No. 765,774. PATENTED JULY 26, 1904.

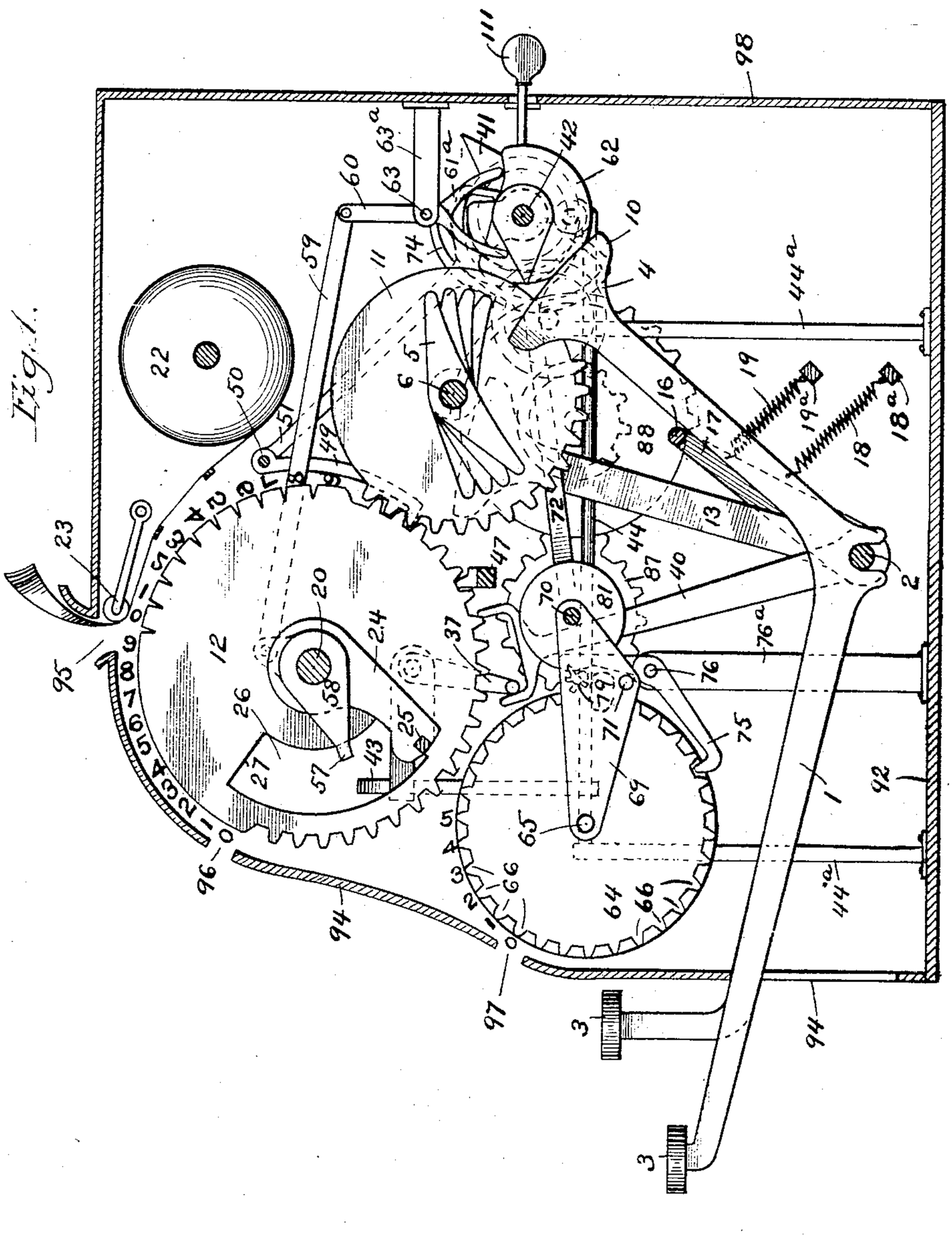
H. E. GOLDBERG.

CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 1.

Fig. 1.



Witnesses

Charles L. Merrick

Eli F. Brandt

Inventor

Hyman Eli Goldberg

By Jesse H. M. Cox

Attorneys

No. 765,774. PATENTED JULY 26, 1904.

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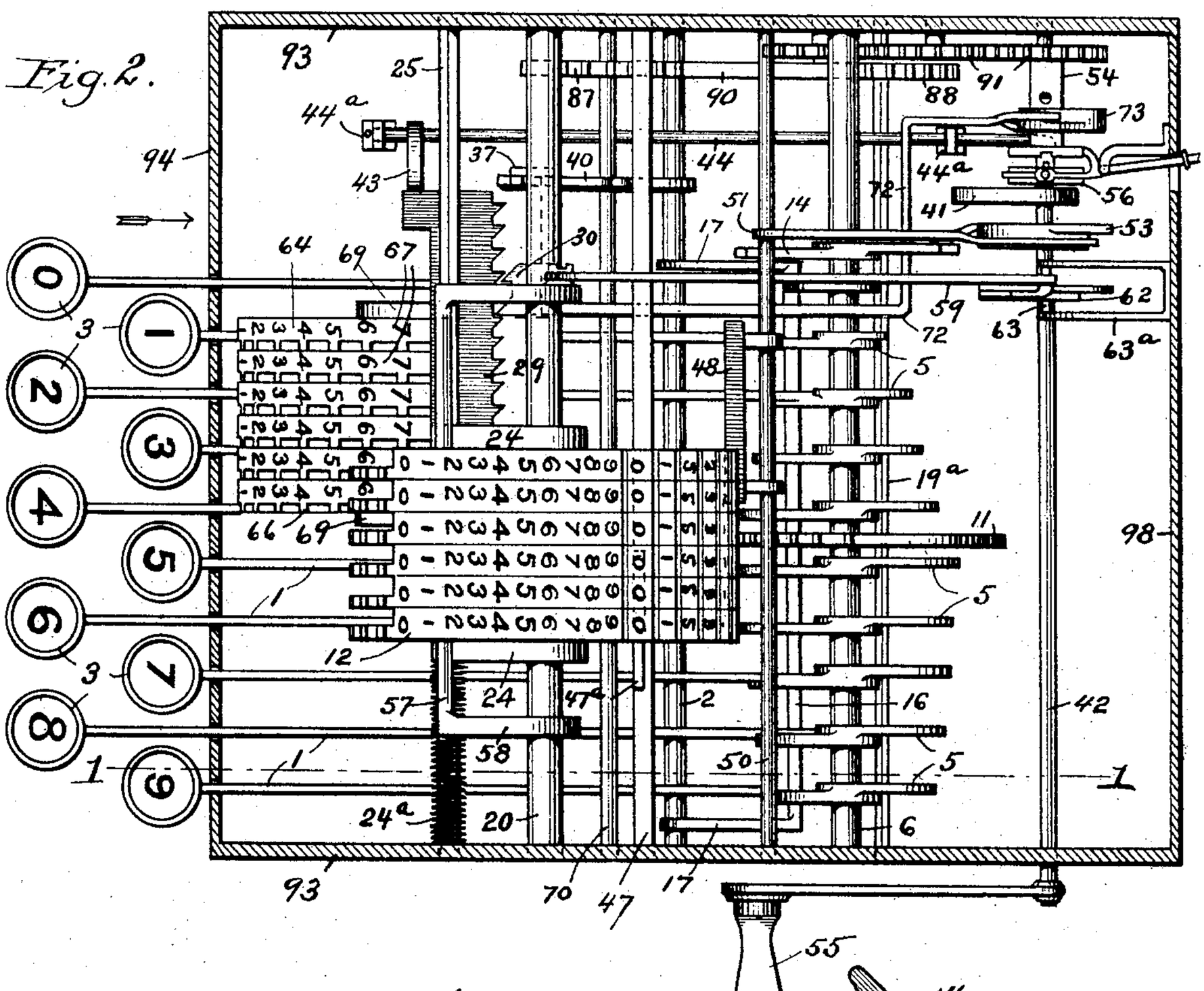
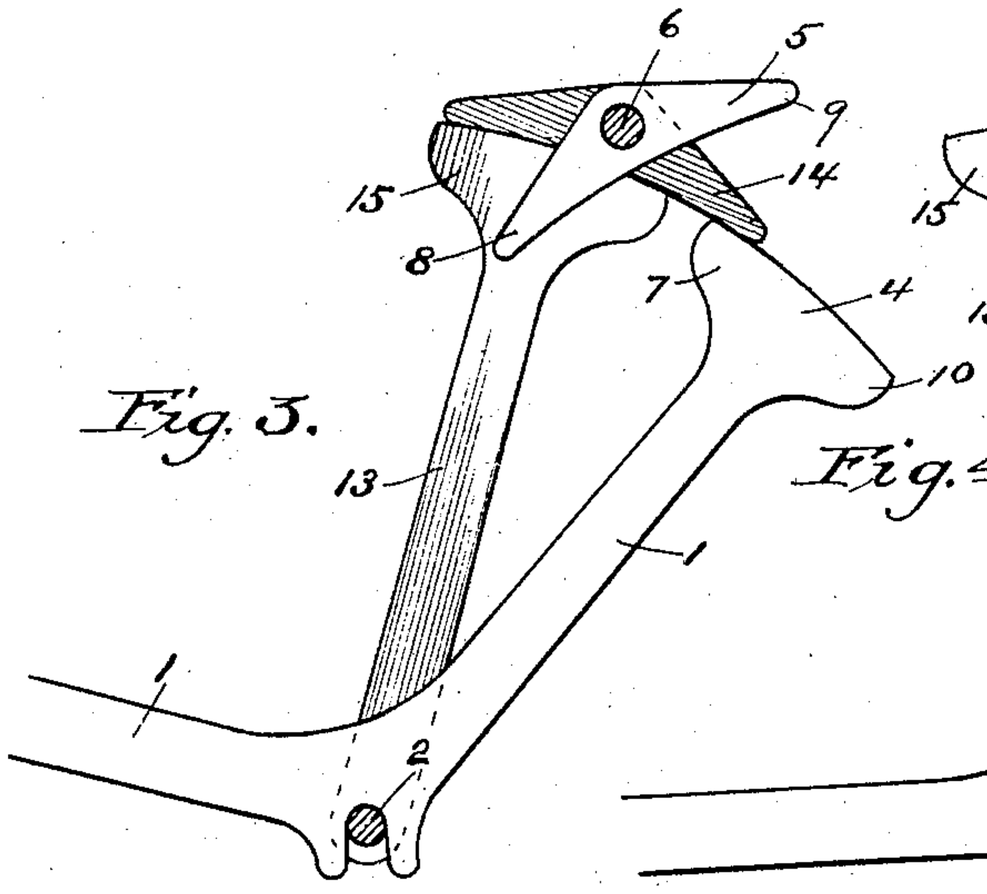
APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 2.

Fig. 2.





