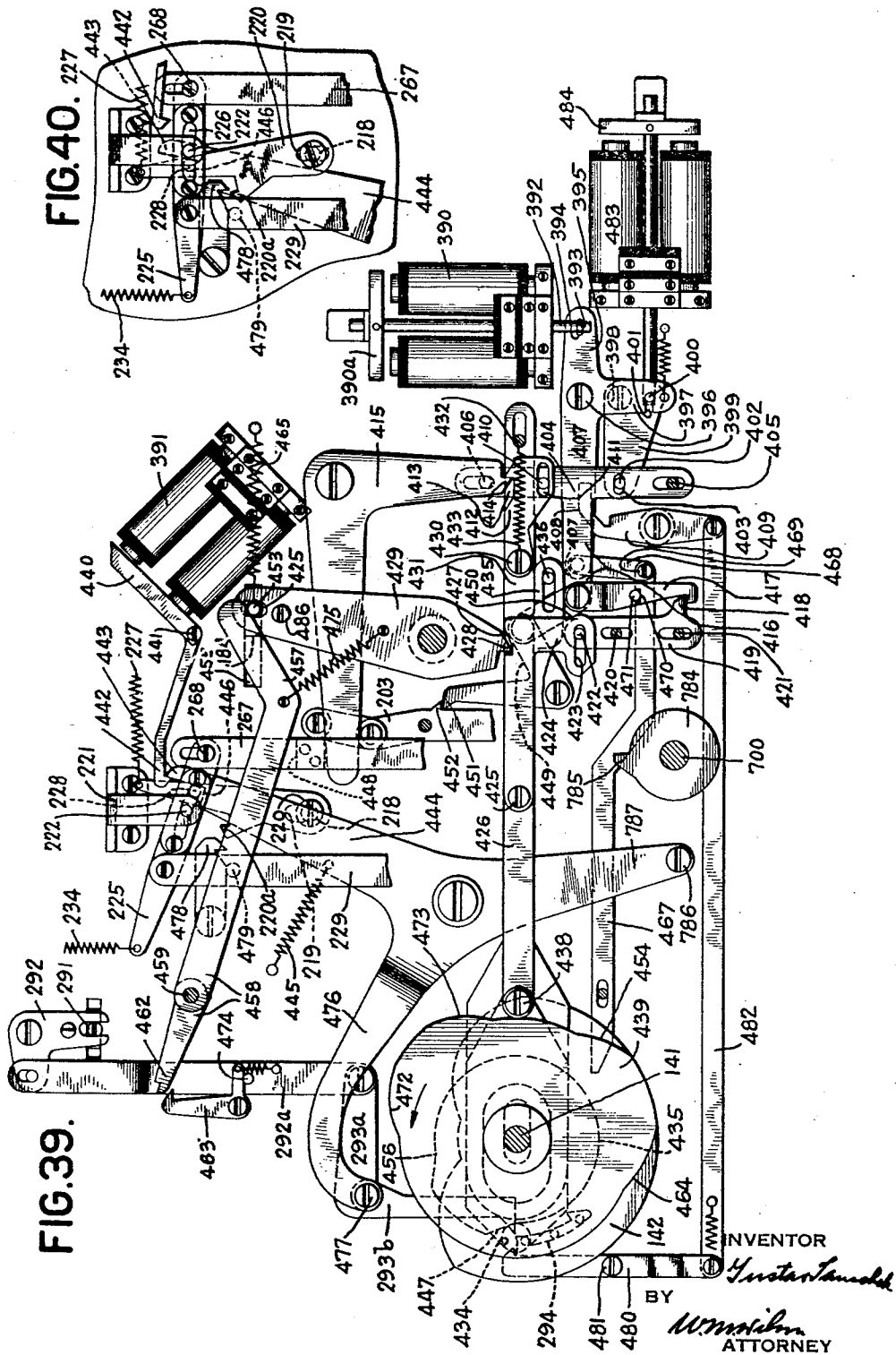
G. TAUSCHEK

2,093,529

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Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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FIG. 41.

JAN	2241	6225
FEB		
MAR		
APRIL		
MAY		
JUNE		
JULY		
AUG		
SEPT		
OCT		
NOV		
DEC		
JAN	2340	6743
FEB		
MAR		
APRIL		
MAY		
JUNE		
JULY		
AUG		
SEPT		
OCT		
NOV		
DEC		
JAN	1864	4283

FIG. 71

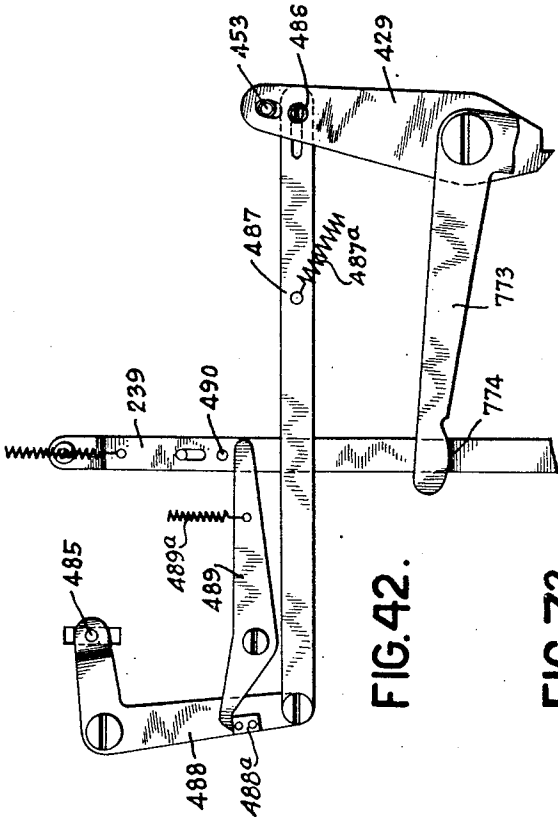
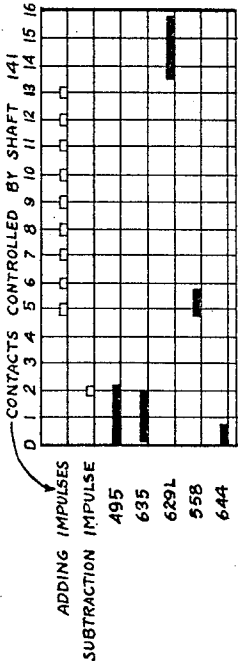
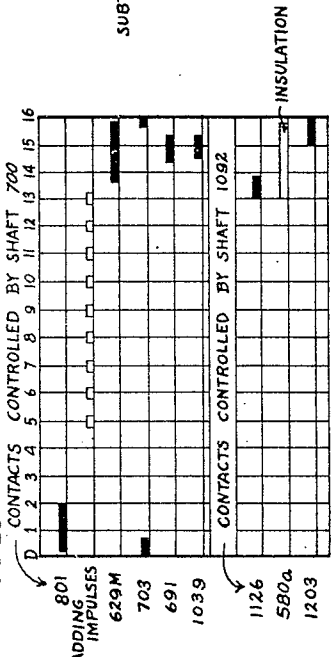


FIG. 72



INVENTOR
Gustav Tauschek
BY
W. M. Schumacher
ATTORNEY

Sept. 21, 1937.

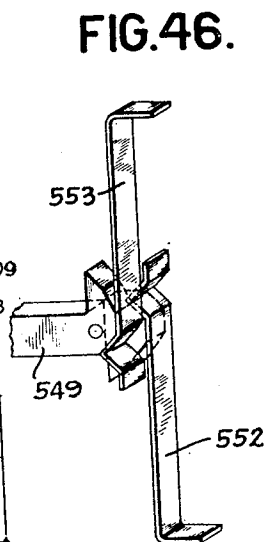
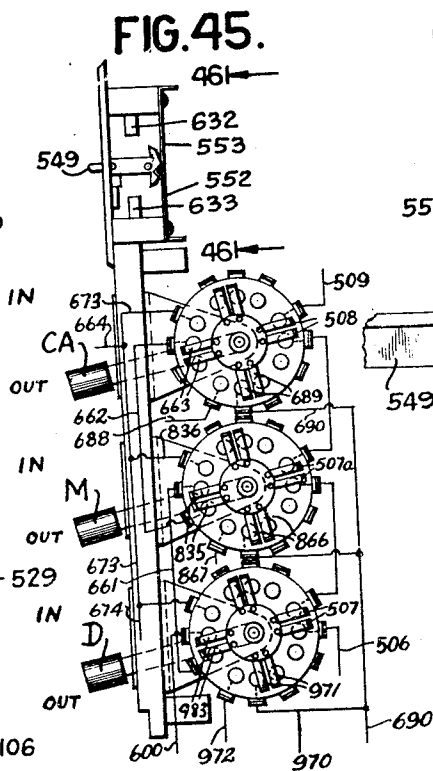
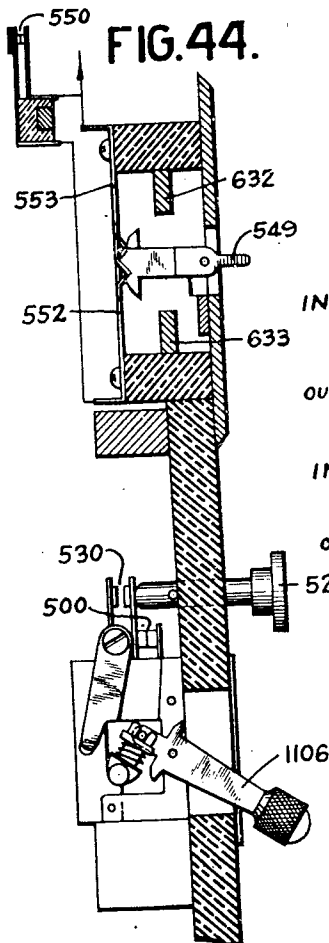
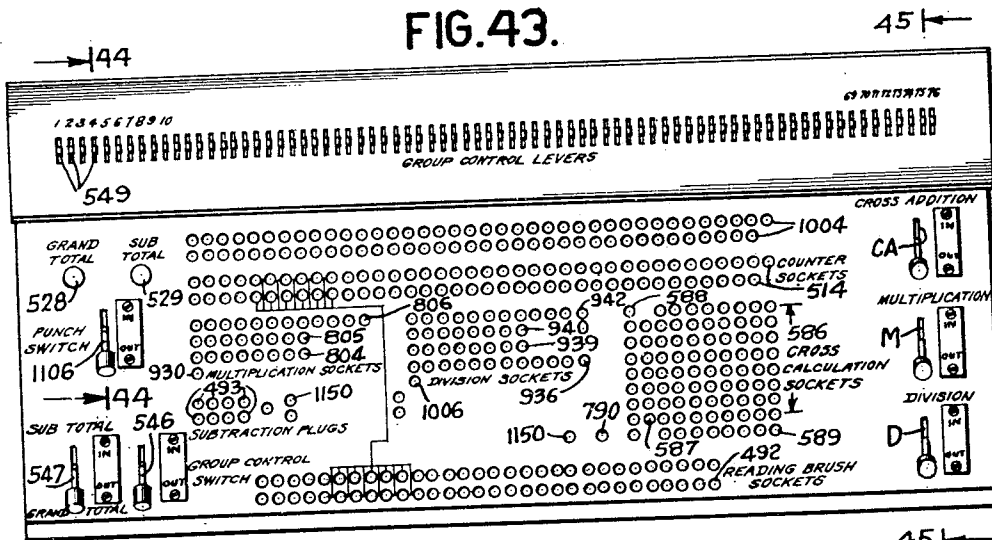
G. TAUSCHEK
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FIG. 43.



INVENTOR
Gustav Tauschek
BY *his* ATTORNEY
W. M. Wilson

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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FIG. 47.

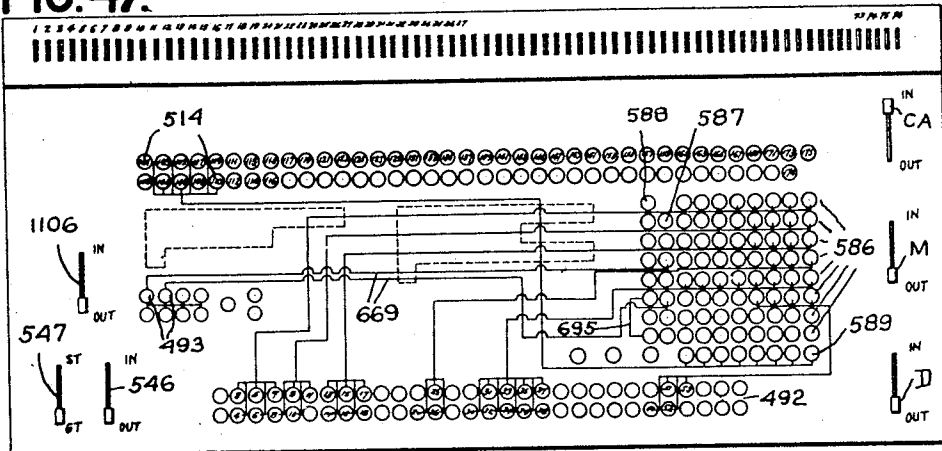


FIG. 49.

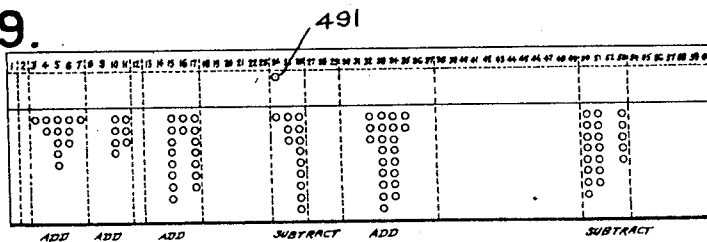
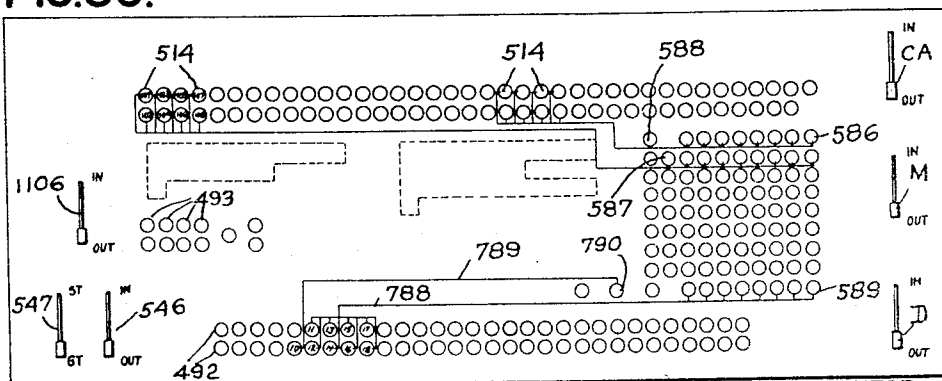


FIG. 50.



INVENTOR
Gustav Tauschek
BY
W. M. Wilson
ATTORNEY

Sept. 21, 1937.

G. TAUSCHEK

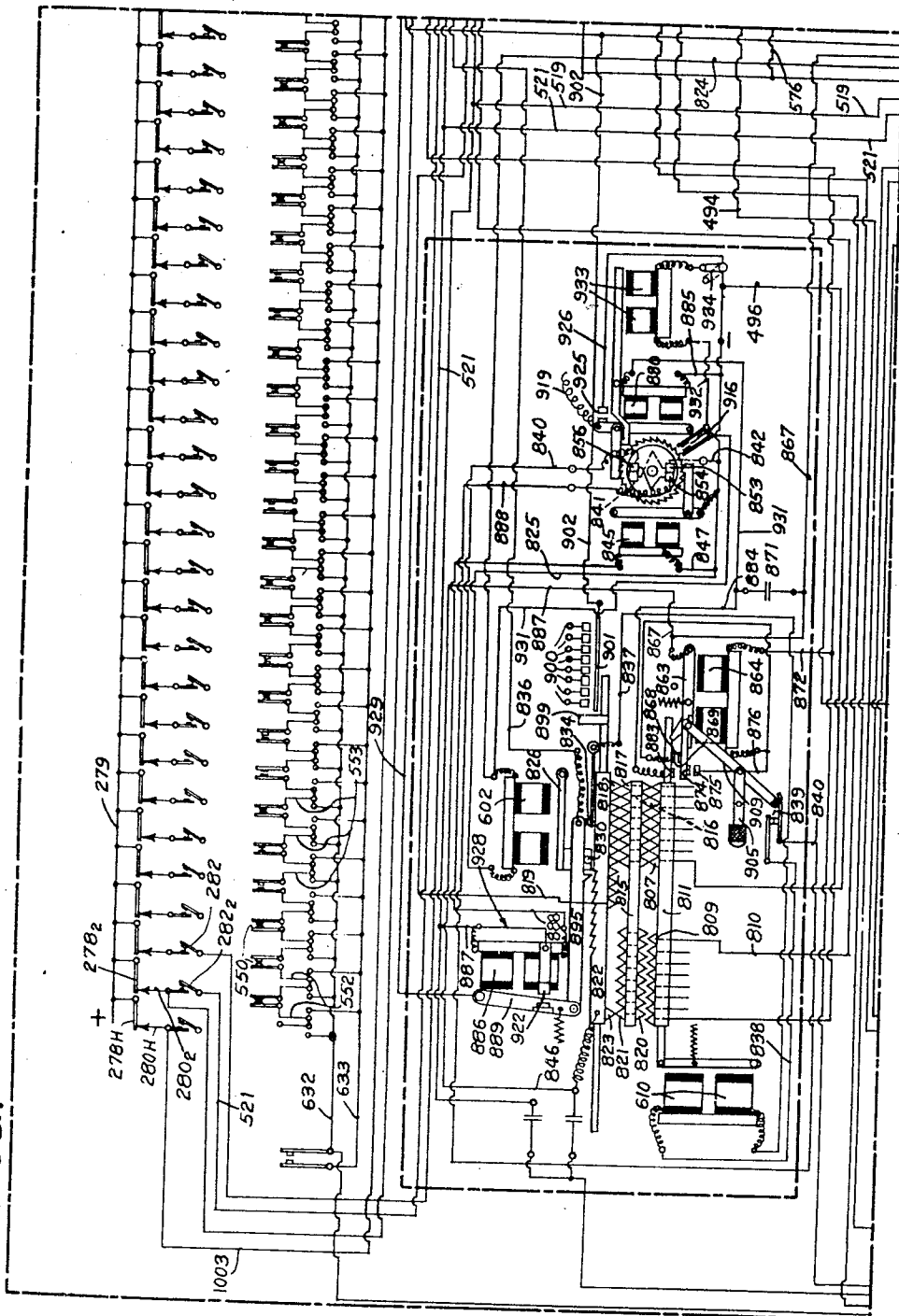
2,093,529

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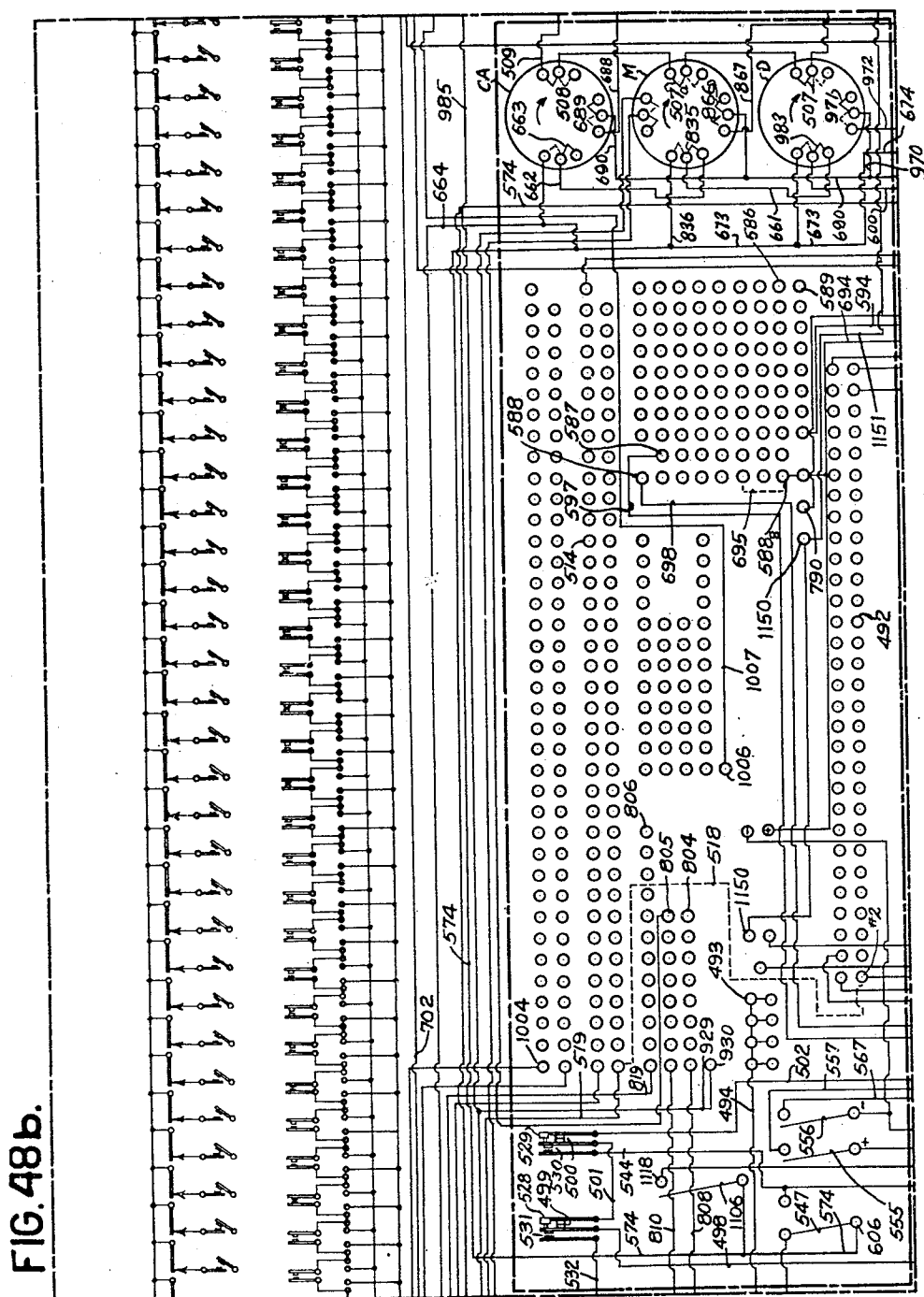
FIG. 48a.



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BY *his* ATTORNEY *Inventor* *Harrold*
Wm Wilson

Sept. 21, 1937.

G. TAUSCHEK

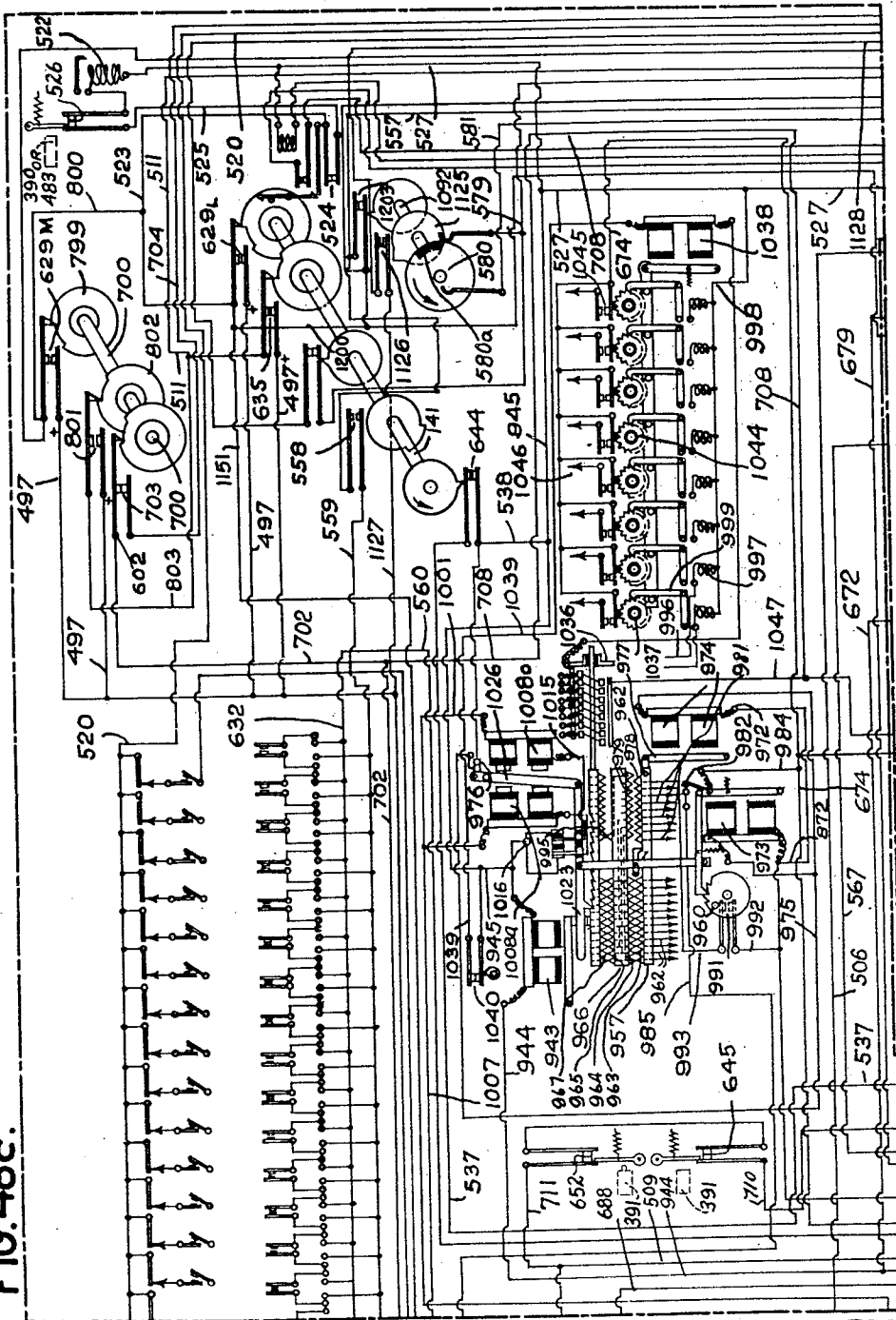
2,093,529

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FIG. 48c.



BY his ATTORNEY *Wm. Wilson* INVENTOR *Gustav Tauschek*

Sept. 21, 1937.

G. TAUSCHEK

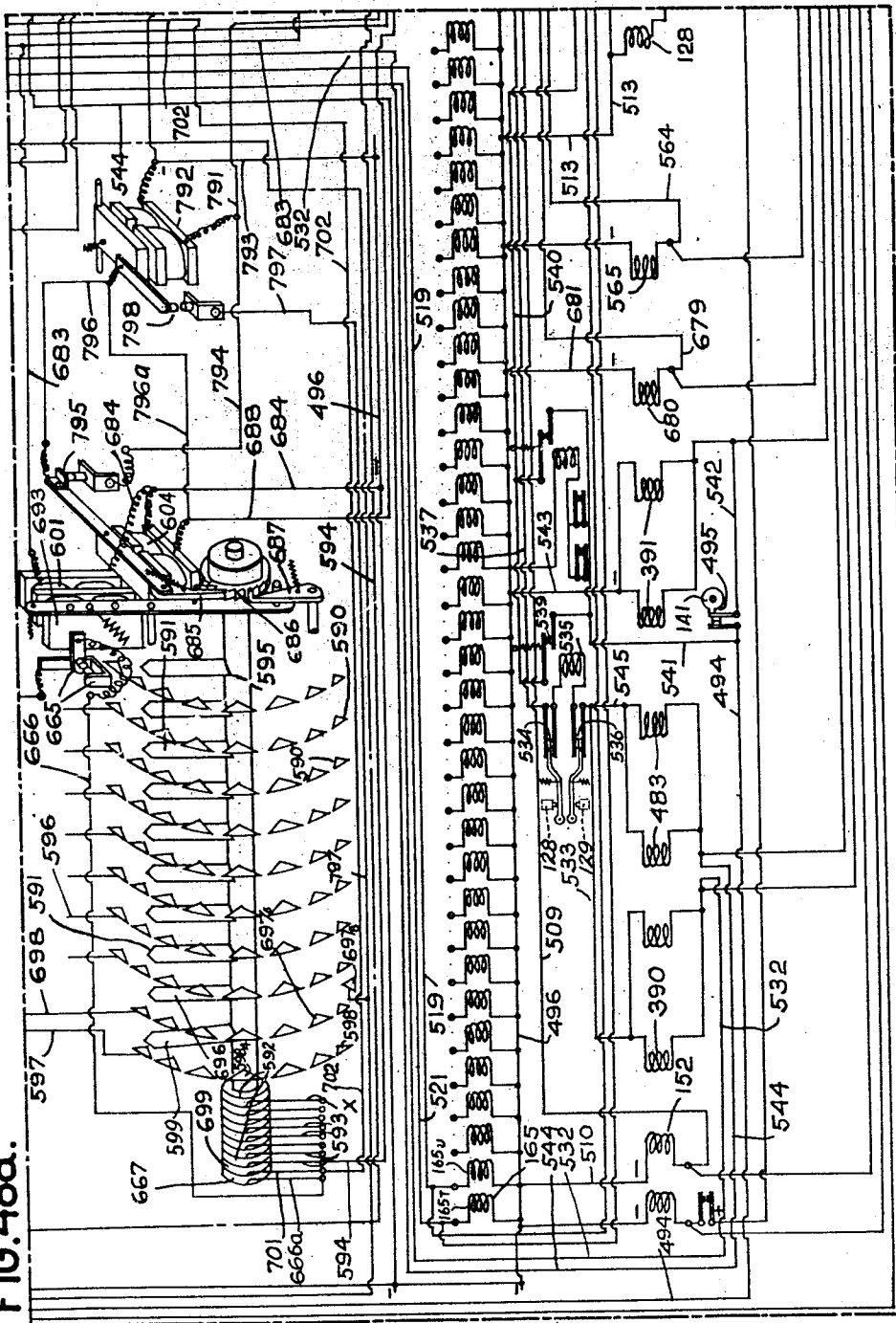
2,093,529

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FIG. 48d.



BY *his* ATTORNEY *Kustav Kuschek*
W. Wilson

Sept. 21, 1937.

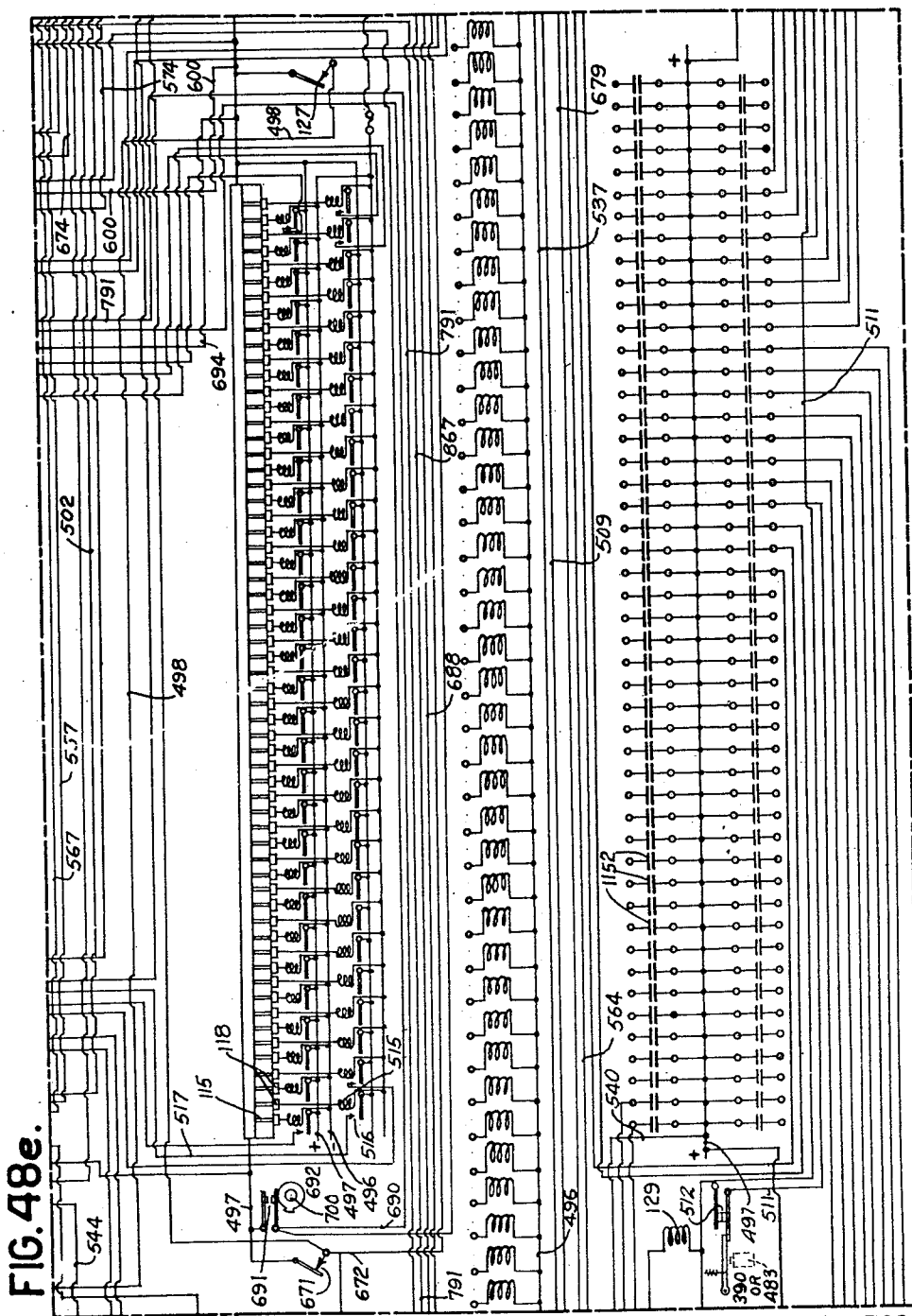
G. TAUSCHEK

2,093,529

TABULATING MACHINE

Filed Oct. 11, 1932

35 Sheets-Sheet 25



BY *his* ATTORNEY *Arthur L. Lunsdale*
Wm. Wilson INVENTOR

Sept. 21, 1937.

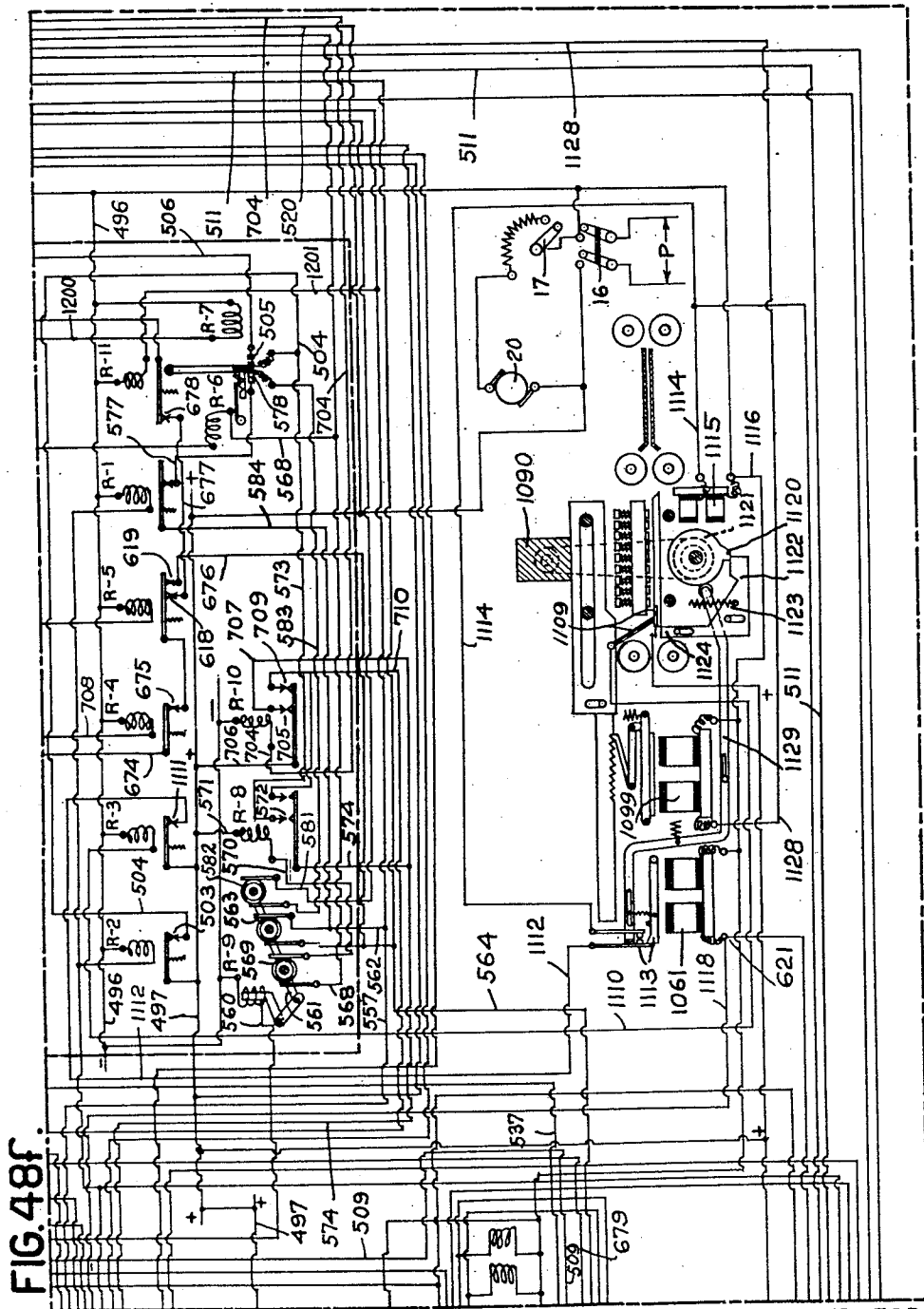
G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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BY his ATTORNEY *Gustav Tauschek*
W. W. Wilson INVENTOR

Sept. 21, 1937.

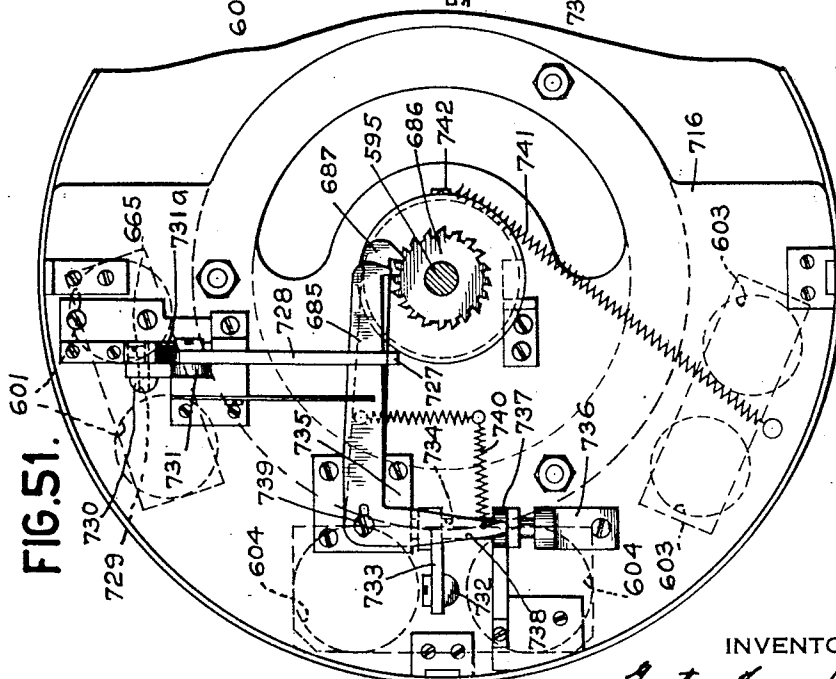
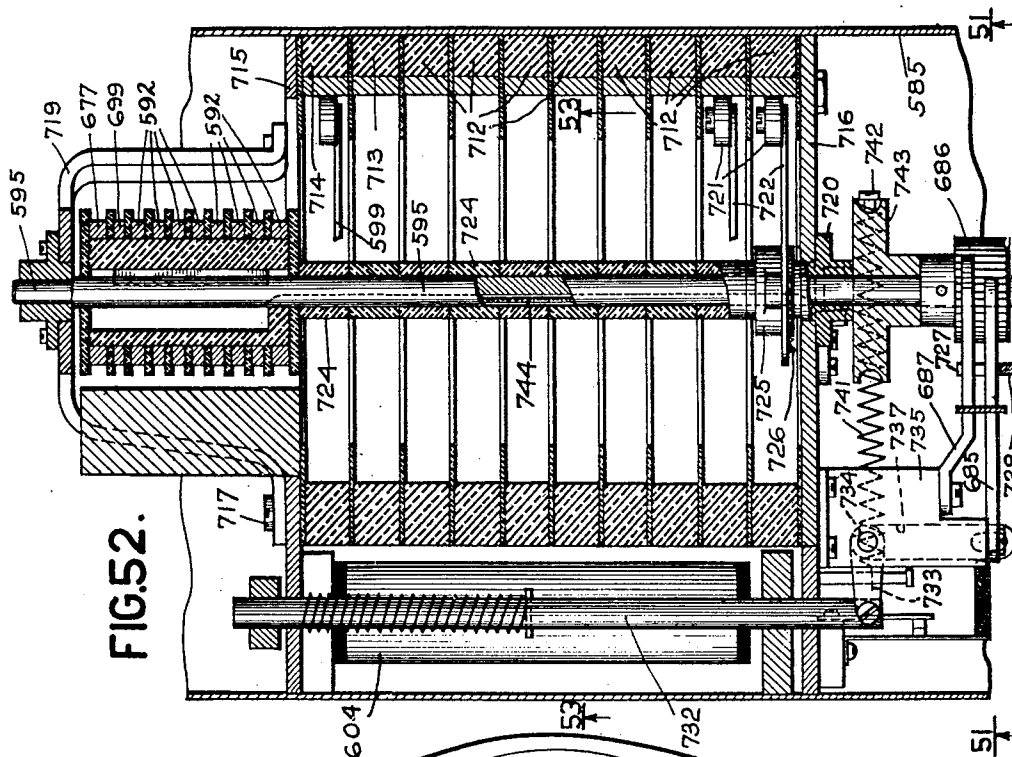
G. TAUSCHEK

2,093,529

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INVENTOR
Gustav Tauschek
BY *his* ATTORNEY
W. M. Salomon

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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FIG. 54.

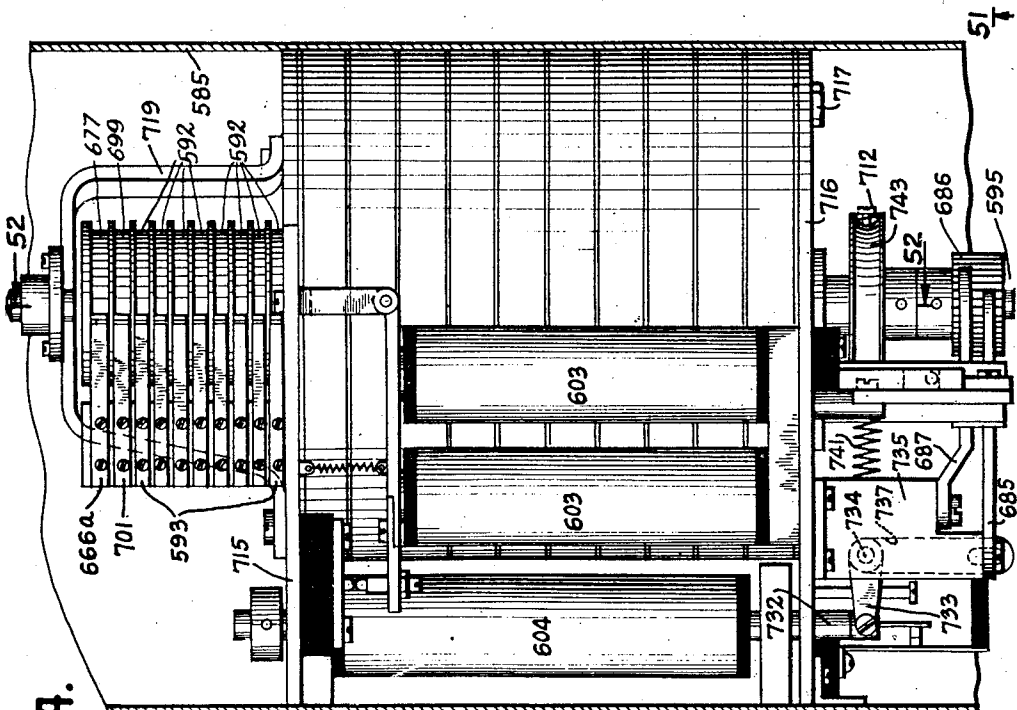
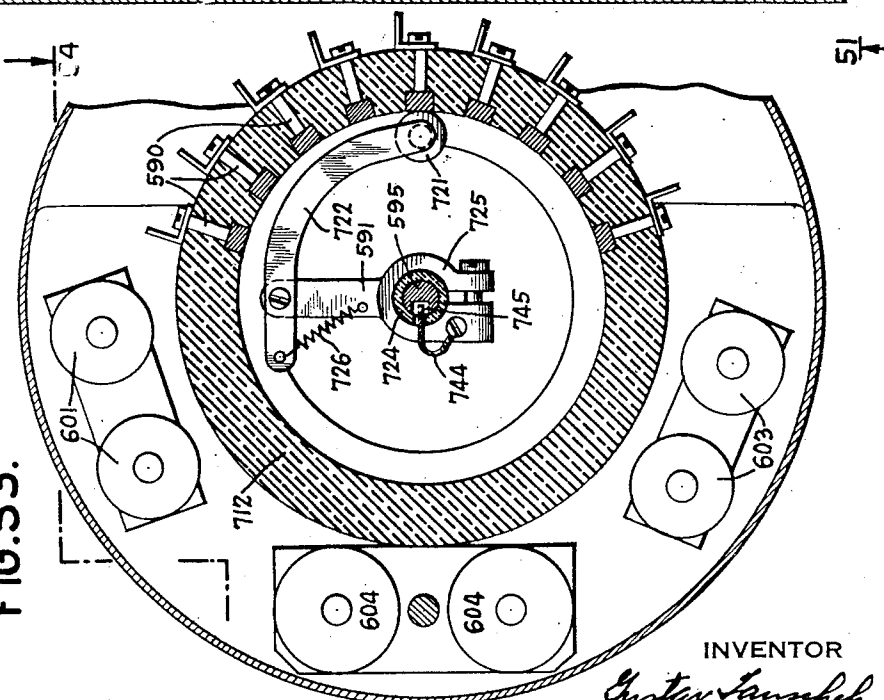


FIG. 53.



INVENTOR

Gustav Tauschek

BY *his* ATTORNEY

W. M. Wilson

Sept. 21, 1937.

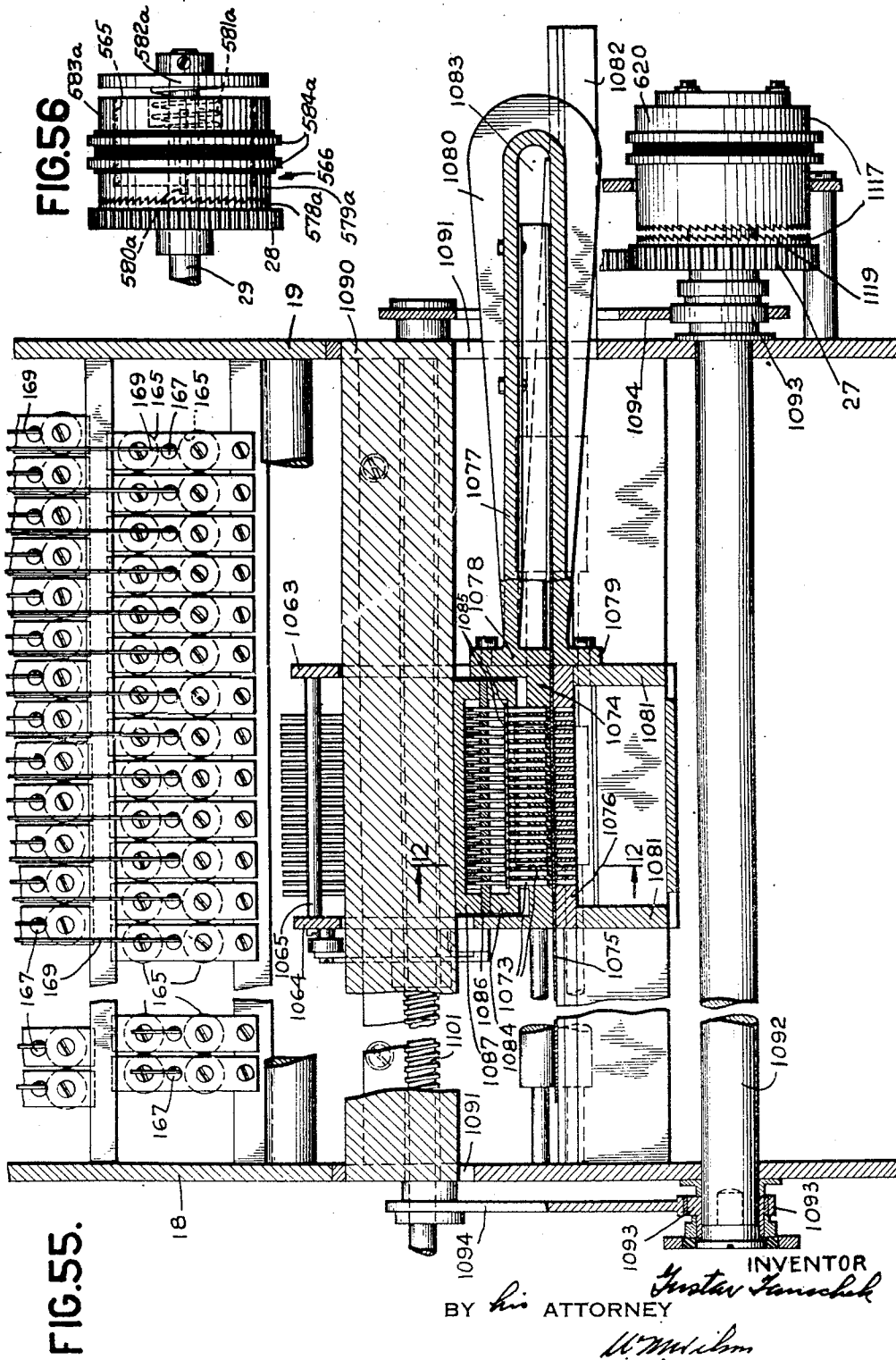
G. TAUSCHEK

2,093,529

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Sept. 21, 1937.

G. TAUSCHEK

2,093,529

TABULATING MACHINE

Filed Oct. 11, 1932

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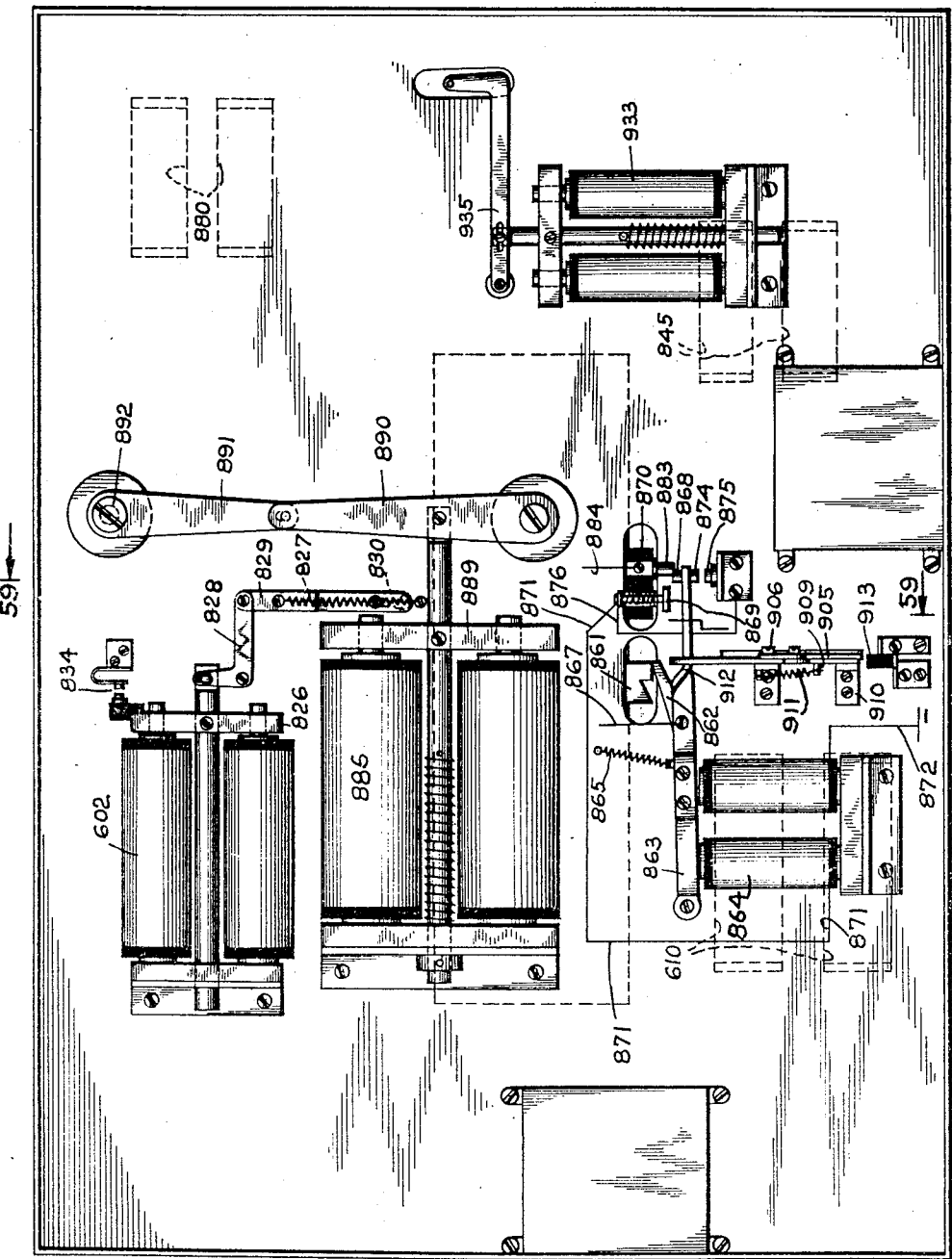


FIG. 57.

INVENTOR
Gustav Tauschek
BY *Leo* ATTORNEY
Wm. W. Smith

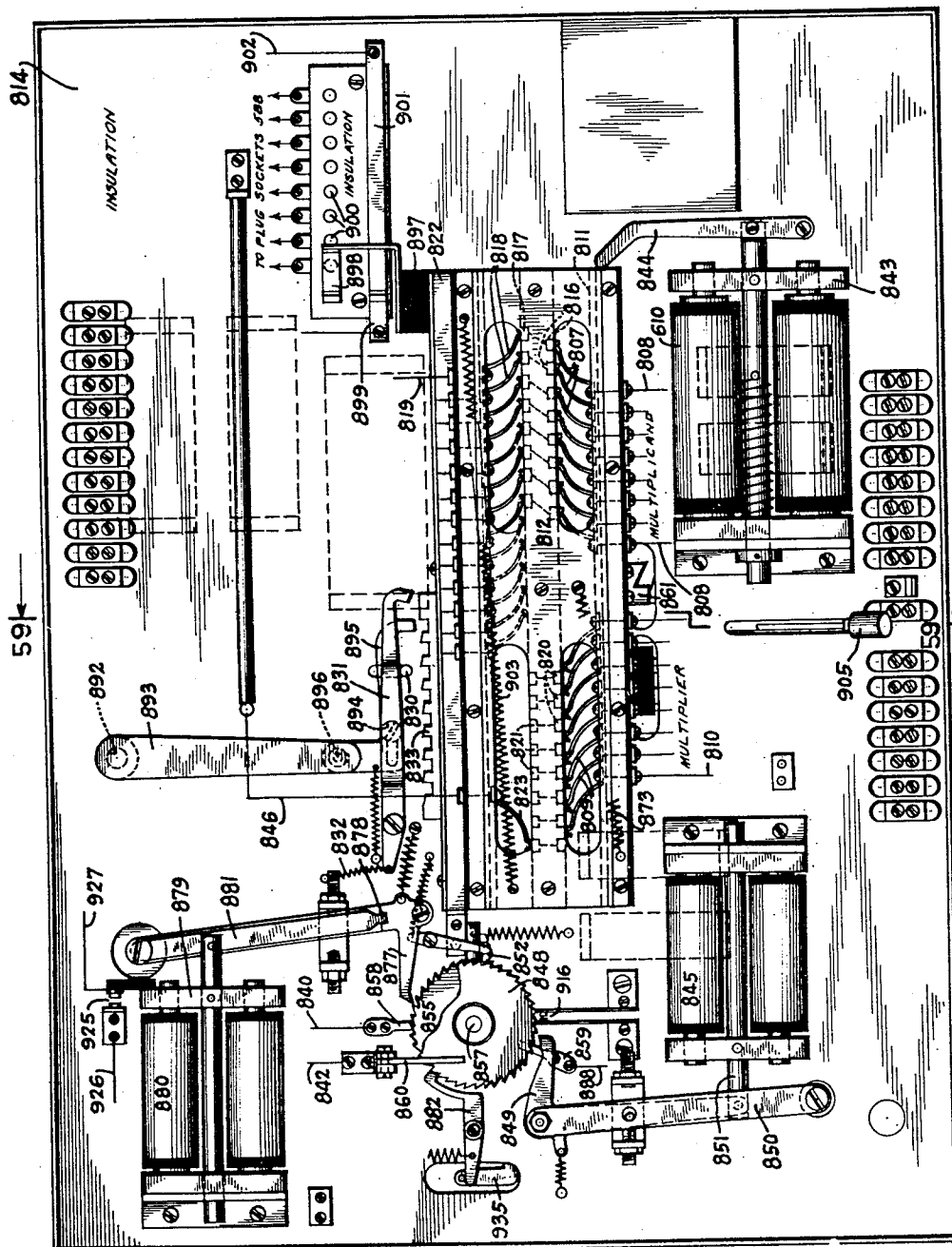
Sept. 21, 1937.

G. TAUSCHEK
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2,093,529

Filed Oct. 11, 1932

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85.613.

INVENTOR

INVENTOR
Gustav Tauschek

BY *Luis* ATTORNEY

Wm Wilson

Sept. 21, 1937.

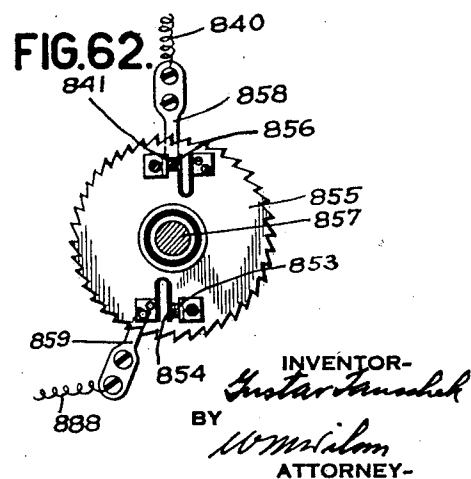
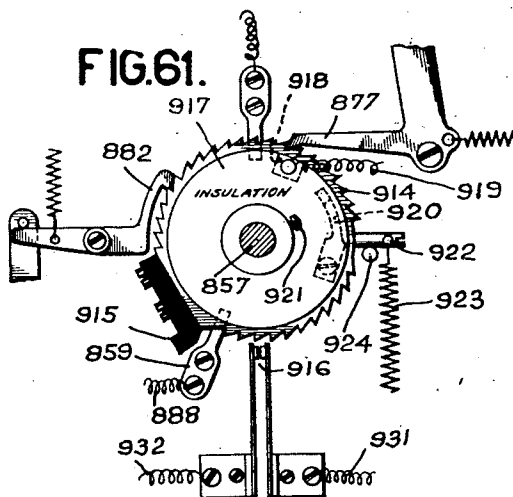
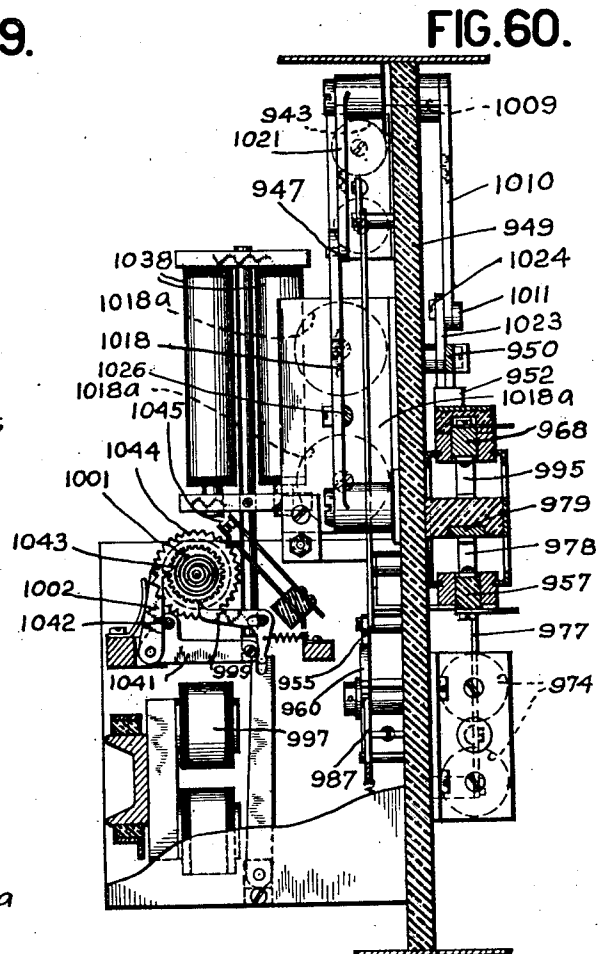
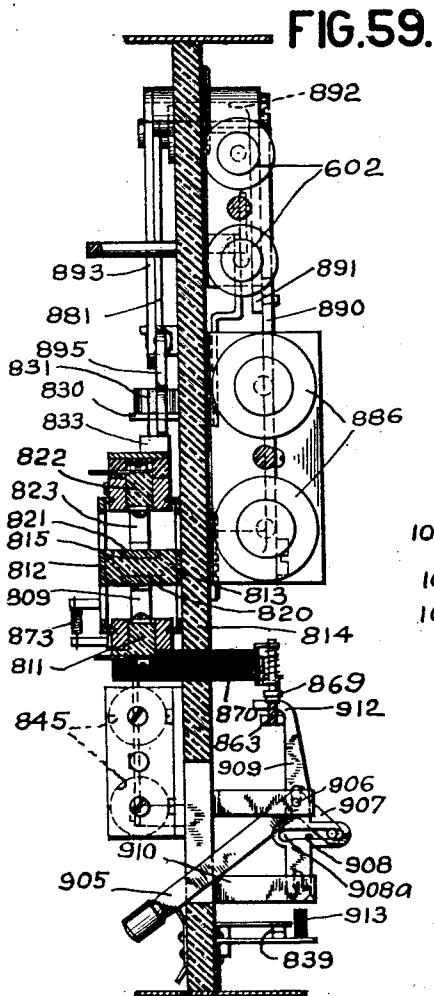
G. TAUSCHEK

2,093,529

TABULATING MACHINE

Filed Oct. 11, 1932

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INVENTOR-
Gustav Tauschek
BY
Wm. Wilson
ATTORNEY-

Sept. 21, 1937.

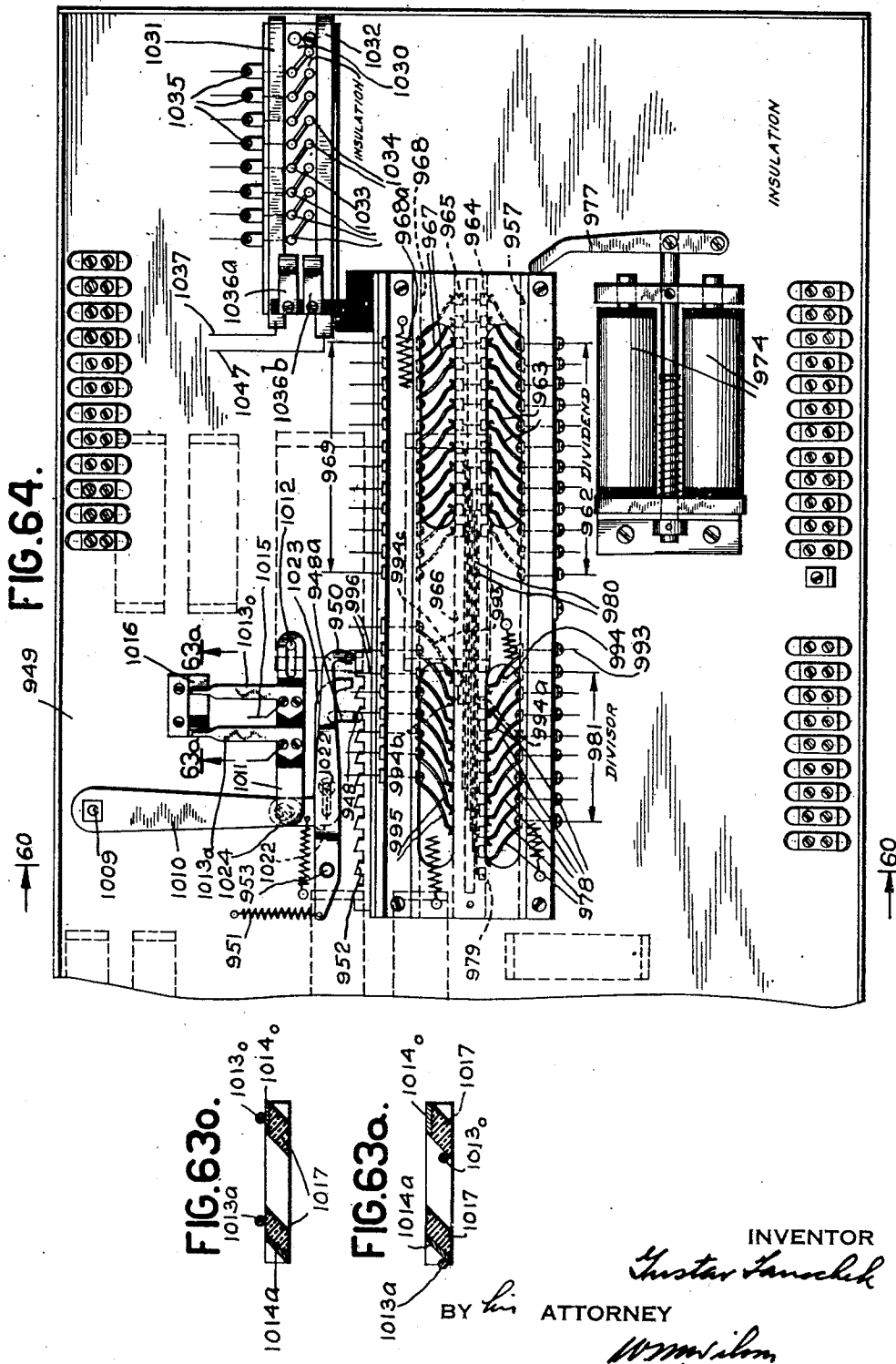
G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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Sept. 21, 1937.

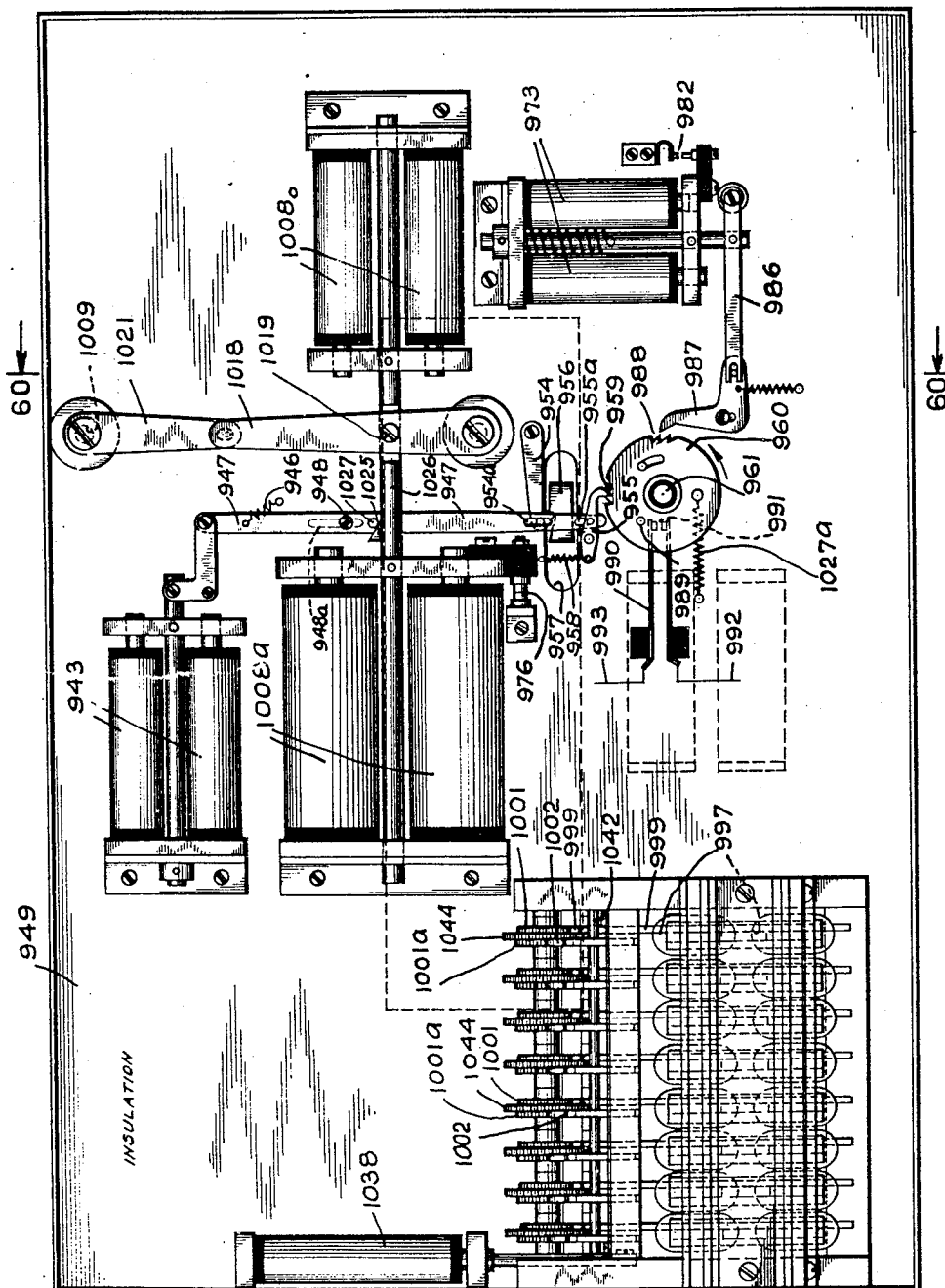
G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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INVENTOR-
Gustav Samach
BY
William
ATTORNEY-

Sept. 21, 1937.

G. TAUSCHEK

2,093,529

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Filed Oct. 11, 1932

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FIG.66.

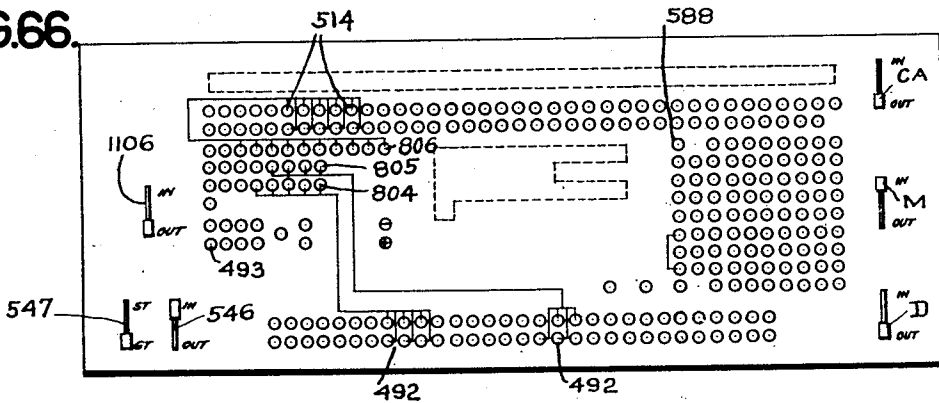


FIG.67.

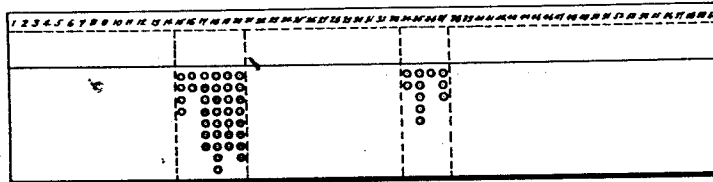


FIG.68.

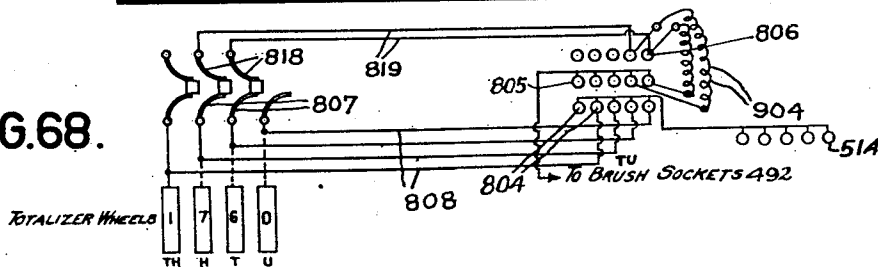


FIG.69.

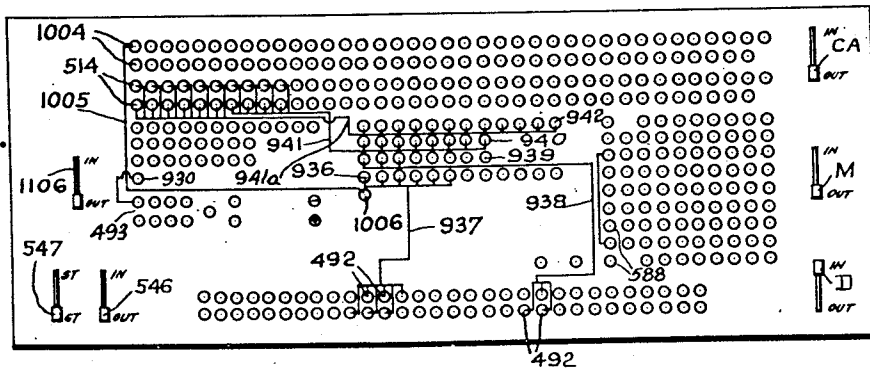
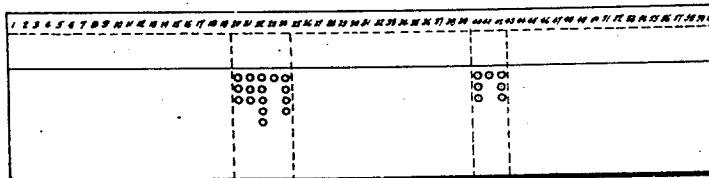


FIG.70.



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2,093,529

TABULATING MACHINE

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This invention relates to accounting machines of the card controlled type generally known as tabulating machines, and has for its main object the provision of improvements which extend the usefulness of such machines.

Tabulating machines are now in use which are capable of effecting calculating operations of two of the arithmetical rules, addition and subtraction and while the functions of such machines are ordinarily sufficient it is frequently desirable that machines of this type be also capable of performing calculations of the two other arithmetical rules, that is, division and multiplication.

Therefore, the main object of the invention is to provide a tabulating machine which is capable of not only adding or subtracting factors on a card but effecting both division and multiplication of factors on a card, dependent upon the type of work the machine is called upon to do.

The improvements specifically, also reside in the card feeding section of the tabulating machine and two detachable card feeding units are provided, one which automatically feeds cards one by one to the analyzing section, and another, or a manually operated card feeding unit which is capable of receiving a single card and which, by a manual movement of a part of the feeding unit, transports the card to the analyzing section. The manually operated card feeding section is especially useful where cards are to be fed singly at irregular intervals and without any predetermined synchronous relationship with respect to machine operation.

It is a further object to cause the data manifesting devices, card analyzing devices, etc. to be set into operation by the card itself so that such devices are only operated when controlling cards are presented to the analyzing mechanism.

As the machine is capable of effecting calculating operations, such as division and multiplication provision is made for repeatedly analyzing the fields of a card while the card is at rest, while in other calculating operations where the result, with respect to a related accumulator is affected by a single card field, such as ordinary addition or subtraction, the card is analyzed once and while in motion.

It is, therefore, an object to cause the analyzing mechanism to repeatedly analyze a card while at rest when certain types of calculation are to be performed, and in motion when other types of calculation are to be performed.

Aside from accomplishing the different types of calculation described, the machine is also provided with an arrangement by which several data

representing fields of a single card may be cross calculated; that is, each individual field of multiple fields of a single card enters to effect the result in an accumulator either additively or subtractively. As such machine operations involve multiple card factors, the analyzing operation is effected repeatedly while the card is at rest, and the card fields are automatically selected one after the other to vary the result of calculation.

The above arrangement is further provided with a mechanism which is capable of diverting into related accumulators the values represented by different fields of a pair of cards, one of which fields may represent addition, and the other field subtraction. As one calculation at a time is controlled by a single card field, the card feeding mechanism is operative so that the analyzer may analyze the card while in motion. The above arrangement is generally known as a "class selection" device.

The machine is normally operative to effect addition or subtraction of a card field which is so designated. To select other types of calculation, it is an object to provide a selective arrangement, and in the present embodiment it consists of three switches, a division switch, a multiplication switch, and a cross calculation switch. It is an object to construct the machine so that when any selected switch is set to operative position it will change the operation of the machine from normal addition or subtraction to the type of calculation it is to effect.

It is a still further object to cause "class selection" to be effected when the machine controlling circuits are so plugged to do this and when the cross calculation switch is set to operative position.

A still further object of the invention, in connection with multiplication of card factors is an arrangement which enhances the speed of multiplication when a single constant multiplier factor enters in the multiplying operation. By the process of repeated addition the required number of machine operations necessary to secure a product is equivalent to the sum of the multiplier digits. For example, multiplication of any amount by nineteen requires ten machine operations but the same product can be more expeditiously secured by multiplying an amount by "20" and subtracting said amount once from the result. Other multiplier amounts can be employed by obvious variations of the arithmetical principles involved.

It is a still further object of the invention to construct the above described arrangement so

that constant multiplier factor operations may be selected at will.

When the tabulating machine above described is employed for bookkeeping purposes, it is desirable to represent upon the accumulator wheels a prior balance, credit, etc., and it is a further object to devise and incorporate an arrangement to provide for manual setting up an amount so that changes of the amount in the accumulator may be effected by card tabulating operations or by an amount manually set in the accumulator.

As the machine is capable of effecting two different types of operations, one involving a single card factor (with respect to a single accumulator) and the other more than one card factor of a single card, it is desirable that machine operations, such as analyzing, calculation, printing, etc. be performed by either one or the other of a pair of operating shafts, herein designated as a main shaft, or a multiplication shaft which is capable of being repeatedly operated.

The main shaft is called into operation by a card when an adding or subtracting operation is performed while the card is in motion, and as it is desirable that a printing of the amount involved in the calculation be effected the main shaft is adapted to control the setting of the printing mechanism to print a representation of the card analyzed. The main shaft is also called into operation when the accumulator is adapted to control the printing of a result of a tabulating operation whether such sum is an algebraic summation, product or quotient.

The multiplication shaft is repeatedly operated to effect repeated analyzing of the card factors, repeated calculation, etc., but as the partial results are usually of no value, the setting of the printing mechanism is not controlled by this shaft. However, in either type of calculation, when desired, the main shaft is set into operation to thereby cause printing of the result standing on the accumulator whether such result is an algebraic summation, product or quotient.

It is a further object to arrange the multiplication shaft so that it may be operated a limited number of times in securing partial results; for example, a number of additions corresponding to the digital value of a multiplier digit or the required number of subtraction operations to effect an overdraft when division operations are performed, and furthermore, to arrange to stop operation of the multiplication shaft when the complete result has been secured, as the desired product is governed by the number of multiplier digits, the quotient by the number of quotient digits desired, or a result of cross calculation operation by the number of card fields involved in a cross calculation operation. The last named provision is particularly useful as it eliminates unnecessary machine operations and secures the complete result more expeditiously.

As the main shaft is automatically set into operation after division, multiplication, or cross calculation operations have been performed, the result is printed as a quotient and remainder, a product, or an algebraic summation, respectively.

It is further desirable that results standing on an accumulator be set forth at division of card groups and it is an object to provide such results obtainable under control of the analyzing mechanism which not only supervises the calculation operations but also determines whether a card is imperforate in an analyzed field so as to set the result printing mechanism automati-

cally into operation immediately without requiring an idle machine operation. This control is not dependent, as is the custom, upon the difference in representation of a pair of cards but rather the lack of representation of a single card and such is located by the ordinary analyzing mechanism in preference to special card levers.

In general, the latter is accomplished by determining whether contacts controlled by actuators corresponding to card columns are at closed position when an impulse is directed to an electric circuit including a series of such contacts. If all the contacts are found closed the circuit immediately alters the type of machine operation to a total printing operation, that is to say, the total printing operation is performed in the same machine cycle that the card which effects the change is analyzed.

While such automatic operations are desirable, provision is further made to effect the printing of the result at the will of the operator in the form of manually operable keys.

The result printed may be either a grand total which involves a clearing operation, or a subtotal which is merely an intermediate result taken without a clearing operation. Either result may be secured, either by the automatic group controlling device, by the sub and grand total keys referred to, or automatically after a result of a cross calculation, multiplying or dividing operation has been secured. Hence, it is obvious that the machine does not only give a printed result of an algebraic addition but also any of the results of the last three named operations and these results may not be only the result of a single controlling card but accumulative results of a series of cards. It is obvious then, that products may be added together, a quotient printed and summed with another, and remainders printed and cleared or aggregated with other remainders. Also algebraic results may be combined with quotients, products, remainders, or each with another in diverse ways so that any result of any tabulating operations may be secured. In general, it is an object to provide for the printing of the final result of a calculation or intermediate results of any calculations, either automatically or under manual control. The flexible control of securing results of calculating operations is of prime importance, as its flexibility lends itself to the adaptation of ordinary and extraordinary bookkeeping methods.

With respect to the printing mechanism it is an object to provide an improved arrangement for the printing mechanism so as to consist of a series of independent units which may be selectively associated with the controlling card columns permitting printing of items or results at desired parts of the record strip. Aside from this desired flexibility the fields of printing may be demarcated by distinguishing characters which permit the utilization of every unit of the printing mechanism. The feature of splitting the printing mechanism is operatively associated with the transfer mechanism permitting, by a single manual operation, the simultaneous splitting of adjacent orders of the printing mechanism and the corresponding orders of the accumulating mechanism. By demarcation of the printing mechanism into separate groups, unrelated groups of items may be separately accumulated and their results printed.

The units of the accumulating printing mechanism are selectively associated with the card columns by plug cords, the plugging being made as

desired. A separate plug section is provided for the card analyzing brushes, the accumulator elements, the multiplying unit, the dividing unit and the cross calculation unit. Several plug sockets are provided to permit automatic subtraction. In addition, a row of sockets is provided for permitting, as desired, the selected accumulator element to function as an electric overdraft determining device when division operations are performed.

The complete plugboard and all manual controls are arranged in front of the machine accessible to the operator for convenient operation and quick changes in machine operations.

It is a further object to provide an improved form of totaling mechanism for taking a total or result at a desired time. This is attained by electrical control of mechanically operated mechanisms which provide for zeroizing the accumulator elements when taking a grand total and restoring the amount cleared from the accumulator when obtaining a sub-total.

A still further object is to employ the subtraction controlling magnet as the means for zeroizing the accumulator elements when taking a total or for reverse actuation of said elements in effecting a subtracting operation.

Sub-total operations or grand total operations are selectively effected by energization of the subtraction magnets with one or the other of sub-total or grand total magnets according to the total to be taken.

The object of simplifying the total taking mechanism has been effectively carried out as will be obvious from the subsequent description.

In connection with the cross calculation device, it is an object to cause subtraction operations to be effected automatically under control of card fields selected for such control by plugging. Therefore, it is unnecessary that such fields be specially characterized as is the case with cards having a field which, by a special perforation, designates a subtraction operation and where repeated card analyzing operations are not performed as in ordinary tabulating operations.