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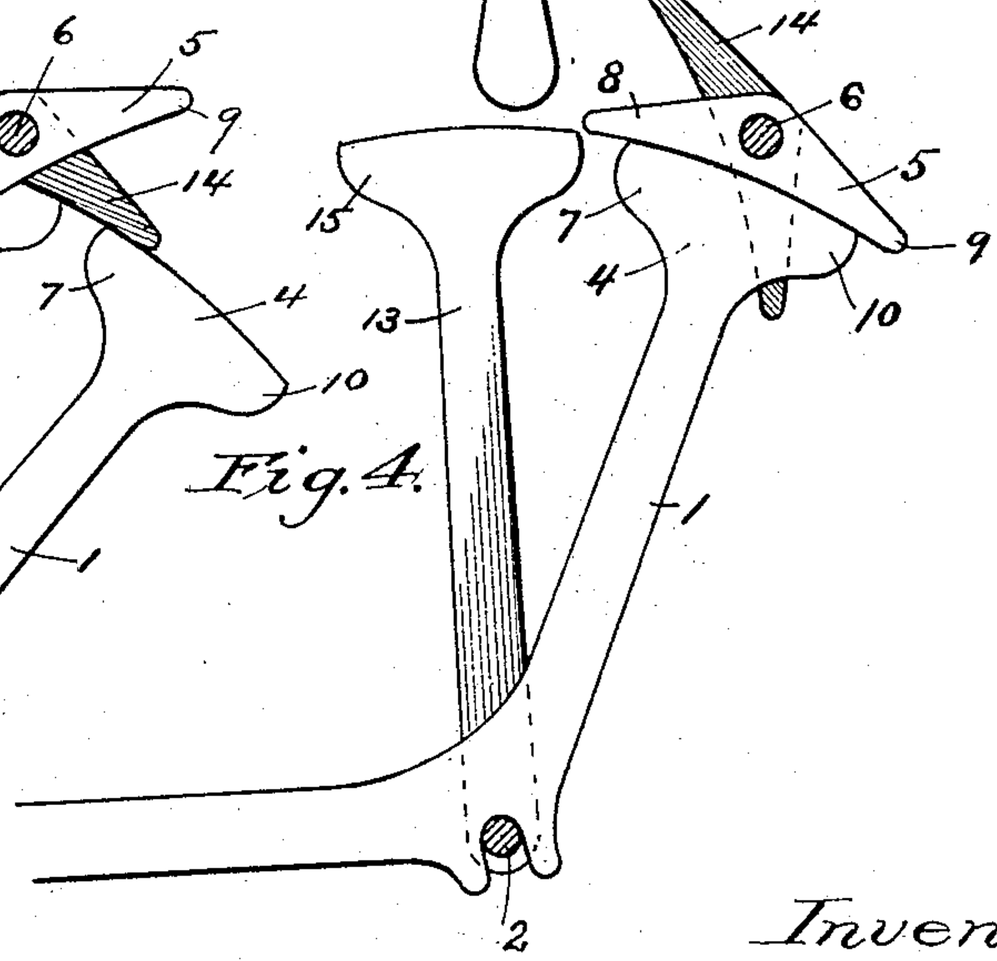

Fig. 4.

Witnesses.
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No. 765,774. PATENTED JULY 26, 1904.

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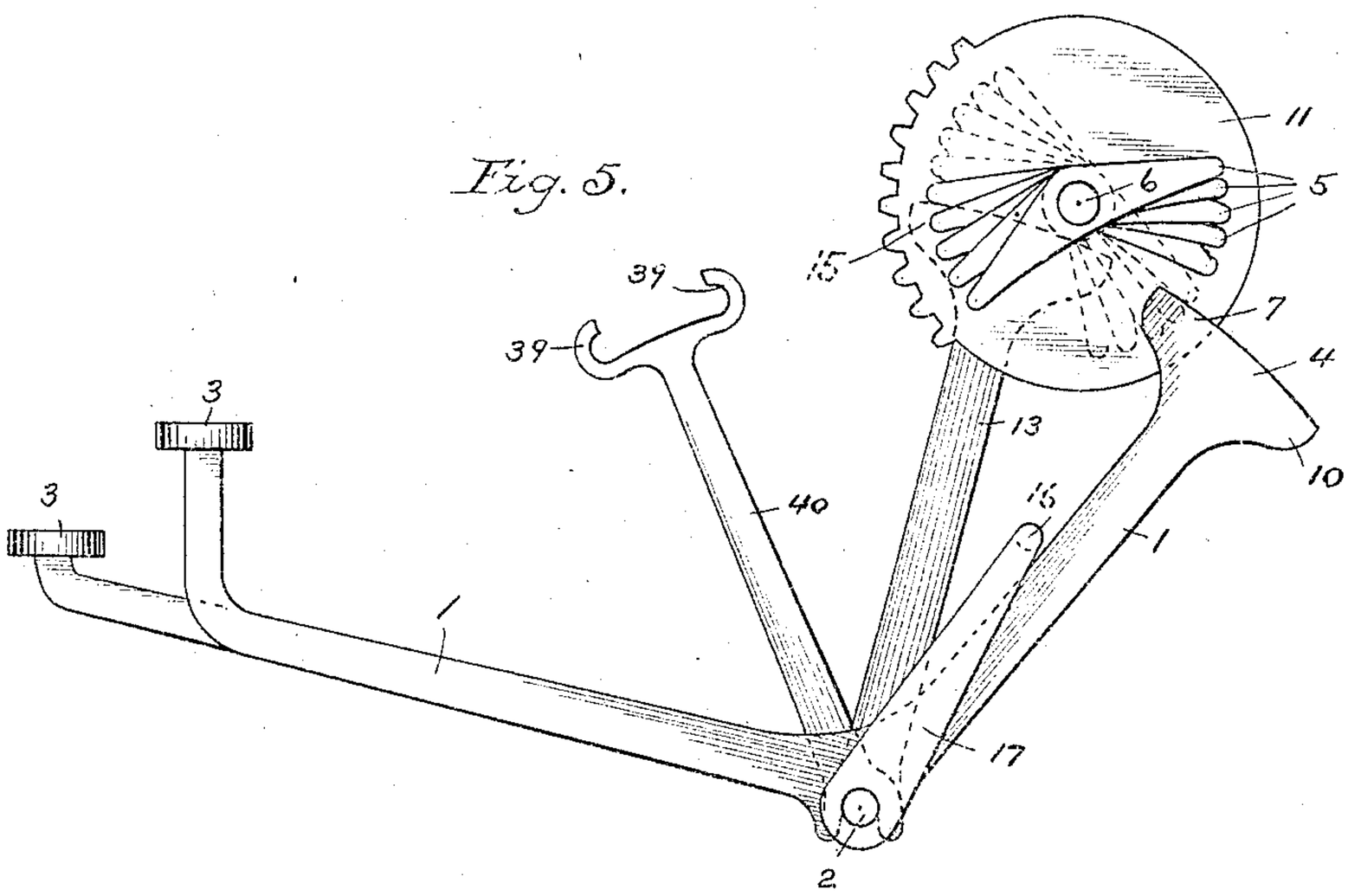
NO MODEL. 11 SHEETS—SHEET 3.

Fig. 5.



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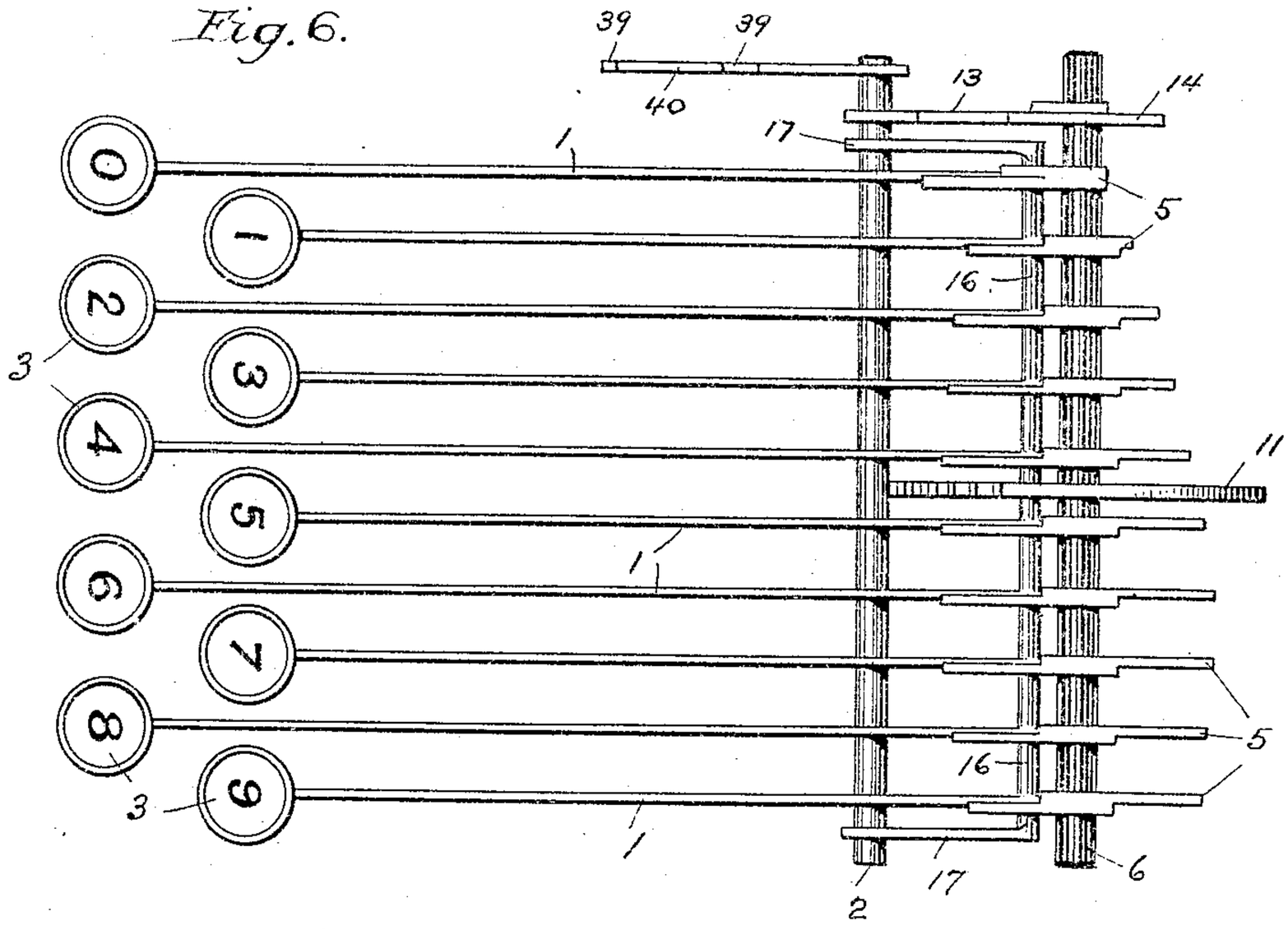

Witnesses
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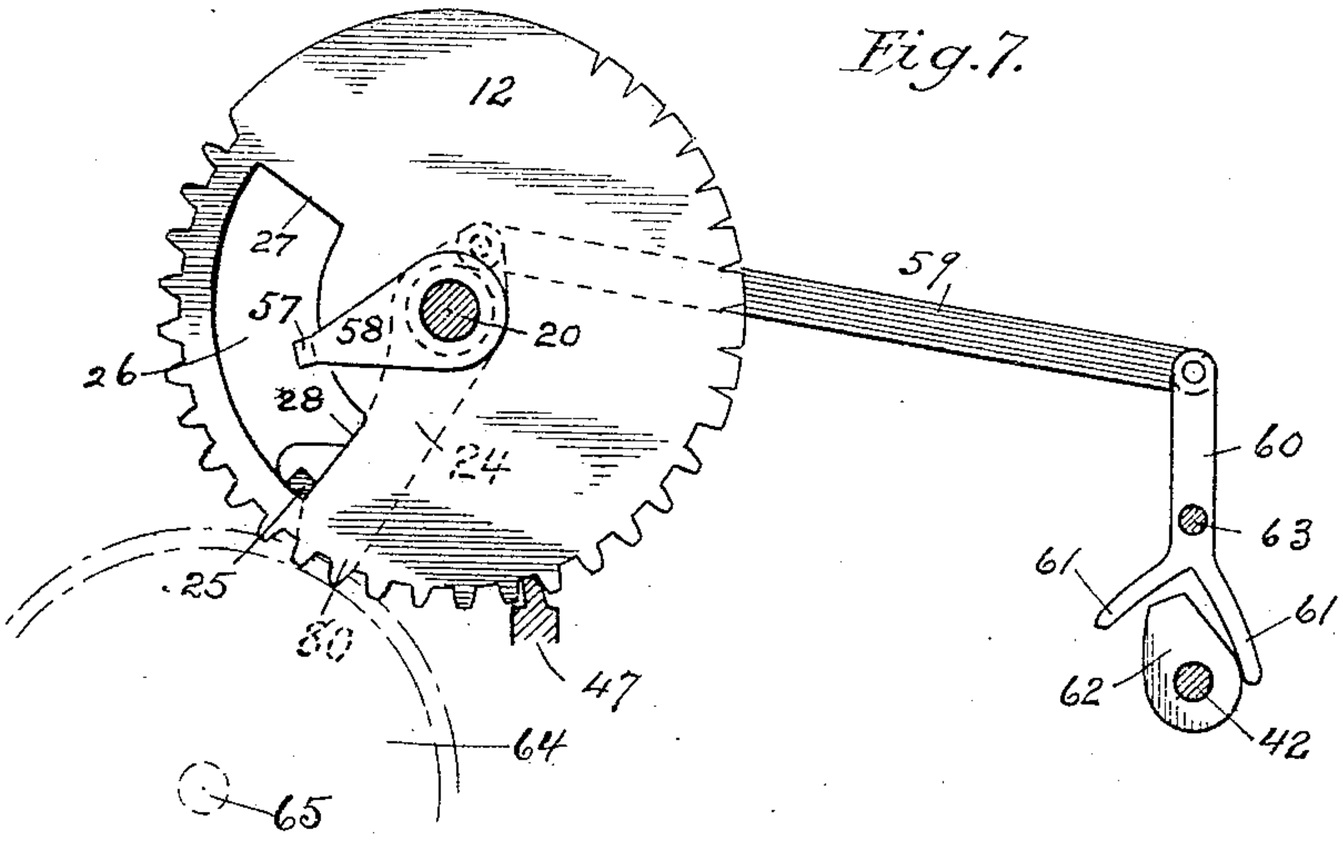
APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 4.

Fig. 7.



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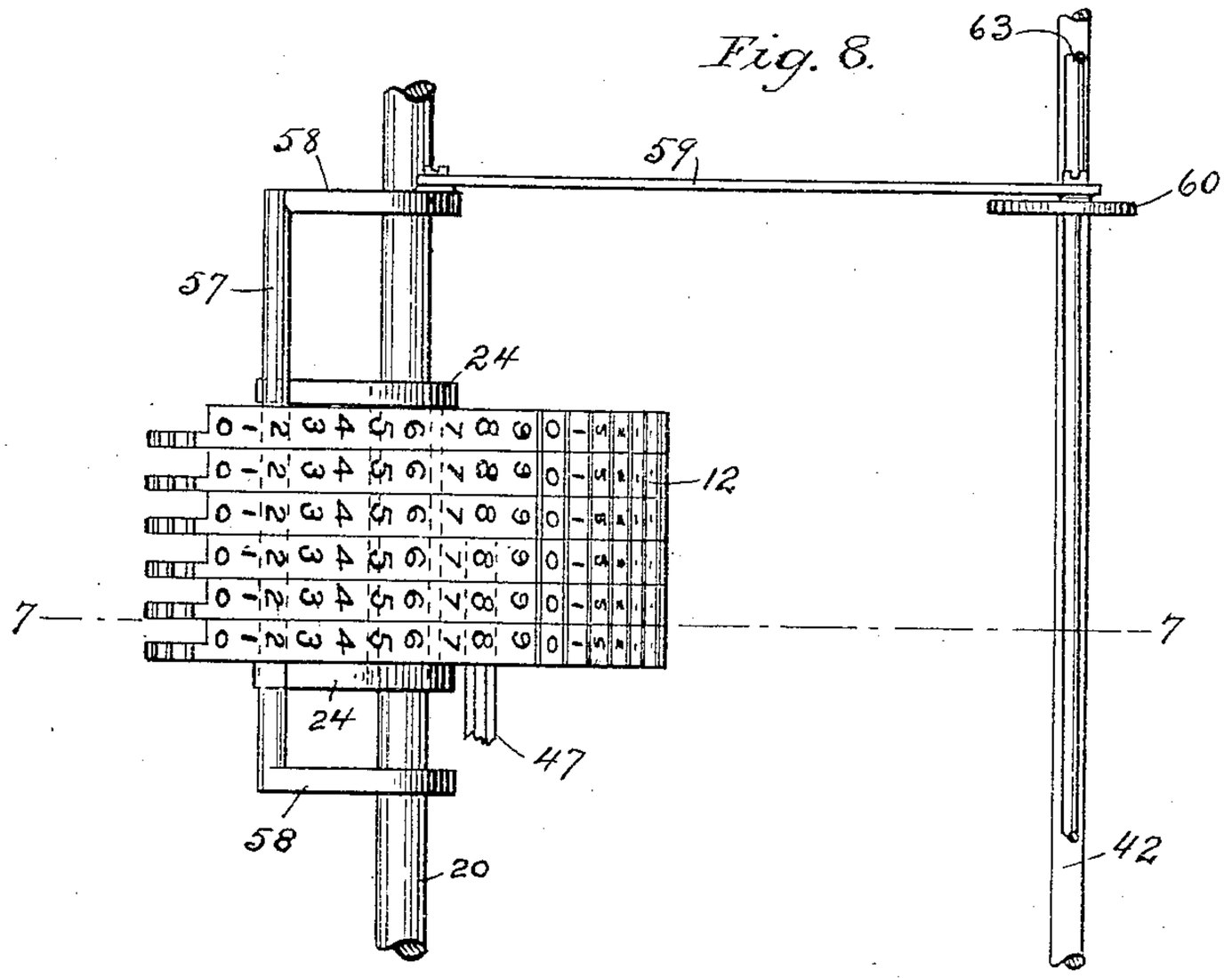

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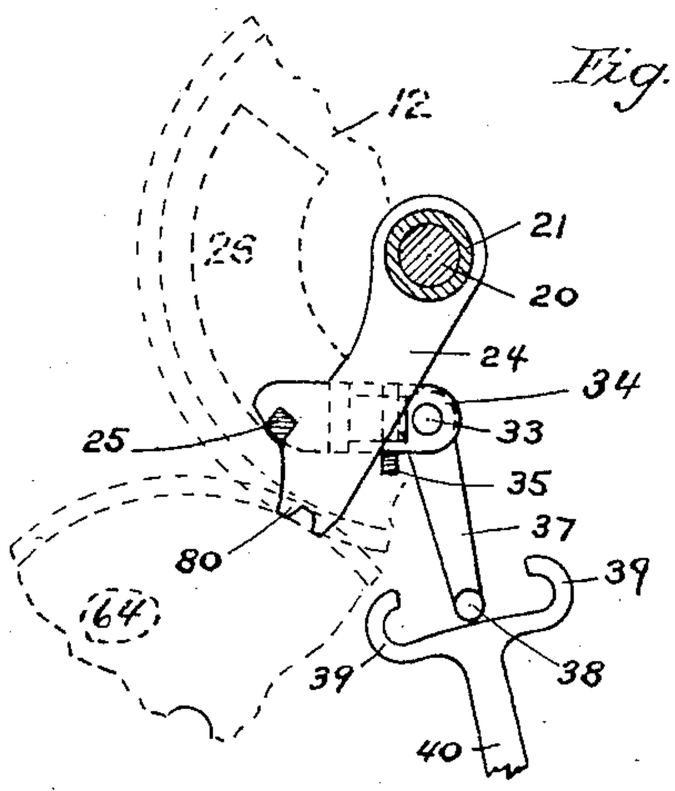
NO MODEL. 11 SHEETS—SHEET 5.

Fig. 9.



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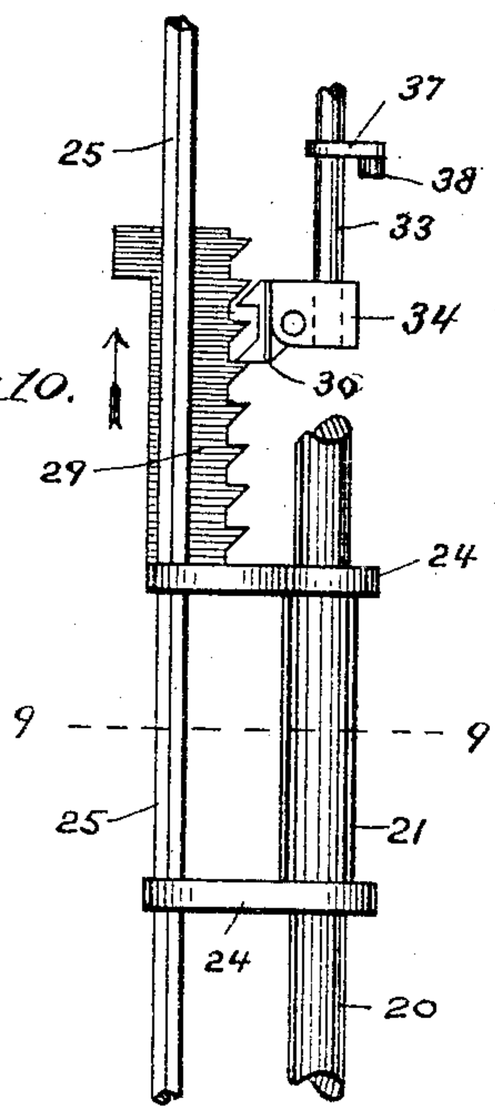

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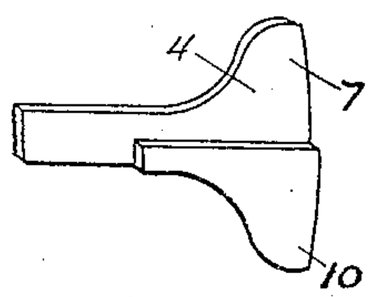

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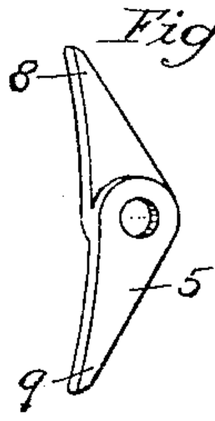

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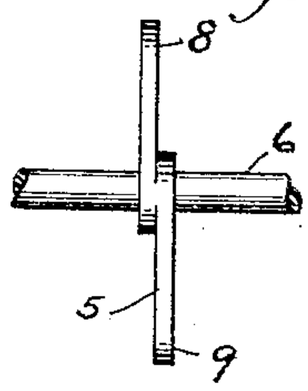

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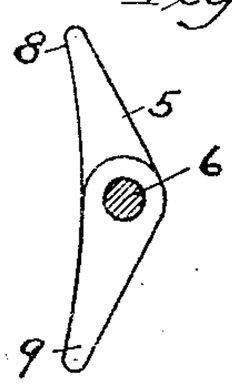

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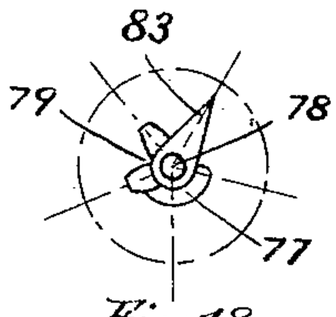
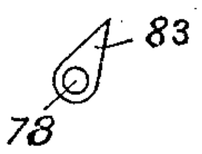


Fig. 15.