It is an object to perform multiplying operations by repeatedly entering the multiplicand in the accumulator elements commensurate in number with the digital value of each digit of the multiplier. This operation is kept up until the required number of entering operations is effected then accomplishing a change in denominational relationship between the accumulator elements and the multiplicand entering means. When the final product is reached, machine operations, as far as multiplying operations are concerned, are stopped, and the result is then secured by printing, or another type of manifesting a result to be later described.

By simply shifting the control of the machine from adding, cross calculation or multiplication, to division, dividing operations ensue. Both the dividend and divisor are represented on the same card. Division operations are effected by successive subtraction of the divisor from the dividend, and when the overdraft is secured, a change in denominational relationship between the divisor and remainder is secured, and subsequently the divisor is subtracted successively from the remainder. Upon securing the complete quotient, or as many digits as are desired determined by the cycle limiting device, the quotient is transferred to a set of accumulator wheels. Thus, the quotient, with the remainder which is

represented on other accumulator wheels, is printed as the complete result.

It is also an object of the invention to improve the types of clutches for securing the desired operations. The main clutch selectively connects the main shaft with the driving shaft and is under control of the usual card lever. The multiplication shaft is also selectively connected to the driving shaft by a multiplication clutch selected for operation by a supplemental card lever, the operativity of which is dependent upon the position of the cross calculation switch, division switch, or multiplication switch. A card feeding clutch, contrasting to the other clutches, is normally energized so that it drives certain card feeding rollers. When a card is fed to the supplemental card lever, the latter causes deenergization of the card feeding clutch so that the card is held at rest and as the multiplication shaft operation is initiated, the card is repeatedly analyzed at rest. Also when a blank card is fed, card feed is temporarily stopped when a total is taken; otherwise the card feeding clutch is continuously operable so that by a continuous card feed the card is analyzed in motion.

It is also an object to provide an improved form of card analyzing device. Upon energization of a magnet, flexible card brushes drop upon the card to be analyzed and rest continuously upon the card while the card is fed past the brushes. When the card is analyzed at rest, the card brushes are shifted while the brushes engage the card to cause electrical impulses to be transmitted when card perforations are encountered. After the card has been analyzed either in motion or at rest, the brushes are elevated so that when the card analyzed at rest is moved past the brushes the retraction of the brushes will prevent their encountering the card perforations. The magnets which control dropping of the brushes are, of course, energized during each card tabulating machine operation irrespective of the type to be performed.

In connection with the transfer mechanism, it is an object to effect transfers by emitting an electrical impulse to the selected accumulator magnet. As several magnets may be energized at a time, a current of large value must necessarily be broken, thus damaging the usual common transfer controlling contacts. This disadvantage is obviated by causing a bar to be shifted at the desired time and such bar permits the closure of the individual transfer contacts. Therefore the series of individual transfer contacts close the circuits to the related magnets obviating the common transfer control contacts and making and breaking a circuit through which large currents flow. As previously intimated, transfers are effected if the accumulator is not split at that point. By the provision of contacts in series with the transfer contacts, the first named contacts may be employed to split the accumulator into desired groups.

It is a further object of the invention to incorporate in the machine a punching mechanism which can be adapted to either punch a card to represent the result of a calculation or to accomplish functions usually performed by independent punching machines. These different functions should, in their following explanations, be considered as objects of the invention.

While it is ordinarily sufficient to indicate the result of a calculation by printing, it is also desirable to punch a card to represent the result whether the result is an algebraic summation,

product, or quotient and remainder. In the present machine a result may be punched either on the card from which the two or more factors are derived, as in cross calculation, multiplication, or division, and such a card punched in another field may be employed to control subsequent tabulating operations. Thus an extra card punched with the result is unnecessary and the same card may be used for dual control.

In algebraic summations where the calculation is terminated by a blank card at the end of a group or the last card of a group, the total or balance can be punched on the last card which, in the case of automatic group control, comprises a blank card. Also in taking totals under manual control a card may be fed to the punching mechanism to receive a perforated total.

It is evident that in punching a result of a calculation, where more than one card factor of a single card is involved, the perforations must be located in a field other than one representing one of the card factors. Also, in deriving the result of an algebraic summation, the total can be punched in the field corresponding to the field which controls entries in the single accumulator, but in some instances it is desirable to perforate the results in another field.

It is the main object of the invention, therefore, with respect to punching results, to accomplish a setting of the punching mechanism by related accumulator elements which receive the result but provide for punching in any desired field of the card.

In the present machine this is accomplished by manually shifting the punching mechanism as a unit so that punches thereof may be correlated with any card field.

In operation, each card as it passes away from the analyzer, whether analyzed at rest or in motion is ultimately correlated with the punching mechanism. If a punch control switch is set to operative position the card fed during the total taking operation is temporarily held in the punching mechanism.

During the total printing operation the punch selectors are effective or held in punch selecting position until the card arrives at the punching position. The card itself (if the machine is set for punching and a result is obtained) causes the punching mechanism to be operative and as punching occurs after control by the accumulator the punching operation can be performed while another calculation is being performed. To this end the punching mechanism is operated by a shaft operated under control of its own clutch and independently of the main or multiplication shafts.

It is frequently desirable to duplicate perforations in a series of cards; for example, numbers that are constant for a group. This can be done by entering an amount set under manual control, for example in the machine disclosed, in an accumulator and accomplishing repeated sub-total operations. For each blank card fed to the machine the group control device will, if the machine is set for sub-total operations, cause a sub-total operation and hence, repetition punching in a series of cards will be effected. This repetition punching however, may be the result of any calculation instead of a manual setting so that any number of cards may represent the same result.

It is obvious then, that amounts perforated in one field of a card may be duplicated in another field of a card affording transfer of data automatically and thus eliminating visual reading of

a card and a manual punching of another card as is now necessary in many duplicating machines.

By an adjunct now to be described, it is possible to consecutively number cards beginning at zero or any desired number in an ascending order. For each machine operation an electrical impulse is transmitted which effects an addition of a unit to an accumulator for each machine operation. In starting at other than zero, a setup in the accumulator under manual control is desirable although a card punched with the starting number may provide the initial set-up. To count above 500, for example, 500 is initially entered in the accumulator and blank cards then successively fed. This will effect a series of sub-total printing operations under group control to cause after taking a sub-total an addition of a unit to the accumulator to represent the next consecutive number to be punched on a following card.

The above described punching mechanism is an important acquisition to the machine as it permits a tabulation of results derived by the machine.

Other and relatively important objects of the invention will be apparent as the specification is read and the functions of the machine understood. Many of the features of the invention are capable of independent use and the application of such features in combination with others is not to be construed herein as a limitation but rather as a single application of each individual improvement.

In the appended drawings:

Fig. 1 is a perspective view of the assembled machine disclosing particularly the controlling devices such as the plugboard and switches which are accessible to the operator for controlling the performance of any of the functions of the machine.

Fig. 2 is a view in side elevation of the mechanism supported by the left side machine frame.

Fig. 3 is also a view in side elevation, the section being taken closer to the left side machine frame in order to more clearly disclose certain parts when other parts have been removed.

Fig. 4 is a view in side elevation of the mechanism supported by the right side machine frame.

Fig. 4a is a plan view of a clutch adapted to cause operation of a shaft employed in cross calculation, multiplication and division operations.

Fig. 5 is a view in side elevation, the section being taken closer to the right side machine frame in order to more clearly disclose certain parts when other parts have been removed.

Fig. 6 is a cross sectional view taken substantially through the center of the machine on the line 6-6 of Fig. 11 disclosing in order from right to left; the card feeding mechanism, the card analyzing mechanism, and the punching mechanism, the various mechanisms having correlated therewith feeding rollers for transporting the card through the machine to each of said mechanisms.

Fig. 7 is a cross sectional view taken on the line 7-7 of Fig. 8 and illustrates particularly the manually operated card feeding mechanism.

Fig. 8 is a plan view of the manually operated card feeding mechanism.

Fig. 9 is a plan view, partially in section, of the automatic card feeding mechanism.

Fig. 10 is a view in side elevation of the punch interposer controlling mechanism.

Fig. 11 is a plan view taken on the line 11—11 of Fig. 6.

Fig. 12 is a sectional view taken on the line 12—12 of Fig. 55, disclosing several of the card punches and the associated interposer.

Fig. 13 is a sectional view taken on the line 13—13 of Fig. 6.

Fig. 14 is a cross sectional view taken on the line 14—14 of Fig. 11.

Fig. 15 is a view in side elevation of the card lever associated with the multiplying, dividing, and cross calculation mechanisms.

Fig. 16 is a view in side elevation showing the supplemental card lever which is selected for controlling normal addition and subtraction operations when the machine is set to perform such operations.

Fig. 17 is a plan view, partially fragmentary, disclosing a part of the card analyzing carriage.

Fig. 18 is a longitudinal sectional view of the punch selecting mechanism, showing an interposer in shifted position for selecting a plurality of punches.

Fig. 19 is a longitudinal sectional view of the punching mechanism disclosing the parts in their normal positions.

Fig. 20 is a longitudinal sectional view of the upper part of the machine disclosing particularly the printing mechanism, the transfer mechanism, the accumulator mechanism, and the associated accumulator controlling magnets.

Fig. 21 is a sectional view taken on the line 21—21 of Fig. 20 disclosing the mechanism provided for inserting zeros in the necessary denominational orders of the number printed by the printing mechanism.

Fig. 22 is an enlarged view of the adding and subtracting mechanism for the accumulator and also discloses details of the transfer mechanism.

Fig. 23 is a view similar to Fig. 22 but showing some of the parts in shifted position for effecting adding operations.

Fig. 24 is a longitudinal sectional view of the main clutch.

Fig. 25 is a plan view of the main clutch.

Fig. 26 is a detached view of the parts provided for the left side of the machine which comprise the mechanism for controlling the position of the actuator holding pawls when adding or multiplying operations are performed, and also discloses the control when manual setting of the actuators is to be performed.

Fig. 27 is a view in side elevation of certain detached parts provided for the right side of the machine and which parts comprise the mechanism for determining the position of the actuators with respect to the accumulator elements during multiplying or adding operations.

Fig. 28 is a sectional view taken on the line 28—28 of Fig. 27.

Fig. 29 is a view in side elevation of the parts provided for the right side of the machine which comprise the mechanism for controlling the shifting of certain plungers disclosed in Fig. 30 for temporarily holding the accumulator pinions while the adding or subtracting racks are moved out of engaging position with said pinions.

Fig. 30 is a view in front elevation, partly fragmentary, disclosing the accumulator pinion holding plungers.

Fig. 31 is a view in side elevation of the mechanism provided for the right side of the machine which permits the movement of a bar which allows the closing of the selected transfer contacts at transfer time.

Fig. 32 is an enlarged sectional view of the printing mechanism showing the parts in their normal position.

Fig. 33 is a sectional view showing the position of a printing bar for printing a digit other than zero and the manner of releasing the type actuating hammer.

Fig. 34 is a view, partially in plan, and partially in section, taken on the line 34—34 of Fig. 32.

Fig. 35 is a view in side elevation of the mechanism provided for actuating the platen so as to feed the paper a distance comprising the length of a form for each paper feeding operation.

Fig. 36 is a view in side elevation of the parts provided for the right side of the machine and which parts disclose the mechanism for releasing the type hammers and restoring them to their normal position.

Fig. 37 is a view in side elevation of the mechanism provided for line spacing the platen during item and total printing operations.

Fig. 38 is an illustrative example of a portion of a record strip which can be printed by the present machine disclosing particularly the printing of special distinguishing dots to vertically demarcate the groups of printed items.

Fig. 39 is a plan view of the mechanism provided at the left side of the machine and which mechanism controls the taking of grand totals and the taking of sub-totals.

Fig. 40 is a detail view in side elevation of certain parts disclosed in Fig. 39 but shown in operated position.

Fig. 41 is a plan view of a portion of a record sheet disclosing how the sheet, when fed the distance of a form each time, is printed with items adjacent corresponding months in the several forms of the sheet shown.

Fig. 42 is a view in side elevation of the mechanism provided for the left side of the machine which causes the released transfer pawls to be returned to normal position either after an operation of the main adding shaft or the multiplication shaft.

Fig. 43 is a front view of the plugboard and associated manually positionable controlling devices.

Fig. 44 is a sectional view taken on the line 44—44 of Fig. 43 and discloses in order from top to bottom a group controlling switch, the sub-total key, and the punch controlling switch.

Fig. 45 is a sectional view taken on the line 45—45 of Fig. 43 and discloses particularly one of the group control switches, the cross calculation switch, the multiplication switch, and the division switch.

Fig. 46 is a partial perspective view showing the extremity of one of the group control switches and associated contacts.

Fig. 47 is a plan view of the plugboard showing an example of the plugging connections necessary for effecting a cross calculation operation.

Fig. 48 is a detail view of certain parts operated by the paper feeding mechanism disclosed in Fig. 35.

Figs. 48a—48f when assembled in the following order—

Fig. 48a, Fig. 48b, Fig. 48c

Fig. 48d, Fig. 48e, Fig. 48f

disclose the electrical wiring connections for the machine.

Fig. 49 is an illustrative example of a card perforated in six different fields, the values represented thereon being capable of being cross cal-

culated by the cross calculation device, the plugging connections being shown in Fig. 47.

Fig. 50 is an illustrative example of the plugging necessary for effecting a class selection operation.

Fig. 51 is an end view of the mechanism of the cross calculation unit and is taken on the line 51—51 of Figs. 52 and 54.

Fig. 52 is a longitudinal sectional view of the cross calculation device.

Fig. 53 is a cross sectional view taken on the line 53—53 of Fig. 52.

Fig. 54 is a plan view of the cross sectional unit, a portion of the enclosing casing having been removed.

Fig. 55 is a view in front elevation of part of the machine disclosing particularly the shiftable punching mechanism and the punch controlling clutch.

Fig. 56 is a longitudinal sectional view of the clutch which controls the feeding of certain of the sets of card feeding rollers.

Fig. 57 is a view in side elevation of some of the parts provided for effecting multiplying operations and which parts are provided upon one side of a support.

Fig. 58 is a view in side elevation of other parts of the multiplying mechanism and which parts are provided on the other side of said support.

Fig. 59 is a cross sectional view taken on lines 59—59 of Figs. 57 and 58.

Fig. 60 is a sectional view taken on lines 60—60 of Figs. 64 and 65.

Fig. 61 is a plan view of certain parts which are employed as a substitute for other parts in the multiplying mechanism when each multiplicand is to be multiplied by the constant multiplier factor.

Fig. 62 is a sectional view disclosing certain contacts carried by a ratchet wheel associated with other contacts which are carried by a companion clutch wheel and which are not disclosed in this figure.

Fig. 63a is a sectional view taken on the line 63a—63a of Fig. 64 disclosing the position of certain switch elements which is necessary when subsequent additions of the divisor to the negative remainder is necessary.

Fig. 63b is a sectional view similar to Fig. 63a but disclosing the position of certain switch elements when an overdraft has been reached.

Fig. 64 is a view in side elevation of part of the mechanism provided for effecting division operations and which mechanism is carried by one side of a support.

Fig. 65 is a view in side elevation of other parts of the mechanisms for effecting division and which mechanism is carried by the other side of said support.

Fig. 66 is an example of the plugboard connections made for effecting the multiplying of two factors of a card.

Fig. 67 is an illustration of a card punched to represent two factors which are to be multiplied, the necessary plug connections for such card being disclosed in Fig. 66.

Fig. 68 is a diagrammatic view disclosing the denominational relationship between associated controlling devices when each multiplicand is to be multiplied by a constant multiplier factor.

Fig. 69 is an example of plug connections when dividing operations are to be performed.

Fig. 70 illustrates a card punched to represent dividend and divisor factors the corresponding

plug connections for effecting division under control of such a card being disclosed in Fig. 69.

Figs. 70 and 71 are timing diagrams of cams used to control electrical contacts.

Reference will now be made to the appended drawings and the following coordinated description. The description is divided into sections appropriated to the description of the construction and operation of each of the units of the machine. Specific reference will also be made to the wiring diagram where the necessary electrical connections must be understood to more clearly observe the operation of the mechanical parts of the machine.

Main drive and feeding rollers

The machine referring to Fig. 2 includes a prime mover designated by numeral 20 the drive shaft 21 thereof driving a main gear 22 through appropriate speed reduction mechanism in a gear box 23a. The gear 22 drives a pinion 23 secured to a drive shaft 24 which passes from the left side shown in Figs. 2 and 3 to the right side of the machine shown in Figs. 4 and 5. As best shown in Fig. 5, the shaft 24 has secured thereto a gear 26 intermeshing with a gear 27 which through an idler pinion 30 drives a gear 28 loose on a shaft 29. While the motor is running the gear 28 is continuously rotating to drive the shaft 29 through an appropriate magnetically controlled clutch. The shaft 29 extends across the machine and at its left side (Fig. 3) has secured thereto a gear 30 which drives a pinion 31. As will be observed in Fig. 6 the shaft 29 carries a feeding roller 32 which cooperates with a feeding roller 33 secured to the shaft 34 to which the previously mentioned gear 31 is secured. This constitutes one set of feeding rollers. Referring to Fig. 3 at the outer end of shaft 29 there is attached a gear 35 in mesh with a gear 36 which in turn drives a gear 37 which is secured to a shaft 38 (Fig. 6) carrying the feeding roller 39 which is in frictional engagement with a feeding roller 40. As shown in Fig. 3 the gear 37 drives an idler gear 41 which in turn drives a gear 42. The latter is secured to a shaft 43 (Fig. 6) to which is secured a feeding roller 44 in frictional engagement with a feeding roller 45 (see Fig. 6). The card feeding rollers in part, therefore, constitute the pairs 45—44, 40—39, and 33—32 which are driven only when the shaft 29 is clutched to the driving gear 28 by means to be later described.

After the card has been analyzed and, if desired, a result perforated thereon, the ejection is accomplished by other sets of feeding rollers to be described in a manner now set forth. To the constantly rotating shaft 24 there is secured a gear 50 (Figs. 2 and 3) which drives a pinion 51 attached to a shaft 53 (Fig. 6) carrying the feeding roller 54 correlated with a roller 55. Through a train of idler gears 56 (Fig. 3) a pinion 57 is driven and the shaft to which this pinion is secured carries a feeding roller 58 (Fig. 6) in frictional engagement with a correlated feeding roller 59 permitting, however, at times the engaged card to be stopped even though rollers 58, 59 rotate.

The gear 50 (Fig. 3) drives a gear 60 secured to a shaft 61 which carries one of a correlated set of feeding rollers 62 (Fig. 6). The gear 60 through an idler gear 63 (Fig. 3) drives a gear 64 secured to a shaft 65 to which is secured one of a correlated set of feeding rollers 66 (Fig. 6). Gear 64 drives an idler gear 67 (Fig. 2) to which is attached a smaller gear 68 meshing with a pinion 69

secured to a shaft 70. The shaft 70 (Fig. 6) carries one of a set of correlated feeding rollers 71. The latter feed the cards to the storage receptacle 72 (Fig. 6) which is in the rear of the machine.

5 The correlated sets of feeding rollers are preferably driven oppositely by intergearing their driving shafts. This arrangement is shown in Fig. 7, for example, in connection with the feeding rollers 44, 45. The drive shaft 43 has attached to it a gear 73 which is constantly in engagement with a pinion 74 secured to the shaft which carries the upper roller 45. The same arrangement may be provided with the other sets of feeding rollers.

15 Secured to shaft 43 (Figs. 6 and 7) is a gear 75 adapted to drive a gear 76 secured to a shaft 77 which extends transversely of the machine and at its mid-point has secured thereto a pair of complementary arranged cams 78 (Fig. 6). Each of the cams cooperates with the related one of oppositely extending rollers 79 carried by a member 80 and which is slotted to receive the shaft 77 and pivoted to an upward extending arm 81 which is secured to a rock shaft 82 extending across the front of the machine. Secured to the shaft and extending upwardly is a pair of arms 83.

Automatic card feeding device

30 The automatic card feeding device is disclosed particularly in Figs. 6 and 9 and comprises a framework detachable from the machine for the substitution of a unit which provides for manual feed of cards. When the framework is in the position shown in Fig. 6 cards are automatically and successively fed by the machine.

35 The framework has a front vertical section 85, a horizontal base section 86 and side walls 87 (Fig. 6). To each side wall 87 and within the pocket formed by the sections and side walls there is secured a pair of guide plates 88, and such plates are the supports for the ends of the picker frame 89 which fits in the pocket. The picker frame is strengthened by ribs 90 (Fig. 6). At each end of the picker frame there is secured a block 91 resting on the related guide plate 88. Upward movement of the picker frame is prevented by cross bars 92 overlying the blocks 91 (see Figs. 1 and 9). Secured to each block 91 is a pin 93 received by the notch 94a (Fig. 6) of the associated arm 83. 50 When the arms reciprocate a stroke of the picker frame in one direction feeds a card to the feeding rollers 44—45 by means of the usual picker knife 94. (Figs. 6 and 9).

55 Secured to the base frame 85, 86 (Figs. 6, 9, and 11) at four corners thereof are upstanding card guides 95 and the plates 96 secured thereto receive the three square corners of the tabulating card, the remaining corner being formed diagonally by means of the triangular plate 97 so as to determine the proper positions of the cards in the hopper.

Manually operated card feed device

65 It may be desirable to feed cards manually one at a time and to this end the arrangement is such that the automatic card feeding section may be withdrawn and replaced by the unit shown in Figs. 7 and 8. The unit in place is shown in Fig. 7 in cooperation with the first set of feeding rollers 44—45. Secured to the card receiving plate 98 are depending plates 99 carrying dowel pins 100 fitting within holes in the framework 101 when the unit is in proper position. Beneath the plate 98 is a reciprocable plate 102 which has guide 75 slots 103 receiving headed pins 104 attached to

the plate 98 to suitably guide the plate 102 in its reciprocation. Plate 102 carries a card picker 105 receiving the front edge of a card. To restore the card supporting plate to normal, there is provided a spring 106 connected to studs, one 5 carried by the plate 102 and the other by a triangular shaped plate 107 secured to the stationary plate 98. A pair of such plates 107 is provided and between plates 107 there is journaled a rock shaft 108 carrying arms 109. To the under side 10 of the plate 102 at each end are brackets 110 which, through a link 111, provide a connection between the plates 102 and shaft 108. It will be obvious that if the operator feeds a card by manually pushing on one end of the plate 105 the shaft 108 will turn, and through the connection comprising arm 109, link 111, bracket 110 will cause movement of the other side of plate 102. This prevents an askew shifting of the plate 102 and thus jamming the cooperating parts. 20

It is pointed out that the card is manually placed between guide plates 112 and that arms 83 take no part in the operation, the upper extensions merely projecting through slots in the bottom plate 102. 25

Analyzing mechanism

The analyzing mechanism is particularly adapted to analyze record cards punched according to the Tauschek system. Differentiating from 30 the usual type of record card, namely, Hollerith type, in which the numerical value is determined by the location of a single perforation in a card column, the card columns of a Tauschek type of card are punched with one or a series of perforations which in number correspond to the numerical value to be designated. For example, to represent the numeral "8", a corresponding number or eight perforations are made in the appropriate card column. Such type of card is shown in Fig. 40 49 and is capable of representing data by sixty card columns. A certain amount of the card area at the extreme left and right of the card is left unpunched so as to effect certain controlling operations to be described hereinafter and as the 45 specification progresses.

From Fig. 6, it will be observed, that as the card is fed by the rollers 39 and 40, it passes over a bed plate 117 and beneath the analyzing device which comprises a single brush 115 made of multiple strands. This brush as shown in Figs. 6 and 13 consists of a series of steel wires carried by a bar 116 and which, in the case of operations involving addition and subtraction, remains at rest while the card is being fed beneath the brush 115. 55 The brush 116 extends the width of the 60 card columns in order to analyze any of the perforations therein. Since the analyzing brush is carried by the metal bar 116 it is electrically connected to the bar. 60

The bed plate upon which the card is fed consists of a base plate of insulating material 117 (Figs. 6 and 13) in which is embodied a series of metallic strips 118, there being one such strip for each card column and each strip is in alignment 65 with the perforations in the related card column. From the above, it is obvious, that upon the passage of a card the cooperation of several metallic strands with the perforations in a card column will permit such strands to successively engage 70 the metallic strip and as many times as there are perforations in the card column analyzed to thereby successively effect a series of electrical impulses.

In the normal position of the parts, the brush 75

115 is elevated by suitable devices from the bed plate 117 and strips 118 so that the card may freely pass beneath the brush. At a predetermined time the brush is lowered so as to encounter the first card perforations in the controlling columns of the card.

The preferred devices for retaining the brush elevated comprises a hood 119 (Figs. 6, 13, and 14) which is arcuate in shape and one edge thereof engages the extremities of the strands of the reading brush 115, it being understood that the hood is coextensive with the width of the reading brush 115. The hood 119 is carried by a pair of arms 120 each of which is pivoted at points 121. Each of said arms is provided with an extending arm 122 (Figs. 13 and 14) to which is connected a spring 123 which normally urges the arms 122 against a bar 124, which in the position shown in Fig. 14, retains the brush elevated by means of hood 119 and against the action of springs 123.

To permit the lowering of the reading brushes 115 at a predetermined time in the card feeding cycle, there is provided a card lever 125 (Fig. 16). The angular arm of the card lever is adapted to be engaged by the left unpunched vertical edge of the card to thereby elevate the same against the action of a suitable spring and by means of an integral horizontal arm 126 open contacts 127. The card lever 125 is so positioned that it will be engaged by the leading edge of the card and prior to the time that the first card perforations are in correlation with the analyzing brushes 115. As will be specifically described in connection with the wiring diagram when contacts 127 open a circuit to a relay will be broken which, in turn, makes a circuit connection to a magnetic clutch which will thereby drive certain parts of the machine in synchronous relationship with the passage of the card beneath the brushes. Certain of the cam contacts, to be later described, will thereby effect energization of brush controlling magnets 128 and 129, magnet 129 (Figs. 4 and 5) being disposed at the right side of the machine and magnet 128 at the left side (Figs. 2 and 3). The function of each of the magnets 128 and 129 is identical and the control will therefore be described only in connection with the magnet 128 shown in Fig. 3. The magnet 128 is provided with a slidably mounted armature 128a which carries a triangular projection 130 (Fig. 3) normally engaging a similar triangular projection 131 of a slidably mounted plate 132 but shown in disengaged position in Fig. 3. By a normal engagement, it will be obvious that the bar 124 restrains movement of the arms 122 (Fig. 13) upwardly as exercised by springs 123. At a certain point in the cycle of the operation of the machine, the magnet 128 is energized to disengage the projection 130 from the projection 131 (as shown in Fig. 3) permitting the plate 132 to be urged upwardly.

The extremities of the bar 124 are provided with reduced portions 133 (Fig. 3) passing through a hole in the upper end of the plate 132 so that the action of spring 123 on bar 124 is similarly effected upon the plate 132. Therefore, the simultaneous energization of magnets 128 and 129 will release the bar 124 for upward movement whereby the hood 119 will be rocked counterclockwise (Fig. 14) sufficiently so that the reading brush 115 coacts with the card and encounters the perforations in the various card columns as the card is subsequently fed past the analyzing brush 115.

Restoration of analyzing brush to uppermost or normal position

At the completion of the adding operations, it is essential in order to permit the unobstructed feeding of a new card into the analyzing position that the analyzing brush be elevated to its uppermost position. This is preferably effected after the analyzing operation and towards the end of the machine cycle. This mechanism is operated by an arrangement now to be described.

Referring to Fig. 2, the gear 23 drives an idler gear 135 which is in mesh with a gear 136. To the gear 136 there is secured a smaller gear 137 which is in the plane of a larger idler gear 138. The latter, through an idler gear 139, continuously drives a gear 140. By means of an electromagnetic clutch device to be described later in detail, a drive shaft 141 is driven a single revolution for each listing, total or result printing operation of the machine. The shaft 141, to be known as the listing shaft, extends transversely of the machine. At its left end the shaft 141 has secured thereto a profile cam 142 to which is secured a cam plate 143 which is in the plane of a roller 144 secured to one arm of an irregular shaped bell crank arm 145. The outside edge of the cam element 143 is adapted to coact with the roller 144 to operate a linkage mechanism to cause the plates 132 to be restored to their normal position.

From what has been previously described, it will be apparent that when the plates 132 are in their unlatched or released position (due to the energization of magnets 128 and 129) a pin 146 carried by a related plate will rock a bell crank arm 147 (Fig. 3) counterclockwise thereby shifting a link 148 to the right against the action of a spring 149. Since the left hand end of the link 148 is connected to the vertical arm of the bell crank arm 145, it will be obvious that the clockwise turning of the bell crank arm 145 will position the roller 144 towards the shaft 141. At the end of the cycle of operation, the outer edge of the cam plate 143 will coact with the roller 144 and through the linkage just described will rock the bell crank arm 147 clockwise thereby depressing the related plate 132 so that the hood 119 (Fig. 6) will elevate the brush 115, such position is maintained by the latching relationship of lugs 130 and 131. Fig. 3 shows the above described mechanism provided at the left side of the machine while in Fig. 5, which discloses the right side of the machine, precisely the same mechanism is provided to restore the plate 132 situated at the right side of the tabulating machine. In view of the description given of the pertinent parts in Fig. 3, there is no necessity for describing or repeating the operation of the same device shown in Fig. 5.

Driving clutches for the various machine driving shafts

As previously suggested the machine also includes a number of magnetically controlled clutches for selectively connecting certain driving shafts with the driving mechanism of the machine. A detailed description of the construction and operation of one of such clutches will now be given and its description will suffice for the various clutches employed as they are generally similar in construction and operation. Where specific differences are found the necessary description will be given in connection with each of such clutches.

The particular clutch now to be described and selected as an example of those utilized in the machine is known as the main clutch and its purpose is to selectively connect the driving shaft 141 (Fig. 2) with the constantly rotating driving gear 139.

Referring particularly to Figs. 24 and 25, it will be observed that there is loosely mounted upon shaft 141 a drum 151 provided with an annular recess receiving a magnetic coil winding 152 the ends of the coil being electrically connected to related collector rings 153, 154 against which bear spring blades 155 and 156. Secured to the drum 151 is the gear 140 which is constantly driven by the gear 139 (Fig. 2). When the coil 152 is energized by opening of the card lever contacts 127 (Fig. 6), as will be later explained, a clutch element 157 will be magnetically attracted to a companion clutch element 158 integral with the constantly rotating drum 151. The electrical impulse is transmitted from the positive side of the line to the spring blade 156 through the coil winding 152 and to the negative side through the contact blade 155. The clutch element 157 will now be attracted and as it has a suitable spline connection 159 to the shaft 141 the latter will be turned. The clutch element 157 is also provided with a collector ring 160 against which bears a spring blade 161 which is connected to the negative side of the line. As the clutch element 157 is shifted the collector ring 160 will now contact blade 161 and a contact blade 162 which is electrically connected with the contact blade 155. The circuit to the coil winding 152 is thereby continued (since circuit connection at 155 will be disconnected) through the contact blade 162 and collector ring 160 since the lateral shifting of the clutch element 157 is insufficient to prevent the continued contact of blade 161 with the collector ring 160.

The shaft 141 will, therefore, be turned a complete revolution until each of the contact blades 161 and 162 engage an insulated block 163 to thereby open the circuit to the coil winding 152, and the companion clutch elements 157 and 158 will thereby disengage after a complete revolution of the shaft 141. The connections whereby the coil winding 152 is energized under control of the card lever contacts 127 will be specifically described in connection with the wiring diagram.

Accumulator and associated entry mechanism

The machine includes accumulating devices and associated entry controlling mechanism in the form of separable and independent units which may be selectively plugged for control by different card columns as required so that the accumulators may be formed of as many denominational orders as may be required.

To this end the machine includes seventy five accumulator controlling magnets 165 (Fig. 20) it being recalled that the card may effect a control from sixty columns. The extra control magnets and associated accumulator wheels are provided to take care of higher orders, the additional transfers being effected in the usual manner. Each accumulator control magnet is connected by suitable plugging devices with the associated contact strip for control by a related column. Each time the reading brush makes contact through a hole in a card column a corresponding relay is energized to effect the energization of the related accumulator magnet. The accumulator magnet may, if desired, be energized under

direct control of a reading brush but it is preferable to interpose contacts of a relay magnet in the accumulator magnet circuit in order that the brush breaks the circuit to the relay magnet which requires little current instead of the accumulator magnet which would result in damage to the brush and card perforations since the accumulator magnet requires currents of a high value.

As is best shown in Fig. 20 each accumulator magnet 165 is provided with an armature 166 secured to a slidably mounted support rod 167 which has a pivotal pin connection 168 with an upstanding arm 169 having an open slot at its upper end receiving a pin 170 (Fig. 22) of an operating pawl 171. The particular formation of the operating pawl 171 and associated devices forms no part of the present invention and is fully described in the patent to Tauschek, 1,781,349 and for this reason will only be generally described herein.

For further details of construction and operation reference may be had to the above designated patent. The pawl has at its right angle portion a slot 172 receiving a pin 173 which pin forms the pivot of pawl 171. A spring 174 is connected to the pawl at a point between the pin 170 and pivot 173. It is obvious from the above described construction that the energization of the armature of a related magnet will shift the arm 169 to the left rocking the pawl clockwise so that the actuating tooth thereof will engage one of the interdental spaces 175 formed at the lower edge of a bar 176 attached to an actuator 177. The engaging tooth of the pawl is therefore rigidly coupled to the member 176 so that a further movement of the arm 169 to the left will shift the pawl longitudinally to the left as far as allowed by the slot 172, the length of which corresponds to a unit distance of feed. A deenergization of a magnet 165 will permit arm 169 to be restored to the right under action of spring 174 to bring the parts to their normal positions.

By the above described arrangement each electrical impulse transmitted to an accumulator control magnet will result in successive operations of the pawl to thereby step the actuator 177 a number of units to the left commensurate with the numerical value in a control column designated by the same number of perforations.

As is fully disclosed in Fig. 20 and Fig. 18 the magnets are arranged in an upper and lower tier, the magnets of the uppermost row being staggered with respect to the magnets of the lowermost row in order that the controlling arms 169 may be separated a distance of half the width of a controlling magnet unit. Those magnets which have their armature rods 167 connected to the associated upstanding arms 169 at points above the pivotal point 178 have their armatures 166 at the right of the magnet cores so that the armatures 166 will be moved to the left and cause the upper end of the arms 169 to move to the left. The armature rods 167 of the lower tier of magnets are connected to the associated upstanding arms 169 at points below the pivotal point 178 and therefore the armatures 166 are at the left of the magnet cores in order that they effect a leftward movement of upper end of arms 169 or in the same direction as is effected by the armatures of the magnets 165 located in the upper tier. The above structural arrangement provides for compactness and a movement of each

arm 169 counterclockwise without requiring additional parts.

Referring particularly to Figs. 22 and 23 the former figure shows an actuating member 177 in a normal position and in Fig. 23 in shifted position. The actuators and associated devices are similar in construction and each is provided with a vertical arm 179, the actuating member 177 being guided in slots in combs 180, 181, and 182, each actuating member being urged to its normal position under the action of a spring 183, the normal position being defined by the coaction of the right end (Fig. 22) of the actuator 177 with a movable stop bar 184.

Slidably mounted upon the vertical arm 179 by means of lugs 185, 186 integral with the arm 179 and engaging rectangular slots is a U-shaped actuating rack 187. A headed screw 188 also provides for the slidable movement of the actuator 187 upon the arm 179 and retains the actuator in assembled position upon the arm 179.

It will be obvious that the actuator 187 partakes of the same horizontal movement given to the member 177 and may also have an independent or vertical movement in order to engage an adding rack 189 with teeth of an accumulator gear 190, or a lower subtracting rack 191 with the same accumulator gear. In the normal operation of the machine when the machine is adapted to add amounts the uppermost rack 189 is in normal engagement with the accumulator pinion 190 and after a differential operation has been given to the actuator 187 the latter is shifted upwardly to effect a disengagement of the adding rack and the accumulator pinion 190 whereby springs 183 will draw the actuator 187 and member 177 to their normal positions. In the case of subtraction two steps of upward movement are given to the actuator 187 in order that the lowermost rack 191 engages the accumulator pinion 190, the adding rack 189 being then disengaged from pinion 190.

Holding pawls for actuators 177

In order to retain the actuator 187 in its successively shifted position during adding operations, there is provided a series of pawls 192 one for each member 177, the pointed end thereof being in the plane of ratchet teeth 193 formed at the upper edge of the member 176. At the beginning of the operation of the machine and prior to the analysis of the card perforations, a bar 194 extending transversely of the machine and positioned beneath the series of holding pawls 192 is dropped downwardly by means to be described more in detail hereinafter. Springs 195 connected to each of the holding pawls 192 hold the pawls resiliently into engagement with the teeth 193 to hold the actuator 187 in successively shifted position. Before the actuators 187 can be restored the bar 194 is elevated and substantially at the same time a pair of bars 196, 197 are elevated.

The bars 196, 197 extend transversely within the side frames 18 and 19 of the machine, and there is slidably mounted by the side frames 18 and 19 a pair of plates 198 to which the extremities of the bars 196, 197 are secured. As is shown in connection with one of such plates 198 in Fig. 23 the said frame 19 of the machine carries a headed pin 199 engaging a slot 200 to provide for the necessary shifting movement of the actuator 187 so that either the adding or subtracting racks are free of pinions 190 and since bar 194 is now

elevated springs 183 may return the actuators to normal.

After the initial operation of the machine it is necessary that the pawls 192 be lowered to engage the ratchet teeth 193. To this end the bar 194 is lowered by the following mechanism best shown in Figs. 3 and 26 for the left side of the machine. The bar 194 extends transversely of the machine and each end is supported by a linkage comprising links 201, 202 and 203 which are joined together by pivotal points 204 and 205, it being obvious that arms 202 and 203 comprise a toggle system. To the pivotal point 205 there is connected a link 206 pivoted at a point 207 which for the purpose of the present description may be considered as fixed. The lower end of the member 203 is provided with an elongated slot 208 which receives a pin 209 secured to the machine frame. Pivoted to substantially the mid-center of the member 203 is a cam plate 210 in the plane of a horizontal arm of a bell crank 211, the vertical arm being connected to a plate 212 which is slidably mounted on the side frame of the machine by means of elongated slots receiving pins 213. The extremity of the plate 212 is urged by a spring 214 so that a roller 215 carried at the extremity of plate 212 engages the outer edge of the cam plate 143. This relationship of the parts shown in Figs. 3 and 26 holds the bar 194 elevated and thereby the holding pawls 192.

At the initial operation of the machine the rotation of the cam plate 143 in a counterclockwise direction permits spring 214 to shift the plate 212 to the left as viewed in Fig. 26 rocking the bell crank 211 clockwise and through the linkage system previously described permits the bar 194 and pawls 192 to be lowered as shown in Fig. 22 by the weight of bar 194 and springs 195 whereby said pawls operate to hold the related members 177 in successively shifted position.

After the racks have been shifted and the entry effected in the accumulator, the outside edge of cam plate 143 again coacts with the roller 215 shifting plate 212 to the right and through the linkage system described elevating bar 194 to disengage the holding pawls 192 from the ratchet teeth 193, this position being maintained to the end of the machine cycle. When such release is effected, the actuators 187 are drawn to their normal positions under the influence of springs 183 (Fig. 22).

Accumulator rack disengaging devices

As previously intimated the adding racks 189 (Fig. 22) are elevated to be disengaged from the adding pinions 190 prior to the restoration of the adding racks 189 under control of their springs 183. This is accomplished by shifting each of the plates 198 upwardly, a pair of such plates being provided, as stated, and slidably mounted by the machine frames.

Each plate 198 is provided with a pin 218 projecting through a slot 219 (Figs. 3 and 5) in the related machine frame and is attached to an associated irregular shaped member 220. Secured to the side frame of the machine is a bracket 221 (Figs. 3, 5, 27 and 28) which has a depending arm carrying a stud 222 which forms the pivot of a plate 223 which is secured by screws 224 to a double arm 225, it being obvious by this construction that the arm 225 is pivotally mounted by stud 222. The arm 225 is provided with a slot 226.

There is connected to the upper end of the member 220 a spring 227 which has sufficient nor-

mal tension so that a pin 228 carried by the upper end of arm 220 engages the left portion (Fig. 27) of the slot 226. By means of the arrangement just disclosed, it will be apparent that if the portion of the arm 225 to the right of the pivot point 222 is rocked downwardly, the engagement of pin 228 with the left end of slot 226 will elevate the member 220 to thereby raise the plate 198 and effect the desired disengagement between the adding racks and totalizer pinions 190. This disengagement is effected when the double arm 225 is shifted to a horizontal position and is preferably effected by means of a link 229 which is connected to the end of the arm at the right (Fig. 27) of the pivot of the double arm 225, and also at its lower end the link 229 is connected at 230 with an arm 231 which may be considered as integral with an arm 232. The arm 232 is provided with a roller 233 which is adapted to be engaged by the inner edge of the cam plate 143 of cam 142 to thereby draw the link 229 downwardly against the action of a spring 234 connected to arm 225. The horizontal positioning of the arm 225 is effected towards the end of the operating cycle and subsequent to the transfer operations which are effected in a manner to be presently described.

Holding devices for totalizer pinions

Secured to each pinion 190 is an accumulator wheel 235 (Figs. 20 and 22) provided on its periphery with three series of figures zero to nine inclusive. The figure characters on the wheels are readable through reading slots 236 formed in the machine casing as disclosed in Fig. 20.

It is desirable that at a certain point in the machine operation while the racks are being disengaged from pinions 190 so that they return to normal that the wheels 235 be held against movement and subsequently released and to this end there is provided a bar 237 (Figs. 22 and 30) which extends across the machine and which is provided with a series of holes each receiving a spring pressed plunger 238, the lower edge of which when the bar 237 is shifted downwardly is adapted to coact with the side of the associated wheel 235.

The preferred devices for shifting the bar 237 comprise links 239 which are connected to the extremities of the bar 237 by studs 240 which are integral ends of bar 237. Two of such links are provided one for each side of the machine as disclosed in Fig. 3 which shows such parts for the left side of the machine and in Figs. 4 and 29 which show the mechanism provided for the right side of the machine. As the operating mechanism is identical for each link it will only be described in connection with the mechanism provided for the right side of the machine and which is illustrated in detail in Fig. 29.

The lower end of the link 239 is connected at 241 to one arm of a bell crank 242 one arm of which carries a roller 243 adapted to be engaged by the outer edge of the cam plate 143. When the cam plate 143 engages the roller 243 it will rock bell crank 242 counterclockwise depressing link 239 to thereby draw the bar 237 downwardly so that the plungers 238 engage the sides of the accumulator wheels. When the cam plate 143 is free of the roller 243 a spring 244 connected to the link 239 will elevate the bar 237 to release the accumulator wheels for free rotation.

Manual entry in accumulator

It is desirable at times to manually enter an initial amount in the accumulator to represent,

for example, a prior balance. Each upstanding arm 179 (Figs. 20, 22, and 23) forms a finger piece 245, since as shown in Fig. 20 it projects through the machine casing. A selected finger piece 245 may be shifted to the left (Fig. 20) until a desired amount is represented upon the accumulator wheel but as it is necessary that the position of the wheel be maintained by the pawls 192 and further, that disengagement be effected between the normally engaged adding racks 189 and accumulator pinions 190, suitable mechanism is provided to effect each of these operations without requiring an operation of the machine.

Such operations are under control of an operating handle 246 (Fig. 1) which is outside of the machine casing for convenient operation by the operator. The mechanism controlled by the operating handle 246 will now be described in detail.

The operating handle 246 (Fig. 2) is loosely mounted upon a shaft 247 and to the handle is secured a pinion 248 adapted to drive a gear 249 which is loosely mounted upon a stud shaft 250. The gear 249 is connected by a sleeve 251 (Fig. 3) to a pinion 252 which is adapted to drive a gear 253 secured to the shaft 247. The gear 253 drives a gear 254 to which a cam plate 255 is secured. As the handle 246 is turned counterclockwise to an extent of one and three quarter revolutions the train of gears will be driven in the arrow directions shown in Figs. 2 and 3 with the result that the cam 255 is driven in a clockwise direction. Pivoted to the cam 255 is a link 256 (Fig. 26) which is connected to an extension 257 of the cam plate 210 which is pivoted by a pivot pin 259 to the previously mentioned link 203. The cam 210 has a low point 260 and a high point 261.

The clockwise rotation of the cam 255 for a half revolution will thereby turn the cam 210 in a clockwise direction and during such turning movement the low point 260 will permit the pawl holding bar 194 to drop to such a position that the pawls 192 will engage the ratchet teeth 193 of the member 176 (Fig. 22). The finger pieces 245 may then be shifted to the left (Fig. 20) to set up the desired amount in the related totalizer wheel 235.

The cam 255 (Fig. 26) is provided with cam edges 262 merging into recesses 263 and 264 with which a roller 265 is correlated. The roller 265 is carried by one arm of a double arm 266 suitably pivoted by the machine frame and connected by a link 267 (Fig. 2) with one extremity of the arm 225. The upper end of the link 267 is provided with an elongated slot receiving a pin 268 secured to the arm 225. As the cam 255 is turned clockwise a cam edge 262 will through the linkage system shift the arm 225 in a horizontal direction thereby disengaging the racks 189 (Fig. 22) from the totalizer pinions but towards the end of the turning movement of cam 255 recess 264 will coact with the roller 265 thereby again permitting the arm 225 to assume its inclined position as shown in Fig. 27 in which position the adding racks 189 are again in engagement with the totalizer pinions 190. This is the position of the parts just prior to the manual shifting of the finger pieces 245 to set up the entry.

After the entry, the handle is restored in a clockwise direction so that the parts will be reversely operated, the pawl holding bar 194 being lifted upwardly to disengage the pawl 192 to release the adding racks. During the restoration

or counterclockwise rotation of the cam 255 the cam edge 262 will shift the arm 225 (Fig. 26) again in a horizontal position and since the adding racks 189 are now out of engagement with the adding pinions 180 and pawls 182 are disengaged from the ratchet teeth 193, the springs 183 will be effective to restore the racks to their normal position thereby retaining the amount manually entered in the accumulator wheels.

Transfer mechanism

The machine also includes an electrically controlled transfer mechanism whereby units are transferred from the lower to the higher order accumulating elements. The transfer mechanism, in general, resembles that fully disclosed and described in the British patent to Tauschek, #289,055 but for a complete understanding of the invention the transfer mechanism will be described herein in sufficient detail.

Each accumulator wheel 235 is provided with a series of transfer projections 270 (Fig. 22) one of each at a time is effective for setting a transfer arm 272 when the wheel, in one-third of its rotation, passes from nine to zero. A spring plate 271 retains the right end of the arm 272 downward in order to be operated by one of the transfer projections 270. The other and integral arm 273 of the transfer arm 272 is provided with a wedge-shaped projection 274 coacting with a similar shaped projection 275 secured to a pivoted transfer lever 276. The wedge shaped projections 274—275 are normally in abutting contact. If a tens transfer is necessary, that is, if the accumulator wheel passes from the nine to the zero position, the right end of the transfer arm 272 will be lifted upwardly whereby the projection 274 slides off the projection 275 (see Fig. 23). The upper end of the transfer lever 276 carries a plate 277 of insulating material to which is attached a contact finger 278. By this arrangement, the contact finger 278 is insulated from the transfer lever. By means of a related bent spring blade 279 which is in continuous contact with the contact finger 278, the transfer lever 276 is normally urged to shift to the right or from the position shown in Fig. 22 to the position shown in Fig. 23. As each transfer lever 276 occupies its shifted position it engages the bar 288 to prevent immediate contact of finger 278 with a contact stud 280.

A series of such contact studs 280 is carried by a bar 281 of insulating material. The spring blades 279, as there is one for each finger 278, are electrically connected together and are electrically connected by a wire 281a to the positive line side. Each contact stud 280 is connected through related split transfer controlling contacts 282 which are in series with the accumulator magnet 165 of the next higher denominational order and which contacts 282 are closed so that a transfer can be effected to the magnet of the higher order.

Prior to the restoration of the actuators 177, and by means to be presently described, the bar 288 is moved to the right (Fig. 23) so that a contact between a released finger 278 and related stud 280 effects an energization of an accumulator magnet of the next higher order, such energization taking place if the related manually controlled contacts 282 also close. The energization of any adding magnet will effect an additional operation of the adding pawl 171 in precisely the same manner as explained in connection with the regular accumulating operations.

The bar 288 is disposed to the right (Fig. 22) of the series of transfer levers 276 and when the transfers are to be effected the bar is shifted to the right. The extremities of the bar 288 are slidably mounted in suitable slots 280 (Figs. 3 and 5) in the right and left machine side frames and the bar 288 is normally urged to the right (Fig. 22), or to the left as viewed in Fig. 31, by the action of springs 295 and is restrained by means of a latching hook 296 engaging a half round pin 291 carried by a bell crank 292 which arm has a notch receiving a circular portion 293 of bar 288. As will be later explained a magnet 522 (Fig. 31) is energized at the required time, thereby, through its armature elevating a link 297 and by means of an arm 298 rocking a rock shaft 299. The latching arm 296 is secured to the shaft 299 to thus release the bar 288 which is forced to the left, as viewed in Fig. 31, to permit electrical contact between certain fingers 278 and contact studs 280.

After the desired transfer operations have been effected, it is necessary, of course, that the released transfer levers 276 be restored to their normal positions. This is preferably effected by means of the bar 288 which is subsequently shifted to the left (Fig. 22) to restore the released transfer levers 276. The reduced circular portion 293 of one end of bar 288, as stated, is received by a notch formed in an arm of bell crank 292, one being provided for each side of the machine (Figs. 3 and 5). By rocking the bell cranks 292 the bar 288 is shifted to effect the restoring operations. As the mechanisms which are provided at the left and right side of the machine are similar in construction and operation the description will be furnished only in connection with the mechanism provided at the right side of the machine which is disclosed in Figs. 5 and 31, reference being had particularly to Fig. 31. One arm of the bell crank 292 is connected by a link 292a to a horizontal arm 293a of a bell crank, the vertical arm 293b thereof adapted to be engaged by a cam plate 294 secured to the cam plate 142 at the right side of the machine. During the rotation of the cam plate 142, in the arrow direction (Fig. 31), the coaction of one edge of the cam plate 294 with the vertical arm 293b will through the linkage just described shift the bar 288 to the right as viewed in Fig. 31 to be relatched by latching hook 296. When the shifted transfer levers 276 (Fig. 22) are restored the spring plates 271 will rock the individual transfer arms 272 to normal position at which time the wedge shaped projections 274 and 275 will again coact with each other to hold the associated transfer arm 272 in position to be again actuated by a projection 270 preparatory to a subsequent transferring operation.

Split transfer control

By means of the contacts 282 which are more fully disclosed in Figs. 32 and 33, transfers between adjacent orders may be interrupted and thereby the accumulating units may be separated to form independent accumulator banks of any desired number of orders. A pair of such contacts 282 is provided for each denominational order. Loosely pivoted upon a rod 283 is a series of levers or plates 284. Each plate 284 has an edge 286 adapted to contact with a plate of insulating material secured to one of the contact blades of contacts 282. When a switch lever is in the position shown in either Figs. 32 or 33, contacts 282 are closed but when a desired lever

is rocked in a counterclockwise direction, the edge 287 being nearer the pivot 283 than the edge 286, it will permit the right blade to open the contacts 282 to suppress the transfer connection to the next higher order accumulating wheel. The switch levers 284 have manually operable parts 285 projecting through slots in the machine casing so as to be externally operable by the operator.

Printing mechanism

The printing mechanism of the machine comprises a series of type bars which are positioned differentially so that the type at printing position may represent the amount to be entered in the accumulator or a total thereon, although as will be further explained even other results of machine operations may be printed. There is provided a type bar for each accumulator wheel, and in the present case, the machine has seventy-five type bars conforming to the number of accumulator wheels.

The printing mechanism is best disclosed in Figs. 20, 32, and 33. Referring particularly to Figs. 20, 32, and 33, the type bars 300 are slidably mounted by guide slots 301 formed in a cross bar 302 and each is provided with a rectangular slot 303 receiving a cross rod 304 carried by a bar 305 and the bar 305 is also provided with guide slots 306. Each actuator 177 extends to the left and is provided with a block 307 in the plane of the lower portion of the type bar and is adapted to coast with one of a series of stepped shoulders 308. Each type bar is normally urged upwardly by springs 309 such action being normally restrained by the coaction of a cross bar 310 (see Fig. 20) which normally occupies the lowermost portion of slots 311 formed in the midportion of each of the type bars 300. In the normal position of the parts, the zero type of a series of percussive digital type members 311 is at the printing line of the usual printing platen 312. After the actuator 177 has been differentially positioned the block 307 will be so positioned that upon a subsequent upward movement of the related type bar 300 one of the stepped shoulders 308 will coast with the related block 307 thereby stopping the type bar at a position where the selected type is at the printing line.

The elevation of the type bars 300 to their differential positions is under the control of the cross bar 310. The extremities of the cross bar 310 are carried by a pair of members 314 (see Figs. 3 and 5). The extremities 313 of the cross bar 310 pass through slots formed in each of the side machine frames and fit in the related members 314 in any suitable manner. Each of the members 314 is urged upwardly by related springs 315 so that rollers 316 carried thereby coast with the previously mentioned pair of profile cams 142.

After the differential positioning of the actuators 177 the turning of the pair of cams 142 in the arrow directions of Figs. 3 and 5 will permit the rollers 316 to coast with descending portions 318 of the cams 142 permitting the springs 315 to elevate the cross bar 310 until the stepped shoulders of the type bar coast with the associated blocks 307 of actuators 177. This action terminates when the type facing the platen 52 correspond to the value represented by the perforations in the card.

Printing from the type is effected by mechanism to be presently described, this operation occurring when the rollers 316 coast with dwell portions 319 of cams 142. After the printing opera-

tion from the type carriers the cam portions 320 of cams 142 cause the bar 310 to descend to its normal position. During such operation, the type bars 300 also descend to their normal positions and when in such position the restoration of actuators 177 will permit the block 307 to engage the uppermost shoulder of the related type bar 300 at which time the zero type of the printing bar is at the printing line.

Type hammers and operating devices

Each of the aforesaid type 311 is shifted to print under the action of a correlated hammer 322 (Figs. 32 and 33), a hammer being provided for each type bar 300. The hammers 322 are loosely mounted upon a supporting rod 323 and each hammer is urged to a position to strike the selected type 311 by a spring 324, this action being normally prevented by the engagement of a latch plate 325 coacting with fingers or projections 321 of the hammers 322. The plate 325 extends across the machine and coacts with all of the projections 321 of the type hammers 322 so that when a rod 326 to which the latch plate 325 is secured is rocked, the hammers 322 which are selectively released will be urged by their springs 324 to type striking positions.

Each of the hammers 322 is also latched by the engagement of a finger 327 thereof with a hook 328 formed as an integral part of an upstanding arm 329. Each arm 329 is pivotally mounted by means of a pin 330 to a related bar 331. It is obvious that when the arm 329 is shifted to the right as viewed in Figs. 32 and 33 the hook 328 will be disengaged from the finger 327 releasing the hammer 322 at this point of latch. The arm 329 has also an integral horizontal arm 332 projecting to the left as shown in Figs. 32 and 33 and also an integral arm 333 projecting to the right as viewed in both of the last mentioned figures. One end of a flat spring plate 334 carried by the related bar 331 and coacting with the extension 333 urges the hook 328 into latching engagement with the finger 327. Further movement in a counterclockwise direction of the member comprising elements 329, 332, and 333 under action of spring 334 is prevented by the coaction of the extremity of the arm 332 with a pin 335 secured to the related bar 331.

Each bar 331 is slidably mounted in suitable slots provided in cross bars 336 and 337. One end of each bar 331 normally engages a slot 338 formed in the related type bar 300, the slot 338 and extremity of bar 331 having coacting inclined parallel edges so proportioned so that when a type bar 300 is shifted upwardly for printing from a particular type 311 other than zero the bar 331 will be positioned to the right as shown in Fig. 33 thereby effecting a disengagement between the finger 327 and hook 328 which will now occupy the dotted line position shown in Fig. 32. Thereafter when the type is at the printing position the latch plate 325 will be shifted from the position shown in Fig. 32 to the position shown in Fig. 33 thereby releasing it from engagement with the finger 321 of the type hammer associated with the type bar shifted to printing position.

The hammer 322 is thereby rocked when unlatched by plate 325 under action of its related spring 324 to strike the extremity of the type to effect a printing impression upon a sheet of paper passing around the plate 312. It is also understood that a suitable inking ribbon is inter-

posed between the paper strip and printing type and positioned at the printing line.

The preferred mechanism whereby the latching plate 325 is shifted to permit printing is disclosed in Figs. 4 and 36. The extremity of the shaft 326 projects through the right side frame of the machine and has secured thereto an arm 340 to which is connected an operating member 341. The latter is urged downwardly by a suitable spring 342 and the member 341 is guided at its lower end for a sliding movement by means of an elongated slot receiving a pin 343 secured to a suitable bracket 344 which is attached to the right side frame. To the shaft 141 there is secured a cam 345 which carries a cam plate 346, the cam edge of the latter being adapted to coact with the lower extremity of the member 341 after the type have been set to printing position thereby elevating the member 341 and rocking the shaft 326 in a clockwise direction as viewed in Fig. 36 or in a counterclockwise direction as viewed in Figs. 32 and 33. The latch plate 325 is thereby disengaged from the fingers 321 of the hammers 322 selected for effecting the printing operation.

Type hammer restoring devices

It is essential of course that the released type hammers 322 be restored to their initial latched positions at the termination of a printing operation. This is effected by means of a cross bar 347 which is normally positioned as shown in Fig. 33 to permit free release of the hammers. The bar 347 is carried at its extremities by a pair of arms 348 and 349 the right arm being shown in Fig. 5 and the left arm being shown in Fig. 3.

The arms are pivoted to the machine side frames by suitable studs 350. The mechanism for rocking the cross bar by means of the arms 348 and 349 is similar for both sides of the machine and the operation will only be explained with reference to the mechanism provided at the right side of the machine as shown in Figs. 4 and 36. A similar mechanism is provided at the left side of the machine as disclosed in part in Fig. 2. The arm 348 is secured by means of a sleeve 351 (Figs. 5 and 36) to an arm 352 the latter being pivotally connected to an operating member 353 which is provided with a suitable guide slot 354 receiving the shaft 141 and a roller 355 coacting with the aforementioned profile cam 345.

After the printing operation has been effected under control of the cam plate 346, the position of the cam 345 is such that the cam portion 356 thereof coacting with the roller 355 elevates the member 353 thereby rocking the bar 347 in an arcuate path in a counterclockwise direction as viewed in Fig. 36 but in a clockwise direction as viewed in Figs. 32 and 33. The bar 347 will therefore engage all of those hammers 322 which have been released for operation so that as the hammers are returned to normal position they may be relatched by the engagement of the plate 325 with the finger 321 of each hammer 322, and also, by the reengagement of the hook 328 with the related finger 327 of a type hammer 322, the last relatching relationship being effected when the bar 331 is permitted to slide to its normal position under the action of a restoring spring 357 (Figs. 32 and 33) which operation occurs when the related type bar 300 is at normal.

Zero insertion mechanism

It is necessary, of course, at times to fill in

zeros to the right of any significant figure and mechanism is provided to automatically release the type hammer 322 of any lower order or lower orders under the action of the movement of a type bar 300 of the adjacent but higher order. For example, with reference to an example of a printed sheet disclosed in Fig. 38, it will be obvious in printing the number "954024" that the type hammer 322 of the hundreds order should be automatically released for operation to print a zero in the hundreds column. This, for example, is automatically effected under control of the bar 331 comprising the thousands denominational order.

As best shown in Fig. 21, it will be noted that each bar 331 (except the one at the extreme right of the printing mechanism) carries a pin 358 which coacts with the extremity of the arm 332 of the next lower order. If, for example, a type bar of higher order is shifted to print a significant figure the related bar 331 will be shifted to the right (Fig. 32) to release its associated type hammer 322 and in so doing, the coaction of the pin 358 carried thereby with the horizontal arm 332 of the next lower order will thereby shift the bar 331 of such order. This shifting movement is sufficient to disengage the hook 328 from the finger 327 of the hammer of lower order so that when the latch plate 325 is subsequently shifted to release all of the hammers printing will be effected from the type which will print a significant figure and also from the type which will print the zeros in an order or orders to the right of the first left significant figure of the number.

Since the hammers 322 in orders above the first left significant figure of the number are not released for operation, due to the particular positioning of the pins 358 on the bars 331, zeros will not be printed to the left of the first significant figure and printing will be effected precisely in the manner disclosed in a representation of a printed sheet shown in Fig. 38.

Splitting of printing mechanism and transfer mechanism

The units of the printing mechanism may be plugged for operation in such a manner that the printed numbers may exhibit numbers representative of various items. The first two columns in Fig. 38 may, for example, represent dates and the next seven adjacent columns may represent values. A demarcation between such sets of figures may be maintained by selecting a sufficient number of orders for printing which would insure that one or a sufficient number of blank columns would always be maintained between the lowest order of one class of items and the highest order of the items of adjacent class. While this would provide the necessary separation at least one or several units would be lost for operation and the present machine therefore includes selective devices whereby all orders of the printing mechanism may be used, and this is accomplished by having the items of different classes separated by printing of some mark of demarcation. In the preferred embodiment this is effected by printing a series of dots as shown in Fig. 38.

To secure such result auxiliary type bars 360 (Figs. 32 and 33) are provided, and in effect are combined hammers and type bars since all of the bars carry at their heads serrations 361 the extremities of which are preferably curved corresponding to the diameter of the platen.

Each hammer or ruling member 360 is situated

between adjacent type bars 300 so that when one of them is projected into the space between the two adjacent type carriers and strikes the ribbon and platen it will form dotted lines on the paper. Each hammer 360 has a finger 362 adapted to coact with the latch plate 325 and is released for operation in precisely the same manner as explained in connection with the type hammers 322.

The latching arms 329, as best shown in Fig. 34, are sufficiently wide to coact with the finger 327 of a type hammer 322 and also a somewhat similar finger 363 (Fig. 33) of the adjacent type hammers 360, it being noted from Fig. 32 that the latching finger 363 is slightly longer than the latching finger 327. The purpose of this is to prevent the release of an unselected ruling member 360 by the shifting of the latch arm 329 effected either by the associated type bar 300 or by the type bar 300 of higher order when filling in zeros. But, however, when a ruling member 360 is selected for printing of dots the hook 328 is rocked sufficiently to disengage it from the latching finger 363.

In the preferred embodiment this is carried out by means of one of the manually settable levers 284 and is provided by having each lever 284 carry a roller 364 adapted when the lever is rocked to a counterclockwise position to engage the extension 333 to thereby rock the hook 328 to such a position that the associated ruling member 360 is released for operation. When a particular lever 284 is rocked to select the desired ruling member for operation, the shifting of the latching arm 329 will also release the related type hammer 322 but as the subdivision is effected by shifting the lever 284 of the lowest denominational order of one group this is satisfactory and desirable as the type hammer of such order will be employed for either printing a zero or some digit. Summarizing therefore, it is only necessary to move a particular lever which corresponds to the lowest order of one of the groups in order to provide for the printing of dividing dots between two groups.

As previously described, contacts 282 also control the transfer from one order to another and from the construction adopted, it will be obvious that when a particular lever 284 is rocked in a counterclockwise position (Figs. 32 and 33) about the pivotal point 283 to thereby effect printing of subdividing dots the right spring plate (Figs. 32 and 33) of contacts 282 will follow the coacting edge 287 of the lever 284 so that in the shifted position of the lever the edge 287 will permit the separation of contacts 282 thereby opening the transfer circuit to the next order. The levers 284 thereby split the printing mechanism into separate groups and also split the accumulator into groups consisting of the same or different numbers of denominational orders. The operator may, therefore, select for printing and accumulating as many denominational orders as is desired and be able to employ all the denominational orders if necessary and still provide for separation of the different classes of items printed.

Paper feeding device

In order to space the printed items, any suitable type of paper feeding device may be employed and the preferred embodiment is disclosed in Fig. 37. The arrangement disclosed is adapted to effect feeding of the paper sheet a single line at a time. To the platen 312 there is secured a ratchet wheel 366. Loosely mounted upon the

shaft 367 to which the platen is secured is an arm 368 to which is pivoted a spring pressed pawl 365 in the plane of the ratchet wheel 366 and engaging the interdental spaces of the ratchet wheel. Connected to the arm 368 is an operating member 369 which is slidably mounted at its lower end by a pin 370 secured to the right side frame 19 of the machine and which fits in an elongated slot in the member 369. Connected to the lower part of the member 369 is a spring 371. The member 369 has a foot 372 engaged by the bar 310.

The bar 310, as stated, is reciprocated for each operation of the printing mechanism. As the bar 310 moves upwardly during the time that the printing bars are being adjusted the spring 371 is effective to elevate member 369 and the pawl 365 will be shifted to engage the next and higher tooth space of ratchet wheel 366. When bar 310 is restored to normal position after the termination of a printing operation it engages the foot 372 to positively move the member 369 downwardly and through the pawl 365 turns the platen a single line space.

The above described pawl and ratchet mechanism is, in general, similar to that employed in connection with typewriting and printing mechanisms of calculating machines and, is therefore, explained only in general herein.

Supplemental paper feeding device

It is occasionally desirable to list an item upon each of several forms comprising a long web or work sheet, each item being printed at the same line for each form. For example, as shown in Fig. 41 in printing yearly bills, it is desirable in entering items for the month of January that after printing the item on one form representing one person's account that the sheet being fed a distance sufficient that the next item to be entered will be printed on the next form representing another person's account upon the line correspondingly designated by the month of January. A suitable paper feeding device for effecting the necessary paper feeding operation to take care of the above requirement is disclosed in Figs. 5, 35, and 48.

As shown in Fig. 35 the member 314 provided at the right side of the machine has an upwardly extending rack 375, the teeth thereof being in continuous mesh with a gear 376 which is loosely mounted upon the shaft 367 of the platen.

Secured to the platen supporting shaft 367 is a disk 377 (Fig. 48) to which is pivoted a pawl 378 adapted when shifted to a certain position to engage the teeth of the gear 376. Upon the upward movement of the member 375 the gear 376 will be turned in a clockwise direction (Fig. 48). The teeth of gear 376 are so shaped that in a clockwise direction of gear 376 they engage a finger 379 of pawl 378 to cam the latter thus preventing turning of disk 377. However, when the rack 375 is restored to its normal or lowermost position, the gear will be turned counterclockwise and by means of the gear teeth engaging pawl 378 the disk 377 will be turned and therefore, the platen to feed the sheet sufficiently so that the subsequent printing operation will be effected on the next form at the desired line.

When the above described mechanism is not required for operation the pawl 378 may be manually shifted out of effective position by manual means, preferably comprising a finger piece 380. The pawl 378 is held in ineffective position by means of a flat spring 381 and the ex-

tremity of the pawl cooperates with a suitably formed notch 378a in the spring 381. When the pawl is in effective position the spring 381 acts to keep the pawl 378 in continuous engagement with the teeth of the gear 376.

Inking mechanism

The inking mechanism comprises preferably an inking ribbon 382 (Fig. 4) the upper color thereof being of one color such as blue, for instance, and the lower portion for printing in a distinguishing color, red, for example. The ribbon is drawn from a spool 383 (Fig. 4) and passes over a suitable roller 384 and then lengthwise of the machine so that the ribbon is interposed between the type and the paper which is wound around the platen. At the left of the machine (Fig. 2) the ribbon 382 passes over a roller 385 and is then fed to a spool 386. Suitable inking ribbon reversing devices may be employed for reversing the direction of feed of the inking ribbon.

A controlling device whereby the ribbon is shifted to print in a distinguishing color when the kind of printing is changed may also be employed.

Total printing operations

The total printing operations capable of being effected by the present machine are of two types, namely, a grand total which involve a clearing of the accumulator, and a subtotal printing which does not involve the clearing of the accumulator. Such operations may be effected manually under control of keys or automatically by a group controlling mechanism.

Grand total printing operations

The description now to be given will be confined to the mechanism involved in securing a grand total from a series of accumulator elements. The mechanism to be described is shown at the left side of the machine as shown in Fig. 3 and duplicated at the right side of the machine as shown in Fig. 5. Fig. 39 also shows the mechanism provided for the left side of the machine and detached from others to more clearly show the construction.

Referring to Fig. 39, particularly, there is provided a grand total controlling magnet 390 and a subtraction magnet 391 both of which are simultaneously energized. To the armature 390a of the grand total magnet 390 there is secured a rod 392 provided with a pin 393 engaging a slot 394 in a double arm 395-407 pivoted at 396. Pivoted to a depending extension 397 of the double arm 395-407 by means of a pin 398 is a plate 399. Passing through the plate 399 is a pin 400 received by a notch 401 of the extension 397. The plate 399 also carries a pin 402 received by a slot 403 of a slidably mounted member 404. The member 404 is slidably mounted by suitable pins 405 and 406.

The arm 407 which is integral with the arm 395 has secured to it a block 408, it being apparent that when the armature 390a is attracted downwardly the double arm 395-407 will be rocked clockwise so that a latch arm 409 will engage beneath the block 408 and thereby hold the parts in the position shown in Fig. 39. During such operation, the engagement of the notch 401 with pin 400 will rock the plate 399 and by means of the pin 402 engaging slot 403 will elevate the member 404 upwardly so that a pin 410 of member 404 engaging a slot 411 will elevate a hook 412 so that a notch 413 therein will engage a

projection 414 of the double arm 415. The plate 404 has an arm 416 extending to the left as shown in Fig. 30 and to which arm is pivoted a depending hook 417, it being obvious that when arm 416 is lifted upwardly the hook 417 will be similarly elevated so that by the engagement of the lower hook portion with a projection 418, a member 419 slidably mounted by pins 420 and 421, will be raised. The member 419 carries a pin 422 in engagement with an elongated slot 423 formed in a depending portion of a hook arm 424 which is pivoted at 425 to a slidably mounted member 426. The arm 424 is provided with a notch 427 adapted to engage a projection 428 of the lower part of a double arm 429. It will be observed, that when the member 419 is raised upwardly by the hook 417 the pin 422 by engaging the slot 423 will elevate the right end of the arm 424 to thereby effect an engagement between the notch 427 and projection 428 of the arm 429. The last mentioned relationship will be maintained by virtue of the fact that the engagement of the holding member 409 with the block 408 will retain all the parts in their shifted positions shown in Fig. 39.

The hook 412 is pivotally mounted by means of a stud 430 upon a plate 431 which has an elongated slot at its extremity receiving a pin 432 carried by the machine frame so as to suitably guide the plate 431 at its right end (Fig. 39).

The plate 431 is shifted to the right under the action of a spring 433. The left end of the plate 431 has a suitable guide slot received by a collar on the shaft 141 and also carries a roller 434 adapted to engage a profile cam 435.

The hook arm 424, as previously mentioned, is pivotally mounted at 425 to the plate 426. The latter is slidably mounted at its right end by means of a pin 436 secured to the left side machine frame engaging an elongated slot provided in the right extremity 435 of the plate 426. The left end of the plate 426 (Fig. 39) has a suitable guide slot so that it may be guided by the shaft 141 and carries a roller 438 coacting with the periphery of a profile cam 439.

Prior to an operation of a shaft 141 and the cams carried thereby, the energization of the grand total magnet 390 will cause the parts just described to be positioned as shown in Fig. 39. With the energization of the magnet 390 the energization of subtraction magnet 391 is also effected. When the magnet 391 is energized, its armature 440 will be attracted and as it rocks about its pivot point 441, it will disengage an integral hook extension 442 from projection 443 of an arm 444 so that a spring 445 will rock the arm 444 in a counterclockwise direction. The arm 444 has a ledge or shoulder 446 coacting, as best shown in Fig. 28 with the pin 228 which is carried by the upper end of the arm 220. The spring 445 is of such size that upon release of arm 444, the shoulder 446 engaging the pin 228 will shift it to the left end (Fig. 40) of the concentric slot 226 rocking the arm 220 in a counterclockwise direction. Pin 228 is now to the left (Fig. 40) of the pivot 222. As the irregular shaped member 220 is rocked in a counterclockwise direction a projection 220a will be engaged and latched by means of a latching hook 478 to thereby hold the member 220 in such position until subsequently unlatched.

As the pin 228 is shifted to the left and elevated by the inclination of slot 226 (since spring 234 is stronger than springs 445 and 227 together)

it will draw the member 220 upwardly and by the arrangement previously described elevate the plates 198 (Figs. 22 and 23) to thereby place the subtracting racks 191 into mesh with the accumulator pinions 190. This is the position of the racks with respect to the accumulator pinions prior to an operation of the shaft 141.

As the shaft 141 and the cam 435 and 439 are turned in a counterclockwise direction (Fig. 39), the engagement of the roller 434 with the cam portion 447 of cam 435 will through the plate 431 draw the hook 412 to the left (Fig. 39) and by its coaction with the projection 414 will rock the arm 415 clockwise. The horizontal arm of the double arm 415 by its engagement with a block 448 of the link 267 will elevate the latter and by engagement of the lower end of the slot formed in the upper extremity of link 267 with a pin 268 will rock the arm 225 so that it assumes a horizontal position as shown in Fig. 40. This will have the effect of depressing the member 220 so that the plates 198 will now be shifted downwardly a slight amount to bring the rack members 187 in such a position that neither rack 189 nor 191 engages the accumulator pinions 191. The racks may now be shifted to the left (Fig. 22) free of the accumulator pinions.

The extremity 416 of the member 404 is connected to a double arm 449 by means of a link 450 so that when the plate 404 is elevated the link 450 will rock the double arm member 449 in a counterclockwise direction to immediately bring an upward extension 451 of the arm 449 beneath a projection 452 of the link 203.

Referring to Fig. 26 it will be observed that even though the link 203 is permitted to be lowered at the initial operation of the machine, the engagement of the extension 451 with the projection 452 will hold the link 203 upwardly to thereby prevent the lowering of the holding pawls 192 and the latter are thereby held up during the cycle of machine operations involving grand total printing or subtotal printing.

Reverting now to Fig. 39, it will be observed that the upper end of the arm 429 is provided with an elongated slot receiving a pin 453 integral with the extremity of the square cross bar 184. The bar 184 is slidably guided by means of slots 455 in each of the side machine frames so that it may be shifted to the left as viewed in Figs. 22, 23 and 39 to thereby shift all of the rack bars 187 to the left, free of the accumulator wheels. This action is effected by means of the coaction of a cam portion 454 with the roller 438, the cam portion being adapted to first shift the plate 426 to the right and by means of the hook of arm 424 rock the arm 429 counterclockwise and thereby shift the cross bar 184 to the left. When all the rack bars 187 are in their shifted position the lower or subtracting racks 191 (Fig. 23) are elevated upwardly and this action is effected when the roller 434 coacts with the descending portion 456, the latter permitting the plate 431 to be shifted to the right under the action of the spring 433 so that it will permit the link 267 to be moved downwardly. Since the lower end of the slot has been engaging the pin 268 as the link 267 drops from the position shown in Fig. 40 spring 234 rocks arm 225 from its horizontal position to its inclined position, this action elevating the member 220 and placing the lower or subtracting racks 191 into engagement with the accumulator pinions 190. Arm 225 is now in the inclined position shown in Fig. 39 with the

exception that pin 228 is now to the left of pivot 222 and hook 478 engages projection 220a.

The pin 453 (Fig. 39) previously mentioned engages an upwardly bent extension 457 of a double arm member 458 which is pivoted and secured to a rock shaft 459. The rock shaft 459 extends across the machine and has secured thereto depending arms 460 (Fig. 22) which carry a total stop bar 461. Therefore as the bar 184 is shifted to the left the shaft 459 will be rocked counterclockwise bringing the total stop bar 461 in the path of the transfer projections 270 of the series of accumulator pinions from which the total is to be derived. The arm 458 has an integral extension 462 which is adapted to be engaged by a spring urged latch 463 to thereby hold the total stop bar 461 in its shifted position.

After the subtracting racks are engaged with the accumulator pinions the roller 438 will engage a descending portion 464 of the cam 439 thereby permitting the plate 426 to be drawn to the left under the action of a spring 465. Therefore the bar 184 will be moved to the right (Fig. 22) permitting the subtracting racks 191 to follow in the same direction and to positions depending upon the amount previously standing upon the related accumulator pinions 190. The subtracting racks 191, it will be recalled, are shifted to the right under the action of springs 183 so that when a transfer projection 270 engages the total stop bar 461 a further movement of the subtracting rack will be prevented and the associated member 177 will thereby position the related block 307 (Fig. 33) so that it may control the differential position of the related printing bar 300 and select the proper type. When the series of accumulator wheels are at their zero position and maintained at such position the printing mechanism will be effective to thereby print the total in the same manner as explained in connection with item printing mechanism and the operation of such will, therefore, not be repeated.

It is pointed out that the members 177 are first shifted to the left and then restored to the right under control of the accumulator pinions 190. If a wheel is at zero a transfer projection 270 is in immediate engagement with the total stop bar 461 so that its member 177 cannot move to the right. When a member 177 is shifted to the extreme left a block 177a (Figs. 20, 33) will engage with a notch 300a to thereby hold the related type bar 300 in its lowest position, wherein the "O" type will be in printing position and print a zero in orders where the digit of the total is "O".

After the total printing operation the outside cam edge of the cam plate 294 (Fig. 39) secured to cam 142 will engage the extremity of a plate 467 thereby shifting the same to the right. From Fig. 39, it will be observed that the arm 407 has pivoted thereto a link 468 which is connected by a pin 469 to the right end of the plate 467. The latter is provided with a notch 470 engaging a pin 471 of the hook 417. When the plate 467 is shifted to the right by cam plate 294 the hook 417 will be rocked to free it from the projection 418 thereby releasing the plate 419 and permitting the hook of arm 424 to drop to its lowermost position where the notch 427 is disengaged from the projection 423 of arm 429. The last mentioned condition is effective in order that the ascending portion 472 and descending portion 473 of cam 439 are ineffective as the cam 439 is turned further in a counterclockwise direction. The portions 472 and 473 are effective only in sub-

totaling operations which do not involve clearing.

It will be recalled that as the bar 184 is returned to the right the accumulator elements are turned to their zero positions. Referring to Fig. 5 27, it will be apparent that as the cam plate 143 engages the roller 233, the link 229 will be depressed to thereby cause the arm 225 to be shifted from its inclined position to assume its horizontal position shown in Fig. 40. This operation de- 10 presses the subtracting racks and frees them from the accumulator pinions so that the racks are now released for movement to their normal positions.

When the link 229 is moved downwardly to 15 cause arm 225 to be shifted towards a horizontal position, arm 220 is depressed sufficiently so that projection 220a is disengaged from the hook 478, since the latter is held up by a stationary pin 479 (Fig. 40) secured to the machine frame.

At this time arm 444 is shifted to the right so that spring 227 is now free to rock arm 220 clockwise (Fig. 39) bringing pin 228 to the right end of the slot 226. Roller 233 (Fig. 27) will now leave the cam 143 so that the parts are in the 25 position shown in Fig. 39 and as arm 220 is lowered the adding racks finally reengage the accumulator pinions as shown in Fig. 22.

At the termination of the cycle the link 292a (Fig. 39) will be shifted upwardly, as explained in connection with transfer operations, so that 30 a pin 474 carried thereby will engage a foot of latch member 463 thereby releasing the arm 458 so that it will be turned in a clockwise direction (Fig. 39) by means of a spring 475 to bring the 35 total stop 461 in normal or ineffective position.

The arm 444 (Fig. 39) has also an integral and curved arm 476 carrying a roller 477 which is adapted to be engaged by the cam 142 to thereby shift the arm 444 in such position that 40 its projection 443 will be engaged and related by the subtraction hook 442.

Sub-total printing operations

In order to effect a subtotal printing operation 45 which permits the amount previously standing upon the accumulator elements to be reinserted a subtotal magnet 483 (Fig. 39) is energized simultaneously with the energization of the subtraction magnet 391. It is clear that when the 50 armature 484 of the subtotal magnet is attracted and shifted to the left the pin 400 which is also carried by the armature rod and passes through a hole in plate 399 will rock the plate 399 in a clockwise direction (Fig. 39) to thereby elevate 55 the plate 404. Since the hook 417 is carried by the arm 416 of a plate 404, the hook arm 424 will be elevated in the same manner as described in connection with grand total printing operations. Since plate 404 is elevated the hook 412 will also 60 be elevated in the same manner as was described in connection with grand total printing operations.

The arm 416 of the plate 404 is also provided with a block similar to the block 408 on the arm 65 407 so that when the arm 416 is elevated the latch arm 409 will engage beneath the same to hold both hooks 424 and 414 in elevated position. It is to be noted, however, that since the arm 407 is not rocked the pin 471 will be positioned above 70 the notch 470 of the restoring member 467.

Since the latter condition now obtains, it will be observed, that after the total has been printed and the accumulator elements are at their zero positions the ascending portion 472 of cam 439 75 will now be effective to rock the slidably mounted

member 426 again shifting bar 184 to the left to pick up the subtracting racks 191 in their differential positions to reinsert the amount previously standing on the accumulator pinions.

When this operation has been effected, the link 5 229 (Fig. 27) will be drawn downwardly to shift the arm 225 towards a horizontal position at which time the accumulator pinions are free of either the racks 189 or 191. As the roller 438 engages the descending portion 473 of cam 439 10 the bar 184 will be shifted to its normal position permitting the racks now free of the accumulator pinions to be shifted to their normal positions shown in Fig. 22.

At the final operation of the machine, as previously stated, the roller 233 (Fig. 27) is disengaged from the cam plate 143 permitting spring 234 to be effective to place arm 225 in the inclined position shown in Fig. 27 so that the upper or adding racks 189 are again in engagement with 20 the totalizer pinions 190.

At the termination of the cycle of machine operation involving both sub and grand total printing the outside edge of the cam plate 294 25 will engage the upper arm of a bell crank 480 pivoted at 481. Below the pivot, the double arm is connected to a link 482 which is connected to the lower end of the latch arm 409. At the final operation of the machine the latch arm 409 is 30 rocked counterclockwise (Fig. 39) thereby removing it from the block 408 of arm 407 so that the member 404 and arm 407 in grand total printing operation may drop downwardly to their normal positions at which time the hook 412 is now out of engagement with the arm 415. In subtotal 35 operations, the latch arm 409 is released from the block of member 404 to release both hooks 412 and 424 simultaneously.

Means for disabling the transfer pawls during total printing operations 40

It is desirable that the transfer arms 272 (Fig. 22) be held upwardly out of engagement with the transfer projections 270 when the accumulator pinions are being zeroized or turned in a 45 counterclockwise direction (Fig. 22). To this end there is provided a rod 485 (Figs. 22, 23, and 42) which overlies the series of transfer arms 273 and when moved downwardly forces the arms 272 upwardly during total printing operations. The 50 mechanism for shifting the rod 485 downwardly is duplicated for both sides of the machines and Fig. 42 shows the mechanism provided at the left side of the machine. The arm 429 is provided with a pin 486 engaging an elongated slot in a 55 link 487 which is pivoted to a vertical arm of a bell crank 488. The horizontal arms of the bell cranks 488 provided at each side of the machine, carry the rod 485. When the arm 429 is rocked to the left (Fig. 42) by the linkage system just 60 described, the bar 485 will be shifted downwardly and held in shifted position by means of a latching pawl 489.

When bell crank 488 is rocked clockwise a sufficient extent a block 488a thereon will be 65 free of the left end of the latching pawl 489 which will be rocked by its spring 489a to pass in front of the block 488a and thereby latch bell crank 488 to hold rod 485 in downward position.

The link 239 is provided with a pin 490 adapted 70 to coact with the latch arm 489 and release the same after which the pin 486 of arm 429 engages the end of the slot in the link 487 restoring the bar 485 to an ineffective position being assisted in this restoring operation by a spring 487a. 75

Wiring diagram—Listing operations

An explanation of the machine for the features previously described will now be given in connection with the wiring diagram disclosed in Figs. 48a and 48f.

Current is supplied from power source P (Fig. 48f) to the positive side 497 and negative side 496 when a switch 16 (Figs. 1 and 48f) is shifted. By then turning a combined switch and rheostat 17 a low voltage is first supplied to motor 20 and then increased as the switch 17 is further turned to thus bring the motor 20 to the desired speed.

As a card is fed to the analyzing section by hand or automatically the card lever contacts 127 (Fig. 48e) are opened which results in the deenergization of the relay R2 (Fig. 48f) by the following circuit. From the positive side 497 through contacts 127 (now open), wire 498, through contacts 499 (Fig. 48b) through contacts 500 by a wire 501, and thence by a wire 502 to the magnet of relay R2 and thence to the negative side 496. The opening of contacts 127 thereby deenergizes the magnet of relay R2 so that the armature will drop to effect a circuit from the positive side 497 through the armature contacts 503 (now closed) and thence by a wire 504 (Fig. 48f) through closed contacts 505. A circuit then extends by a wire 506 (Fig. 48f) through contacts 507 of switch D, (see also Fig. 45) contacts 507a of switch M, contacts 508 of switch CA and thence by a wire 509 to the magnet winding 152 (Fig. 48d) of the main clutch (Fig. 24). The circuit is then extended by a wire 510 to the negative side 496. Energization of this clutch magnet effects the operation of the shaft 141.