Fig. 16.



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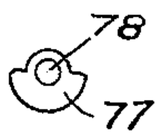

Witnesses:
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Attorneys

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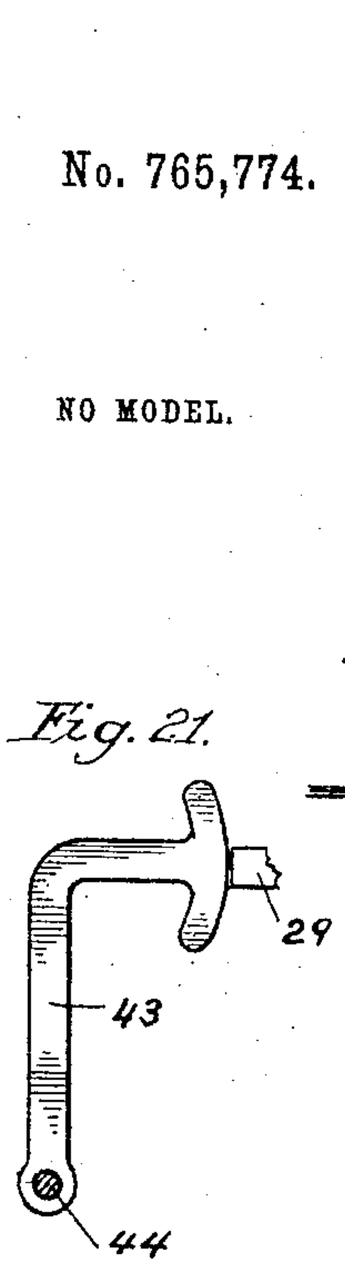
NO MODEL. 11 SHEETS—SHEET 6.

Fig. 21.



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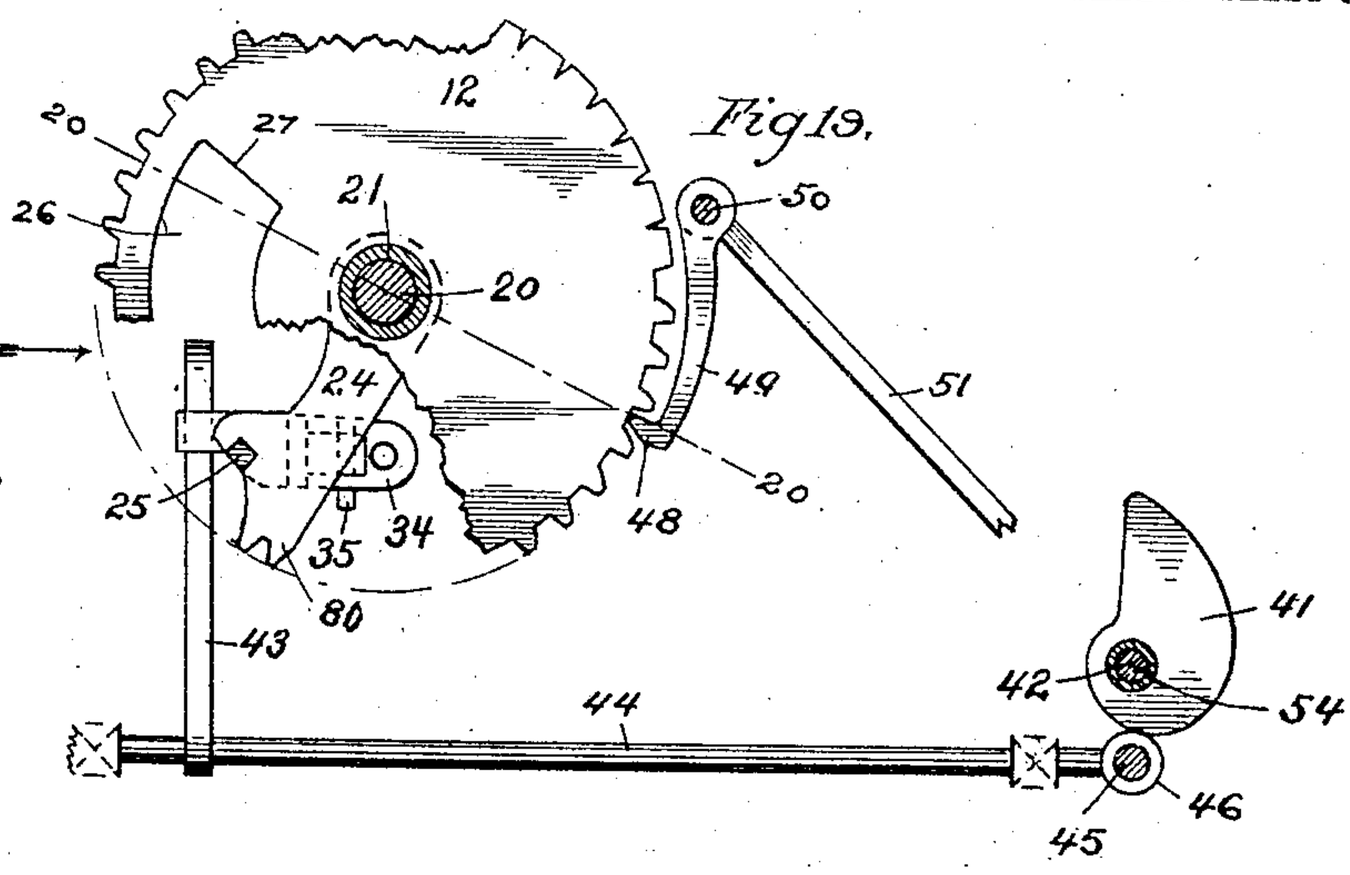

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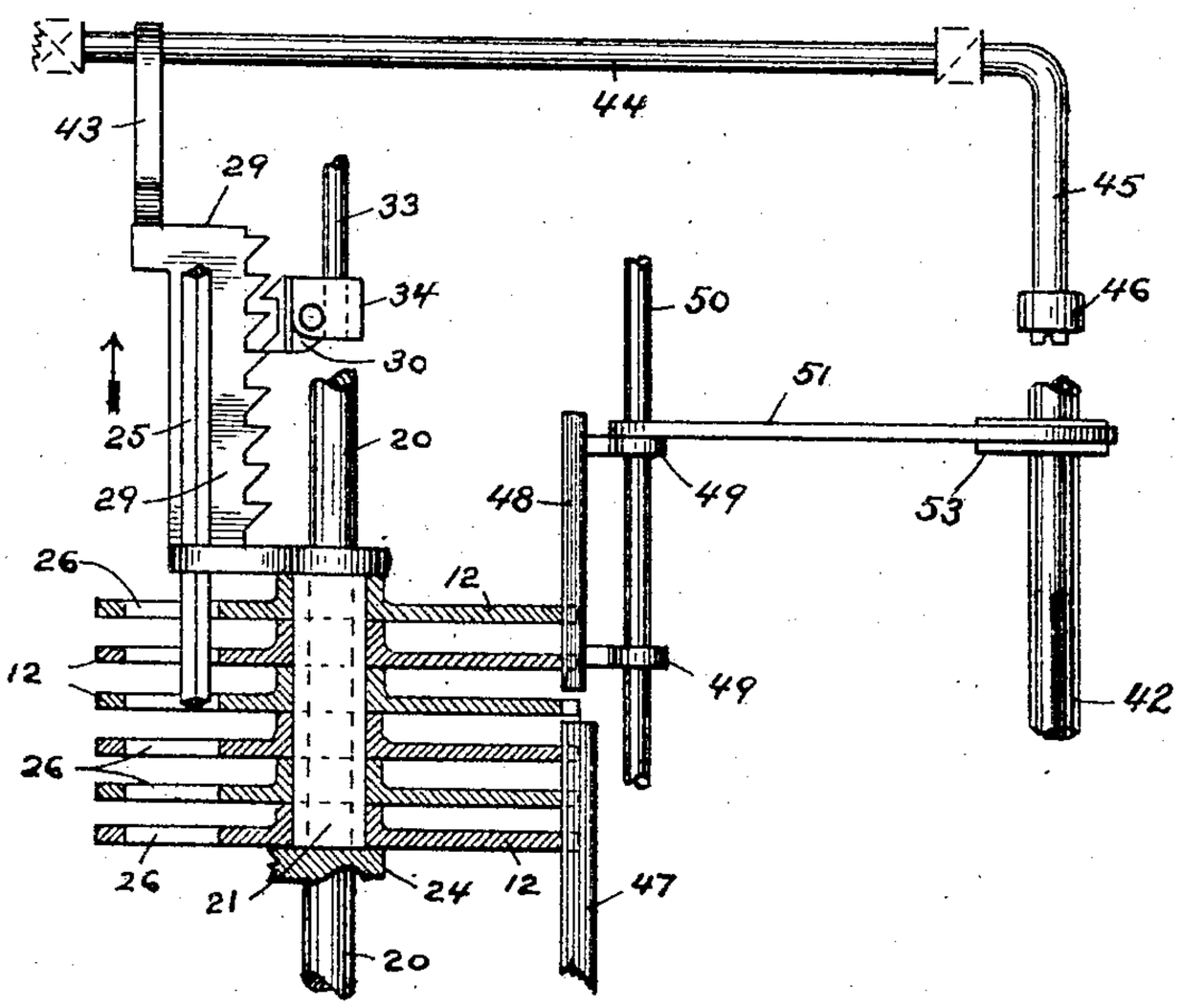

Witnesses
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No. 765,774. PATENTED JULY 26, 1904.

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CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 7.

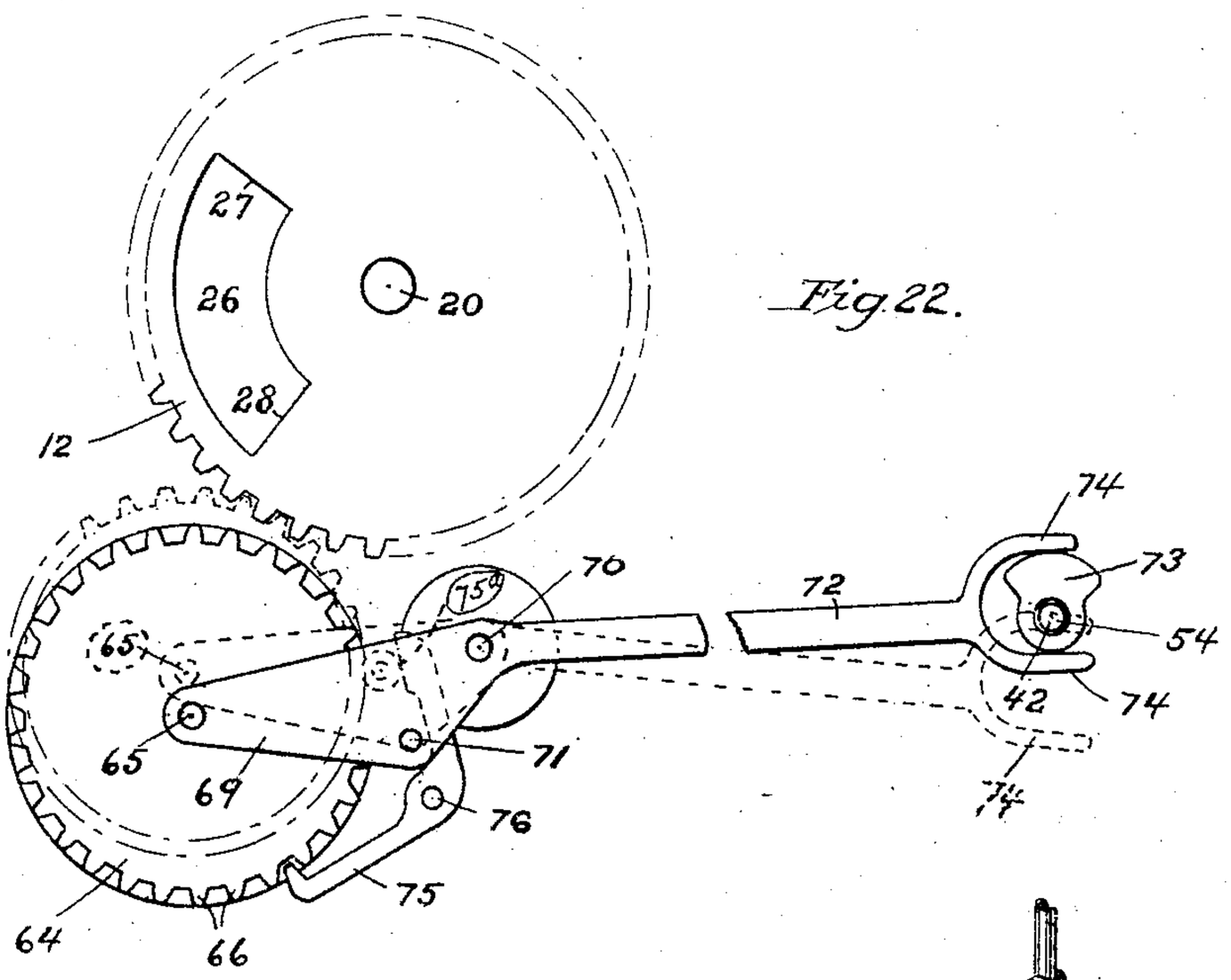


Fig. 22.

Fig 23.

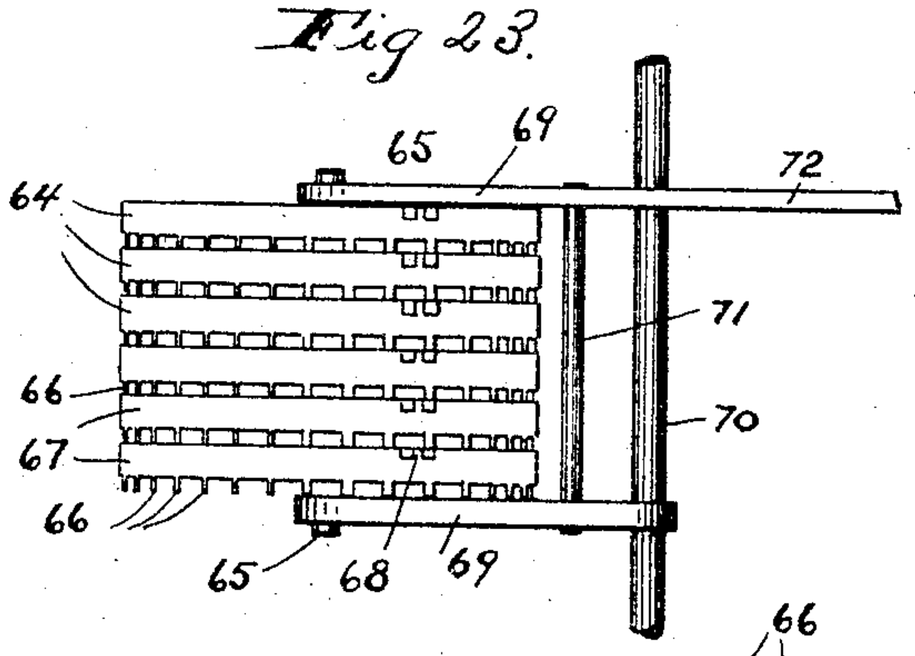
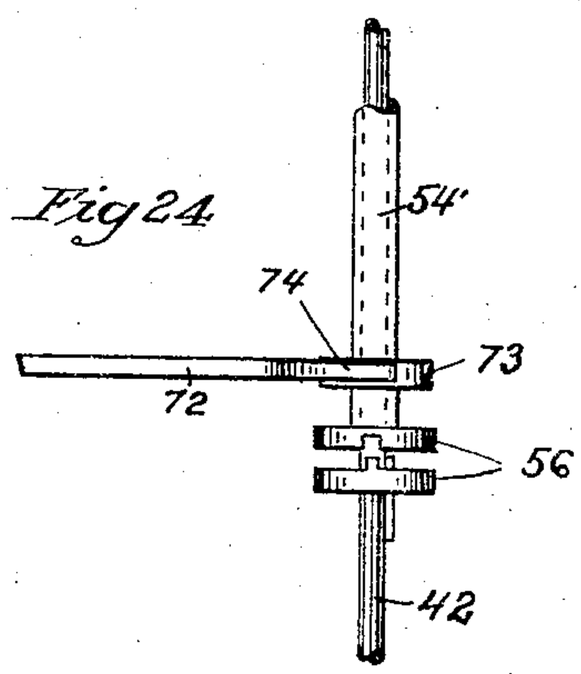


Fig 24



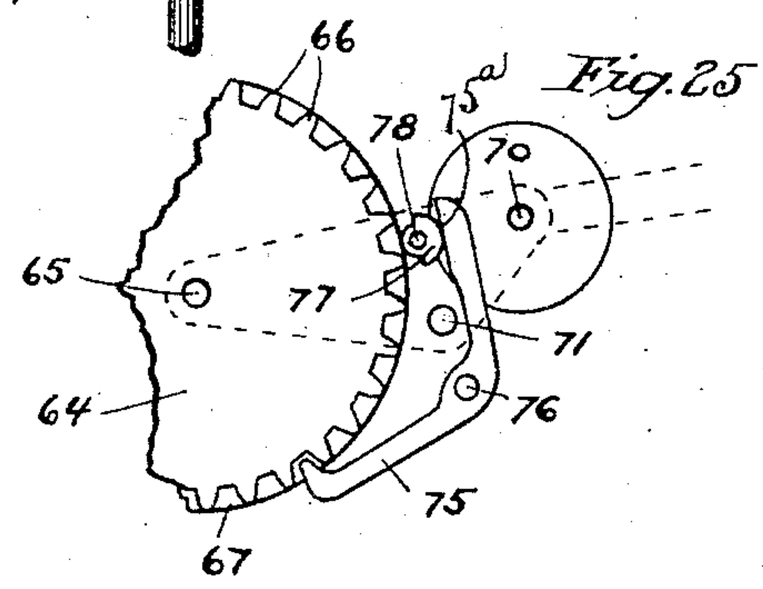


Fig. 25

Witnesses:
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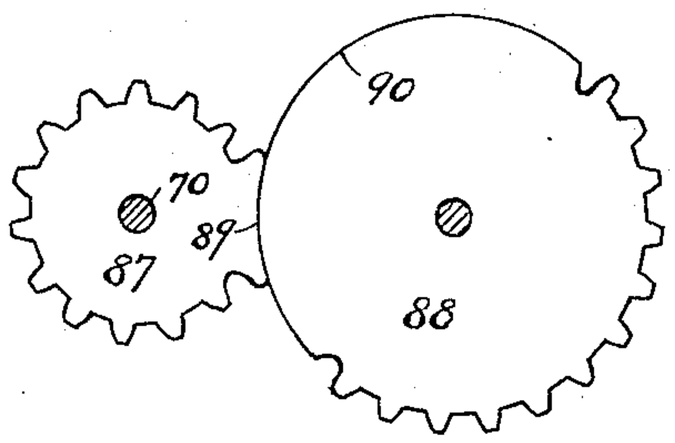
H. E. GOLDBERG.

CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 8.

Fig 26.



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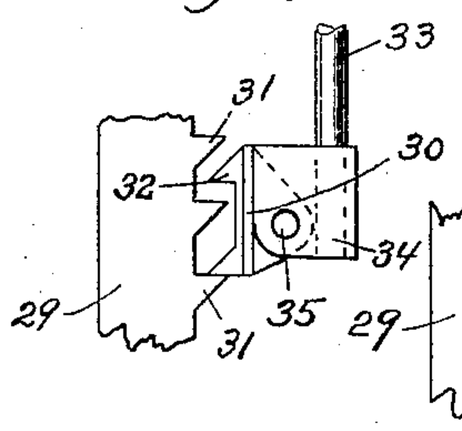
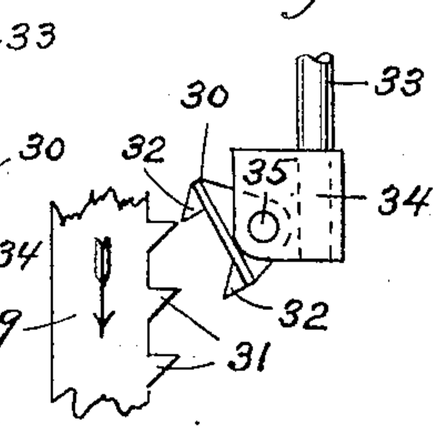


Fig 28



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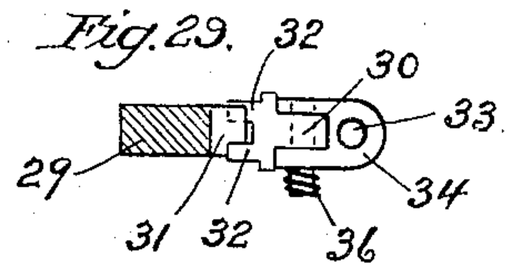

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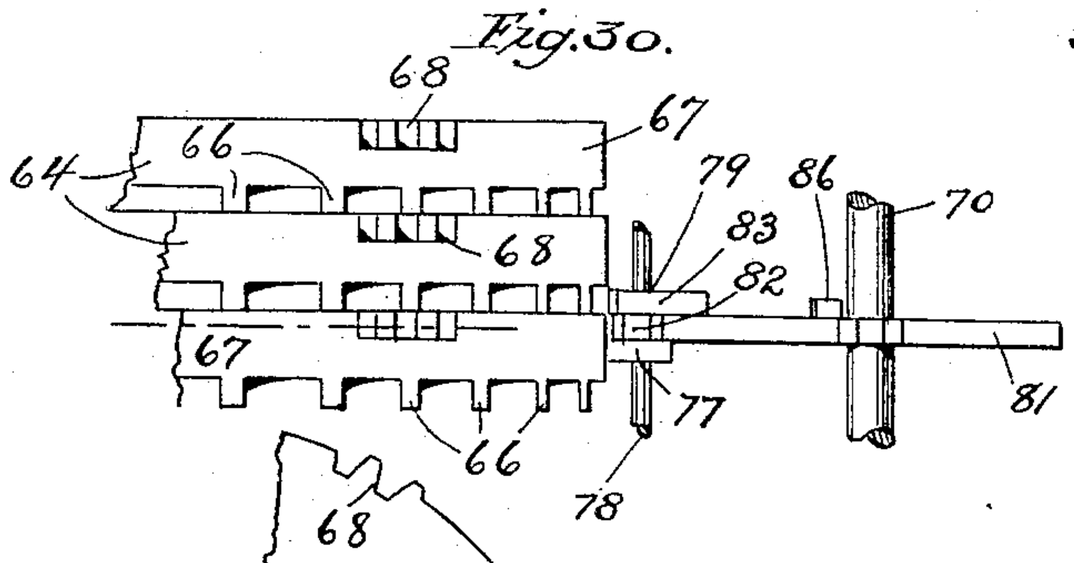