The circuit for causing the energization of the brush magnets 128 and 129 in order that the brushes 115 may engage the cards is as follows. A circuit extends from the positive side of the line 497 through contacts 535 (Fig. 48c) which are controlled by a cam on the shaft 141 of the machine and closed at the required time. The circuit then extends by a wire 511 (Fig. 48c) through contacts 512 now closed and to each of the magnets 128 and 129 which are connected together by a wire 513 to lead to the negative side 496.

It will be recalled that when either magnet 390 or 483 is energized for grand or sub-total taking operations respectively the plate 404 is elevated upwardly. As is best shown in Figs. 2 and 3 plate 404 in its upward movement will open contacts 512 to thereby prevent the energization of the brush control magnets 128 and 129 during a total taking operation.

The adding circuit which effects the accumulation of amounts represented by the card perforations will now be traced with particular reference for a single column only as the operation is identical for all columns. It will be assumed that the control for each card column is effected by suitable plug connections from the related brush reading socket 492 to the selected accumulator magnet socket 514 of the related accumulator magnet 165 of the series. The circuit for the units column extends from the positive side 497 (Fig. 48e) through one of the brushes 115 to contact the segment 118 of the second controlling or units representing column through the card perforations of the second column. This effects the energization of a magnet of a relay 515 as such relay magnet is connected to the negative line side 496. The energization of the relay magnet 515 will close contacts 516 extending a circuit from the positive side 497 and by a wire 517 to the

#2 brush reading socket 492. By the plug connection 518 made between said socket 492 and a selected socket 514 a circuit is extended from the accumulator magnet socket 514 through a wire 519 (Fig. 48d) to the accumulator magnet 165u comprising the units order and thence to the negative line side 496. It will be apparent that for each perforation analyzed an impulse will be transmitted to the accumulator magnet 165u.

The transfer circuit whereby a transfer is effected from the first order to the second order will now be described in detail.

It will be recalled that as a transfer projection 270 of the first order, for example, passes through zero, contacts 278 and 280 are closed when the bar 288 is subsequently shifted (Fig. 22). A circuit will, therefore, be extended from the plus side 497 by a wire 520 (Fig. 48c) to the transfer plate 279 (see Fig. 22), thence the circuit extends through the transfer contacts marked 278₂, 280₂ in Fig. 48a through the split transfer contacts 282₂ and since it is assumed that the transfer is described for the accumulator magnet 165_r of the tens denominational order the circuit will be extended by a wire 521 to the accumulator magnet 165_r of the tens denominational order. In the same manner each set of transfer contacts 278, 280 are closed to effect the transfer provided that the associated split transfer contacts 282 are closed. Opening of such contacts will prevent a transfer to the higher order by the passing of the lower order wheel through the zero position. While there are transfer contacts 278_H and 280_H for the highest order they are only used for a special purpose in connection with division operations to be described later.

It will be recalled that the bar 288 is shifted to the right (Fig. 22) under control of a magnet 522 to thereby permit the closure of such contacts 278 and 280 that have been selected to effect a transfer. The circuit for this magnet is as follows. From the positive line side 497 through listing shaft cam controlled contacts 629_L (Fig. 48c) closed at transfer time, wire 523, relay contacts 524 not involved in the present invention and now closed, wire 525, contacts 526 now closed, and thence to the transfer controlling magnet 522 by wire 527 to the negative line side 496.

From Fig. 5 it will be seen that contacts 526 are normally closed but as shown in Fig. 4 when the plate 404 is elevated upwardly by the energization of either magnet 390 or 483 contacts 526 are opened thereby opening the transfer circuit just described.

As previously intimated the machine is so arranged that either grand total or subtotal printing operations may be effected under control of manually operated keys. In Fig. 43, numeral 528 designates the grand total key and numeral 529 designates the subtotal key. The subtotal key 529 when depressed is adapted to shift an intermediate contact blade to first close contacts 530 (Fig. 44) and after such contacts 530 are closed a pair of contacts 500 are opened. This is effected by causing the resilient right blade of contacts 500 to follow the intermediate blade until contacts 530 close. Further operation opens contacts 530. In a similar manner, the grand total key 528 is adapted to first close contacts 531 (Fig. 48b) and thereafter open contacts 499. As each of the contacts 499 and 500 are in the card lever circuit 501, it will be obvious that opening of either of these contacts will cause the energization of the

main clutch magnet 152 in the same manner as previously explained. When the grand total key 528 is depressed, a circuit will be extended from the positive side 497 through contacts 127 by the wire 498 (Fig. 48e) and through the grand total contacts 531 (Fig. 48b) to a wire 532. Wire 532 is connected to one side of each of the pair of grand total magnets 390 (Fig. 48d), the other side of the grand total magnets being interconnected by a wire 533 and the circuit thereafter extends through contacts 534 through magnet 535 and through contacts 536 to a wire 537, and through contacts 644 controlled by a cam on the listing shaft 141. A circuit is completed from contact 644 (Fig. 48c) by a wire 538 which is connected to the negative line side 496. By the circuit just traced depression of the grand total key will effect the energization of the grand total magnets 390. It will be recalled that with the energization of the grand total magnets 390 the subtraction magnets 391 are also energized. This is effected by the energization of the relay magnet 535 which closes contacts 539 one blade of the contacts being connected by a wire 540 to the plus line side 497.

From the lower blade of contacts 539 a circuit is extended by a wire 541 through cam controlled contacts 495 controlled by a cam carried by shaft 141 and by a wire 542 to the pair of subtraction magnets 391. One side of each of the subtraction magnets 391 is connected by a wire 543 to the negative line side 496.

When the subtotal key is depressed the contacts 530 are adapted to energize the subtotal magnets 483 and the subtraction magnets 391 simultaneously. This is effected by electrical connections now to be described. The wire 501 (Fig. 48b) is connected through normally closed contacts 499, wire 498, and through closed contacts 127 (Fig. 48e) to the positive line side 497 and since contacts 500 are only opened after the contacts 530, the circuit extends by means of a wire 544 (Fig. 48d) to the subtotal magnets 483. The circuit then extends by wire 545 through the contacts 534, magnet 535, contacts 536, and wire 537 to the negative line side in the same manner as previously traced in connection with grand total printing operations. The subtraction magnets 391 by energization of magnet 535 are, therefore, also energized simultaneously with the subtotal magnets 483.

Contacts 534 are shown in Figs. 2 and 3 and contacts 536 are shown in Figs. 4 and 5. These contacts as shown in Fig. 48d are normally closed but upon the energization of the brush release magnets 128 and 129 the sets of contacts 534 and 536 will open preventing the improper energization of any of the magnets 483, 390 or 391 by depression of the grand or sub-total key 528 during a card controlled operation and before a card has caused the opening of the card lever contacts 127 (Fig. 16).

Subtracting operations

There is also included in the machine a control for subtracting items when the field representing a value by perforations is characterized to represent a negative or subtractive item.

This characterization comprises a perforation placed in advance of the numeral representing perforations and which may be analyzed after the reading brushes 115 are lowered or at the time the brushes are lowered and in any event before the numeral representing perforations are analyzed.

This perforation 491 (Fig. 49) may be in any card column and the brush reading socket 492 (Fig. 48b) representing such column is plugged to one of the subtraction sockets 493 (Fig. 48b). Each socket is wired by a wire 494 (Fig. 48d) to one side of the subtraction magnets 391 through contacts 495 closed by a cam on shaft 141. The other sides of the subtraction magnets are connected to the negative line side 496 by the wire 543. The card brushes are connected to the plus side 497 to complete the circuit.

As stated in connection with total taking operations the energization of the subtraction magnet causes the lower subtracting racks 191 to engage the accumulator pinions 190 so that the latter are actuated in a direction reverse than to that effected in adding operations. Hence subtracting operations are effected by the direct process and since the transfer arms 273 may be operated in either direction of the accumulator pinions the necessary "borrowing" is effected in a manner well known in the art.

The subtracting racks 191 engage the accumulator pinions during the time the racks are being moved differentially and after the necessary transfers have been effected the subtracting racks 191 are disengaged from the accumulator pinions and returned to normal since at this time the link 229 (Fig. 39) is depressed thus depressing member 220 (Fig. 43) so that the subtracting racks may be free of the accumulator pinions after which the adding racks may subsequently engage the accumulator pinions. The latter operations have been described in considerable detail in the explanation rendered in connection with total taking operations.

Cross calculation device—electrical features

The machine also includes an arrangement whereby successive fields of the same record card may be tabulated and these items may be either added or subtracted depending upon the nature of the value represented by the field analyzed. This arrangement is particularly valuable in calculating successive amounts which may comprise, for example, wages, extra compensation and the like, the necessary deductions being made from such additive amounts for insurance, taxes, advanced compensation, etc. This arrangement is generally known as a cross calculation device and in the present machine comprises a self contained unit 585 (Fig. 1) which is incorporated in such tabulating machines where this unit would be especially desired.

In the present construction, it is possible to accumulate entries designated by eight fields of the same tabulating record and values represented by any of the fields may be additively entered. The items may be subtractively entered in the accumulator under control of all 80 fields except the first depending upon the selective plug connections made in the plugboard.

The plugboard provided for the cross calculation device as best shown in Figs. 47 and 48b comprises nine horizontal rows of plug sockets, the first eight horizontal rows 586 (from the top) of eight sockets each (from right to left) being adapted to be plugged to eight fields of a record card. Of the vertical column of seven plug sockets designated 587 each is employed to characterize the entry of the controlling card columns plugged to the related horizontal row 586, as a subtractive entry. The extreme left hand vertical row of plug sockets 588 is employed to limit the number of successive additions or subtract-

tions to the number of fields represented on the card which controls the cross calculation device.

As an explanation of the latter, it will be recalled that since there are eight horizontal rows of plug sockets 586 corresponding to the number of card fields which may be cross calculated, it will be obvious in some cases that fewer controlling fields will be employed. For example, if only six calculating operations are necessary the machine will by the device to be described be limited in operation to only six cycles.

As an illustration of the utility of this device, it will be supposed that it is desired to calculate by machine operations from six controlling fields of a single card, and two of such fields (the fourth and sixth) may represent a subtractive entry. A record card illustrative of the above example is shown in Fig. 49 and the necessary plug connections for the machine are shown in Fig. 47. To set the machine for cross calculation, it is necessary that the switch disk of the switch CA (see Fig. 45) be turned in a clockwise direction which is performed by shifting the cross addition lever CA (Fig. 47) from the "out" position to the "in" position. The first adding field is represented by columns 3 to 7 inclusive, and plug sockets 492 related to such columns are plug connected (as shown in Fig. 47) to the five plug sockets (from the right) of the upper horizontal row of sockets 586. The second field comprising columns 8 to 11 are plug connected to the related sockets 586 of the second horizontal row from the top. The plug sockets relating to the third adding field, or columns 13 to 17, are connected by suitable plug connections to the third row of the plug sockets 586. In the same manner the remaining three fields are connected to the related sockets of the fourth, fifth and sixth horizontal row of sockets 586. Since the fourth and sixth fields are adapted to designate subtractive entries the subtraction plug 587 of the related row, that is, the fourth and sixth row from the top are each connected by plug wires 669 to the subtracting plug sockets 493.

The row of plugs 588 are connected by a jumper 695 as shown in Fig. 47 with the sixth plug socket from the top connected to the eighth socket of the row 588. This connection will limit the number of machine operations to six cycles commensurate with the number of controlling fields. A row of sockets 589 is connected by suitable plug connections to the accumulator magnet sockets 514 so that successive additions or subtractions may be entered in the selected accumulator elements represented by the plug sockets employed.

The principle of operation for effecting cross addition and subtraction is best understood from the wiring diagram comprising Figs. 48a to 48f. For the accumulation or subtraction of the amounts, there is provided eight rows of contacts 590, each row being of circular formation. Associated with each circular row of contacts is a contact finger 591. The eight contact fingers 591 have, as will be later explained, suitable wire connections to eight contact rings 592 against which bear the eight blades 593. The contact blades 593 are connected by wire connections 594 (only one being shown for clearness) to the row of sockets 589 (Fig. 48b) which it will be remembered are plug connected to selected accumulator magnets.

The contact fingers 591 are carried by a shaft 595 (Fig. 48d). Normally fingers 591 contact with the first horizontal row of contacts 590 so that upon a subsequent step of movement of shaft

595 the contact fingers 591 will now contact the second horizontal row of contact points 590 and so on. By means of connecting wires 596 the uppermost horizontal row of contact points 590 is connected to the uppermost row of plug sockets 586 (Fig. 48b) and corresponding connections are provided between each row of contact points 590 and the related row of plug sockets 586.

From the above, and recalling the plug connections shown in Fig. 47, it will be obvious that when the first field is analyzed electrical impulses will be transmitted to the uppermost row of sockets 586 thence through the wire connections 596 to the first horizontal row of contacts 590. Since at this time the contact fingers 591 contact such points 590 the impulse (for one order) will be transmitted to the contact blade 593, and thence by a wire connection 594, the impulse will be transmitted to a socket in the row of sockets 589 and, thence for all orders, by the plug connections shown in Fig. 47 to the accumulator magnets related to the plug sockets 514 employed. After the first analyzing operation, the card is again analyzed at which time impulses will be transmitted to the second (from the top) horizontal row of plug sockets 586 thence by the second horizontal row of contact points 590 and by the fingers 591 and wire connections 594 to the same accumulator magnets. The third addition is performed in precisely the same manner. However, when the fourth or subtractive field is to be analyzed the following electrical connections are made. Each of the seven subtraction plug sockets 587 is connected by a wire connection 597 (Fig. 48b) to the related one of a row of seven contact points 598 (Fig. 48d) and the contact finger 599 associated with such row is a half step ahead of the other contact fingers 591 so that as the shaft 595 is given an initial step of movement for a control from the second field the finger 599 will contact one of the points 598 prior to the time that the contact fingers 591 will engage the contact points 590 of the row to be subsequently employed. The reason for such construction is that it is necessary to energize the subtraction magnet 391 prior to the analyzing operation, since in effecting cross calculation no special characterization is employed as is necessary when performing controlling operations from successive records.

By the above arrangement the following electrical connection will be made. From the positive side 497 by means of a wire 600 (Fig. 48e) thence through a connecting contact 983 of a switch D, a wire 661 through connecting wire 835 of switch M thence by a wire 662 to a connecting contact 663 of the switch CA and since the latter has previously been shifted the connection will be extended to a wire 664 and thence through closed contacts of a switch 665 (Fig. 48d) and by a wire 666 to the contact blade 666a associated with collector ring 667 and thence to the contact finger 599. As the finger 599 engages the fourth contact point 598 of the fifth horizontal row from the top the circuit will be extended by wire 597 (Fig. 48d) (similar to the connection shown for a particular point 598) to the fourth plug socket of the row 587 and thence by a plug connection 669 (Fig. 47) to one of the subtraction sockets 493. It will be recalled that the circuit extends from all of such sockets to the subtraction magnet 391.

When it is desired to cross calculate entries on a single record such record may be fed manually or by the automatic card feeding device and in

either instance the pairs of feeding rollers 43—45 and 39—40 (Fig. 6) will feed the record card to the analyzing brushes 115 since the card feeding clutch is normally engaged.

Referring to Fig. 15, it will be noted that there is provided a supplementary card lever 670 which is similar in construction and operation to the previously mentioned card lever 126 so that as the card which is to be cross calculated is fed, the card lever 670 will be raised to open up contacts 671. As previously stated the circuit 509 (Fig. 48d) to the main clutch magnet 152 is closed through connecting contact 508 of switch CA but shifting of switch CA (Fig. 48b) opens such circuit through contacts 508 so as to prevent operation of the listing shaft 141 during cross calculation.

To stop the card when it is in the analyzing section the opening of the contact points 671 will deenergize the relay magnet R—5 by opening the following described circuit. From the positive side 497 (Fig. 48e) through card contacts 671, by a wire 672 to the relay magnet R—5 and thence to the negative side 496. Deenergization of R—5 effects the closure of contacts 619 and contacts 618. A circuit will then be extended from the positive side 497, wire 600 (Fig. 48e) connecting contacts 983 (see also Fig. 45) of switch D, wire 661, connecting contacts 835 of switch M, wire 662, the connecting contacts 663 of switch CA now shifted and thence by a wire 673 to a wire 674 and through contacts 675 which are in series connection with the closed contacts 618 and 619. From the contact 619 a wire connection 676 extends to the wire 564 which it will be observed from Fig. 48d connects to the card feed clutch magnet 565 thereby energizing the same and as will be later explained preventing further operation of the feeding rollers. The card will then stop between and is held by the feeding rollers 32—33 and 39—40 (Fig. 6).

The closure of contacts 618 (Fig. 48f) will, through a wire 677, closed contacts 678, and a wire 679 (Fig. 48d), cause the energization of a multiplying clutch magnet 680 which is connected to the negative side 496 by a wire 681. This magnet is adapted to control a clutch 682 (Figs. 4 and 4a) for a repeatedly operated multiplying shaft 700. The magnetic clutch 682 is similar to the main clutch shown in Figs. 24 and 25, that is, it requires an energization of the magnet to effect an operation of the shaft 700.

When card lever contacts 671 open by the passage of a card a circuit to a magnet 601 (Fig. 48d) will be opened by opening the following circuit. From the positive side 497 through contacts 671 opened by the card to be analyzed, a wire 683, magnet 601, wire 684 to the negative side 496. When the magnet 601 is deenergized a bar will permit a pawl 685 to engage a ratchet wheel 686 secured to the shaft 595 and also permit a holding pawl 687 to engage the ratchet wheel 686. This condition will be maintained as long as the card is beneath the card lever 670.

To successively step the shaft 595 the pawl 685 is reciprocated for each operation of the multiplying shaft which corresponds to each analyzation of a field of the record card and the operation of the pawl 685 is under control of a magnet 604. The electrical circuit for causing energization of this magnet is as follows: from the negative side 496 (Fig. 48d), wire 684, through magnet 604, by a wire 688, connecting contacts 689 of switch CA now shifted (see also Fig. 45), wire 690, through 75 contacts 691 (Fig. 48e) to the positive side 497.

The contacts 691 are closed at the end of each analyzing operation by means of a cam 692 secured to the multiplying shaft 700 so that for each operation of the shaft 700 the contacts 691 close at the end of the cycle to transmit an electrical impulse to the magnet 604.

It will be observed that after the third analyzation, in the example assumed, the shaft 595 will be given a subsequent step of movement so that the subtracting contact finger 599 (Fig. 48d) will now contact the fourth horizontal contact point 598 of the first circular row thereby setting the machine for a subtraction operation just before the contact fingers 591 contact with the fourth horizontal row of contact points 590 which is effected just before the analyzing brushes are drawn over the card to be analyzed. From Fig. 48d, it will be observed that when the magnet 601 is deenergized in the manner explained the armature 693 thereof will close the switch points of the switch 665 (previously mentioned) thereby completing at this point the circuit to the subtraction magnet 391.

Total printing—after operation of shaft 700

To limit the number of machine operations to the number of controlling record fields the following electrical control devices are preferably employed. The circuit connection is effected from the positive side 497 and thence by means of a wire 694 (Fig. 48e) to the lowermost plug socket of the vertical row 588 (Fig. 48b). Since it is assumed that only six controlling fields are employed the jumper connection 695 is made so that after analyzing of the sixth field, a contact finger 696 (Fig. 48d) will contact the contact point 697, which is the contact point in the sixth horizontal row associated with the finger 696. Therefore from this contact a connection will be effected to the sixth counter plug socket of the row 588. An example of the last named connections is shown in the wiring diagram in connection with the contact point 697 of the second horizontal row by a wire connection 698 which leads to the uppermost plug socket of the row 588. It is obvious that by a similar connection the circuit will then be extended from the contact point 697, to the collector ring 699 by the contact blade 701 to a wire 702 to contact points 703 (Fig. 48c) which are controlled by a cam on the multiplying shaft 700. After the last accumulating operation has been effected and substantially at the termination of the last cycle contacts 703 close thereby extending a circuit by the wire 704 (Fig. 48f) to the magnet of a relay R—10 which leads to the negative side of the line 496. Energization of the magnet of R—10 closes contacts 705 thereby extending a circuit by a wire 706 from the positive side 497 through the contacts 705 and by a wire 707 which is connected to the wire 574 (Fig. 48b) which it will be observed terminates at the terminal 606 to automatically select the subtotal controlling magnets 483 for operation or the grand total controlling magnets 390 for operation dependent upon the position of the switch blade 547.

At the same time the card feed clutch magnet 565 is deenergized to start the operation of the pairs of feeding rollers 43—44 (Fig. 6) and 39—40, 32—33 so that the last two pairs feed the card out of the analyzing mechanism.

At the last operation the circuit to the clutch magnet 680 which controls operations of shaft 700 is opened to discontinue further operation of the multiplying shaft 700. To accomplish these functions from the wire 702 a wire connection 708

(Fig. 48c) leads to a magnet of a relay R—4 thereby energizing the same to open contacts 675. Contacts 675 open prior to opening of contacts 618, 619 which is caused by deenergization of R—5 when the card leaves card contacts 671 thereby opening the circuits 676 and 677 to deenergize the clutch feed magnet 565 and multiplying clutch magnet 680. Contacts 618 control magnet 680 and contacts 619 control magnet 565. The multiplying clutch is, however, enabled until the end of the last cycle by means to be later described.

Summarizing, the card to be cross calculated is fed to the analyzing section and feeding of such card causes the multiplying clutch magnet 680 to be energized to cause repeated operations of shaft 700. When a card is in analyzing position opening of card contacts 671 causes card feed to stop by deenergization of relay magnet R—5. For each analyzing operation the multiplying shaft 700 causes contacts 691 to close thus stepping shaft 595.

When the last analyzing operation is completed relay magnet R—4 is energized which causes card feed to be resumed. At the last operation relay magnet R—10 is energized permitting either the sub or grand total magnet to be energized with the subtraction magnets. The multiplying clutch magnet 680 is also deenergized to stop operation of shaft 700 at the last analyzing operation.

It is necessary, of course, that the listing shaft be operated during the total taking operation after a cross calculation operation and the circuit to the main clutch magnet 152 is automatically closed by the following circuit. When the relay magnet R—10 (Fig. 48f) is energized, contacts 709 will close thereby extending the circuit from the positive side through closed contact 709 to a wire 710 (Fig. 48c) thence through closed contacts 645, 652 to a wire 711 which is electrically connected to the wire 509 which it will be recalled extends to the main clutch magnet 152 thereby energizing the latter to start an operation of shaft 141. As the total printing operations are precisely the same as previously explained the description will not be repeated.

As shown in Figs. 2 and 3 the contacts 652 are normally closed and in Figs. 4 and 5 the contacts 645 are normally closed. The two sets of contacts are opened only when the pair of magnets 391 is energized.

In cross calculation operations the shaft 141 is idle and therefore, the printing mechanism will not be operative to effect printing of the values represented by card fields and which are employed in a cross calculating operation. As just described after the last calculating operation, printing of the total only will be automatically effected since shaft 141 is operable during this operation. The record sheet will, therefore, be printed only with the result secured after cross calculating the fields of a tabulating card.

Wiring diagram group control total taking mechanism

Provision is also made for automatically taking a subtotal or grand total when a certain mechanism detects the fact that one of the cards fed to the analyzing mechanism is imperforate in the field from which normal accumulating operations are controlled. To provide for this automatic arrangement a control device comprising a switch lever 546 and a supplemental switch 547 (Fig. 43) are provided.

To effect automatic total taking operations,

the switch 546 is shifted to its uppermost or "in" position (Fig. 43). The switch lever 547 is shifted to its uppermost or "in" position to automatically effect a subtotal printing operation and to its lowermost or "out" position to effect a grand total printing operation.

To effect automatic total printing operations under control of a field comprising adjacent card columns, there is provided a series of switch levers 549 each of which is normally in an intermediate position, as shown in Figs. 44 and 45. By suitably adjusting the outer end of one of such levers upwardly for the first column of the controlling field, for example, and the lever 549 associated with the last controlling column downwardly, the desired control may be effected.

Automatic total printing operations are as previously suggested, taken when the normal controlling card columns do not contain perforations. Such cards may be either blank cards fed to the analyzing mechanism or cards containing other perforated fields and the field from which the normal accumulation is effected being unperforated so that, as will be subsequently explained, total punching operations may be effected in the blank field.

To provide for the above, a series of group control contacts 550 is provided. When an actuator 187 of a particular order is at its normal position, a plunger 551 (see Fig. 22) is adapted to retain the related contacts 550 closed. When an actuator is moved as shown in Fig. 23 the resiliency of the left contact blade permits contacts 550 to open. Under such conditions a total printing operation will not be effected.

As best shown in the wiring diagram (Fig. 48a) contacts 550 are electrically connected in series so that an electrical circuit may be effected through a group of contacts 550 if none of the contacts is open. From the wiring diagram, it will be apparent that if a switch element 552 for the lowest order is shifted to the left, the left blade of the first order of contacts 550, for example, will be connected to a bus bar 633 and if any of the switch elements related to successive orders and designated by 553 are shifted to the right, they will connect the right contact blade of the last in the group with a bus bar 632. Hence, by such a connection, a circuit may be effected from the bus bar 633 to the lowest order switch 552 thence through the series of contacts 550 and by one of the shifted switch elements 553 to the bus bar 632.

Such is the manner in which the contacts 550 are selectively electrically connected to the bus bars 632 and 633 but the actual mechanical and electrical devices for providing such selective interconnections are preferably of the form shown in Figs. 44-46. In such case the metallic switch levers 549 normally engage both the spring blades 552 and 553. The right and left contact blades of a pair of contacts 550 (Fig. 44) are connected to the spring blades 552 and 553 respectively, so that when a switch lever 549 is turned counterclockwise an electrical connection will be effected between the left contact blade of contacts 550 with the lower bar 633. The latter is effected because in such adjusted position of the switch lever 549 a contact will be provided between the spring blade 552 and the bar 633 through the metallic switch lever 549 which contacts both blade 552 and bar 633. The other blade 553 is not in contact with the lever 549 at this time.

When the switch member is rocked clockwise the contact between the spring blade 553 and,

therefore right blade of contacts 550 will be made to the upper bar 632.

If it is desired, for example, to control by columns 1 to 10 inclusive the switch lever 549 for the first column 1 will be shifted in a counter-clockwise direction thereby effecting a connection from the bar 633 through switch lever 549, spring blade 552 to the left blade of contacts 550. The circuit then extends through the series of switch contacts 550 and for the tenth column the switch blade 549 is rocked clockwise thereby the right contact blade of the contacts 550 of the tenth column will be connected by the associated contact blade 553, switch element 549 to the bus bar 632. As an unpunched card passes a reading brush the actuators corresponding to the perforate columns will remain in their starting position and an electrical impulse will be passed through the group control contacts to start a total printing operation.

When the group control switch 546 is shifted to the "in" position (Fig. 43) a single throw double pole switch is shifted, the switch blades comprising blades 555 and 556 (see Fig. 48b). When blade 555 is shifted to the right a connection will be effected from the positive side through the switch blade 555, a wire 557 (Fig. 48c) through the contacts 558 which are closed by a cam on the shaft 141 to close when the index points in the first horizontal row of the controlling columns are analyzed to thereby close the circuit at this point. If no perforations are located, the circuit extends from the contacts 558 now closed by the cam on shaft 141 by a wire 559 to the switch bar 633 and thence through the series of closed contacts 550 to the switch bar 632 and thence by a wire 560 (Fig. 48f) to the magnet of a relay R-9 and thence to the negative line side 496. When the magnet of relay R-9 is energized, it will rock a lever secured to a rock shaft 561 to thereby close other circuits now to be explained.

One of the circuits extends from the positive side 497 by wire 557 (Fig. 48f) through a wire 562 and thence through contact blades closed by an intermediate switch disk 563 and thence by a wire 564 to the card feed clutch magnet 565 which is connected to the negative side of the line.

The card feed clutch magnet 565 of clutch 566 (Figs. 4 and 56) when energized effects a disconnection between the constantly turning gear 28 (Fig. 5) and the shaft 29. The shaft 29, it will be recalled, is adapted to turn by the gears 35, 36, 37, 41, and 42 disclosed in Fig. 2 the sets of feeding rollers 32-33, 39-40 and 44-45 (see Fig. 6). When shaft 29 is stopped the card is stopped at the analyzing position held by and between the sets of feeding rollers 32, 33 and 39, 40.

The clutch 566 is similar to the main clutch; with the exception that it is normally enabled and its energization disables the coupling. The details are best shown in Fig. 56.

The gear 28 which is loose on shaft 29 has attached thereto one clutch element 578a the other clutch element 579a being an integral part of a drum 583a which has a spline connection 580a to shaft 29. By means of a spring 581a which bears against the drum 583a and also against a disk 582a which is attached to shaft 29, clutch elements 578a-579a are normally engaged.

The drum also carries the magnet coil 565 and electrical connections to control the energization of the coil are provided for as usual, by means of

collector rings 584a carried by the drum and brushes bearing against said rings.

When magnet coil 565 is energized the drum 583a being of a magnetic substance will be magnetized and will be attracted to the disk 582a also of magnetic material. This will cause a separation of the clutch elements 578a-579a and, therefore, the stopping of the shaft 29 and the feeding rollers turned thereby.

As the card which causes the total operation to be effected passes beneath card lever 125 it opens contacts 127 and as the card is kept at rest the contacts stay open and thereby causes the clutch magnet 152 to be energized and the main clutch enabled or coupled during the total printing cycle. This action is precisely the same as with any card from which tabulating operations are effected.

Another circuit extends from the negative side of the line through the switch blade 556 (Fig. 48b) and a wire 567 to a magnet of a relay R-6 (Fig. 48f) thereby energizing the same since the circuit now extends by the wire 568 through switch blades and associated metallic elements of switch disk 569 and thence, by a wire 570 to a magnet of a relay R-8 thereby energizing the same since the circuit from the magnet of the relay R-8 is connected by a wire 571 to the positive side of the line. This circuit effects energization of relay magnets R-6 and R-8.

The cam which controls contacts 558 is so proportioned so as to cause magnet of relay R-9 to be energized during a portion of the total taking cycle. As the contacts 558 open relay magnet R-9 is deenergized but a circuit to continue energization of the card feed clutch magnet 565 will be maintained by the following electrical connection.

From wire 562 which leads from the positive line side, since switch blade 555 is closed, wire 584, contacts 577 now closed because R-1 is deenergized as there is a card beneath the card lever 127, contacts 578 now closed because previous energization of relay magnet R-6 caused such contacts to be held latched in closed position, wire 583, contact elements 582, wire 581, metal disk 580 rotatable by a total punch controlling shaft and contact blades of said disk, and thence by wire 579 and 564 to the card feed clutch magnet 565. Thus magnet 565 is energized until the end of the cycle at which time relay magnet R-7 is energized.

Magnet R-7 when energized at the end of a total taking cycle opens contacts 578 and closes contacts 505 to thus permit subsequent energization of the main clutch magnet 152. When contacts 578 are opened card feed resumes. Cam controlled contacts 629L (Fig. 48c) continue a circuit from the positive line side 497 by wire 1200 to one side of the relay magnet R-7, (Fig. 48f) the other side being connected to the negative side of the line 496.

Energization of the magnet of relay R-8 closes contacts 572 thereby extending a circuit from the positive side of the line through contacts 503 now closed since relay R-2 is not energized at this time because the card has stopped below card lever 125, thence by the wire 504 and a wire 573 through the closed contacts 572 and the circuit then extends by a wire 574 to a terminal 606 (Fig. 48b). Reference has previously been made to the switch 547 which is shifted to the "in" position (Fig. 43) for selecting automatic sub-total printing operation and to the "out" position for 75

effecting automatically grand total printing operations. This is merely a single pole double throw switch, the single blade of which is electrically connected to the terminal 606. When the switch blade 547 is shifted to the left the circuit from 606 is extended by a wire 576 to the wire 532 which it will previously be recalled effects the energization of the grand total printing magnets 390 and the subtraction magnets 391. When the switch 547 is in its "uppermost" or "In" position the blade 547 will be shifted to the right to connect the terminal 606 to the wire 544. It will be recalled that when an electrical impulse passes through this wire the sub-total magnets 483 and subtraction magnets 391 will be simultaneously energized to automatically control sub-total printing operations.

When magnet R-6 is energized contacts 505 (Fig. 48e) open so as to open the circuit to the main clutch magnet 152 but the clutch magnet circuit is retained, as described, until the end of the cycle.

Summarizing therefore at the last point in the operating cycle either the grand total magnets or sub-total magnets, depending upon position of switch 547 (Fig. 43), are energized for the subsequent total printing operation and the card feeding rollers are now driven to feed the calculated card away from the analyzing brushes.

Automatic total printing operations require a prior positioning of the switch 546 (Fig. 43) to the "In" position otherwise the keys 528 or 529 must be depressed.

If so desired, a series of cards to be cross calculated may be successively fed and each card cross calculated in the manner previously explained. If the switch blade 547 is first shifted to the "sub-total" position (Fig. 43), after the calculation from the first card a sub-total will be printed and the next total automatically taken after a control operation from a succeeding card will be a summation of the results of the two cards analyzed. Hence, in successively cross calculating a series of cards, a sub-total can be automatically derived after each cross calculating operation from a card. If the switch lever 547 is shifted to the "grand total" position (Fig. 43) before the calculation of the last card of a series is completed, there will be automatically effected a grand total printing operation.

It is stated that since the machine has an automatic total taking mechanism when calculating from several factors of a card the group control device is not used nor is it necessary. In fact, if the machine is set for group control the shaft 700 cannot be employed for calculating operations. This preventive device is described as follows: From the negative line side 496 (Fig. 48f) to one side of the magnet of relay R-11 by a wire 1201 to the wire 557 which, as previously stated, is connected to the positive line side 497 when the blade 555 is closed to effect automatic group control. Energization of relay magnet R-11 opens contacts 678 which, as described, and shown in Fig. 48f are in series circuit with the multiplying clutch magnet 680. This prevents the use of the shaft 700 for calculation purposes when the machine is set for group control.

Cross calculation—mechanical features

The mechanical and electrical details of the cross calculation device are best shown in Figs. 51, 52, 53, and 54.

Mounted within the housing 585 of the cross calculation device is a series of rings 712 and two

special rings 713 and 714 all of insulating material. The series of rings 712 are related to the controlling fields of the record card; the ring 713 is associated with the cycle limiting device and the ring 714 is associated with the subtraction controlling device.

Each of said rings (as shown in Fig. 53 for one ring 712) has embedded therein the series of contact points, and in Fig. 53 the contact ring shown is associated with a card controlling field and carries the contact points 590. The rings 712, 713, and 714 are mounted between end plates 715 and 716 and are secured together by bolts 717 so as to form a rigid unit.

Mounted centrally with respect to the contact rings is the shaft 595 which is journaled at one end by a bracket 719 carried by the end plate 715. The other end of the shaft 595 is journaled by means of a bushing 720 carried by the plate 716. Secured to the shaft 595 are the series of eight collector rings 592 and the supplemental rings 699 and 667 (Fig. 52). The series of contact blades 593 bear against the rings 592, and blades 701 and 666a bear against the collector rings 699 and 667, respectively. Contacting one at a time with a row of contact points 590 (for example) is an associated roller 721 (Fig. 55) carried by an arm 722 pivotally mounted upon the arm 591 which is fastened to a split insulated tube 724 and shaft 595 by means of a hub clamp 725. Each arm 722 is urged by a spring 726 so that the contact roller 721 is urged in contact with the contact points of the related series. The arrangement shown in Fig. 53 and described for one order is duplicated for all orders and in this connection it is to be noted that by the split clamps 725 and tubes 724 the various contact arms 591, 696, and 599 are all movable with the shaft 595.

To one end of the shaft 595 there is secured a ratchet wheel 686 and correlated with the ratchet wheel is the spring urged retrograde preventing pawl 687 and the operating pawl 685. Underlying the extremity of the pawl 685 is a cross bar 727 which is a right angled integral part of a plate 728.

Normally the bar 727 holds the pawl 687 out of engagement with the ratchet wheel 686 and when the plate 728 is lowered said pawl engages the teeth of the ratchet wheel 686. This action is effected by the deenergization of magnet 601 which, when deenergized, permits a suitable armature spring to shift an armature rod 729 and by a pin connection 730 with one arm of a bell crank 731 rocks the same. The plate 728 is pivotally connected to the vertical arm of the bell crank so as to drop the plate 728 to permit the lowering of pawl 687 and also permit pawl 685 to be lowered. Energization of the magnet 601 also effects the closure of the contacts of the switch contacts 665 (Fig. 51) by the action of a block of insulating material 731a carried by the vertical arm of bell crank 731 upon one of the spring blades comprising a contact blade of the switch 665.

At the initial operation of the machine, the series of contact rollers 721 associated with the controlling card columns normally contacts the first horizontal row of contacts 590 and to successively step the shaft 595 the magnet 604 (Figs. 52 and 54) is energized as previously described momentarily after each calculating operation. The armature rod 732 of magnet 604 is pivotally connected to an arm 733 attached to a rock shaft 734. This shaft is journaled in a block 735 and 75

a bracket member 736 both secured to the end plate 716. Attached to the rock shaft 734 is an upstanding arm 737 which at its extremity has an open notch so that it receives the extremity of an arm 738. The arm 738 is an integral part of the pawl 685 and is pivotally mounted by means of a pin 739 secured in the block 735 receiving an elongated slot forward in the pawl 685.

By means of a spring 740 the engaging end of pawl 685 is maintained upwardly out of cooperation with the ratchet wheel 686 even though the bar 727 is dropped as previously described so that upon an initial movement of the arm 737 by energization of the magnet the pawl 685 will be rocked clockwise and further movement of the arm will cause the pawl 685 to be shifted to the left (Fig. 53) to turn the ratchet wheel 686 and thereby the shaft 595. This action is precisely the same as described in connection with the accumulator rack operating pawls 171 shown in Figs. 22 and 23 and, therefore, will not be described in further detail. It should be noted that each step of movement effected to shaft 595 will be held by means of the spring urged pawl 687.

As the shaft 595 is stepped in a counterclockwise direction (Fig. 51) a return spring 741 will be tensioned. One end of the spring is connected by a screw 742 to a wheel 743 secured to the shaft 595. After the last calculating operation has been effected the magnet 601 is energized thereby elevating the pawl 687 to release the shaft 595 which is now restored under the action of spring 741 in a clockwise direction to a normal position defined by suitable stop devices.

It is pointed out that the series of arms 696 and 691 (Fig. 48d) are in alignment but the arm 699 related to the subtraction contact ring 714 is a half step ahead of the other arms to provide for the prior energization of the subtraction magnet.

Any suitable arrangement may be provided for effecting a connection between the contact arms and the collector rings and is preferably effected by having a wire connection 744 from each one of the hub clamps 725 passing through an elongated slot 745 provided in the shaft 595. Such wire connections 744 are suitably connected to the related collector rings.

Operations caused by shaft 700

Reference has been made to the shaft 700 which causes certain operations to be performed in connection with the cross calculation operations. This shaft 700 is herein designated as the multiplying shaft as it is involved in multiplying, division, and cross calculating operations each of which require successive revolutions of this shaft.

Referring particularly to Fig. 2, it will be observed that the gears 136 and 137 which are attached together are secured to a shaft 746 and this shaft is suitably journaled at its ends in the right and left machine side frames. At its right end (Figs. 4 and 4a) the shaft 746 has secured thereto the fixed clutch element 747 of the multiplying clutch 682. The movable clutch element 748 contains the magnet coil 680 of the clutch so that when energized clutch element 748 is attracted towards the companion clutch element 747. Clutch element 748 is loosely mounted upon the shaft 746. The clutch element 748 carries a disk 750 having an aperture which, in the normal position of the disk 750, is received

by a lug extension 749 of a fixed plate. During the shifting of the clutch element 748 the disk 750 will also be shifted along shaft 746 so that upon an initial turning of the disk 750 by clutch element 747 the lug 749 will engage a side face of the turned disk 750 thereby holding clutch element 748 shifted and establishing the clutch connection for a full revolution of the clutch element 747. This is merely a mechanical arrangement for holding a clutch connection between relatively movable parts for a complete revolution.

The clutch element 748 has secured thereto a driving gear 751 in continuous mesh with a gear 752 rigidly secured to the multiplying shaft 700. It will be observed that if the clutch magnet is still energized when a complete revolution of shaft 746 has been effected the shaft 700 will be driven for another revolution.

The various functions of the shaft 700 will now be described, and as far as possible, in sequence, so that the calculating operations of the machine for cross calculation will be more readily understood.

One of the functions of the shaft 700 is to successively reciprocate the analyzing brush carriage 753 (Figs. 6, 11, 13, and 14). The carriage 753, as will be obvious from Fig. 11, is provided at its extremities with pairs of feeding rollers 754 and as shown in Fig. 14 the rollers 754 at the right end of the carriage 753 are correlated with a pair of rails 755 secured to one of the machine side frames (Fig. 14). The rollers for the other end of the carriage 753 are guided by similar rails. To prevent any lateral shifting of the carriage 753 the carriage is also provided at each end with supplement rollers 756 (best shown in Figs. 13 and 14) which are at right angles to the rollers 754 and cooperate with the side faces of the lower side rails 755. The bar 116 of carriage 753 carries a metal block 757 which carries the brushes 115 and is pivoted in the carriage 753 at 121 is the hood elevating member 119. During the reciprocation of the brush carriage, it is essential, of course, that the brushes 115 be continuously electrically connected with the positive side of the line and this is effected by having a suitable wire connection 757a between the metal block 757 which carries the brushes 115 and a spring pressed contact element 758 (Fig. 6). The latter is in continuous electrical contact with a contact plate 759 which is connected to the positive line side.

To reciprocate the brush carriage 753, at each end there is provided a bracket member 760 (Fig. 11) each of which clamps a laterally extending pin 761 to the brush carriage 753. The pin 761 extends laterally so as to project through the side machine frames 18 and 19 and the pins are received by collars 762 (see Figs. 2 and 4) carried by arms 763.

For reciprocating the arms 763 and thereby carriage 753 each arm carries a roller 764 (Figs. 2 and 4) coacting with a profile cam 765 secured to shaft 700. It will be obvious that as the cam 765 shown in Fig. 4 turns in a clockwise direction the brush carriage 753 will be first drawn towards the right (as viewed in Fig. 6) to analyze all the perforations of the card (which is now at rest) and then to the left to be restored to its normal position.

Prior to the movement of the brush carriage to the right, or in the analyzing direction, the brush holding magnets 128 and 129 (Figs. 2 and 4) are energized as will be explained so that the hood 119 (Fig. 6) will be rocked to permit the brushes 115 to contact the card in precisely the manner

explained in connection with ordinary tabulating operations. As the brushes in their movement to the right (Fig. 6) encounter the perforations in the card the accumulator magnets will be energized by successive electrical impulses, in the manner previously explained, to effect accumulating or subtracting operations dependent upon whether the adding or subtracting racks are employed.