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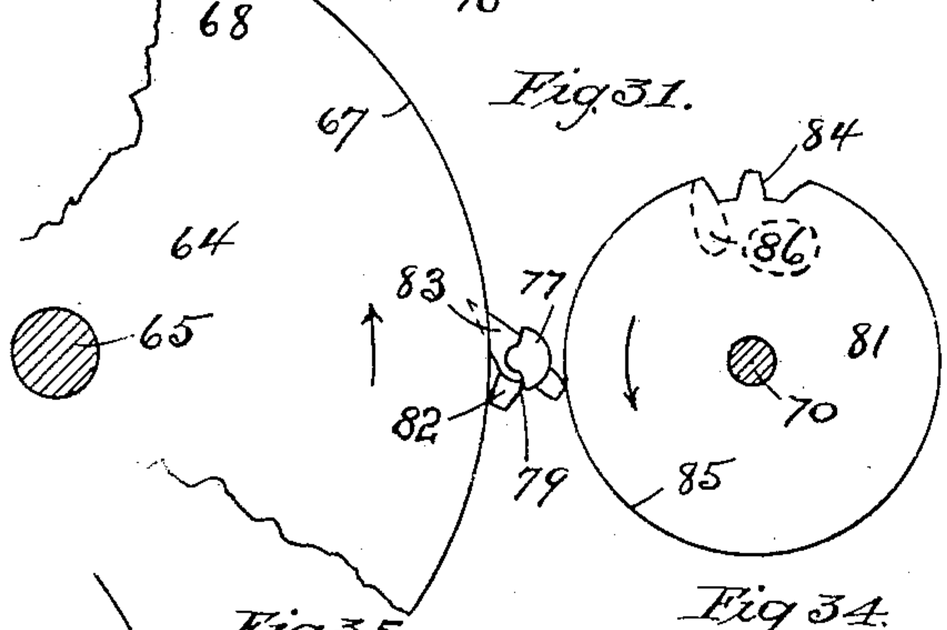


Fig. 32.

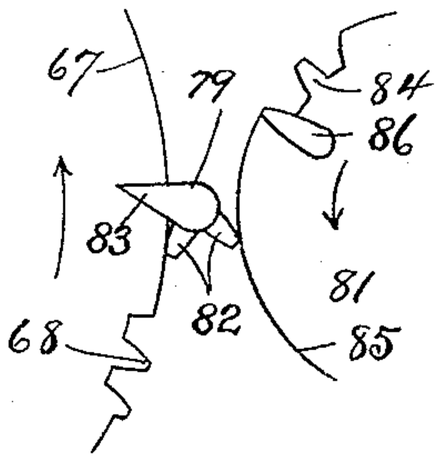
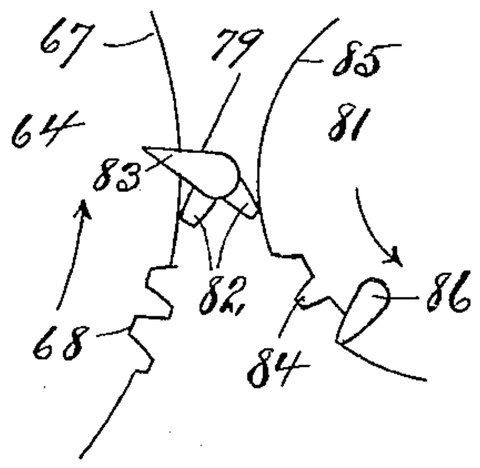


Fig. 33.



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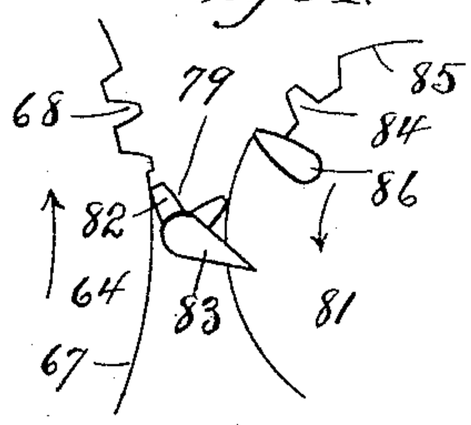

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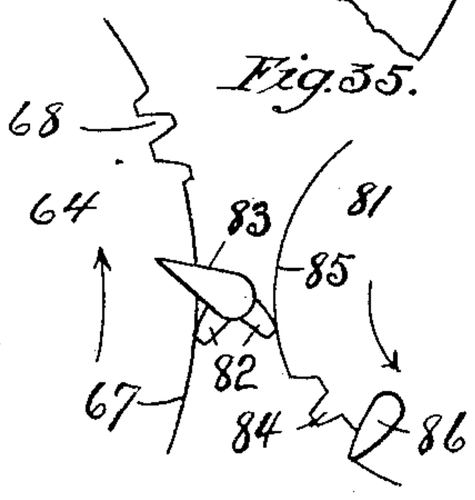

Witnesses:
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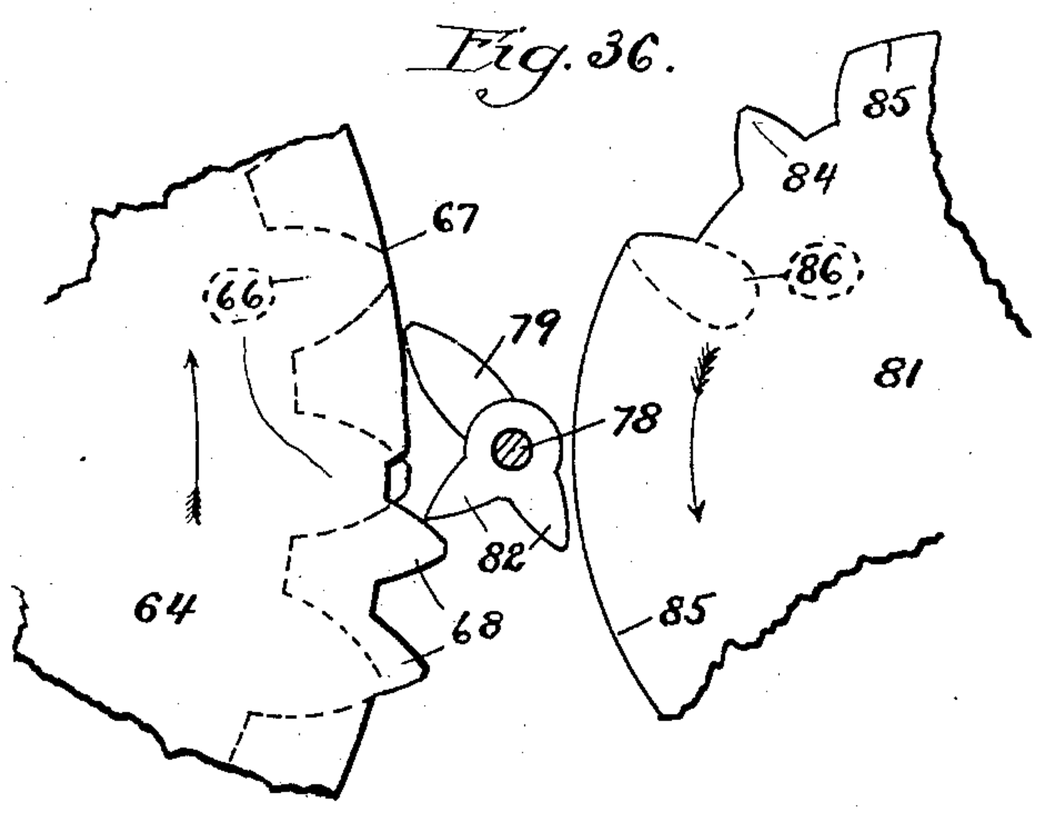
H. E. GOLDBERG.

CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 9.

Fig. 36.



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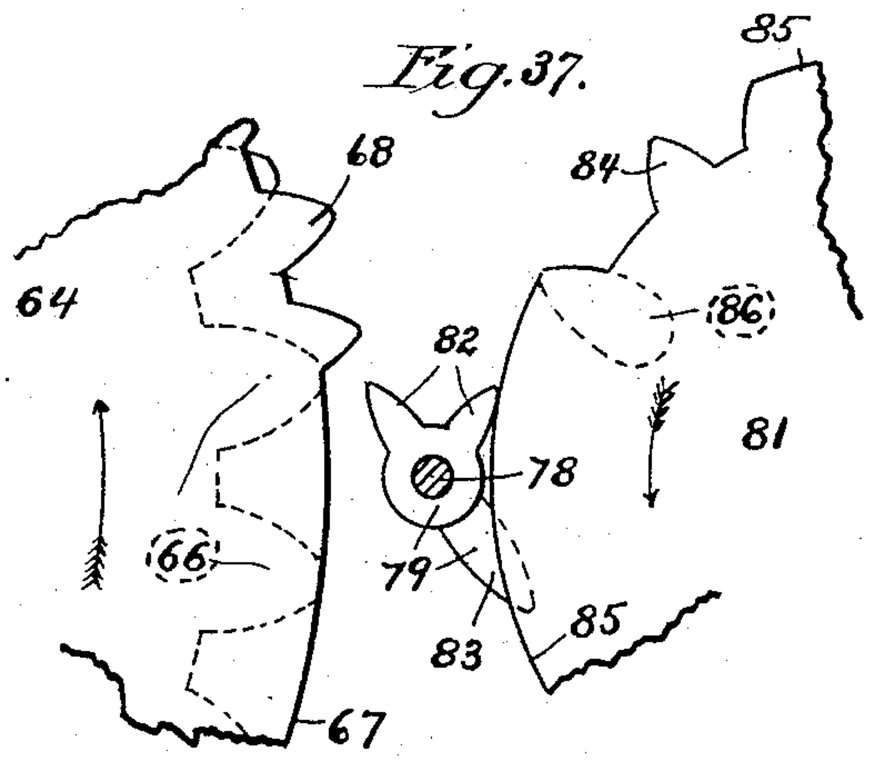
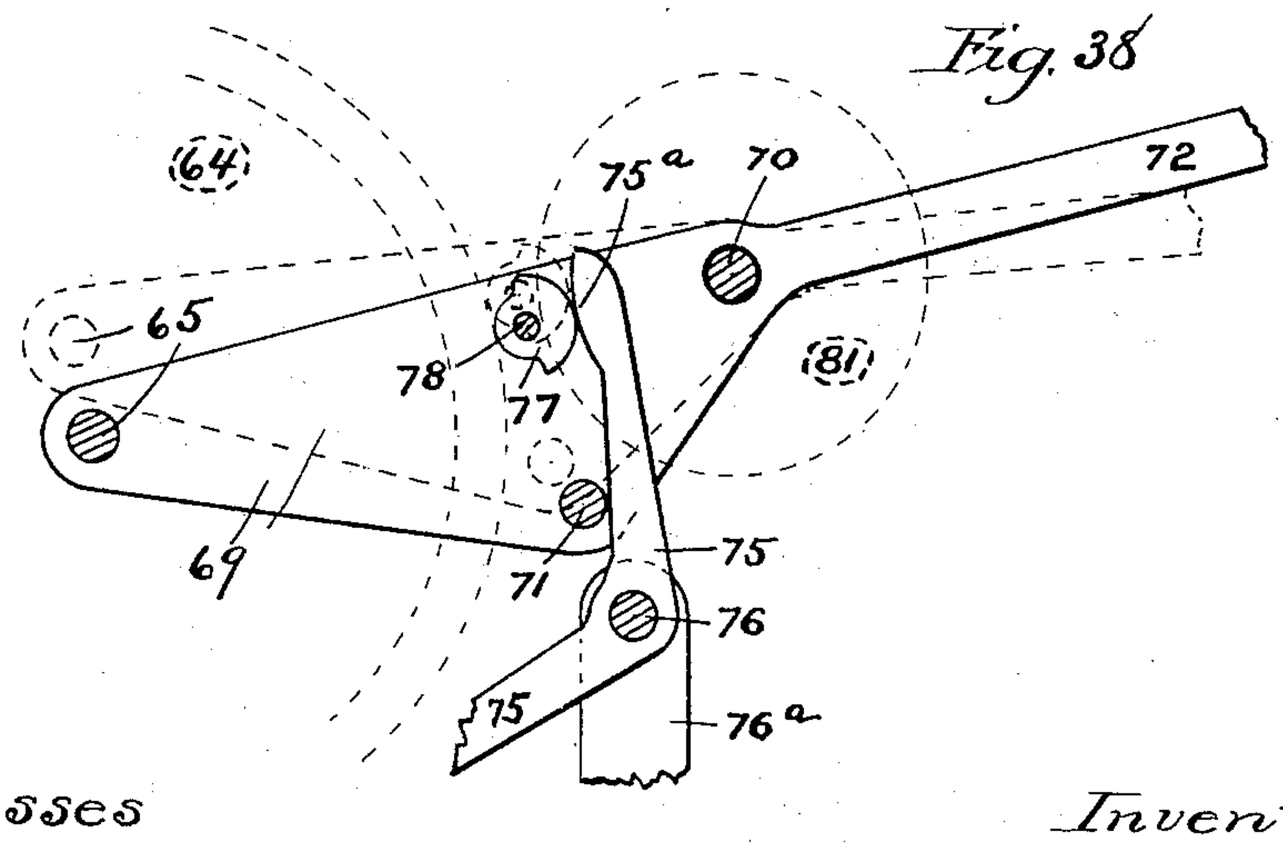


Fig. 38



Witnesses

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CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 10.

Fig. 39.

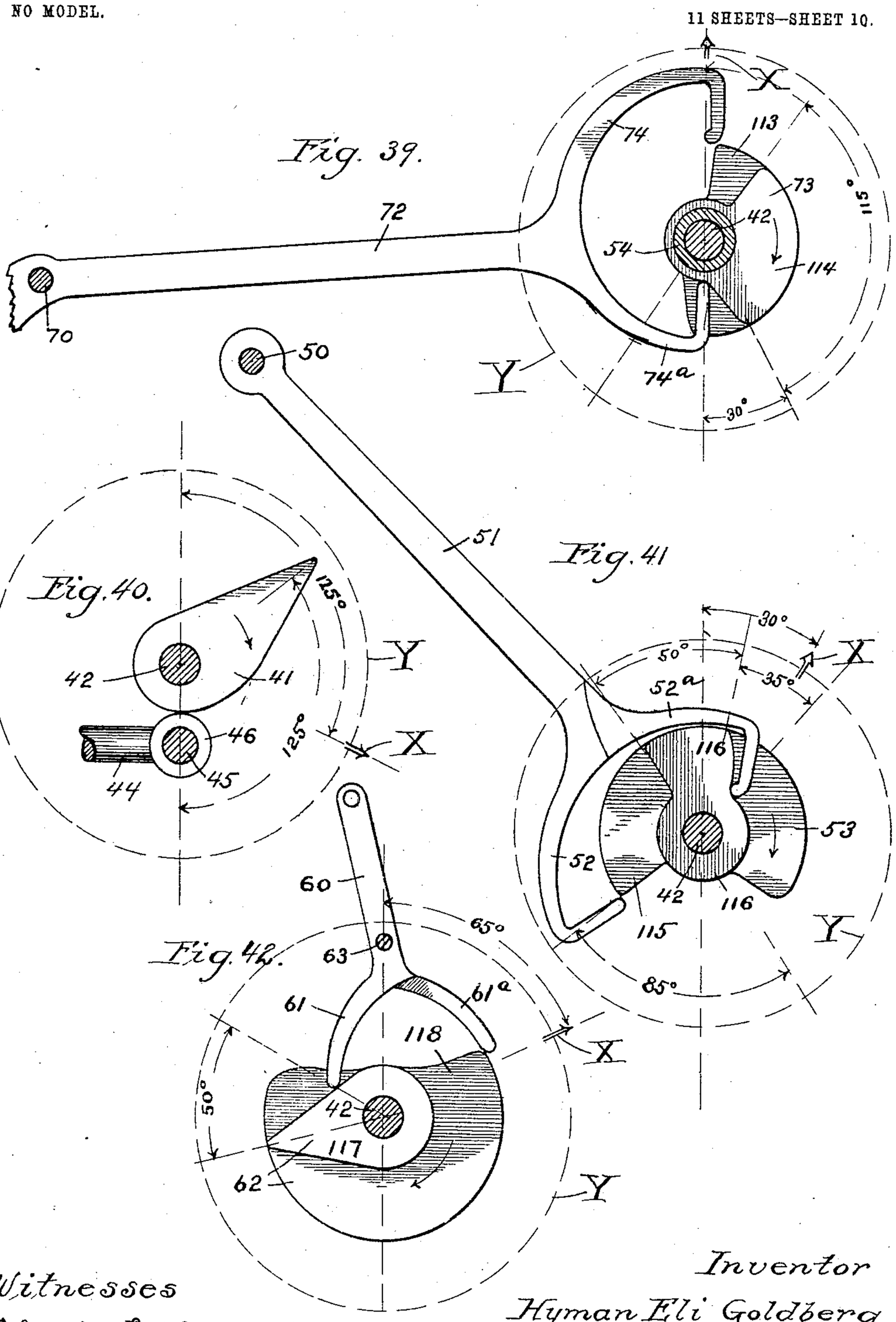

Fig. 40.

Fig. 41

Fig. 42.

Witnesses
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No. 765,774. PATENTED JULY 26, 1904.

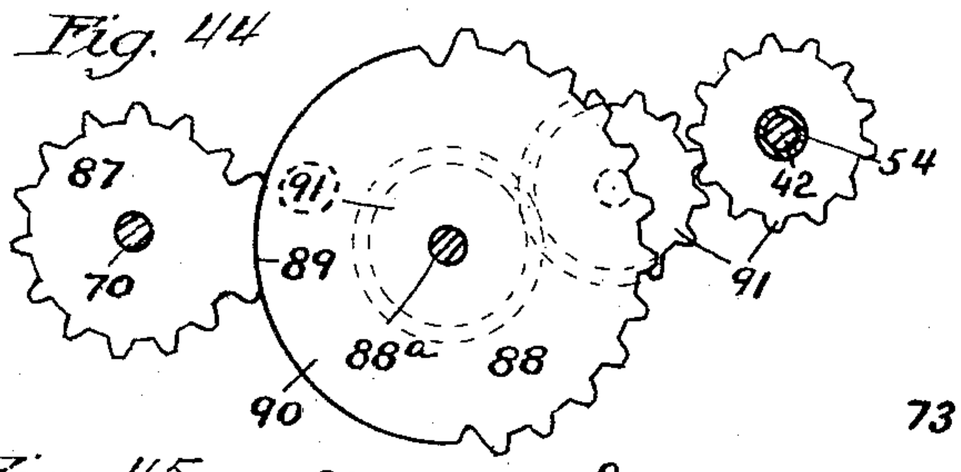
H. E. GOLDBERG.

CALCULATING MACHINE.

APPLICATION FILED OCT. 1, 1900.

NO MODEL. 11 SHEETS—SHEET 11.

Fig. 44



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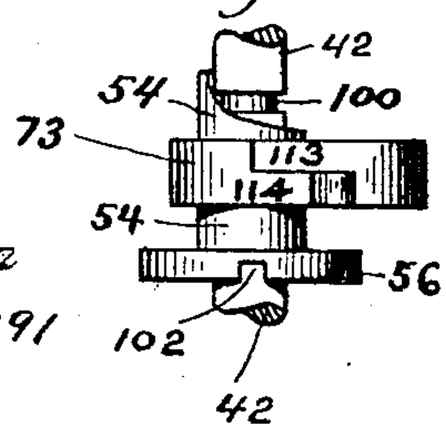

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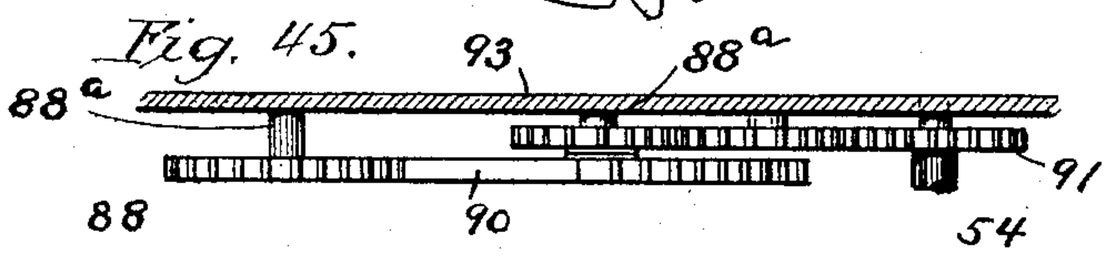