In order to hold the racks in their successively shifted position, it will be remembered that the engaging pawls 192 (Fig. 26) are lowered and such operation is also under control of the shaft 700. The mechanism for performing this operation is shown in Fig. 26 for the left side of the machine. To shaft 700 is secured a profile cam 766 which, upon an initial operation in a counterclockwise direction, permits a roller 767 under the action of a spring 768 to drop off the high part 766a of the cam 766 thereby rocking a double arm 769 in a counterclockwise direction and through the link 206 (now shifted to the left) change the angular displacement of the members 202 and 203 to thereby through link 201 drop the bar 194 and permit pawls 192 to engage the rack teeth 193.

It is, of course, understood that at the end of the operation, the high part 766a of cam 766 will, through a reverse action, elevate pawls 192 to permit the free restoration of those racks which have been employed for the accumulating or subtracting operation and without turning the accumulator pinions back from their turned positions:

After the brushes have swept the card perforations of the card to be analyzed they are elevated by means of the hood 119 (Fig. 6) to permit the brush carriage to be restored without creating an interference between the perforations and the flexible wire brushes. This is effected in the manner as previously described, it being obvious that when the brush carriage is at its right position (Fig. 6), the bar 124 will still be positioned over the extensions 122 but closer to the pivotal point 121 of the hood 119. The downward movement of the bar 124 to elevate the brushes and relatch the hood 119 is under control of cams 771 (Figs. 3 and 5) which are each secured to the shaft 700. After the analyzing operation a projection of one of the cams 771 engages a related plate 772 thereby shifting the same to rock, for example, the bell crank 147 shown in Fig. 3 in a clockwise direction, to depress the bar 124 (Fig. 6) which causes the lifting of the brushes 115 out of contact with the card and the relatching of hood 119 in the manner previously described.

After the accumulating operations the necessary transfers are made to effect addition of units to the required higher orders. This is performed in the manner previously explained, the only difference being as will be described that certain cams driven by shaft 700 control the contacts governing the transfer circuit. However, it should be noted that the shaft 700 has suitable mechanical connections for restoring the tripped transfer levers and which is effected by means of the bar 288 (Fig. 22).

The mechanism for shifting this bar is shown, for example, in Fig. 3 for the left side of the machine and in Fig. 5 for the right side of the machine. As shown in Fig. 5, it comprises a cam 777, the high portion of which engages a roller carried by one arm of a bell crank 778 thereby rocking the bell crank in a clockwise direction (Fig. 5) (after the transfers have been effected)

thereby shifting a link 779 to the right and a bell crank 780 pivotally connected to link 779 in a counterclockwise direction. The horizontal arm of the bell crank 780 engages a pin 781 attached to the link 292a thereby elevating the same to restore the tripped transfer levers in the manner previously explained.

Prior to the disengagement of the actuators from the accumulator pinions 190, it will be remembered that the plungers 235 (Fig. 30) are dropped downwardly so as to temporarily engage the side faces of the accumulator wheels 235. This operation is also effected under control of the shaft 700 and similar mechanism is provided for the right and left sides of the machine (Figs. 2 and 4 respectively) and as shown in Fig. 4 for the right side of the machine comprises a bell crank 773 the horizontal arm of which is adapted to engage a laterally bent portion 774 of the link 239 so as to depress the link 239 when the bell crank is rocked clockwise (Fig. 4) to effect the engagement of plungers 238 and wheels 235. A clockwise rocking of the bell crank 773 is performed by means of a cam 775 secured to the shaft 700 and cooperating with a roller 776 secured to the vertical arm of the bell crank 773.

During an operation involving accumulation of amounts, the lever 225 (Fig. 27) is rocked to assume a horizontal position to thereby elevate the adding racks 189 free of the accumulator pinions 190. This is performed by means of the arm 266 which as shown in Fig. 27 is provided with a depending portion 782 provided with a roller engaging a profile cam 783 secured to the shaft 700. The high portion of the cam 783 at the termination of the revolution of shaft 700 is adapted to elevate the link 267 and, in the manner previously explained, to disengage racks 189 from the accumulator pinions 190 to permit the free restoration of the racks to normal position.

From what has previously been explained, in connection with subtracting and total taking operations, it will be recalled that when the subtraction magnet 391 (Fig. 39) is energized the bell cranks 444, 476 will be released for a counterclockwise positioning (Fig. 40) so as to shift the subtracting racks in engagement with the accumulator pinions. In operations of the shaft 700 involving subtracting operations, the arm 444 for the left side of the machine is restored to normal by means of a cam 784 (Fig. 39) secured to the shaft 700. The high portion 785 of cam 784 is adapted to coast with a roller 786 of a vertical extension 787 of the arm 444 to thereby restore the same and permit it to be relatched by the engagement of hook 442 with the projection 443 of the arm 444.

Summarizing, therefore, the operation of the shaft 700 effects certain of the mechanical operations which were normally effected by the shaft 141 during accumulating operations.

In this respect when the subtracting racks are engaged with the accumulator pinions, pin 228 is at the right end (Fig. 27) of the slot 226. Cam 783 is effective after the subtracting operation to elevate link 167 and by rocking arm 225 clockwise depress member 220 so that projection 220a (Fig. 40) is disengaged from the hook 478, which is held up by the stationary pin 479.

To effect the transfer operations during cross calculation operations, it is necessary, of course, that the magnet 522 (Fig. 31) be energized to allow the movement of the bar 288 to close those contacts 278, 280 (Fig. 22) that have been selected to effect a transfer in the manner pre-

viously explained. The circuit connection for causing the energization of magnet 522 under control of the multiplying shaft 700 is effected under control of a cam 799 (Fig. 48c) which permits closure of contacts 629_M thereby extending a circuit from the positive line side 497 through contacts 629_M (closed at transfer time) thence by means of a wire 800 to the wire 523 which extends, as previously described to complete the circuit to the transfer controlling magnet 522.

The brush magnets 129 and 130 are energized before the movement of the brush carrying carriage to the right (Fig. 6) by means of contacts 801 (Fig. 48c) which are closed under control of a cam 802 secured to the multiplying shaft 700. Closure of contacts 801 effects a circuit connection from the positive side 497 through closed contacts 801, and thence by means of a wire 803 to the conductor 511. The circuit connection then extends, as previously explained, by the wire 511, through closed contacts 512 (Fig. 48e) to the brush control magnets 128 and 129 and thence to the negative side of the line.

Class selection

The cross calculation device just described is especially useful where it is desired to effect the algebraic summation of additive and subtractive values in a single accumulator where such values are represented by more than two fields of the same tabulating card. It is desirable at times to enter selectively in a pair of accumulators values consisting of two distinct classes. For example, it is especially desirable to enter credit and debit values in the related accumulators to thereby make it unnecessary to sort the debit and credit representing tabulating cards before they are tabulated.

In this case, the credit and debit values are represented by perforations in the same card field and only one of the values, debit, for example, is designated by a characteristic perforation. In the present machine any card column may be selected for characterizing the value by the characteristic perforation.

Figure 50 shows an example of a plugging arrangement when the class selection mechanism is used. If, for example, the debit and credit values are represented by card columns 11 to 18 the plug sockets 492 of such columns are plug connected by plug wires 788 to a corresponding number of the sockets 589 and, which it will be recalled, are electrically connected to the selector fingers 591 (Fig. 48d). The uppermost row of plug sockets 586 is plug connected to the desired plug sockets 514 of the accumulator in which credit values, for example, are to be entered. The second row of plug sockets 586 (from the top) is plug connected to other accumulator magnet sockets 514 related to the accumulator which is to receive debit values. It will be recalled that the selector fingers 591, in their normal position, contact the first horizontal row of contacts 590 so that normally values represented by the columns 11 to 17 will, through such contacts, be entered in the related accumulator wheels. However, when a value is represented by a characteristic perforation and which is adapted to be analyzed before the perforations representing the value, certain selecting mechanism will be operated to enter the debit value in the related accumulator. This characteristic perforation may occupy any card column and, as shown in Fig. 50, for the example selected, the card column "10" is appropriated. A plug connection 789 (Fig. 50) is thereby made

from a plug socket associated with this column to a special plug socket 790.

It should also be pointed out that when the class selection mechanism is employed the controlling switches "CA", "M" and "D" (Fig. 47) are all placed in their ineffective or "out" position so that the card lever 127 (Fig. 48e) is effective. The cards, therefore, will be analyzed while the brushes are at rest and the tabulating cards in motion and the shaft 141 operated as explained in connection with normal tabulating operations. It is pointed out that by the normal position of switch CA, the connecting contacts 663 (Fig. 48b) breaks the circuit 674 from the positive side to the multiplying clutch magnet 680 and card feed clutch magnet 565 and which circuits were previously traced in the section "cross calculation device electrical features."

Referring now to the wiring diagram, it will be noted that when either type of card is fed the card lever contacts 671 (Fig. 48e) will be separated and, therefore, the circuit to the magnet 601 will be opened as explained in connection with cross calculating operations so that the holding pawl 687 may engage the ratchet wheel 686 (Fig. 48d). But, however, when a card with a characteristic perforation is fed the special perforation will cause a circuit to be extended from the positive side of the line through the related brush 115 and contact segment 118 and thence by the plug connection 789 (Fig. 50) to the plug socket 790. The circuit will then be extended by a conductor 791 (Fig. 48b) to a magnet 792 (Fig. 48d) and thence the circuit is extended to the negative side of the line by a wire 793. The closing of the circuit just traced will cause the energization of the magnet 792. A circuit will also be continued from the wire 791 by means of a conductor 794 through normally closed contacts 795 thence by a wire 796 to one side of the magnet 604. The circuit from the other side of the magnet 604 is extended to the negative side of the line by a wire 684.

Therefore, a circuit will be extended to cause energization of magnet 604 which circuit is under control of the special perforation of the card representing a debit value. Energization of magnet 604 will attract its armature and through pawl 685 cooperating with ratchet wheel 686 will turn shaft 595 a step of movement to cause the selector fingers 591 to be correlated with the second horizontal row of contact points 590. As these contacts 590 are connected to the second row (from the top) of plug sockets 589 (Fig. 50) it will be noted that by this connection debit values will be entered in the related accumulator wheels.

It will be obvious that the time duration of contact through the special perforation of the moving card representing a debit value is momentary and it is, therefore, desirable to provide a supplementary "stick circuit" which insures a complete energization of the magnet 604. This circuit is traced as follows: Referring to Fig. 48b, it will be noted that the 8th plug socket 588 (from the top) designated 588₈ is permanently connected to the positive side of the line by a wire 694. This plug socket is, of course, connected by a suitable wire such as the wire 698 shown for the top plug socket of the row of sockets 588 to the contact point 697₈ (Fig. 48d) so that the circuit now extends from the positive side of the line by the last named contact point 697₈ and to a wire 797. The circuit then extends by wire 797 through

contacts 798 which are closed when the magnet 792 is energized. The circuit then extends by means of the wire 796a to the magnet 604 and thence by the wire 684 to the negative side of the line.

Even though the brush associated with the special perforation leaves the perforation and engages in intact portion of the moving tabulating card the circuit 794 to the magnet 792 will be closed as long as contacts 795 are closed and the circuit 796a to the magnet 604 will be closed as long as contacts 798 are closed. Contacts 795 are so designed that the resiliency of the contact blades keeps the contacts closed during a part of the movement of the armature and they are not opened until the armature of magnet 604 is moved sufficiently by the energization of the magnet to cause a complete step of movement to be given to the ratchet wheel 686, such step of movement occurring, of course, before the first value representing perforation of the moving card is encountered. After a full step of movement of the ratchet wheel 686 which is then held by pawl 687 (Fig. 51), contacts 795 will open, thereby first opening the circuit through wire 794 to the magnet 792 to cause deenergization of the same. When the latter is deenergized, contacts 798 open thereby breaking the circuit to the conductor 796a to cause deenergization of the magnet 604.

The object of the circuit arrangement just described is to insure a complete energization of magnet 604 independently of the momentary closure of the circuit 794 closed by the special characteristic perforation of the moving debit value representing card.

After the analysis of a tabulating card the continued movement of the card will permit card lever contacts 671 to close thereby energizing magnet 601 which will result in causing the pawl 687 to be disengaged from the ratchet wheel 686 and the shaft 595 will thereby be restored, in the manner previously explained to normal position, thus positioning the selector arms 591 to contact the first horizontal row of contacts 590 so that the next value to be entered provided it is a credit value will be entered in the related accumulator.

Multiplying mechanism

The machine also includes a multiplying mechanism for automatically multiplying factors on a card which factors represent a multiplicand and multiplier. This mechanism is particularly useful when it is desired to effect the multiplication of two amounts. For example, it is useful when computing interest where it is required to effect multiplication of the sum at interest and the rate of interest or when calculating wages, which requires a multiplication of the rate per hour and the number of hours.

To effect multiplication, the factors on the cards are repeatedly analyzed so that by the process of repeated addition the multiplicand may be multiplied by the digital value of the multiplier. In order to more clearly perceive the operation of the multiplying mechanism, it will be assumed that it is desired to multiply the amounts represented on the card illustrated in Fig. 67 in which columns 15 to 20 represent a multiplicand amount of —427978— and columns 34 to 37 represent the multiplier amount of —2513—.

The plugging necessary to effect multiplication for this example is illustrated in Fig. 66 in which the plug sockets 492 relating to columns

15 to 20 representing the multiplicand are plug connected to the five plug sockets at the extreme right of the multiplicand sockets 804. The card controlling columns 34 to 37 representing the multiplier are plug connected to the four plug sockets at the extreme right of the row of multiplier sockets 805. Above the multiplicand plug sockets 804 and multiplier sockets 805 there is provided a series of plug sockets which is the product plug sockets 806 and such sockets are plug connected to desired accumulator magnet sockets 514 in order that the product may be entered in the desired accumulator wheels and printed under control of the accumulator wheels receiving the product.

Prior to starting multiplication the multiplying switch M (Fig. 48b) is shifted counterclockwise or in Fig. 66 rearwardly so that the controlling lever M is positioned adjacent the indication "in". As the other switches "CA" and "D" are in their "out" positions the machine is now conditioned for automatic multiplication and the card may be fed either manually or automatically if there is a card in the magazine by the previously described automatic card feed mechanism when the operation of the motor 20 is effected.

Referring now to the wiring diagram when the card to effect multiplication is fed, contacts 671 are opened thereby opening a circuit 672 in order that, as previously described in connection with the description of the cross calculating device the card feeding mechanism is stopped so that the card will stop beneath the analyzing brushes, and furthermore, the multiplying shaft controlling clutch magnet 680 is energized to thereby effect successive operations of the multiplying shaft 700.

The circuit 509 to the main clutch magnet 152 is opened by the shifting of switch M as the connecting contacts 507a (Fig. 48b) open the circuit 509 to the magnet 152. Hence, shaft 141 will not be turned and printing of the multiplicand factor, multiplier factor, or any of the partial products will not be effected.

The multiplicand plug sockets 804 are connected to a series of contact blades 807 which in the construction adopted comprise curved resilient contact blades shown in Fig. 58. The connection between one of such sockets 804 and contact blade or point 807 is shown in the wiring diagram (Figs. 48a and 48b) by means of a connecting wire 808, each of the plug sockets 804 and contact blades 807 being similarly connected. The multiplier plug sockets 805 are similarly connected to related contact blades 809 and a connection between one of such contacts 805 and related blade 809 is shown in the wiring diagram by the connecting wire 810.

The two series of contact blades 807 and 809 are carried by a bar 811 (Figs. 58 and 59) which is of insulating material and which has suitable longitudinal guide slots for receiving angular portions of vertical side plates 812 and 813 (Fig. 59). Both of said side plates are fixedly secured to a vertical support plate 814 which is also of insulating material. Above the bar 811 is a bar of insulating material 815 which, however, is immovable and is provided with several series of contact points. The contact blades 807 contact with the related contact points 816 which are electrically connected to related contact points 817 and with the latter are correlated spring contact blades 818. The latter contact blades 818 are, as shown in Figs. 48a and 48b connected to the product plug sockets 806, one of such con-

nections being shown in the wiring diagram by means of the conductor 819.

Referring to Fig. 58, in the normal position of the lower shiftable bar 811, the multiplicand contact blades 807 have direct electrical connections through the series of contact points 816, 817 with the contact blades 818 and thereby to the product sockets 806 and the accumulator magnets so that a reading of the multiplicand representing perforations effected by the analyzing bushes will be directly transmitted to the accumulator magnets. However, in connection with the multiplier blades 809 such contact blades in the normal position of the bar 811 are not in contact with the contact points 820 which are electrically connected to a related series of contact points 821. Each of the series of contacts 820 and 821 is carried by the intermediate and immovable bar 815 (Fig. 59). The multiplicand contact blades 818 are carried by the uppermost or movable bar 822 which is also of insulating material and guided for movement like the lowermost bar 811.

The bar 822 also carries a single contact blade 823 which may be moved by a step by step movement of bar 822 into electrical contact successively with the series of contact points 821. Thereby when the bar 811 is shifted to the left contact 823 is electrically connected with one of the multiplier contact blades 809 dependent upon the position of bar 822. By such a connection the digits of the multiplier in order from the lower to higher denominations may have successive control over the number of successive entries of the multiplicand. To accomplish this the multiplier sockets 805 are connected to the multiplier contact blades 809 in inverted order so that the units card column is plugged for control to the extreme left contact blade 809 as shown by the left wire connection 810.

Referring now to the wiring diagram when the card to be fed causes opening of the card lever contacts 671 a circuit to a magnet 602 will be opened as long as the card is in analyzing position. The circuit for magnet 602 is traced as follows: from the positive side 497 (Fig. 48e), contacts 671 now open, wire 683, wire 824 (Fig. 48a) which is connected to one side of the magnet 602 the other side of the magnet being connected by means of a wire 825 to the negative side of the line 496. The magnet 602 will thereby be deenergized. The magnet 602 is shown in Fig. 57 and from the showing there, it will be obvious that when the magnet is deenergized the armature 826 thereof will be drawn to the right by the action of a suitable spring 827 so that by means of an intermediate bell crank 828 a plate 829 will be forced downwardly. The plate 829 at its lower end carries a stud 830 which, as shown in Fig. 58 when moved downwardly, permits a pivoted holding pawl 831 to be rocked in a clockwise direction under the action of a spring 832 to thereby rest upon the top of a plate 833 attached to the uppermost or movable bar 822. The pawl 831 is adapted to engage suitable notches formed in the plate 833 to hold the bar 822 in its successively shifted position.

Referring now to Fig. 57 when magnet 602 is deenergized contacts 834 will close to thereby energize a magnet 610 (Fig. 58) by means of a circuit traced as follows: from the positive side 497 (Fig. 48e), a wire 600, connecting contacts 903 of switch D (Fig. 48b and Fig. 45), wire 661 and thence by means of connecting contacts 835 of the shifted switch M to a wire 836, the circuit

then extending to the contact points 834 (Fig. 48a) which are now closed so as to further extend the circuit by means of a conductor 837 to one side of the magnet 610. The other side of the magnet is connected to a wire 838 and the circuit then extends from this wire through contacts 839, now closed, and thence by a wire 840 through the multiplier controlling contacts 841—856, which are now closed at this time so as to complete by a terminal 842 the circuit to the negative side of the line 496. Energization of the magnet 610 (Fig. 58) attracts its related armature 843 to thereby rock an arm 844 which normally abuts against one end of the lower contact carrying bar 811. When the contact bar 811 is shifted to the left (Fig. 58) it will cause the multiplicand contact blades 807 to be shifted out of contact with the lower related contact points 816 and cause the multiplier contact blades 809 to be placed in contact with the related contact points 820 so that at the beginning of the multiplying operations the units controlling column of the multiplier is now to be sensed since the circuit extends from the positive side by the related brush 115 and contact segment 118, the units multiplier socket 805, contact blade 809, connected contact points 820 and 821 and thence to the first multiplier contact blade 823 at the left in Fig. 58. When the first cycle of machine operation is instituted the brushes sweep over units column of the card and a series of electrical impulses will be transmitted by the circuit just traced to successively energize a magnet 845 (Fig. 48a).

If the units denominational value of the multiplier is represented by three perforations, as assumed, three electrical impulses will be transmitted to the magnet 845. In the wiring diagram (Fig. 48a) the multiplier contact point 823 is connected to one side of the magnet 845 by means of a wire connection 846, the other side of the magnet being connected to the negative side of the line 496 by a terminal 847.

For each impulse transmitted to the magnet 845 (Fig. 58) a step of movement will be given to a ratchet wheel 848 by means of an operating pawl 849 in the plane of ratchet wheel 848, the pawl being pivotally mounted upon an arm 850 and having a vertical arm connected to the armature rod 851. The initial movement of the armature rod 851 is adapted to first bring the engaging end of pawl 849 into engagement with the teeth of the ratchet wheel 845 so that further movement of the armature rod 851 will rock arm 850 clockwise as viewed in Fig. 58 to turn the ratchet wheel 848 counterclockwise. Associated with the ratchet teeth of ratchet wheel 848 is a holding pawl 852. The ratchet wheel 848 has secured thereto a plate carrying a contact point 853 (Fig. 62) which, prior to analyzing the card to determine the digital value of a digit of the multiplier, is in contact with a contact point 854 carried by a second coaxial ratchet wheel 855. The inside ratchet wheel 855 also carries a contact point 856 which, under the normal conditions mentioned, is in contact with the contact point 841 which is also carried by the outside ratchet wheel 848 to thereby continue the circuit to the magnet 610 (Fig. 48a) when contacts 834 are closed.

Therefore, it will be clear that when the ratchet wheel 848 is thereafter turned commensurate with the digital value of a digit of the multiplier the contact point 853 will be moved away from the contact point 854, and contact

point 841 away from contact point 856, a number of steps proportional to the value of the digit of the multiplier in the column analyzed. This separation of contacts 853 and 854 predetermines the number of subsequent analyzing operations for successively entering the multiplicand in the accumulator wheels. It should be pointed out that the metal ratchet wheels 848 and 855 are insulated from each other and from the stud 857 which carries the coaxial ratchet wheels. The necessary electrical connections to the various contacts carried by the two ratchet wheels for effecting the circuit connection shown in the diagram is performed by means of resilient contact blades 858 and 859 each of which frictionally contacts with one side of the ratchet wheel 855 (Fig. 62) and a spring urged contact blade 860 (Fig. 58) having a frictional electrical contact with one side of the outside ratchet wheel 848.

To lower side of the bar 811 there is secured a bracket plate 861 (Fig. 57) having a notch adapted to be engaged by an upturned projection 862 carried by the armature 863 of a magnet 864. A spring 865 urges the holding member 862 upwardly so that when the bar 811 is shifted prior to sensing perforations in a multiplier card column the engagement of projection 862 with the notch of the plate 861 will hold the bar 811 in shifted position until the energization of magnet 864, which occurs at the end of the cycle in which the digital value of the multiplier has been set up in the machine.

The circuit for the magnet 864 which causes energization of the magnet and lowering the armature 863 to permit return of the bar 811 to normal after sensing the multiplier digital value is traced as follows: from the positive side of the line 497, through contacts 691 (Fig. 48e) controlled by the cam 692 on the multiplying shaft 700 and closed at the end of each revolution of cam 692 by shaft 700 to thereby extend the circuit by the wire 860 (Fig. 48b) to the connecting contacts 866 of the switch M (Fig. 48b and Fig. 45) now shifted, thence to the wire 867 (Fig. 48a). The wire 867 is electrically connected (as shown in Figs. 57 and 48a) to the armature 863 of magnet 864. Since the bar 811 is in shifted position during the multiplier digit analyzing operations the upper contact point 868 (Fig. 57) is now in contact with a point 869 carried by a bar of insulating material 870 also attached to the lower side of the bar 811. The circuit will then be extended through contacts 868 and 869 and by means of a wire 871 to one side of the magnet 864, the other side being connected by a terminal wire 872 to the negative side 496. Magnet 864 will, therefore, by its energization cause the armature 863 to be forced downwardly disengaging the upturned projection 862 from the notch of the bracket plate 861 so as to release the bar 811. To the bar 811 there is secured a return spring 873 (Fig. 58) which causes the return of the bar 811 to normal position.

It should be noted, however, that by the turning of ratchet wheel 848 (Fig. 58) the contacts 841 and 856 were previously separated to deenergize magnet 810 and as arm 844 is now shifted it will permit the return of the bar 811 to normal when unlatched in the manner just described.

Referring now to Fig. 57, it will be noted that the contact point 869 is sufficiently wide and resiliently urged downwardly by a suitable spring so that when the contact point 868 is shifted

to the left by the unlatching of the bar 811, it will continuously contact with the point 868 and also during a certain portion of the downward movement of armature 863 retaining magnet 864 energized, after which a contact point 874 secured to the lower side of the bar will contact a point 875 which as shown in the wiring diagram and in Fig. 57 is electrically connected to one side of the magnet 864 by a conductor 876. Closure of contacts 874 and 875 will continue energization of magnet 864 thereby extending the circuit connection to magnet 864 from the positive side of the line to the negative side 496 retaining the magnet 864 energized to prevent contact 868 engaging a contact 883 to establish a circuit connection to a magnet 880, which is only to be made in multiplicand analyzing operations and until cam control contacts 691 open which cause deenergization of the magnet 864.

It will be apparent that since the bar 811 is now in its normal position circuit connections are made under control of the perforations in columns representing the multiplicand to the magnets controlling the accumulator wheels to be operated.

The next operation of the machine requires repeated analyzing operations of the multiplicand factor corresponding in number to the digital value of the multiplier. It has been assumed that the digital value of the units denomination of the multiplier was "3" and, therefore, three entries of the multiplicand will be effected under control of the multiplying shaft 700. For each entry of the multiplicand the ratchet wheel 855 will now be turned in the same direction that ratchet wheel 848 was turned to thereby shift contacts 854 so that they subsequently engage contacts 853 (now stationary at this time) and contacts 856 finally engage contacts 841 (now stationary at this time).

The number of such operations required to effect contact, as described, is dependent upon the number of steps of operation that were previously employed to effect the desired separation of the related sets of contacts which, in example, comprised three operations.

To turn the ratchet wheel 855 a step for each multiplicand entry there is provided an operating pawl 877 (Fig. 58) which is pivotally mounted upon an arm 878 pivoted to the support plate 814. An armature 879 of a magnet 880 is adapted to be shifted to the left (Fig. 58) when the magnet 880 is energized to thereby rock an arm 881. The arm 881 has its lower end engaging a notch in one arm of the operating pawl 877 so that initial movement of the arm 881 will cause the pawl 877 to be rocked counterclockwise to engage the teeth of the ratchet wheel 855. Further movement of the arm 881 under control of armature 879 shifts the pawl 877 to the left to turn the ratchet wheel 855. Associated with ratchet wheel 855 is a holding pawl 882.

To effect a series of electrical impulses to the magnet 880 to cause the contacts to subsequently reengage an electrical impulse is transmitted to magnet 880 for each multiplicand entry. Such controlling circuit is under control of the cam controlled contacts 691. The circuit for magnet 880 will now be traced. Since the bar 811 is now in its normal position shown in Fig. 57 and the bar 870 is in the position shown in Fig. 57 the electrical impulse transmitted through the wire 867 will be transmitted by means of the armature 863 to a contact point 868 which is now

in electrical contact with a contact point 883 also carried by the bar 870. This is so because there is no circuit connection through either contacts 875 or 869 to magnet 864. The circuit will then be extended by means of a wire 884 to the magnet 880, one side of magnet 880 being connected by a terminal wire 885 to the negative line side 496.

Therefore, for each multiplicand entry the ratchet wheel 855 (Fig. 62) will be shifted a step under control of the magnet 880 and at the termination of the last multiplicand entry, contacts 854 and 856 will be in position to engage contacts 853 and 841, respectively. When contacts 841 and 856 contact, the magnet 610 will again be energized to thereby shift the bar 811 so that the tens denomination digit of the multiplier factor may control the number of multiplicand entries for the next operation of the machine.

It is essential, however, that after the multiplying operation under control of a denomination of the multiplier has been completed by the process of repeated addition that the ordinal relationship between the controlling card columns representing the multiplicand and the denominations of the accumulator wheels be changed and such change in relationship, in the present machine, is effected by causing the uppermost bar 822 to be shifted to the right. This shifting is controlled by a magnet 886 (Figs. 48a and 57) and the magnet is energized by closure of a circuit traced as follows: from the wire 867 which transmits an electrical impulse to a wire 887 which is connected to one side of the magnet 886, the other side being connected by a wire 888 through the contacts 854 and 853 and such contacts are only closed at the termination of the last multiplicand entry for a digital value so that when closed they extend the circuit by the wire 842 to the negative side 496.

Energization of the magnet 886 attracts an armature 889 (Fig. 57) to thereby rock an arm 890 counterclockwise and an interconnecting arm 891 clockwise to thereby rock a stud 892. From Fig. 58, it will be observed that rocking of the stud 892 rocks an arm 893 as arm 893 is secured to stud 892. By means of a stud 894 secured to the plate 814 an operating pawl 895 is pivotally mounted.

The vertical arm of the operating pawl 895 is connected by a pin and slot connection 896 to the lower extremity of the arm 893. As the arm 892 is shifted counterclockwise by energization of magnet 886 the pawl 895 will be initially rocked in a clockwise direction so that the pawl first engages one of the ratchet teeth of the plate 833, it being obvious that further rocking movement of the arm 892 will cause the pawl 895 to be shifted to the right to thereby move the upper contact bar 822 a step to the right in which position it will be held by means of the holding pawl 831. The ordinal relationship between the controlling columns of the multiplicand representation and the accumulator wheels will now be changed so that the successive multiplicand entries under control of the tens denomination multiplier digit will be effected beginning at the tens order wheel of the accumulator wheels instead of the units accumulator wheel.

In precisely the manner explained successive multiplication operations will be effected under control of the remaining digits of the multiplier, there being one operation of the multi-

plying shaft 700 to sense the value of the multiplier digit and none, one or a subsequent series of multiplicand entries effected by shaft 700 commensurate in number with the value of the multiplier digit previously determined.

It will also be obvious that the bar 822 is shifted a step for each denomination of the multiplier after the units denomination digit has been determined. The present machine is capable of effecting multiplication by a multiplier value representing eight denominations and if it is not known in advance the number of denominations comprising the multiplier value, after the multiplicand entries controlled by the last denomination of the multiplier there is an alternate shifting of the bars 811 and 822 under control of the magnets 610 and 886 respectively until bar 822 occupies its extreme right position and when the bar occupies such position total printing operations will be automatically instituted provided switch 546 is in its "in" position (Fig. 66).

To the bar 822, there is secured a block of insulating material 897 (Fig. 58) to which is secured a contact blade having a contact finger 898 and a contact finger 899. For each position of the bar 822 the contact blade 898 contacts one of the points 900 while the contact finger 899 has a continuous contact with a blade 901. There are eight of such contact points 900 and each is connected to the related one of the upper eight cycle limiting plug sockets 588. It will also be recalled that the lowermost plug socket 588 is connected to the positive side of the line by means of a wire 694 so that when the contact finger 898 engages the contact point 900 at the extreme right the circuit will then be extended through such contact point 900, contact finger 898, contact finger 899, contact blade 901, and thence by a wire 902 (Fig. 48a) to the wire 702. As previously described in connection with automatic total taking operations, in the section under the heading "Cross calculation device" certain operations are then automatically effected and such operations comprise, the subsequent turning of the card feeding rollers, the stopping of the operation of the multiplying shaft and the initiating of the operation of the listing shaft 141. By means of the latter a subtotal or grand total printing operation will be effected depending upon the position of the switch blade 547 (Fig. 66). When the card is fed out by the feeding rollers to permit contacts 671 to close, magnet 602 is then energized elevating the holding pawl 831 (Fig. 58) for releasing the bar 822 which is now shifted to the normal position by means of a return spring 903.

If, however, it is known in advance the number of denominations comprising the multiplier, suitable plug connections may be effected in the row of sockets 588 to thereby limit the number of multiplying operations to the number necessary to secure the product.

If the number of denominations of the multiplier comprises six (as explained by way of example described in connection with the cross calculation device) the plug connection will be shown as provided for in Fig. 48b. Therefore, when the contact finger 899 contacts the sixth contact point 900 from the left (Fig. 48a), a circuit connection will be made at the end of the sixth multiplying operation to automatically effect a sub or grand total printing operation depending upon the preselection.

From the description given in this section, it

is apparent that the number of multiplicand entries correspond to the sum of the digits of the multiplier. To save time in machine operations, it is desirable, that the factor employed as a multiplier be selected as the one of the two factors which represents the smaller sum of its digits.

Multiplication by a constant factor

In certain instances, it is desirable that the sums represented by a tabulating card be multiplied by a constant factor. For example, in effecting tabulation from cards representing a number of kilowatts of electricity consumed, it is desirable that such quantities be multiplied by the price per kilowatt which is constant. Mechanism for carrying out this operation will now be described.

To more clearly understand the principle of operation on which the alternative method is based, it will be clear that if a multiplicand is to be multiplied by the value 19, multiplying operations effected as previously described will require ten machine operations. The same result can, obviously, be effected by multiplying the multiplicand by 20 and deducting once the value of the multiplicand. For example, 88 times 19 gives a result of -1672 , but the same result can be effected by multiplying the multiplicand 88 by 20 (equal to adding 880 twice) which gives a result of -1760 and subtracting once, the multiplicand value 88, which gives the same final result -1672 .

Multiplying operations effected in this manner will require only three machine operations, two operations for addition and one operation for subtraction.

The plugging of the machine for effecting multiplying operations by the new method is diagrammatically shown in Fig. 68, and since it is somewhat different than the plugging arrangement employed in the first described method, a detailed explanation will follow: The units and tens sockets 805 plugged to sockets 492 so as to be controlled by corresponding columns of the card are plug connected by connecting plug wires 904 to corresponding plug sockets 806, which it will be recalled, are permanently connected by wires 819 to the contact blades 818 which, in the normal position of the bar 811 have electrical contact with contact blades 807. The contact blades 807, it will be recalled, are permanently connected by wires 808 to the plug sockets 804 and such plug sockets are selectively connected to the desired accumulator magnet sockets 514 (Fig. 48b) which, of course, represent certain accumulator wheels. It will be observed in Fig. 68 that the connection is so made that the units card controlling column will effect additive entries in the tens totalizer wheel and the values represented by the tens card controlling column will be additively entered in the hundreds totalizer wheel, no entries at this time being, of course, effected in the units totalizer wheel.

Therefore, two successive additions of the multiplicand value 88 is represented by 1760 which, in effect, is the multiplication of the multiplicand value by a constant factor "20".

Summarizing, therefore, two successive additions of the value 88 effected by a corresponding number of card analyzing operations, will be presented on the totalizer elements as 1760. The initial denominational relationship described is essential in order that the subsequent deductions of the multiplicand value is effected beginning at the units order of the totalizer wheel such

being performed by shifting the contact blades 818 one step to the right after the last operation in a manner which will be presently explained.

It often occurs that there is a card in the analyzing section in which case contacts 671 (Fig. 48e) are opened and as previously explained their opening causes energization of magnet 610 (Fig. 48a) to shift the lower bar 811 so that erroneous values would be secured in multiplying by the new method. To prevent this possibility there is provided a switch 905 which as shown in Fig. 59 is pivotally mounted on a bracket plate at 906. The switch lever has a right angled portion 907 carrying a pin which is received by a horizontal slot 908 in a vertically slidably mounted member 909. By means of the pin 906 receiving one elongated slot in the member 909 and a pin carried by a bracket plate 910 receiving another elongated slot formed in the lower part of member 909, the latter is slidably mounted and urged downwardly against the action of a spring 911 (Fig. 57). The upper part of the member 909 has a hook 912 which, as shown in Fig. 59 overlies substantially the middle part of the armature 863. If the upturned member 862 should be in engagement with the notch of the bracket plate 861 which occurs when the bar 811 is shifted manual rocking of the switch lever 905 in a clockwise position (Fig. 59) will depress plate 909 and by the hook 912 depress the upturned member 862 releasing the bar 811 which then returns to normal position.

When the pin of the angular plate 907 is in its extreme left position it will be received by a somewhat larger portion 908a of the slot 908 so that the plate 909 may, under action of spring 911, be elevated slightly permitting the armature 863 (Fig. 59) to be raised sufficiently by spring 865 (Fig. 57) so that contacts 868 normally contact with the contact point 823. Also referring to Fig. 59, when plate 909 is depressed the lower part thereof will engage an insulating button 913 to depress a lower contact blade to subsequently open the previously mentioned contacts 839 which referring to the wiring diagram (Fig. 48a) are in series connection with the magnet 610 thereby opening the circuit to the magnet 610 and preventing its energization by closure of the contacts 834.

If there is no card in the analyzing section such card may be fed automatically or manually which will cause contacts 834 to be opened by energization of magnet 602 but irrespective of such the circuit to magnet 610 will not be closed due to the previous manual opening of contacts 839.

To employ the method of multiplication now being described the ratchet wheels 855 and 848 are manually removed from stud 857 and a metallic ratchet wheel 914 (Fig. 61) is first placed upon the stud 857 in such a position that it is in the plane of the operating pawl 877 and the retrograde preventing pawl 882 and also in such a position that three operations of the machine are required before the right edge of an insulating block 915 secured to the ratchet wheel 914 engages the left contact spring of contacts 916 to close such contacts. The operator also places upon the stud 857 a disk 917 which is of insulating material and such disk carries an embedded contact plate designated by numeral 918 and which is shown as having a wire connection 919. Secured to the ratchet wheel 914 is a metal contact spring 920. The disk 917 is fixedly secured by means of a lock screw 921 to the stud 857

in such position that two machine operations are required to cause the contact spring 920 of the ratchet wheel 914 to engage the contact plate 918.

Secured to the periphery of the ratchet wheel 914 is a stud 922 to which is secured a spring 923 which maintains the normal positioning of the ratchet wheel 914 defined by the engagement of the stud 922 with a fixed pin 923.

With this construction in mind, it will be obvious that with a card in position for a card analyzing operation, and the multiplying shaft turned to effect such analyzing and an additive entry of the value in the accumulator wheels, that when contacts 691 close (Fig. 48e) an impulse will be directed by means of the conductor 867 through closed contacts 868 and 883 (Fig. 57) to the magnet 880 in the manner previously explained. Therefore, pawl 877 (Fig. 61) will shift the ratchet wheel 914 an equivalent of one step of movement such positioning of the ratchet wheel being effected under the action of spring 923 and held by the pawl 882. The accumulator wheels will now indicate "0880". A subsequent operation of the multiplying shaft will then be effected resulting in another energization of the magnet 880 and the second entry of the value on the card in the accumulator wheels which will now indicate "1760". At the termination of the second operation of the multiplying shaft and when the additive accumulating operations have been completed contact spring 920 will now contact with the plate 918 to thereby close a circuit now to be traced.

Referring to Fig. 58, it will be clear that when the magnet 880 is energized during the second operation of the machine the armature 879 thereof will cause the closure of contacts 925 simultaneously with the contact of the contact spring 920 with contact plate 918 so that a circuit will then be made traced as follows: from the negative side of the line 496 (Fig. 48a) by a wire 926 through the closed contacts 925 (Fig. 58) and then by a wire 919 (see Fig. 61) to contact elements 918, 920 now closed, the contact blade 859 in frictional connection with the ratchet wheel 914 and thence by the wire 888 (Fig. 48a) to one side of the magnet 886 (Fig. 48a).

Thence from the other side of the magnet by a wire 887 to the wire 867 which is in series connection with the cam controlled multiplier contacts 691 (now closed) and thence to the positive side of the line. Therefore, at the end of the second accumulating operation, magnet 886 will be energized and as it attracts its armature 889 it will close contacts 922. A circuit will then be extended from the wire 887 which transmits the electrical impulse to magnet 886 and then by means of a wire 928 which is connected to one of the contact points 922 through such contacts now closed and thence by means of a wire 929 to a special plug socket 930 (Fig. 48b). A plug connection is made from this socket to one of the subtraction plugs 493 to thereby effect energization of the subtraction magnets 391 (Fig. 48d) which effect the shifting of the subtracting racks in the manner explained so that in the next operation of the machine the value will be subtracted from the accumulator wheels beginning at the units order.

The change in relationship between the controlling card columns and the accumulator elements is, of course, effected when the magnet 886 (Fig. 57) is energized which causes the shifting of the bar 822 by pawl 895. Since the magnet 602 has been previously deenergized by the presence

of a card the holding pawl 831 (Fig. 58) will hold the bar 822 in its shifted position.

The multiplying shaft 700 will now be given a third successive operation effecting the subtraction of the amount 88 from the prior indication on the accumulator wheels "1760" giving a final result of 1672 accomplished by three machine operations.

At the third operation of the machine ratchet wheel 914 will be turned another step so that the contact block 915 will effect the closure of the contacts 916 and a circuit will then be made which will now be traced. It is pointed out that in the final position of the ratchet wheel 914 contacts 916 will be retained closed so that when the card just analyzed is subsequently fed out from the analyzing section as explained in the last part of the section captioned "Cross calculating device" contacts 671 will be closed. As such contacts 671 are closed a circuit will be made by means of the wire 683 (Fig. 48b) to one side of the magnet 602 and thence by means of a wire 931 (Fig. 48a) through contacts 916 (now closed) and the circuit then extends by a wire 932 to a magnet 933 the other side of the magnet being connected through contact points of a manual switch 934 and thence to the negative side of the line 496. The manual switch 934 is closed (as stated) when it is desired to employ the arrangement just described. When the magnet 933 is energized, referring particularly to Fig. 57, its armature will be depressed thereby rocking a pivoted arm 935 clockwise, as viewed in Fig. 57 and by means of a pin attached to the upper end of the arm 935 overlying an extension of a pawl 882 (Fig. 61) the holding pawl will be shifted to release the ratchet wheel 914 which then returns to normal by the action of spring 923. Magnet 602 is, of course, also energized so that it will elevate pawl 831 (Fig. 58) permitting the bar 822 to return to its normal position.

The contact points 900 (Fig. 48a) which, it will be remembered, are electrically connected to the cycle limiting contact plugs 588, control, if desired, as previously described the automatic total taking operations either subtotal or grand total dependent upon the position of the controlling switch blade 547 (Fig. 48b).

In the present case a plug connection is effected between the third plug socket 588 from the top and the lowermost sockets in row 588 so that after one subtracting operation occurring in the third machine operation a total printing operation will automatically ensue.

Dividing mechanism

The dividing mechanism which is included in the present machine is capable of dividing a dividend factor by a divisor factor, both represented on the same tabulating card. The dividing operations are carried out by the successive subtraction method. During the first operation of the machine the dividend factor is read from the card and transferred to an accumulator so that upon successive readings of the divisor factor on the card the divisor will be successively subtracted from the dividend and each digit of the quotient entered in a suitable indicating controlling device.

After each quotient digit is secured which is determined by an overdraft, the remainder is then divided by the divisor and the process is then carried out further until the complete quotient and a remainder, if any, are derived. To better understand the operation, it will be

assumed, that a dividend factor on a card shown in Fig. 70 representing a value of "33514" designated in columns 20 to 24 is to be divided by the divisor "313" represented in columns 40 to 42 of the same card.

To condition the machine for a dividing operation, the switch D (Fig. 69) is first shifted to the "in" position. If it is desired that a total be automatically secured the total switch 546 is shifted to the "in" position and the kind of total secured after each dividing operation will be determined by the position of switch 547.

Brush reading sockets 492 of columns 20 to 25 are plug connected by wires 937 as shown in Fig. 69 to the dividend plug sockets 936. The brush reading sockets 492 related to columns 39 to 42 are plug connected by wires 938 to the divisor plug sockets 939. The quotient plug sockets 940 are plug connected by wires 941 to certain of the accumulator magnet sockets 514. The uppermost row of sockets 942 in the division section of the plugboard is also plug connected to accumulator plug sockets 514 (constituting connections to the last twelve magnets 165 at the left of the machine) and which sockets are related to the accumulator wheels adapted at the initial machine operation to represent the dividend and at the termination of the dividing operation the remainder, if any. Other plug connections are also made and these will be explained as the description progresses.

The card (Fig. 70) representing the factors to be divided is fed to the analyzing section either manually or automatically and when it reaches the analyzing section certain of the card feeding rollers are stopped in their operation and the card thereby held for successive analyzing operations in the manner previously explained.

As the card is fed to the analyzing sections card controlled contacts 671 (Fig. 48e) will be separated thereby opening a circuit to a magnet 943 and this circuit is traced as follows: from the positive side of the line 497, contacts 671 now open, wire 672 to which is connected a wire 944 (Fig. 48c) which leads to one side of the magnet 943. The other side of the magnet 943 is connected by a wire 945 to the wire 527 which leads to the negative side 496. The magnet 943 is shown in Fig. 65 where it will be seen that when it is deenergized a spring 946 is adapted to force a plate 947 downwardly. The plate 947 carries a stud 948 which projects through a slot 948a (Fig. 64) formed in the supporting plate 949 of insulating material and upon which is supported most of the parts of the dividing mechanism. As the stud 948 is lowered, referring to Fig. 64, a pivoted holding pawl 950 will be urged clockwise under the action of a spring 951 so as to rest upon the top of a notched plate 952. The holding pawl 950 is pivoted at 953.

Referring to Fig. 65 the lower end of the plate 947 is provided with a pair of slots 954a and 955a engaging pins carried by pawls 954 and 955, respectively.

An angular notch associated with pawl 954 is formed in a bracket plate 956 and said bracket plate 956 is secured to a lower shiftable bar 957 so that when the bar 957 is shifted to the right (Fig. 65) the pawl 954 previously lowered by plate 947 will engage the vertical edge of the notch in bracket plate 956 to hold the bar 957 in shifted position.

When the pawl 955 is lowered under the action of a suitable spring 958 it will engage the teeth 959 of a disk 960 pivotally mounted on a

stud 961 so as to thereby hold the disk 960 when the latter is subsequently successively turned.

In the normal unshifted position of the lowermost bar 957 (shown in Fig. 64) there is normally a connection between the analyzing elements of the columns representing the dividend and the electrically connected accumulator magnets so that upon the first card analyzing operation the dividend only will be entered in the accumulator. This connection is described as follows: from the dividend sockets 936 (Fig. 69) there are suitable wire connections 962 (Fig. 64) made from such sockets to contact screws of the bar 957 which are electrically connected to a series of twelve contact blades 963. In the normal position of the bar 957 (Fig. 64) the series of contact blades 963 electrically contact a series of contact points 964 which are electrically connected to other contact points 965, both series of contact points 964 and 965 being carried by the intermediate and stationary bar 966. The contact points 965 normally contact with blades 967 carried by the upper or movable bar 968 and to the contact blades 967 there are suitable electrical wire connections 969 which are connected to the plug sockets 942 shown in Fig. 69. Thereby as the dividend is read from the card, electrical impulses are transmitted by the connections comprising the plug sockets 492 (Fig. 69), plug cords 937, plug sockets 936, wires 962 (Fig. 64), contact blades 963, contact points 964 and 965, contact plates 967, wire connections 969, plug sockets 942 (Fig. 69), plug cords 941a to certain of the accumulator sockets 514 which are related to certain accumulator magnets and wheels.

At the termination of the first cycle of the machine the accumulator will represent 33514. Also at the termination of the first cycle of operation, shaft 700 (Fig. 48e) will, through cam 692, close contacts 691 hereby effecting an electrical impulse to certain magnets by circuits now to be traced: from cam contacts 691, wire 690 (Fig. 48e), a wire connection 970 (Fig. 48e) and which through connecting contacts 971 of switch D (now shifted) extends the circuit by the wire 972 which leads, as shown in Fig. 48c, to one side of each of the magnets 973 and 974. From the other side of each of the magnets mentioned a common terminal 975 extends the circuit through contact points 976 now closed to the negative side of the line by the wire 538. The position of contacts 976, in the form of the mechanism adopted is, as shown in Fig. 65, controlled by an armature rod 1026.

When the magnet 974 (Fig. 64) is energized, it will rock an arm 977 and by engagement with one end of the lower bar 957 will shift the same to the left as shown in Fig. 64 thereby bringing the dividend contact blades 963 out of circuit connection with contact points 964 and shifting the eight divisor blades 978 also carried by the lower bar 957 into contact with the related contact points 979 which are carried by the intermediate and immovable bar 966. Suitable wire connections 980 are made between the contact points 979 and to the contact points 965 which lead to the accumulator magnets. Thereby the electric impulses effected under control of the divisor perforations will be directed to the accumulator magnets. The divisor sockets 939 (Fig. 69) have suitable wire connections 981 (Fig. 64) to the contact blades 978. The effective analyzing of the divisor factor is performed during the second cycle of operation although the

controlling circuits are prepared during the last part of the first cycle of operation.

Also during the last part of the first machine cycle a connection is effected to set the machine for a subtracting operation and this is effected by means of the magnet 973 (Fig. 65) which when energized closes contacts 982. The circuit for effecting energization of the subtracting magnet is traced as follows: from the positive side 497, through wire 600 (Figs. 48e and 48b) through connecting contacts 983 of switch D (now shifted) (see Fig. 45 also) and the circuit then extends by the previously mentioned wire connection 674 to a wire 984 (Fig. 48c). The circuit then extends through contacts 982 now closed, wire 985 which extends to the plug socket 930 (Fig. 48b). A suitable plug connection is made from such socket to one of the subtraction sockets 493 to thereby energize the subtraction magnets 991 and adjust the subtracting racks for a subtracting operation.

Also referring to Fig. 65 when magnet 973 is energized, it will rock an arm 986 clockwise to thereby first rock the engaging end of a bell crank operating pawl 987 into engagement with one of the ratchet teeth 988 of the disk 960 so that further operation of the arm 986 will shift the pawl 987 upwardly in the manner previously explained so as to turn the disk 960 one step of movement. At the extremity of such movement a pin 989 carried by disk 960 merely contacts the upper blade 990 of contacts 991 without actually closing such contacts.

The machine then commences its second cycle of operation and during the second operation of the machine the divisor factor is read out and by means of the subtraction mechanism it is subtracted from the accumulator to effect the following operation:

40 33514
 -313

 02214

45 The figure on the line above represents the remainder in the accumulator after the first subtracting operation.

During the second operation of the machine the magnets 973 and 974 are again energized but the magnet 974 (Fig. 64) is ineffective to shift the bar 977 since the bar is already shifted and held in such shifted position by pawl 954 (Fig. 65). However, when the magnet 973 is energized it attracts its armature and again closes contacts 982 (Fig. 69) to set the machine for a second subtraction operation to be effected during the third cycle of operation. The pawl 987 is again shifted so as to turn the ratchet disk 960 a second step of movement to close the contacts 991 to complete a circuit to the first quotient magnet traced as follows: from the wire 972 (Fig. 48c), a wire 992 (Fig. 65) is connected to the lower blade of the pair of contact points 994 which are now closed at this time. The upper contact blade 990 is electrically connected by wire 993 (Fig. 64) to a contact blade 994 carried by the lowermost bar 957 and, which in the shifted position of the bar 957, has an electrical connection to a contact point 994a which is connected by a wire connection 994b to a contact point 994c, contacts 994a, 994c and wire 994b being carried by the intermediate movable bar 966. From contact point 994c the circuit extends to the right blade of a series of contact blades 995 carried by the uppermost bar 966. From the con-

tact blades 995 wire connections 996 are made to the series of quotient magnets 997 (Fig. 48c). The magnets 997 are diagrammatically shown in Fig. 48c and are all connected together at one side by a wire 998 to the negative side of the line 496. Thereby for the first subtraction operation an electrical impulse will be transmitted by cam contacts 691 to the quotient magnet 997 of the first order. As the magnet 997 is energized (Fig. 48c) it will rock an operating pawl 999 (Figs. 48c, 60 and 65) which will turn a gear wheel 1001 a single step of movement and this position of the gear wheel 1001 and a dentated wheel 1044 secured thereto will be held by means of a spring pressed pawl 1002 (Fig. 60) engaging a gear wheel 1001a (Fig. 65) secured to gear 1001 and dentated wheel 1044.

Therefore, the first quotient representing wheel 1001 will be set to represent "1" as the first quotient.

As the third cycle of operation begins the card will again be analyzed and the divisor value will again be subtracted from the last remainder and this operation is tabulated as follows:

 02214
 -313

 70914

This, of course, indicates that an overdraft has been determined. To effect certain operations when an overdraft has been reached suitable connections are made to the tens transfer controlling contacts of the accumulator wheel of the highest order. This connection is traced as follows: Referring to Fig. 48a it will be observed that the transfer contacts 278H, 280H which are in the example assumed, selected as the highest order of the dividend effect a connection from the positive side of the line 496 through such contacts, which are closed as the highest order wheel turns reversely through zero to thereby extend the circuit by means of wire 1003 to a plug socket 1004. The corresponding highest order magnet 1005 is, of course, selected as part of the series controlling the representing of the dividend, so as to turn the related accumulator wheel. However, any order may be used as a series of such sockets 1004 are provided at the upper part of the plug-board, one for each denominational order, so that a control may be exercised by any denominational order selected as the highest order of the dividend. From the plug sockets 1004, a plug connection 1005 (Fig. 69) is made to a plug 1006. From this plug, referring to Figs. 48a, 48b, and 48c, a wire connection 1007 is made to one side of a pair of magnets 1008, 1008a. The magnet 1008 is energized as designated by its subscript when a subtraction operation effects an overdraft of the dividend and the magnet 1008a, is, as designated by its subscript, energized when an adding operation is performed to subsequently place the dividend in a positive condition.

Referring to Fig. 64, it will be observed that secured to a stud 1009 which passes through the supporting plate 949 is an arm 1010 and to the arm 1010 is pivoted a plate 1011 which has an elongated slot receiving a stud 1012 carried by the supporting plate 949. The arm 1010 is shown in Fig. 64 in shifted position but in the normal position of the arm 1010 and the plate 1011 a relationship is effected between contact fingers 1013, 1013a and contact plates 1014, 1014a respectively, as shown in Fig. 63. The bar 1011

carries insulated therefrom these two contact fingers 1013_a and 1013_a which at their ends are reduced circular portions of spring plates carried by the plate 1011. From the magnet 1008_a (Fig. 48c) a wire connection 1015 is made to the contact finger 1013_a and since in the normal position of the bar 1011 the contact finger 1013_a engages the contact plate 1014_a (Fig. 63_a) the circuit will be extended by the plate 1014_a to a terminal 1016 which as shown in Fig. 48c extends to the negative side of the line. However, when the bar 1010 is shifted to the position shown in Fig. 64, due to the energization of magnet 1008_a, contact finger 1013_a will now engage a face of a block of insulating material 1017 and the contact finger 1013_a will engage the contact plate 1014_a (see Fig. 63_a) preparing the magnet 1008_a for energization during the subsequent operation. Substantially the middle portion of an arm 1018 (Fig. 65) is connected by a screw 1019 to the armature rod 1026 of the magnets 1008_a and 1008_a so that when an overdraft is determined by the tens transfer mechanism, energization of the magnet 1008_a will rock the arm 1018 clockwise and an interconnecting arm 1021 counterclockwise thereby rocking the stud 1009 in the opposite direction or clockwise as viewed in Fig. 64 retracting the arm 1010 to the position shown in Fig. 64.

Pivotal and slidably mounted by means of a stud 1022 (Fig. 64) secured to the supporting plate 947 is a pawl 1023 of bell crank formation and which is connected to the lower extremity of arm 1010 by means of a pin and elongated slot connection 1024. The shifting of the arm 1010 to the position shown merely retracts the pawl 1023 to the position shown in Fig. 64 where its vertical engaging end is now positioned over the first tooth from the right end of the bar 952 without, however moving the bar during this movement.

During the operations effected during the second subtraction machine operation an electrical impulse will also be directed to the wire 975 but since contacts 976 (Fig. 65) are now open, due to the energization of magnet 1008_a, magnets 973 and 974 will not be energized during the dividing operations in which an overdraft is determined. As contacts 982 (Fig. 65) are not closed the subtraction magnets will not be energized and the machine will now effect a normal adding operation.

During the second subtraction machine operation when the magnet 1008_a is energized, a cam projection 1025 (Fig. 65) integral with the armature rod 1026 coacting with a pin 1027 carried by the plate 947 elevates the latter as armature rod 1026 is shifted to the right due to the energization of magnet 1008_a. The slot 955_a coacting with the pin carried by the pawl 955 is shorter than the slot 954_a so that when the plate 947 is shifted upwardly only the pawl 955 will be elevated sufficiently to release it from the ratchet teeth 959 of disk 960. Stud 948 will not be elevated a sufficient amount at this time to elevate pawl 950 (Fig. 64). When release of pawl 955 is effected the disk 960 will be turned clockwise under the action of a spring 1027_a which was previously tensioned by the turning of the ratchet disk 960 in a counterclockwise direction by pawl 987. Therefore, it will be apparent that contacts 991 are opened during the cycles of operation in which an overdraft is reached.

Referring to the wiring diagram, it will be ob-

served that by the opening of contacts 991 a circuit will not during the adding operation be closed to the first quotient magnet 997 and, therefore, the associated representing wheel 1001 will remain in its adjusted position indicating "1" for the first quotient digit.

The fourth cycle of machine operation will now be instituted and as previously described will effect the addition of the divisor to the remainder effecting the operation stated below:

$$\begin{array}{r} 70914 \\ +313 \\ \hline 02214 \end{array}$$

During such operation, it will be apparent that the tens transfer contacts 278_H, 280_H will again close and since the contact points 1013_a and 1013_a are in the position shown in Fig. 63_a a circuit will be effected by means of the contact point 1013_a and a contact plate 1014_a and by the closing of the tens transfer contacts to effect the energization of the magnet 1008_a. As this magnet is energized, it will shift the armature rod 1026 to the left (Fig. 65) rocking the arm 1018 counterclockwise and by means of the arm 1021 the stud 1009 is rocked in a counterclockwise direction as viewed in Fig. 64. Since arm 1010 is now in the position shown in Fig. 64, the initial rocking of the arm 1010 in a counterclockwise direction will first rock the pawl 1023 clockwise so that its end engages the first notch of the bar 952. Thereafter, further movement of arm 1010 will shift the notched plate 952 and, therefore, the uppermost bar 968 to the right in which shifted position it will be held by the pawl 950. The denominational relationship will now be changed by one order between the accumulator elements and the controlling card columns of the divisor and, at the same time, the contact blade 994 (Fig. 64) will be associated with the second blade (from the right) of the group 995 which blade 995, of course, is connected by a suitable wire connection to the second order quotient magnet 997.

As the arm 1010 is shifted to the right (Fig. 64) the contact points 1013_a and 1013_a will be positioned as shown in Fig. 63_a so that upon the next overdraft operation the magnet 1008_a will be energized to repeat the operations previously described.

As the armature rod 1026 is shifted to the left (Fig. 65) by the action of magnet 1008_a the plate 947 will drop downwardly a sufficient extent so that the pawl 955 again cooperates with the ratchet teeth 959. At the termination of the fourth cycle of operation, or stated in general, for each operation where an overdraft is corrected by an adding operation the magnet 973 will be energized under control of the cam operated contacts 691 (Fig. 48e) thereby closing the contacts 982 to energize the subtraction magnets 991 (Fig. 48d). Also the pawl 987 effects a step of movement of the ratchet disk 960 so that pin 989 now coacts with the uppermost blade 990 of contacts 991 preparing for the closure of such contacts during the next operation of the machine in which the first subtraction is effected from the amount standing on the accumulator to ultimately determine the digital value of the next quotient.

The machine is now conditioned to effect subtraction of the divisor from the remainder and

this operation is illustrated below, noting the change in denominational relationship

02214
-313

99084

In such operation, the totalizer will immediately be placed in a negative condition so that an adding operation will subsequently follow in the manner previously described and the bar 967 (Fig. 64) will be shifted one more step to the right. It will also be understood that there will be no entry in the second quotient magnet and the related set of wheels 1001, 1001a, 1044 will not be turned but will remain at normal to indicate "0".

The third quotient magnet will now be selected for energization due to the shifting of the bar 967 and the machine will be conditioned for the fifth cycle of operation which will effect the addition operation as follows:

99084
313

02214

The next operation will effect the following subtraction operation with the change in denominational relationship noted below:

02214
313

01901

Thereafter seven more subtraction operations will follow resulting in subtracting the divisor 313 from the remainder 02214 seven times after which an overdraft will be reached and causing through repeated closure of cam contacts 691 the transmission of impulses to the third quotient magnet. The third quotient magnet wheel 1001 will then be set to represent "7" and when an overdraft has been reached an adding operation will subsequently follow giving a third shift to the bar 968 and a subtraction operation will thereafter take place. In the example assumed, a remainder of "23" will be obtained in the accumulator and since the remainder "23" is a fractional value of the divisor "313" the third quotient wheel will represent the last digit of the quotient and the accumulator wheels will represent the remainder "23". Thereafter, at the completion of the dividing operation just described, the quotient representing wheels will represent "107" and the accumulator which received the dividend will represent the remainder "23".

It is desirable in order to avoid unnecessary operations of the machine to limit the number of machine operations after the desired number of quotient digits has been secured. For example, in the example discussed, the quotient is 107 and it is desirable that upon securing the last quotient digit "7" to immediately indicate the result in some suitable manner and then permit the result to be directly printed without intermediate idle machine operations.

It will also be apparent that when the dividend comprises a large number of denominations which may be a decimal value and the divisor comprises a few denominations, it is sometimes desirable to secure only a few of the quotient digits.

To this end, there is attached to the plate 949 (Fig. 64) a bar 1030 of insulated material and which has embedded therein two metallic strips 1031 and 1032. The bar 1030 also carries a series

of eight contact points 1033 and a second series of contact points 1034 each set of which is arranged as shown for reasons which will be later obvious. The series of contacts 1033 and 1034 are electrically connected to wire connectors 1035 and each of the eight wire connectors 1035 are connected by suitable wire connections to the eight related plug sockets in the row 588 (Fig. 48b).

It will be clear that after the third quotient digit has been secured and bar 968 has received its third step of movement the third contact point 1033 from the left will now be in electrical engagement with the strip 1031 by means of a finger of the upper contact plate 1036a which is carried by a block attached to the bar 968.

Suitable plug connections are made to the third plug from the top of row 588 (Fig. 48b) so that a connection from the positive side of the line is now made to the strip 1031. The strip 1031 is connected by a wire 1037 to a magnet 1038 (Fig. 48c) one side of which is connected by a wire 1039 to cam controlled contacts 1040 which lead to the wire 945, which it will be recalled, connects to the negative side of the line. The cam which controls contacts 1040 is mounted upon the multiplier shaft so that after the last quotient digit has been entered in the related wheel and the dividend totalizer is now in a positive condition the contacts 1040 close to energize magnet 1038.

Referring now to Fig. 60, it will be clear that when magnet 1038 is energized the armature thereof will be moved upwardly so as to rock one arm 1041 which is one arm of a pair which are connected together by a rod 1042. When the frame constituting arms 1041 and rod 1042 is rocked the rod 1042 by coacting with the series of holding pawls 1002 will rock the holding pawls to release the gear wheels 1001a and therefore dentated wheels 1044. As each dentated wheel 1044 is turned to represent a value a coil spring 1043 will be coiled so as to later return the dentated wheel 1044 to normal position. Each dentated wheel 1044 which is attached to related gear wheels 1001 and 1001a is adapted when restored by related coil spring 1043 to close related contacts 1045 (Fig. 60) one or more times as the set of wheels 1001, 1001a and 1044 are released to be returned to its normal position. For example, if a wheel set was set to represent "7", upon its return the associated dentated wheel 1044 will close contacts 1045 seven times.

One side of each of the series of contacts 1045 is connected to the wire 674 (Fig. 48c) which leads to the positive side of the line. The other side of each of the series of contacts 1045 are connected by individual wire connections 1046 to the quotient plug sockets 940 (Fig. 69) so that by a series of electrical impulses controlled by contacts 1045 the related magnets will be energized by a series of successive impulses to thereby set associated accumulator wheels to represent the quotient.

A following operation of the machine then ensues during which time the divisor is subtracted from the remainder and following such operation the divisor is again added to the remainder restoring the remainder "23" in the example involved on the dividend totalizer. During the latter operation, the lower finger of contact plate 1036b (Fig. 64) will now engage the contact point 1034 just ahead of the contact point 1033 previously engaged by the upper finger 1036a.

In the same manner, a connection will be ex-

tended from the positive side of the line to the contact plate 1032 and thence to a wire 1047 (Fig. 48c) which leads to one side of the relay magnet R4, the other side being connected to the negative side of the line so as to thereby energize magnet R4.

As the function of this relay magnet was previously described in the last part of the section designated "Cross calculation devices" and also "Total taking" it will only be generally explained herein that this relay magnet causes the subsequent feeding of the card involved in the division operation. That is, relay magnet R4 causes the deenergization of the card feed clutch magnet 565 and the deenergization of the multiplying clutch magnet 680. From Fig. 48c, it will be observed that wire 1047 is connected to the wire 708 which leads to cam controlled contacts 703. As previously stated the timing of these contacts is such that the magnet R—10 will be energized at the desired time to effect a circuit connection by wire 574 to the total taking controlling switch 606. Also contacts 709 are closed, and by means of relay magnet R—10 they effect the energization of the main clutch magnet 152 thereby causing an operation of the listing shaft and printing the remainder standing on the dividend accumulator elements and also the quotient standing on other accumulator elements and which were previously set under control of the quotient digit wheels 1001.

It is also pointed out that when the card passes to allow closure of contacts 671, magnet 943 (Fig. 48c) will be energized to thereby elevate bar 947 to elevate both pawls 954 and 955 (Fig. 65) and also holding pawl 950 (Fig. 64) so as to permit return of the shifted bar 968 to normal by a spring 968a.

Also during the last cycle in which an addition was performed since contacts 976 (Figs. 65 and 48c) are closed, magnet 973 will be energized to close contacts 982 thereby causing the subtraction magnet 391 to be energized, as it is involved in either a grand and subtotal printing operation which operations are necessary to secure a result.

Summary and numerical punch

The present machine also includes a punching mechanism which serves primarily to punch the results of any calculating operation on a card. The punching mechanism, if set for an operation is adapted to punch any card it receives so that the result of the calculation secured by the total taking mechanism can be punched upon a blank portion of a card. This may be a card from which the factors of the calculation were derived or the last card of a group.

In general, the punching mechanism consists of a laterally shiftable unit comprising twenty rows of punches. The plurality of rows, each row consisting of nine punches, may be correlated for punching in any twenty card columns. The punching unit is shiftable manually by means of a crank and a numbered dial designates which card columns will be punched.

The details of the punching mechanism are disclosed in Figs. 6, 10, 11, 12, 18, 19, 20, and 55. Reference to specific figures will be made when such figures best illustrate the parts to be described.

As the punching mechanism is controlled for setting by twenty denominational orders of the accumulator, corresponding controlling connections are provided for. In the present machine the first twenty accumulator elements at the left

of the machine are adapted to control the setting of the punching mechanism.

Therefore, in order to punch the results of the calculation, the results to be represented by punching a card are entered in these accumulator elements by suitable plugging arrangements. For example, in multiplying operations, the product plug sockets 806 (Fig. 66) are connected by plug cords to the first twenty accumulator magnet sockets 514 at the left of the machine. In division operations, the quotient plug sockets 940 (Fig. 69) are connected by plug cords to any of the accumulator plug sockets 514 of said twenty denominational orders.

Referring to Fig. 20 which discloses one of the type bars of the first twenty denominational orders (and also to Fig. 10) slidably mounted in a frame comprising a pair of side plates 1050 and 1051 (Fig. 20) is a series of members 1052 each of which is normally urged upwardly by a spring 1053 so that a tube 1054 which is the upper and integral part of the related member 1052 engages the bottom edge of the related type carrier 300. The frame 1050—1051 also carries a series of tubes 1055 and in each tube there is fitted a Bowden wire 1056 and the wire passes through the tube 1055 and the tube 1054, and one of its ends is suitably anchored at the upper extremity of tube 1054. The illustration and connection is omitted in Fig. 20 for the sake of clearness. Therefore, it will be evident that as the type carrier 300 rises spring 1053 will shift related tube 1054 upwardly thus pulling the Bowden wire 1056.

It is undesirable that the members 1052 and wires 1056 be adjusted during type bar setting operations in which no punching operations are desired. To this end each of the series of members 1052 has a shoulder 1057 which is normally caught by a latching ball 1058. The latching ball extends transversely of a series of the twenty members 1052.

A cross bar 1059 connects the side arms of the bail 1050 and a bracket 1060 is attached to the cross bar 1059. A magnet 1061 may be energized so as to rock downwardly a member 1062 which has a suitable pin and slot connection to the bracket 1060 to thereby shift bail 1058 to release the series of members 1052. Magnet 1061 is energized for a sufficient length of time during a total taking operation and at the time the type carriers 300 are beginning to rise to represent a total. Therefore, the unlatching position of bail 1058 is retained so that at the initial rise of the type carriers 300 during a type setting operation the punching mechanism may be set.

Referring to Figs. 11 and 55, it will be observed that the punching unit is supported mainly by two side frame plates 1063 and 1064 which are joined together by suitable cross members, such as a tie rod 1065 (Fig. 55) and other members which will be referred to hereinafter.

The punching unit is slidably mounted by a pair of cross rods 1066 and 1067 (Fig. 6) which pass through the side frames 1063 and 1064 and which are suitably fastened at their ends to the inside of the machine side frames. Therefore, the punching unit may be shiftable laterally along the cross rods to the desired position.

Carried by means of a bar 1068 (Figs. 18 and 19) which is carried by the side frames of the punching unit is a series of twenty bell cranks 1069. The horizontal arms of the bell cranks have connected thereto the other of the ends of the Bowden wires 1056. The vertical arm of each bell crank 1069 has a pin and open slot connec-

tion with a slidably mounted member 1070 and the latter, in turn, has a pin and slot connection to a punch interposer 1071.

Each punch interposer is slidably mounted and is shifted differentially under control of the related Bowden wire so that a depending portion 1072 of the interposer may cover one or more of the series of nine punches 1073 of the related row. For example, when an interposer is shifted from the Fig. 19 position to the Fig. 18 or Fig. 12 position three punches 1073 are covered by the portion 1072 and by suitably effecting depression of the interposer 1071 the punches 1073 which are covered by the portion 1072 will be shifted downwardly to effect a punching operation.

Referring particularly to Fig. 55 the side plates 1063 and 1064 are joined together at their bottom to provide a cross plate 1074 which is provided with a series of holes so as to receive and guide the punches 1073. The card designated by numeral 1075 in Figs. 18 and 55 is adapted to be fed beneath the punches 1073 when they are all in their upward positions. Spaced apart from the cross plate 1074 (Fig. 55) is a die plate 1076 which also has a series of punch receiving holes. The desired separation between the cross plate 1074 and die plate 1075 to receive the card is effected as shown in Fig. 55 by a U-shaped member 1077 which at its left end (Fig. 55) has an upper plate 1078 and a lower plate 1079 a slot being provided between said plates in order to unobstruct the passage of the card 1075. The U-shaped member 1077 has a central strengthening rib 1080. Plate 1078 is attached to the side plate 1063 and plate 1079 to a casting 1081 by suitable fastening means so as to provide a rigid structure. As is best shown in Fig. 6, the die plate 1076 is carried by the casting 1081. By the U-shaped member 1077 the lower portion of the punching unit and the framework 1063, 1064 are rigidly secured together so as to provide the necessary rigidity in construction and still permit passage of the card. It will be clear from Fig. 55 that the U-shaped member 1077 provides an interior slot 1082 through which the card 1075 may be fed in any position of the punching unit.

Referring particularly to Figs. 5 and 55, it will be observed that the bottom portion of the U-shaped member 1077 rests upon a pair of guide rails 1082 so that the punching unit is thereby guided for a slidable movement by said bars.

For depressing the punches which are selected for a punching operation by the interposers 1071 the following arrangement is preferably employed.

As best shown in Fig. 12 and Fig. 55, a lower U-shaped member 1084 is provided with a series of holes receiving the punches 1073 but circular shoulders 1085 of such pins rest upon the upper surface of the horizontal portion of the member 1084 thereby holding the punches in normal elevated position permitting free movement of the card to be punched.

Above the member 1084 there is provided a cross plate 1086 which also guides the punches 1073 and above such plate there is provided an upper U-shaped member 1087 similar to the member 1084 and in which the interposers are slidably mounted. The members 1084 and 1087 as well as plate 1076 are suitably connected together so as to receive together a simultaneous movement of depression. Member 1084 is suitably guided for reciprocation in the punching

unit by means of holes receiving pins 1088 carried by the plate 1074 (see Fig. 18).

The top plate 1087 has secured thereto two right angled brackets 1089 (Fig. 19) receiving side bars 1090a secured to a punch block 1090. By depression of the latter the upper or movable portion of the punching unit is depressed and since the interposers select a certain number of punches the interposer and such punches will also be depressed downwardly so as to perforate the card in the selected card columns and be returned positively by restoration of block 1090.

As best shown in Fig. 55 the punch block 1090 is reciprocally movable in the side machine frames 18 and 19 by means of slots 1091.

As best shown in Figs. 5 and 19, the punch operating shaft 1092 is provided with a pair of eccentric disks 1093 and each of such eccentric disks are adapted to rock a related plate 1094 (see Fig. 5 and Fig. 55) which at its upper end is attached to one end of the extremity of block 1090. Therefore, it will be apparent that upon a rotation of shaft 1092 the punch block 1090 will be shifted downwardly so as to effect a punching operation.

It is pointed out, as best shown in Figs. 18 and 19, that each plate 1070 is provided with ratchet teeth 1095 which are adapted to be engaged by a spring pressed holding plate 1096 so as to hold the shifted interposers 1071 in punch selecting positions. The plate 1096 has pivoted thereto a link 1097 (see Fig. 6) which is connected to an armature 1098 of a magnet 1099. When magnet 1099 is energized plate 1096 will be forced downwardly so that springs 1100 return the bell cranks, 1069 and interposers 1071 to their normal positions.

It is, of course, understood (referring to Fig. 20) that springs 1053 will be likewise effective to return members 1052 to normal position at which time tubes 1054 will abut the bottom edges of the controlling type carriers 300.

In order to laterally shift the punching unit to punch in the selected twenty card columns there is provided a worm screw 1101 which is journaled in the machine side frames 18 and 19 (Fig. 11). Secured to the side frame 1064 is a nut 1102 receiving worm screw 1101 and which has internal threads similar to those of the worm screw 1101. By turning the worm screw 1101, it will be obvious that the punching unit may be shifted to any desired position.

Referring to Fig. 11, it will be observed that the worm screw 1101 extends through the left side frame 18 and has secured thereto a handle 1101a (Fig. 1) and a disk 1103 (Fig. 2) provided with a pin 1104. Pin 1104 is provided at the periphery of disk 1103 and is adapted to engage successively notches in a disk 1105 and therefore turn the disk 1105 by a Geneva movement as the punching unit is shifted to a desired position. The disk 1105 carries two concentric series of numerals, both sets of which are visible through a suitable aperture in the machine casing. The set of figures on the same radial line at reading position determines which columns of the record card will be punched.

Punching control electrical features

To effect card punching, control switch 1106 (Fig. 66) is shifted from the "out" position to the "in" position in which latter position it causes punching.

Referring to Fig. 6 it will be observed that when a card reaches rollers 58 and 59 which are

constantly rotating said rollers feed the card beneath the punches.

Referring now particularly to Fig. 19, it will be observed that when a card reaches a card lever 1107 pivoted at 1108, it will rock the same so that the left end (Fig. 19) is lifted upwardly to open contacts 1109 (Fig. 48f). Therefore, it will be observed that such contacts open a circuit which extends from the positive line side and by a wire 1110 to the magnet of a relay R3, the other side of said magnet being connected to the negative line side. As the magnet is deenergized its armature will drop closing contacts 1111. One side of said contacts is connected to the positive line side 497 and the other side leads by means of a wire 1112 to contacts 1113 which are now unlatched in closed position at this time, by means which will be presently described.

The circuit extends through such closed contacts 1113 and by a wire 1114 to the magnet 1115 of the punch control clutch which effects punching operations. The other side of the magnet 1115 is connected by a wire 1116 to the negative line side. The effectivity of the magnet which controls the punch control clutch is therefore dependent upon the previous closure of contacts 1113 as well as the opening of card control contacts 1109 effected by the card when it arrives in the punching mechanism.

Contacts 1113 are unlatched for closure by the energization of the magnet 1061 and the energization of the magnet is placed under control of the punch control lever 1106 (Fig. 48b) and the total taking mechanism. The lever 1106 is connected by a wire 574 to terminal 606 which is connected to the positive line side in each operation in which a total or result is taken from the accumulators.

It will be recalled that in group controlled total taking operations relay R-3 will close contacts 572 to extend the positive side of the line to the terminal 606. In securing the result of a cross calculation, division, or multiplication operation, relay R-10 will close contacts 705 to also extend the positive line side to terminal 606.

Also manually controlled total taking operations will extend the positive line side to terminal 606 by closure of contacts 531 in taking a grand total and closure of contacts 530 in taking a sub-total (see Fig. 48b).

Hence in taking a total under any type of control punching of the result on the card fed will ensue, provided switch 1106 is in effective position.

Therefore, when switch 1106 is closed, it will engage a terminal which is connected to a wire 1118 thereby extending the circuit from the positive line side during total taking operations by wire 1118 which leads, as shown in Fig. 48f to one side of the magnet 1061, the other side being connected to the negative line side. Therefore, it will be apparent that when the magnet 1061 is energized its armature will be attracted to permit contacts 1113 to be unlatched and held in closed position. When magnet 1061 is energized it will release the members 1052 (Fig. 20) for differential positioning under control of the type bars 300 during total taking operations. Members 1052 will be held in shifted position until the card to be punched opens contacts 1109.

The clutch 1117 (Fig. 55) which controls punching operations is similar in construction and operation to the main clutch of the machine and the circuit to the controlling magnet 1116 is retained for a complete cycle of operation pre-

cisely in the manner previously explained for the main clutch disclosed in Figs. 24 and 25 and will, therefore, not be repeated herein. It should be observed, however, that driving member 1119 (Fig. 55) of the clutch is secured to the gear 27 which, it will be recalled, constantly rotates (see Fig. 5).

When the clutch connection has been made and the shaft 1092 rotated partially in the arrow direction in Fig. 19 an abutment 1120 of a disk 1121 secured to shaft 1092 will be drawn away from a shoulder of a slidable member 1122 thereby permitting a spring 1123 to draw the same upwardly to bring a card stop 1124 into position so as to act as an abutment for the leading edge of the card to be punched.

The trailing edge of the card, however, still cooperates with the feeding rollers 58, 59 (Fig. 6) and such rollers are preferably frictionally driven so that while they have a frictional engagement with the upper and lower surfaces of the card, they will be ineffective to feed the card further against the action of the card stop 1124. The card will thereby be held in a position for the punching operation which occurs after the interposers have been set under differential control of the type carriers. The latter, of course, are set to represent any amount from the accumulator elements of the first twenty orders and which may represent a total, a balance, a quotient, or the product of a multiplying operation.

After the punching operation has been effected a cam 1125 (Fig. 48c) on the punch controlling shaft 1092 will close contacts 1126 thereby extending the circuit from the positive line side by a wire 1127 through such closed contacts to a wire 1128 which leads to one side of the magnet 1099, the other side being connected to the negative line side. This magnet, it will be observed from Fig. 6, effects shifting of the holding bail 1096 to permit the interposers to return to their normal position. The magnet, of course, is energized at the end of the punching operation so that the interposers are now in position for a subsequent setting.

Referring to Fig. 48f it will be observed that cam 1121 also shifts a slide 1129 so as to shift one blade of contacts 1113 permitting armature of magnet 1061 to be shifted upwardly to hold the shifted blade in latched position at which time contacts 1113 are in open position.

It will be recalled that card feed is stopped during a total taking operation under control of a disk 580. This prevents feeding of a card from the analyzer to the total punch which may have a card therein for the purpose of being punched. Otherwise one card may be fed over another.

If a card has been punched and the punching mechanism is in readiness to receive another card an insulated part 580a of the disk 580 (Fig. 48c) will break the circuit to the card feed clutch 555 and therefore card feed will be resumed. Thus, time is saved in allowing overlapping cycles between the total taking mechanism and the punching mechanism.

The total punch shaft is provided with a cam which controls the closure of contacts 1203 (Fig. 48c). The upper blade of such contacts is connected to the positive line side by wire 557 when group control is used. The circuit is then extended by the contacts 1203 to the wire 1200 which as previously stated continues the circuit to one side of the magnet of relay R-7 (Fig. 48f), the other side being connected to the negative line side. Thus magnet R-7 is energized to cause

the closure of contacts 505 in readiness for further operations requiring the main clutch.

There will now be described some of the possible operations which can be performed by the machine when utilizing the punching mechanism.

In general, it is stated that any result designated on the accumulator elements which control the setting of the punching mechanism can be punched on a card fed to the punching mechanism. In each case, it is necessary, of course, that a total taking operation be instituted and the punch control switch 1106 (Fig. 43) be previously shifted to the "in" position.

It is necessary that the card fed to be punched be blank in the field in which the result is to be punched. However, other fields may be punched but of course the machine will not be plugged to control calculation from such fields when a total taking operation is to be performed. It is obvious, also that the result may be punched either in the field correlated with the order of the accumulator elements controlling the setting of the punching mechanism or by suitably positioning the punching mechanism any other unperforated field of the card may be punched to represent the result.

Punching of result controlled by automatic group control

It is desirable in many instances that the punching of the result automatically occurs between groups of items, each of said groups representing a distinct classification. Between each group of classified cards there is interposed a card which is either blank in all of the card columns or blank in the card columns which are adapted to effect the automatic control. Assuming that the card is unpunched in all fields the first group control switch 549 at the left in Fig. 43 is shifted to either its uppermost or lowermost position and the remaining group controlling switches 549 are permitted to remain in their intermediate or neutral position. It is also necessary to shift the group control switch 546 (Fig. 43) to the "in" position and also the switch 547 to the desired position depending upon whether a sub-total or grand total is to be taken. Therefore, as an unpunched card passes to the analyzing mechanism the machine automatically senses, as previously described, the fact that the card is unpunched and, therefore, a total taking operation will ensue. The result on the accumulator controlling the punching mechanism will control the setting of the punching unit and when the card arrives in the punching unit a punching operation will be effected.

It is obvious that the result may be punched in the field correlated with the orders of the accumulator elements controlling the setting of the punching mechanism or in any field, the latter being performed by suitably shifting the punching unit.

In the event that a certain unpunched field is to effect an automatic total taking operation, the associated group controlling switches 549 are shifted to delimit the field, in the manner previously described, so as to cause an automatic total taking operation and the punching of the result in the card which is unpunched in the controlling field. The result, of course, can be punched in this field or in any other field depending upon the position of the punching unit.

Punching result of cross calculation, multiplication or division operations

To effect the punching of the result of a multiplying, dividing, or cross calculating operation the

punch control switch 1106 is, as usual shifted to the "in" position and immediately after completing the calculation, the result of the calculation is secured and the card fed to the punching unit will be punched to represent the result. As in such types of calculation under discussion two or more factors are involved, it is necessary of course that the punching unit be properly positioned so as to cause the punching of the result in one of the unused card fields. The result of the calculation is, therefore, punched in the same card from which the factors are derived and this card can then be used as the controlling instrumentality for subsequent calculating operations. If this is not desired a card can be fed during the securing of the result of any of the types of calculation under discussion and the result punched in this card instead of in the card from which the controlling factors were derived.

Duplicate or repetition punching

It is desirable at times that repetition punching be effected for one or a number of cards and this is usually performed by means of a supplementary card punching machine but the present machine is capable of securing this result avoiding the necessity of providing a separate punching machine.

The data to be repeatedly punched on successive cards is, of course, limited to twenty card columns but the repetition or duplicate punching may be performed in any card field comprising twenty card columns, dependent upon the position of the punching unit. The data to be punched in duplicate is initially set up in the accumulator which controls the setting of the punching mechanism. The initial set up is effected either under card control or by the manual setting mechanism previously described. After the initial set up in the accumulator, the machine is preferably set for automatic group control, the machine also being conditioned to perform sub-total taking operations.

Each card which is blank in the field which controls the group control mechanism may be punched, if desired with the result standing on the accumulator or any other field may be so punched. As previously stated the group control switches 549 (Fig. 43) are adjusted in accordance with whether a single controlling field is blank or whether the card to be punched is unpunched in all columns.

Consecutive numbering punching

In addition to the above described punching operations the machine is also capable of punching a series of cards to consecutively number such cards.

To this end there is provided a pair of plug sockets 1150 (Fig. 48b) either of which has a suitable plug connection to the units magnet of the accumulator which controls the setting of the punching mechanism. Each of said plug sockets 1150 is connected by a wire 1151 to one blade of the cam controlled contacts 622L (Fig. 48c) and thence through such closed contacts to the positive line side 497. Therefore, for each operation of the shaft 141 an impulse will be directed to the units accumulator magnet (as one side of the magnet is connected to the negative line side) effecting the addition of one to the related accumulator wheel. When a series of cards are successively fed to the punching mechanism and the machine set for a successive sub-total taking operation the first card will be unpunched if the

accumulator initially represents zero. For each card thereafter passed to the machine, corresponding to each operation of shaft 141, each addition of a unit to the accumulator will change the accumulator setting to thus cause the punching of the series of cards to represent consecutive numbers.

In the event that the consecutive numbers do not require the use of all of the twenty columns of the punching unit, and if so desired, the columns not employed for consecutive numbering punching may be used to cause repetition punching. The repetition punching will be effected simultaneously with the punching of each of the consecutive numbers.

In the event the consecutive number should start above zero, as for example 500, idle operations of the machine to reach such setting will be eliminated if the initial number is set in the accumulator either under manual control or card control. After the punching of the number representing the initial setup each successively fed card will receive a punching representing a number which is one higher than the number punched on the preceding card.

Other features of the machine

In order to complete the description of the machine as actually constructed for operation, it is pointed out that certain auxiliary devices are employed and of such devices, a series of condensers 1152 (Fig. 48e) are provided. It is generally known that upon the making and breaking of contacts in a circuit in which a current flows sparking will be effected at such contacts. To prevent destructive effects of the sparking upon the contacts the machine employs a series of condensers provided to absorb the spark.

In the wiring diagram there is shown a condenser for each of the transfer contacts and also a condenser for certain cam controlled contacts and relay contacts especially provided in the circuits in which current of large value flow.

To eliminate any unnecessary description the circuits which involve connections to each of the spark absorbing condensers has been eliminated as its use is well known.

Referring particularly to Fig. 1, it is pointed out that the condensers 1152 are mounted in a box 1153 provided at the bottom of the machine. The boxes designated 1154 and 1155 contain the various relays previously described. The receptacle designated 1156 is adapted to receive the chips manufactured during punching operations. Fuses for the motor circuit are provided in the fuse receptacle boxes 1157 and other fuses for the machine controlling circuits, apart from the motor circuit are provided in receptacles 1158.

What is claimed is as follows:

1. A tabulating machine comprising an accumulator, means for operating said accumulator to enter items additively, means for operating said accumulator to enter items subtractively, means for causing the entering by either of said means in said accumulator in succession of each of a plurality of values represented by the same record, each value being entered either additively or subtractively, and means one for each record field selectable under control of the operator and rendered effective by means operable with the means for causing the entering for predetermining whether the values represented by certain fields of the record will be additively or subtractively entered.

2. In a tabulating machine, an accumulator, analyzing devices, a printing mechanism, a shaft for causing the operation of means for controlling the differential setting of the printing mechanism under control of said accumulator, a supplemental shaft, value entering means including means whereby said supplemental shaft is repeatedly and uninterruptedly driven to repeatedly reciprocate the analyzing devices to control the entering of values in said accumulator, and connections including the supplemental shaft whereby the first named shaft is automatically called into operation when the last analyzing operation from a card is completed.

3. In a tabulating machine, in combination, means including analyzing means for effecting under control of a plurality of fields of a record card adding or subtracting operations, selective set-up means for determining which fields shall cause subtracting operations, a subtracting control device, and means including a device shiftable step by step coincident with adding and subtracting operations for causing under control of said set-up means the subtracting control device to be operative prior to the analyzing of the card field which is to control subtraction operations.

4. In a tabulating machine, a single accumulator, means for effecting the entry of values represented in a plurality of fields of the same record in said accumulator, a sub-total taking controlling mechanism and a grand-total taking controlling mechanism for said accumulator, means for selecting either one of said mechanisms, means automatically operated with the operation of the first named means, and means rendered effective by the last named means when the final entry has been effected and including said selecting means for causing the selected controlling mechanism to operate to take either a sub-total or a grand-total from said accumulator.

5. In a tabulating machine, a single accumulator, entering means therefor, a plurality of sets of analyzing devices for analyzing representations of values in a plurality of fields of the same record, entry directing means for causing the entering means to be controlled in succession by the sets of analyzing devices to cause the single accumulator to receive the plurality of values represented by the card fields, means settable to represent less than a predetermined maximum number of entering operations which correspond to the number of values to be entered, means operable in timed relationship with the entry directing means, and means controlled by the last two named means for automatically taking a total from said accumulator after a predetermined number of entries in said accumulator.

6. In a cross calculation device, an accumulator, means including analyzing means for analyzing a plurality of card fields of a single card for effecting a series of operations for entering values in said accumulator, means including means operable with the first named means for causing entries to be effected subtractively in said accumulator, recording means, means for calling the latter into operation automatically after the last entering operation of the first named means for recording the result on said accumulator, and means for causing the suppression of the recording means during each operation of the first named means.

7. In a machine of the class described, a plurality of sets of analyzing devices, means for causing said sets of analyzing devices to effect in

succession a predetermined number of analyzing operations on the same tabulating card, an accumulator, means for directing entries in succession to said accumulator under control of said sets of analyzing devices, type elements settable under control of said accumulator, means operable with the entry directing means for limiting the number of analyzing operations to the actual number of entry controlling fields of said card and means inoperative during the analyzing operations and automatically called into operation by said limiting means for causing the setting of said type elements to cause the recording of the result of the entering operations.

8. In a cross calculation device, in combination, an accumulator, analyzing means for analyzing a plurality of card fields of a tabulating card, a repeatedly operated operating mechanism, means rendered operative by said repeatedly operated operating mechanism for successively directing entries into said accumulator from said analyzing means for each of said card fields, recording means settable under control of said accumulator, a supplemental operating mechanism for said recording means, and means operated with the aforementioned entry directing means for automatically initiating the operation of the supplemental operating mechanism only when the last calculation has been performed.

9. In a tabulating machine, means for effecting in succession a plurality of analyzing operations of a corresponding number of card fields of the same tabulating card, an accumulator, means for successively directing entries into said accumulator from the portions of said analyzing means analyzing each of said card fields, means including means operable with the last mentioned means for limiting the number of analyzing operations to the number of controlling fields of the card, means under control of the accumulator for recording the result upon the card controlling the entry operations, and means automatically operated by said limiting means for initiating the operation of the recording means to record the result of the entering operations upon the card controlling said entering operations.

10. In a tabulating machine, means for effecting in succession a plurality of analyzing operations of a corresponding number of card fields for each of a series of tabulating cards, an accumulator, means for successively directing entries into said accumulator from the portions of said analyzing means analyzing each of the card fields of each tabulating card, means including means operable with the last mentioned means for limiting the number of analyzing operations to the number of controlling fields of each tabulating card, means under control of the accumulator for recording the results of the entering operations for each of the series of tabulating cards, means for feeding a tabulating card to said recording means to operatively correlate the tabulating card with the recording means, and means controlled by said limiting means for initiating the operation of the recording means to cause the latter to record on a tabulating card the result of the entering operations for the card controlling said entering operations.

11. In a tabulating machine, an accumulator, means for repeatedly analyzing a multivalue entry representing card, means for directing each of the entries analyzed by said analyzing means into said accumulator, a card lever, means for feeding said card to said card lever, means operated by said card lever for causing the auto-

matic operation of the entry directing means and for causing the stopping of the card feeding means, means operated step by step coincident with the entry directing means, a mechanism operable independently of the entry directing means for taking a total from said accumulator, means controlled by said step operated means for causing the feeding means to feed the card from said card lever, and means controlled by said step by step means for suppressing the operation of the entry directing means and for causing the automatic operation of the total taking mechanism.

12. In a tabulating machine, analyzing devices, card feeding means normally operable for feeding the card in motion past said analyzing devices for controlling a calculation involving a single analyzing operation, a cross totalizing control means settable at will by the operator prior to effecting cross totalizing involving repeated analyzing operations, normally inoperative means for repeatedly reciprocating said analyzing devices, and means including means rendered effective by said control means when set to effect cross totalizing for rendering the feeding means ineffective to feed the card and for causing the operation of said reciprocating means when a card is operatively correlated with said analyzing devices.

13. A tabulating machine comprising, an accumulator, accumulator actuating means including adding racks to enter items additively and subtracting racks to enter items subtractively, one of said racks being normally effective to control accumulator entries, means for causing the other of said racks to be effective to control accumulator entries, automatically operated means for causing the entering in succession by said accumulator actuating means of each of a plurality of items represented on a plurality of record fields of the same record, and controlling devices, one for each record field, selectable under control of the operator and rendered effective by means operable with the means for causing the entering to cause the operation of the means for rendering the other of said racks effective whereby adding or subtracting operations under control of said record fields may be effected.

14. In a record controlled tabulating machine, an accumulator, record analyzing means, means for feeding a record to and past the analyzing means, means for rendering the feeding means ineffective to feed the card when the record is at analyzing position, cross tabulating means comprising means for repeatedly reciprocating said analyzing means to analyze the record and entry directing means for causing the analyzing means to enter in succession in said accumulator each of a plurality of values represented on the same record, means movable step by step in timed relationship with the operation of the entry directing means, means for taking a total from the accumulator, and means controlled by the step by step movable means when the latter is moved to a predetermined position for causing the automatic operation of the feeding means to feed the record from analyzing position and for causing the automatic operation of the total taking means.

15. In a record controlled machine, analyzing means, means for effecting in succession a number of card analyzing operations of the analyzing means, a plurality of devices including a single manually settable means which is settable in operative relationship with one of said devices

to represent less than a predetermined maximum number of card analyzing operations, means operable in timed relationship with the means for effecting the card analyzing operations, and means controlled by the last named means, the operative device and the manually settable means for terminating the operation of the means for effecting the operation of the analyzing means.

16. In a cyclically operable tabulating machine, cross adding means comprising an accumulator, entering means therefor, a cyclically operable operating mechanism for said entering means, a plurality of sets of record analyzing devices corresponding in number to the number of controlling fields of the same record, and entry directing means for causing the entering means to be controlled in succession by each of said sets of analyzing devices to cause the entering means by successive cycles of operation of the operating mechanism to enter values in said accumulator represented by a predetermined maximum number of controlling fields, in combination with means for preventing further cycles of operation of the operating mechanism, and means including means operable in timed relationship with the entry directing means for rendering the preventing means effective to limit the number of cycles of operation of the operating mechanism to a predetermined number.

17. In a record controlled tabulating machine, in combination, an accumulator, additive entering means and subtractive entering means for said accumulator, means for causing the differential actuation of either of said entering means, analyzing means comprising separate sets commensurate in number to the number of controlling fields of the same record, automatically operated means for successively connecting the sets of analyzing means to the means for causing the differential actuation of either of said entering means, and means including means operable with the automatically operated means for predetermining which of said entering means is operative in accordance with the type of entry to be effected by the record field analyzed.

18. In a tabulating machine, a plurality of sets of analyzing means for analyzing a plurality of item representing fields of the same tabulating card, an accumulator, normally operative additive entering means for said accumulator, a subtractive entering means for said accumulator, a control means to render the subtractive entering means operative, entry directing means for successively connecting the sets of analyzing means for control of either of the additive or subtractive entering means, supplemental means operable with the entry directing means, and means one for each record field and co-operating with the supplemental means for causing the operation of the control means for rendering the subtractive entering means operative for a pre-selected record field.

19. In a machine of the class described, in combination, a punching mechanism including punches, an accumulating device, means under control of the latter for selecting punches of said punching mechanism, means for operating the punches of the punching mechanism to punch on a card the result on said accumulating device, means cooperating with a card and controlled by the marginal edge of the card and effective upon the absence of perforations therein for effecting the operation of the operating means, and means whereby the selection of the punches is dependent

upon the absence of perforations in predetermined columns of the card to be punched.

20. In a machine of the class described, the combination with an accumulating mechanism, of analyzing devices for sensing the control perforations in a plurality of card columns for effecting entries in said accumulating mechanism of the values represented by the perforations, punches selected under control of said accumulating mechanism for effecting the punching on cards of the result standing on the accumulating mechanism, and means controlled by the card to be punched and dependent upon the absence of control perforations in certain columns of said card for selectively causing the selection of the punches and causing the operation of the punches to concurrently punch in a plurality of card columns.

21. In a machine of the class described, the combination with an accumulating device, of punching elements selected under control of said accumulating device for effecting the punching on a card of a result represented on said accumulating device, a single card reading station comprising card perforation sensing elements, an electromagnet for controlling the operation of the punching elements, means for feeding said card to the perforation sensing elements and subsequently to the punching elements for a punching operation, and means for energizing said magnet to control the operation of the punching elements when the sensing elements of the single card reading station determine the absence of perforations in the card to be punched and which was analyzed by said perforation sensing elements.

22. In a machine of the class described, the combination with an accumulating device, of a punching mechanism including punches and punch control elements set under control of said accumulating device for controlling the punching of a result represented on said accumulating device, an electro-magnet for controlling the operation of the punches of the punching mechanism, a series of sets of interconnected contacts for controlling the energization of said electromagnet, a single card reading station comprising card perforation sensing elements, means for causing each of said elements to effect the setting of the related set of contacts, whereby said contacts prevent the energization of said magnet when card perforations are sensed by said elements, and means for feeding a card to the card perforation sensing elements and subsequently to said punching mechanism.

23. In a machine of the class described, the combination of an accumulator, a punching mechanism including punches and punch selectors, means for feeding cards to control calculations and then to said punching mechanism, and means controlled by the absence of perforations in certain columns of a card to cause a setting of said punch selectors under control of the accumulator and then upon arrival of the card in the punching mechanism an operation of said punches to punch the result on the card.

24. In a machine of the class described, an accumulator, means for analyzing a card to control an entry in said accumulator, a punching mechanism including punches, means dependent upon the absence of perforations determined by said analyzing means to cause a selection of the punches of said punching mechanism to represent the result on the accumulator, and a card sensing element in said punching mechanism engaged by the card to cause punching by said

punches of the imperforate part of the card when the card arrives in said punching mechanism.

25. In a record card controlled machine, analyzing devices for controlling computations under control of perforated record cards, an accumulator for representing the result of computations, punches of a punching mechanism, a total taking mechanism, means whereby said analyzing devices control the operation of said total taking mechanism to cause the latter to control the selection of punches of said punching mechanism under control of said accumulator, and means whereby the record card to be punched in conjoint operation with said analyzing devices causes the operation of the punches.

26. In a tabulating machine, a punching mechanism including punches, means for selecting said punches to represent the result of a computation, means for effecting a computation to control said punch selecting means, means for shifting said punches to punch in a blank part of a card, and means including means controlled by the same blank part of the card or another blank part of the card for causing the operation of the punch selecting means and the selected punches.

27. In a tabulating machine, in combination, card analyzing devices, an accumulator for representing the result of a computation, punching means including punches, means for feeding a card from the analyzing devices to the punches, card sensing means for sensing the position of a card with respect to said punches, means rendered operative under control of said analyzing devices when the latter senses that a card is blank in the particular portion analyzed for causing the selection of punches under control of the accumulator, and means rendered operative by said sensing means for causing the operation of the selected punches when the card having the blank portion is presented to said punches.

28. In a tabulating machine, an accumulator, a punching means including punches selected under control of said accumulator, an analyzing means, means for feeding a card to said analyzing means to control the entry of an amount in said accumulator and thereafter to said punching means, means for selecting punches under control of said accumulator, a card group control mechanism controlled by said analyzing means for causing the operation of the punch selecting means, punch operating means, means manually settable for selecting the punch operating means for operation, a card operated means, and means conjointly controlled by said settable means, said card operated means, and the group control mechanism for causing the operation of the punch operating means.

29. In a tabulating machine, an accumulator, card punching devices selected under control of said accumulator, card analyzing devices, means under control of the latter to effect a computation and enter the result in said accumulator, means for successively feeding cards each to said analyzing devices and from the card analyzing devices to the card punching devices, card sensing means for sensing the presence of a card in said card punching devices, operating means for said card punching devices, means controlled by said analyzing devices for determining if successive cards have variant characteristics, and means controlled conjointly by the last named means and the card sensing means to cause the operation of the punch operating means.

30. In a tabulating machine, in combination, analyzing devices, punches of a punching mechanism, said punches being selected to punch the result of a computation, a frame carrying said punches, means for feeding a card to be punched to said analyzing devices and from said analyzing devices to said punching mechanism, means for shifting said frame for co-ordinating the punches with a desired portion of the card to be punched and which is analyzed by said analyzing devices, card sensing devices for sensing the presence of a card in said punching mechanism, operating means for said punches, means controlled by said analyzing means for analyzing the portion of the card to be punched for determining if one of a series of cards has a variant characteristic, and means controlled conjointly by the last named means and the card sensing devices to cause the operation of the punch operating means.

31. A tabulating machine comprising a subtracting mechanism, means for analyzing designations on a record representing one or more subtractive values and including means for analyzing a special perforation, means under control of the special perforation analyzing means to render the subtracting mechanism operative to effect subtraction, devices for causing the portions of the first named analyzing means analyzing each subtractive value to successively control the subtracting mechanism, means operable with the last mentioned means to render the subtracting mechanism operative to effect subtraction, and selecting means for causing the aforementioned devices to be rendered operative.

32. In a tabulating machine, an accumulator, a punching means including punches, means for feeding a card to said punching means, means for selecting punches of said punching means under control of said accumulator prior to the arrival of a card in said punching means, and means controlled by the card for stopping movement of the card when it arrives in said punching means, the last named means also causing an automatic operation of the punches of said punching means.

33. In a tabulating machine, a punching mechanism including punches, a die, and punch selectors all shiftable as a unit whereby the punches are adapted to be correlated with any card field, means for shifting said punching mechanism, means having flexible operating connections with said punch selectors for controlling the selection of the punches of said punching mechanism, calculating means and means settable according to the result of a calculation to select said punches by said controlling means.

34. In a tabulating machine, analyzing devices, means for feeding a card to and from said analyzing devices, a computation result representing means, means for causing the card to be stopped when in cooperation with said analyzing devices during a computation the result of which is entered in said result representing means, a punching mechanism including punches, means under control of the result representing means for automatically selecting punches of said punching mechanism to punch the result of the computation, means whereby the operation of said feeding means is effected to feed the card to said punching mechanism from said analyzing devices and means controlled by the card for causing the stoppage of the card and the operation of the punching means when the card is in cooperation therewith.

35. In a computing tabulating machine, an accumulator, a punching means including punching elements, analyzing means, means operative for feeding a card to said analyzing means and then to said punching means, means for causing said feeding means to be inoperative during one or more computing cycles of machine operation to hold the card in correlation with the analyzing means, and means thereafter operative to cause said feeding means to feed the card to said punching means, means for selecting punching elements of said punching means under control of the accumulator, means for holding the selection, and means controlled by the card to be punched and effective when the card arrives in the punching means to cause operation of the selected punches.

36. In a tabulating machine, a card analyzing means, calculating means under control of said card analyzing means, a card punching means including punches, an accumulator for controlling the selection of the punches, means for feeding a card first to said analyzing means to control the representing of a result of a calculation on said accumulator and then to the punches of said punching means, means for selecting the punches under control of said accumulator for punching the card to represent the result, means for causing the selected punches to be operated independently of the calculating means to provide for punching the card while a following card controls and causes the operation of said calculating means to secure the result of the next calculation, and means controlled by said punching means to prevent the feeding means from feeding a card from the analyzing means to the punching means until the preceding card has been punched.

37. In a tabulating machine, a punching mechanism comprising punches, punch selectors, both of which are shiftable as a unit transversely of a card for correlation with any part of a card to be punched, means for spacing a die plate from said punches and to cause the die plate to move with said punches, said means having a looped portion to receive the entire width of the card to be punched irrespective of the position of the punching mechanism, an accumulator representing the result of a computation, devices for reading out the result on the accumulator and controlling the position of the punch selectors, and flexible operating connections between the punch selectors and the devices for reading out the reading of the result on said accumulator.

38. In a tabulating machine controlled by a series of cards, an accumulator, a punching mechanism including punches, means including analyzing means for determining the presence of perforations in a card, means for feeding cards to said analyzing means and from said analyzing means to said punches, means controlled by the first named means for causing the selection of said punches in accordance with the setting of said accumulator, means controlled by the first named means for causing the feeding means to feed the card from the analyzing means to said punches, means including means controlled by said card for causing the stopping of the feeding of the card when the latter is in correlation with said punches and for causing the operation of said punches, and means for preventing the operation of the feeding means to prevent the feeding of a following card until the preceding card has been punched.

39. In a tabulating machine, an accumulator,

a punching means including punches selected under control of said accumulator, punch operating means, analyzing means, means for feeding a card to said analyzing means and thereafter to said punches, means for rendering the feeding means ineffective to feed the card during one or more computing cycles of the machine to hold the card in correlation with the analyzing means during the computing operation, means thereafter operative to cause said feeding means to feed the card to said punching means, means for selecting the punches under control of said accumulator, means for holding the selection while the card is being fed to said punching means, means manually settable to select the punch operating means for operation, card operated means, devices rendered effective under control of the settable means when the latter is set to select the punch operating means for operation, and means controlled conjointly by said devices and said card operated means for causing the operation of the punch operating means.

40. In a machine of the class described, in combination, an accumulator for representing the result of a computation, means for taking a total from said accumulator, a punching means including punches, means controlled by said total taking means for causing said punches to be selected under control of said accumulator, means for feeding a card to said punching means, card operated means, punch operating means, manually settable means for selecting the punch operating means for operation, and means controlled conjointly by said manually settable means and said card operated means for causing the operation of the punch operating means.

41. In a tabulating machine, a card analyzing means, adding and subtracting calculating means, cyclically operable entry directing means for causing said calculating means under control of said analyzing means to effect calculating operations by one or more cycles of operation, means operable with said entry directing means for preselecting the number of cycles of operation of the last named means, punches selectable under control of said calculating means to represent the algebraic result of the calculation, means controlled by said preselecting means for causing the selection of the punches after the last cycle of operation of the cyclically operable means, means for operating the selected card punches, means for feeding the card to be punched to said punches to correlate the card with said punches, and means controlled by said card for causing an automatic operation of the punch operating means.

42. In a machine of the class described, in combination, means for successively feeding cards uninterruptedly to card punching mechanism including punches, a consecutive numbering means for controlling the selection of said punches, means controlled by the card for changing the value of said consecutive numbering means a fixed increment for each card fed, and a perforation analyzing mechanism operatively correlated with certain card columns for causing when the card is determined to be unperforated the selection of the punches and the operation of said punches so that a series of unperforated cards is punched to represent consecutive numbers.

43. In a machine of the class described, card punching devices, a card analyzing mechanism, a consecutive numbering means, means controlled

by the analyzing mechanism upon the absence of perforations in certain card columns of a card to cause said punching devices to be set under control of said consecutive numbering means, and means for changing the representation of the consecutive numbering means a fixed increment for each card fed.

44. In a record controlled multiplying machine, the combination of an accumulator, additive entering means and subtractive entering means for said accumulator, means for analyzing designations on a record representing a multiplicand, a denominational shift means, means for representing the highest denominational order digit of the nearest tens multiple of a multiplier factor, means controlled thereby for causing said additive entering means to repeatedly enter the multiplicand under control of the analyzing means in said accumulator, in denominational orders thereof determined by said denominational shift means, means controlled by said representing means for thereafter causing the operation of the denominational shift means, a unit digit representing means for representing the tens complement of the units denominational order of the multiplier factor when said factor ends in nine, and means controlled thereby for causing said subtractive entering means to effect the subtraction of the multiplicand amount once from said accumulator under control of the multiplicand analyzing means beginning at a next lower denominational order of said accumulator determined by said denominational shift means.

45. In combination with the multiplying machine set forth in claim 44, feeding means for feeding the record to and from said analyzing means, means for stopping the feeding of the record when the latter is in analyzing position, means for causing the operation of the feeding means to feed the record from analyzing position, and means operable with the denominational shift means for causing the automatic operation of the feeding means to feed the record from analyzing position when the multiplying operation is completed.

46. In a record controlled multiplying machine, the combination of means for analyzing successively fed cards each representing a multiplicand amount, an accumulator, additive entering means, and subtractive entering means, a denominational shift means, means set in said machine which is constant for each multiplicand amount and having devices for representing the highest denominational order digit of the nearest tens multiple of a multiplier factor and supplemental devices for representing a unit digit which is the tens complement of the units denominational order of the same multiplier factor when the latter ends in nine, a denominational shift means, means controlled by the first named devices for causing said additive entering means to repeatedly enter the multiplicand under control of the analyzing means in said accumulator in denominational orders thereof determined by said denominational shift means, means controlled by the first named devices for thereafter causing the operation of the denominational shift means, and means controlled by the second named devices for causing said subtractive entering means to effect the subtraction of the multiplicand amount once from said accumulator under control of the multiplicand analyzing means beginning at a next lower denominational order of said accumulator determined by said denominational shift means.

47. In combination with the multiplying means set forth in claim 46, means for feeding cards to analyzing position and from said analyzing position, and means operable with said denominational shift means for causing the automatic operation of the feeding means to feed the card controlling the multiplying calculation out of analyzing position and a subsequent card into analyzing position for causing another multiplying operation to be effected under control of such card.

48. In a tabulating machine, means for analyzing a dividend value and a divisor value represented on a card, means controlled by the analyzing means for effecting the operation of division to secure the result as a quotient and a possible remainder, a result representing mechanism, means settable under control of the result representing mechanism for recording the result on the card at a blank part thereof, means for limiting the number of digits in the quotient in the operation of division, means controlled by the limiting means to effect the automatic operation of the feeding means to feed the card to the recording means, and means for causing the automatic operation of the recording means when the card is in recording position.

49. In a dividing machine, a dividend amount receiving mechanism, means for setting a dividend amount in said dividend amount receiving mechanism, a quotient digits representing mechanism, dividing means for effecting the operation of division of the amount in said dividend amount receiving mechanism in accordance with a divisor factor representing means and means controlled by said dividing means for entering quotient digits in said quotient representing mechanism, quotient digit receiving mechanism, means operable with said quotient entering means and means controlled thereby for transferring the amount in the quotient representing mechanism to said quotient receiving mechanism upon securing the last quotient digit, and means controlled by the means operable with said quotient entering means for recording a possible remainder on said dividend amount receiving mechanism and the quotient on said quotient receiving mechanism.

50. A cyclically operable calculating machine comprising, analyzing devices, an accumulator, means for feeding a card to and from said analyzing devices, means for stopping the feeding of the card when in analyzing position, means for then effecting a computation under control of said analyzing devices and entering one or more digits of the result in said accumulator, a total taking means for taking a total from said accumulator, means operable with the computing means for selecting the number of digits of the computation entered in said accumulator, and means under control of the selecting means for causing when the desired number of digits have been entered in the accumulator the operation of means to effect an automatic operation of the total taking means, and for coincidentally causing the operation of the feeding means to feed the card controlling the computation out of analyzing position.

51. In a tabulating machine, in combination, analyzing devices, means for reciprocating said analyzing devices for repeatedly analyzing card perforations, means for feeding a card to and from said analyzing devices, means for stopping the feeding of said card when in analyzing position, means for causing the operation of the re-

reciprocating means to effect repeated reciprocations of the analyzing devices when the card is in analyzing position, an accumulator, calculating means operable under control of said analyzing devices for effecting a calculation and entering one or more digits of the result in the accumulator, total taking means for taking a total from said accumulator, means operable with the calculating means for selecting the desired number of digits of the result of the calculation entered in said accumulator, and means under control of the selecting means for preventing when the desired number of digits have been entered in the accumulator further operation of the means for reciprocating said analyzing devices and coincidentally causing the operation of means to effect an automatic operation of the total taking means.

52. In a tabulating machine, analyzing mechanism for analyzing card factors representing a dividend value and a divisor value, a quotient digit receiving means, means for feeding a card to and from said analyzing mechanism, means for rendering the feeding means ineffective to feed the card when the card is operatively correlated with said analyzing mechanism, means for then effecting under control of said analyzing mechanism the operation of division of said factors to secure quotient digits and means for entering the quotient digits in said quotient digit receiving means, means set up in accordance with the number of quotient digits, quotient digit recording means under control of the quotient digit receiving means to record the quotient result on said card, means controlled by the settable means to cause said feeding means to feed the card into position for a recording of the quotient result on a part of the card not representing either factor, and means for causing the automatic operation of the recording means when the card is in recording position.

53. In a card controlled calculating machine which is selectively capable of effecting adding, subtracting, multiplying or dividing calculations, in combination, card analyzing means for analyzing data to be calculated, means for causing the analyzing means to analyze the card in one manner and means to cause said analyzing means to analyze the card in a different manner, an accumulator for receiving the result of any calculation, an accumulator actuating mechanism; accumulator actuating controlling means, intermediate said analyzing means and the accumulator actuating mechanism for variably controlling the actuating mechanism according to which type of calculation is to be performed and comprising, means for causing said actuating mechanism to enter a value additively in said accumulator, means for causing said actuating means to enter a value subtractively in said accumulator, dividing means for causing said actuating mechanism to enter a quotient result in said accumulator, and multiplying means for causing said actuating means to enter a product in said accumulator, each of the aforesaid four means being correlatable for control by said analyzing means and normally ineffective in their control over said accumulator actuating mechanism, calculation selecting means, means controlled by said selecting means for rendering any one of the aforesaid four means comprising the accumulator actuating controlling means effective for control over said accumulator actuating mechanism and causing the selected means to be operatively correlated with the analyzing means, and means whereby said selecting means

in accordance with the type of calculation to be performed selects for operation either of the two means for analyzing the card in the two different manners.

54. In a card controlled calculating machine which is selectively capable of effecting adding, subtracting, multiplying or dividing calculations, in combination, analyzing means for analyzing data to be calculated, means for feeding the card for causing the analyzing means to analyze the card when it is in motion past said analyzing means, means for reciprocating said analyzing means to cause said analyzing means to analyze the card while it is at rest, an accumulator for receiving the result of any calculation, accumulator actuating mechanism; an accumulator actuating controlling means intermediate the analyzing means and the accumulator actuating mechanism for variably controlling the actuating mechanism according to which type of calculation is to be performed and comprising, means for causing said actuating mechanism to enter a value additively in said accumulator, means for causing said actuating means to enter a value subtractively in said accumulator, dividing means for causing said actuating mechanism to enter a quotient result in said accumulator, and multiplying means for causing said actuating means to enter a product in said accumulator, each of the aforesaid four means being correlatable for control by said analyzing means and normally ineffective in their control over said accumulator actuating mechanism; calculation selecting means, means controlled by said selecting means for rendering any one of the aforesaid four means comprising the accumulator actuating controlling means effective for control over said accumulator actuating mechanism and causing the selected means to be operatively correlated with the analyzing means, and means whereby said selecting means in accordance with the means selected selects for operation either the card feeding means or the analyzing reciprocating means.

55. In a card controlled machine which is selectively capable of effecting adding, subtracting, multiplying or dividing calculations, in combination, analyzing means for analyzing data to be calculated, an accumulator for receiving the result of any of said calculations, accumulator actuating mechanism; an accumulator actuating controlling means intermediate said analyzing means and the accumulator actuating mechanism for variably controlling the latter according to which type of calculation is to be performed and comprising, means for causing said actuating mechanism to enter a value additively in said accumulator, means for causing said actuating mechanism to enter a value subtractively in said accumulator, dividing means to divide data representing a divisor value and a dividend value and enter the quotient result in said accumulator, and multiplying means to multiply data representing a multiplier value and a multiplicand value and enter the product in said accumulator, each of the aforesaid four means being correlatable for control by said analyzing means and normally ineffective for control over said accumulator actuating mechanism; calculation selecting means, means controlled by said selecting means for rendering any one of the aforesaid four means effective and to cause the selected one of the four means to be operatively correlated with the analyzing means, means whereby said selecting means causes the

analyzing means to analyze data to be added or subtracted once only when the adding or subtracting means are selected for operation and causes the analyzing means to repeatedly analyze the data on a card when the multiplying means or dividing means are selected for operation.

56. In a tabulating machine which is provided with one calculating means for effecting under control of a card one type of calculating operation and another calculating means for effecting under control of a card another type of calculating operation, the combination with a plurality of card operated levers, of selecting means for selecting for operation the desired calculating means and a related card operated lever, and means controlled by each of said card operated levers to cause the operation of the selected and correlated calculating means.

57. In a tabulating machine capable of selectively effecting cross totalizing, multiplying or dividing calculations, in combination, analyzing means for analyzing data to be calculated on a single tabulating card, an accumulator for receiving the result of said calculations, accumulator actuating mechanism; accumulator actuating controlling means intermediate said analyzing means and the accumulator actuating mechanism for variably controlling the actuating mechanism according to which type of calculation is to be performed and comprising, means for causing said actuating mechanism to enter a plurality of values represented on a single tabulating card additively or subtractively in said accumulator, dividing means for causing said actuating mechanism to enter a quotient result in said accumulator and multiplying means to enter a product in said accumulator, each of the aforesaid three means being correlatable for control by said analyzing means and normally ineffective for control over said accumulator actuating mechanism; a calculation selecting means, means controlled by said selecting means to render any of the aforesaid three means effective and to cause the selected means to be cooperatively correlated with the analyzing means and the accumulator actuating mechanism, means controlled by said accumulator for recording on the same card which previously controlled the selected one of the aforesaid three means the result of the calculation performed thereby and common means controlled by means independently operable in each of the aforesaid three means and each operable with the related one of the means of the aforesaid three means for causing an automatic operation of the recording means.

58. In a card controlled calculating machine which is selectively capable of effecting cross totalizing, multiplying or dividing calculations, in combination, analyzing means for analyzing representations of two values to be calculated and designated on the same tabulating card, an accumulator for receiving the result of any calculation, accumulator actuating mechanism; an accumulator actuating controlling means intermediate the analyzing means and the accumulator actuating mechanism for variably controlling the actuating mechanism according to which type of calculation is to be performed and comprising, means for effecting a cross-totalizing of two values on the same tabulating card and for causing said actuating mechanism to enter the result in said accumulator, dividing means for causing said actuating mechanism to enter a quotient result in said accumulator, and multiplying means for

causing said actuating means to enter a product in said accumulator, each of the aforesaid three means being correlatable for control by said analyzing means and normally ineffective for control over said accumulator actuating mechanism; calculation selecting means comprising a plurality of manually set control devices, and means controlled by each selected control device to render the selected one of the three aforesaid means comprising the accumulator actuating controlling mechanism effective and causing the selected means to be cooperatively correlated with the accumulator actuating means and the analyzing means.

59. In a tabulating machine having separate computing means for performing different types of computations, in combination, means for analyzing designations on a card representing two factors involved in different types of computations, means for selecting either of said computing means for operation, means for feeding a card to and past said analyzing means, and means rendered effective by said selecting means when the latter is positioned for selection of either of said computing means for rendering the feeding means ineffective to feed the card when the latter is in operative relationship with the analyzing means.

60. In a tabulating machine having a calculating means for effecting one type of calculating operation and another calculating means for effecting another type of calculating operation, analyzing devices for controlling either of said calculating means, means for repeatedly reciprocating said analyzing means, card feeding means for feeding a card to and past said analyzing means, a plurality of manipulative means selectively settable for selecting for operation the desired calculating means, and means rendered effective by any one of said manipulative means when set for selecting the related calculating means for causing operation of the analyzing reciprocating means and stopping of the card feed.

61. In a tabulating machine having a calculating means for effecting one type of calculating operation and another calculating means for effecting another type of calculating operation, analyzing devices for controlling either of said calculating means, means for repeatedly reciprocating said analyzing means, card feeding means for feeding a card to and past said analyzing means, a plurality of manipulative means selectively settable for selecting for operation the desired calculating means, and common means rendered effective by any one of said manipulative means when set to select a related calculating means and including means operated by the card when it is operatively correlated with the analyzing devices for causing the operation of the analyzing reciprocating means and the stopping of the card feeding means.

62. In a card controlled machine having separate card controlled computing means for performing different computations, common computation result receiving means, and common total taking means therefor, in combination, means for selecting any one of said computing means for operation, means for causing an operation of the total taking means, a plurality of means one in each of said computing means and each operated by the related computing means only when the latter is selected for operation for causing the operation of the means for causing, and means for rendering one of the plu-

rality of means effective during the operation of the related computing means and including means rendered effective by the selecting means when the latter is set to select a computing means for operation.

63. A tabulating machine comprising, card analyzing brushes, a frame carrying said brushes, a spring urged member pivoted to said frame and contacting with said brushes, latching means for normally latching said member in a certain position to cause said member to hold the brushes out of contact with the card to be analyzed, a card lever operated by the card to be analyzed, and electrical means rendered effective by said card lever for disabling said latching means to permit the brushes to contact with the card.

64. In a tabulating machine, card analyzing brushes, a reciprocable carriage carrying said analyzing brushes, means for reciprocating said carriage, electromagnetic means and means controlled thereby for holding said brushes out of contact with a card, means operable in timed relationship with said reciprocating means for transmitting a single electrical impulse to said electromagnetic means prior to a movement of the carriage in one direction to cause the holding means to be disabled to permit the brushes to contact with the card, and means for operating said holding means prior to a movement of the carriage in the other direction to cause the brushes to be moved out of contact with the card during the movement of the carriage in said other direction.

65. In a tabulating machine, card analyzing brushes, a reciprocable carriage carrying said brushes, restraining means and means controlled thereby for holding said brushes out of contact with a card, a shaft, means controlled by movement of said shaft for causing said restraining means to be disabled prior to a movement of the carriage in one direction to permit the brushes to contact with the card, and means controlled by the movement of said shaft for causing the brush holding means to be restored to its initial position and effective to move the brushes out of contact with the card prior to a movement of the carriage in the other direction.

66. In a tabulating machine, an accumulator, a total taking mechanism and a controlling circuit therefor, sets of interconnected contacts electrically connectible in said circuit, card controlled means for determining the position of said contacts, a plurality of manually set switching elements, one for each set of contacts, a pair of bus bars in said circuit, and switching devices each movable by the related element for selectively electrically connecting one or more sets of contacts in series between said bus bars.

67. In a tabulating machine, an accumulator, item entering actuators therefor, a total taking mechanism for said accumulator, means for analyzing cards perforated in columns vertically and horizontally with each digit represented by a commensurate number of perforations in a vertical column, means controlled by said analyzing means for effecting a step by step movement of said actuators and each in accordance with the number of perforations in a correlated vertical column, and means including a plurality of devices shiftable under control of said actuators for controlling the operation of said total taking mechanism, each of the last named devices being shiftable by the first step of movement of the related one of said actuators to prevent the operation of said total taking mechanism.

68. In a tabulating machine, means for analyzing perforated records, a plurality of sets of serially interconnected group control contacts, one set for each controlling record column, a total taking circuit for controlling the automatic operation of total taking means and in which said sets of contacts are connectible in series, a plurality of manually operable levers, one for each set of contacts, and a plurality of electrical switching means each moved by the related one of said levers for connecting one or more sets of contacts delimited by a pair of levers in series in said total taking circuit, and means controlled by said analyzing means to control the position of the sets of contacts connected in said circuit.

69. In a group control device, a total taking controlling circuit, a plurality of sets of contacts electrically connectible in said circuit, a plurality of elements each manually settable from a normal position, a plurality of switching devices set by said settable elements, each switching device normally connecting adjacent sets of contacts in series, and by the setting of the related element from normal disconnecting adjacent sets of contacts, and means controlled by said switching devices for connecting a plurality of sets of contacts delimited by a pair of set elements in said total taking circuit.

70. In a tabulating machine, a total taking circuit, a plurality of sets of group control contacts electrically connectible in said circuit, a plurality of manually operable means, each settable to an off-normal position, a plurality of switching means each movable by the setting of the related manually operable means to an off-normal position, and means controlled by said switching means for selectively connecting by the setting of a pair of manually operable means which are set to an off-normal position a plurality of sets of contacts, delimited by the pair of manually operable means which are set, in said total taking circuit.

71. A tabulating machine comprising a single card analyzing means for analyzing columns of record perforations arranged vertically and horizontally, each vertical column containing a number of perforations corresponding in number to the digit represented, a total taking controlling means, means controlled by said analyzing means for determining the presence or absence of perforations in the first horizontal line of the record columns analyzed, and means controlled by the last named means and rendered effective when the last named means determines that the record columns analyzed are imperforate along the first horizontal line for causing the operation of the total taking controlling means.

72. In a tabulating machine, in combination, analyzing devices for electrically analyzing value representing perforations in the same field of cards of two different types, analyzing means to determine the presence of a special perforation in a card of one type, a pair of accumulators, magnets controlling entries in said accumulators; an electrical switch comprising, two sets of stationary concentrically arranged electrical contacts, each set electrically connected to the magnets of the related accumulator, and a pivotally mounted rotatable set of electrical contacts electrically connected to said analyzing devices and shiftable from normal contact with one set of contacts to contact with the other set of contacts to divert values into said accumulators selectively; means controlled by said analyzing means and responsive to the presence of a special

perforation in a card of one type for shifting the rotatable set of contacts from normal contact with one set of contacts to contact with the other set of contacts, a pawl for holding the rotatable set of contacts in shifted position in contact with the other set of contacts, resilient means for restoring said rotatable set of contacts from shifted position into contact with the set of contacts normally in contact therewith, and means effective after said set of rotatable contacts have been shifted to move the pawl to release the rotatable set of contacts and permit the restoring means to be effective.

73. In a tabulating machine, in combination, analyzing devices for electrically analyzing value representing perforations in the same field of cards of two different types, analyzing means to determine the presence of a special perforation in a card of one type, a pair of accumulators, magnets controlling entries in said accumulators; an electrical switch comprising, two sets of stationary concentrically arranged electrical contacts electrically connected to the magnets of the related accumulator, and a pivotally mounted rotatable set of electrical contacts electrically connected to said analyzing devices and shiftable from normal contact with one set of contacts to contact with the other set of contacts to divert values into said accumulators selectively; means controlled by said analyzing means and responsive to the presence of a special perforation in a

card of one type for shifting the rotatable set of contacts from normal contact with one set of contacts to contact with the other set of contacts, a pawl for holding the rotatable set of contacts in shifted position to contact with the other set of contacts, resilient means for restoring said rotatable set of contacts from shifted position into contact with the set of contacts normally in contact therewith, a card operated lever, and means controlled by said card lever to move the pawl to release the rotatable set of contacts and permit the restoring means to be effective at the termination of an entry operation for one accumulator.

74. In a tabulating machine, several sets of accumulator entry control contact elements, a set of contact fingers, cross adding control means for causing said contact fingers to contact in succession the several sets of contact elements when a corresponding number of card fields of the same card are analyzed, means for analyzing a special designation of a card of one type, class selection control means controlled by said analyzing means to cause the change of contact of said contact fingers from one of the two sets of contact elements to the other of the two sets of contact elements when said special designation is analyzed, and settable means for selecting the cross adding control means or the class selection control means for operation.

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