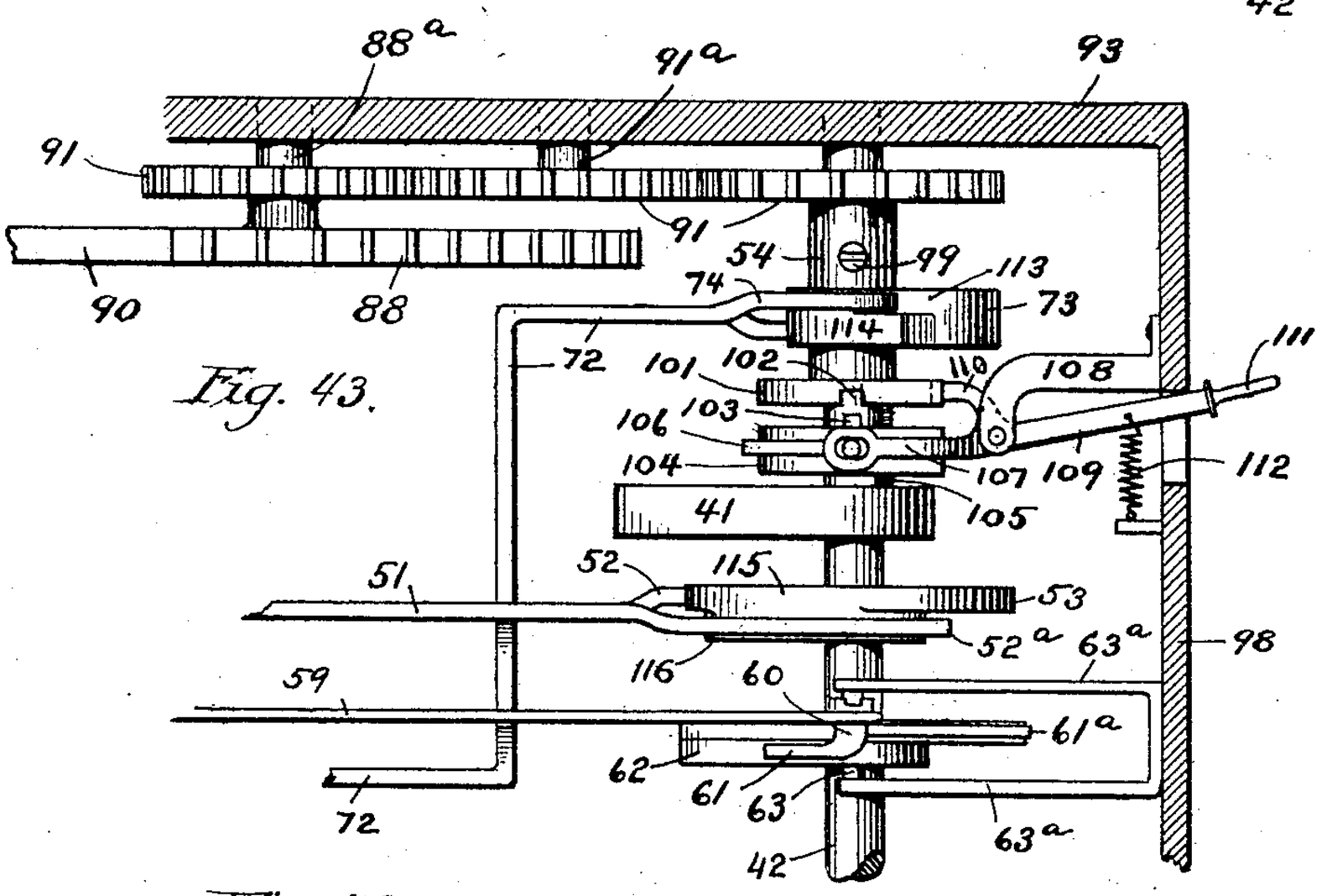
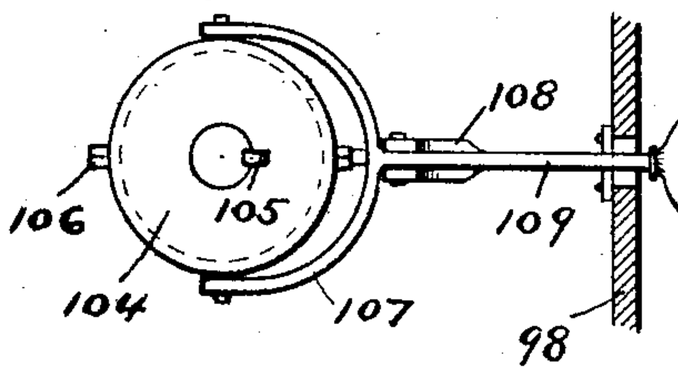


Fig. 43.

Fig. 46.



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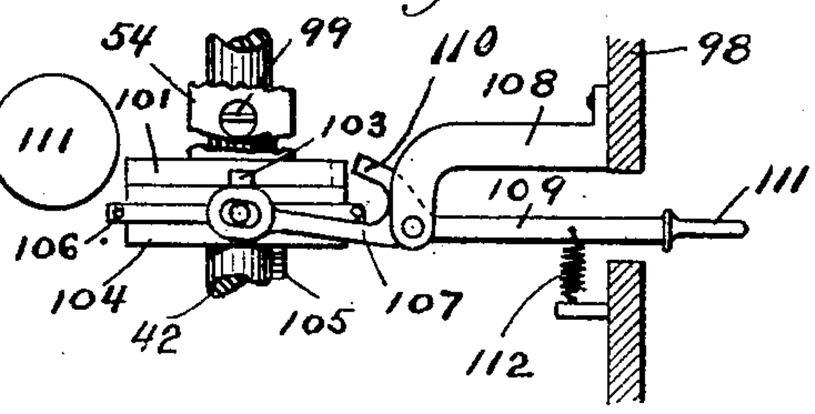

Witnesses

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Eli Brandt

Inventor

Hyman Eli Goldberg

By Jesse & H. M. Cox

Attorneys

No. 765,774. Patented July 26, 1904.

UNITED STATES PATENT OFFICE.

HYMAN ELI GOLDBERG, OF CHICAGO, ILLINOIS.

CALCULATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 765,774, dated July 26, 1904.

Application filed October 1, 1900. Serial No. 31,666. (No model.)

To all whom it may concern:

Be it known that I, HYMAN ELI GOLDBERG, a citizen of the United States, residing in the city of Chicago, county of Cook, State of Illinois, have invented a new and useful Calculating-Machine, of which the following is a specification.

My invention relates to calculating-machines in which arithmetical operations are accomplished mechanically; and the objects in general of my invention are, first, to provide a machine operated by but ten figure-keys and of such construction that when a number is to be set the keys are struck in the order in which a number is commonly read—that is, highest figure first, units last—said machine automatically adjusting itself to the number of figures in the number to be set; second, to eliminate both gravity and inertia as factors in the operation of the machine; third, to eliminate as far as possible the use of springs in the machine and to employ in their stead positive-acting locking and interlocking devices; fourth, to provide a machine which in adding shall show or indicate the number set before the same is actually added, which in case a number is by mistake incorrectly set may afford opportunity for erasing the incorrect number without affecting the total previously obtained, which shall at all times show the total, and which shall at all times show a printed list of the numbers added.

The elements of the machine which more particularly embody my invention are, first, the tappets and tappet-actuating hammers; second, the indicators and indicator-carriage, together with the setting-wheel and carriage-escapement; third, the devices for locking and erasing or resetting the indicators; fourth, the registers and their mountings in the rocking frame; fifth, the register-locking mechanism; sixth, the tens storing and carrying mechanism and the actuating devices thereof.

Claims to the registering mechanism are contained in a separate application for Letters Patent filed by me in the United States Patent Office on the 25th day of October, 1902, Serial No. 128,716.

I accomplish my objects by the mechanism illustrated in the accompanying drawings, in which—

Figures 1 and 2 are side and plan views, respectively, showing the chief parts of the machine in their proper relative positions. Fig. 1 is in section taken on the line 1 1, Fig. 2. Figs. 3 and 4 are side views of the tappets and tappet-actuating hammers, illustrating the operation of the same. Figs. 5 and 6 are side and plan views, respectively, of the setting-wheel mounted upon the tappet-axle, the tappets, the hammers, the keys, and the carriage-shifting yoke and lever-arm. Figs. 7 and 8 are side and plan views, respectively, of the indicators and erasing or resetting mechanism, Fig. 7 being in section taken on the line 7 7, Fig. 8. Figs. 9 and 10 are side and plan views, respectively, of the indicator carriage and escapement, Fig. 9 being in section taken on the line 9 9, Fig. 10. Fig. 11 is a side view of a portion of a tappet-actuating hammer. Fig. 12 is a view in perspective of a tappet. Figs. 13 and 14 are views of a tappet, showing, respectively, the side and the edge thereof. Figs. 15, 16, and 17 show the component parts of the tens-storing wheel, Fig. 15 showing the teeth for engagement alternately with the register and with the tens-carrying disk. Fig. 16 shows the elongated tooth for engagement alternately with the tens-carrying disk and the next higher register, and Fig. 17 shows the cam for operating the register-locking lever. Fig. 18 is a side view of the complete tens-storing wheel, the components parts whereof are shown in Figs. 15, 16, and 17. Figs. 19 and 20 are side and plan views, respectively, of the carriage-resetting mechanism and adjuncts thereof, Fig. 20 being partly in section on the line 20 20, Fig. 19. Said figures also show a portion of the indicators, the indicator-locking bar, and the actuating device of the latter. Fig. 21 is a detail view of one of the carriage-resetting arms, the view being taken in the direction of the arrow, Fig. 19. Fig. 22 is a side view of the registers and of the rocking frame wherein said registers are mounted. Fig. 23 is a plan view showing the registers and a portion of the rocking frame. Fig. 24 is a plan view

showing a portion of the arm whereby the rocking frame is actuated, said figure also indicating the mechanism for operating said arm. Fig. 25 is a side view in detail showing the register-locking lever and adjacent parts. Fig. 26 is a side view of certain of the gears connecting the tens-carrying axle with the operating-axle. Figs. 27, 28, and 29 are detail views showing the construction of the ratchet-escapement on the indicator-carriage. Fig. 30 is a detail view in plan, and Fig. 31 is a detail view from the side, showing the relative positions of the registers, tens-storing wheels, and tens-carrying disks. Figs. 32, 33, 34, and 35 are diagrammatic views showing the operation of the tens storing and carrying mechanism. Figs. 36 and 37 are diagrammatic views, drawn to an increased scale, indicating suitable relative proportions of the tens-storing wheel and related parts. Fig. 38 is a detail view of a portion of the rocking frame, showing the operation of the locking-levers. Fig. 39 is a detail view of the cam and arm whereby the rocking frame is operated. Fig. 40 is a detail view of the cam whereby the carriage-resetting mechanism is operated. Fig. 41 is a detail view of the cam for operating the indicator-locking bar. Fig. 42 is a detail view of the cam and lever whereby the erasing-bar is operated. Fig. 43 is a plan view in detail showing a portion of the operating-axle, operating-cams, and related parts. Figs. 44 and 45 are side and plan views, respectively, of the gears connecting the tens-carrying axle with the operating-axle. Figs. 46 and 47 are side and plan views, respectively, showing the operating-axle, clutch, and mechanism for setting and releasing the same. Fig. 48 is a detail view in plan, showing the means for preventing the sliding of the operating-sleeve longitudinally upon the operating-axle.

Similar letters refer to similar parts throughout the several views.

For convenience of description the parts of the machine will be grouped under the following heads: "The number-setting part," "The indicators," including the indicator carriage and escapement, "The erasing or resetting mechanism," "The registers," including the register-supporting frame and adjuncts, and "The tens-carrying mechanism."

The number-setting part.—The keys are ten in number and are supported upon the key-fulcrum 2 in such a manner as to rotate freely thereon. Said keys are provided with the usual finger-pieces 3, which bear upon their exposed faces the character from "0" to "9," indicating the value of the key. The keys 1 are also provided with the segmental portion or hammers 4, the curved faces whereof are concentric with the key-fulcrum 2. The faces of the hammers 4 are of special construction and will be described in connection with the tappets 5.

The tappet-axle 6 is revoluble, but has a fixed position in the machine, being located a slight distance beyond the path of the faces of the hammers 4. The tappets 5, above mentioned, are rigidly secured to said axle 6 and are so constructed that when in position upon said axle the concave segmental faces of said tappets may lie in the path of and make contact with the curved faces of said hammers 4. Said tappets extend in both directions from said axle 6, the purpose thereof being hereinafter pointed out. The object of the said hammers and tappets is to impart a definite amount of rotation to the tappet-axle 6, and the final position of any tappet when engaged with its hammer is the position in which the curved faces of said hammer and tappet are in contact and concentric with the key-fulcrum 2. The operation of said hammers and tappets is illustrated in Figs. 3 and 4. Referring to Fig. 3, it will be seen that when the forward portion 7 of the hammer 4 approaches the tappet 6 said forward portion will strike the portion 8 of said tappet which lies within the circle described by the face of said hammer. The continued travel of said hammer causes the tappet to rotate until the rear portion 9 of said tappet comes into contact with the rear portion 10 of said hammer, as shown in Fig. 4, the motion of said tappet being thereby arrested. By this means the danger of too great rotation of the tappet is eliminated and the tappet is positively locked in its proper position.

In order that the forward portion 7 of the hammer may not interfere with the rear portion 9 of the tappet upon occasions when said tappet is rotated by the axle consequent upon the operation of any of the other keys, said portions 7 and 9 are offset or cut away in the manner shown in Figs. 11 to 14, inclusive. Said tappets and hammers are so constructed that the forward portion 7 of the hammer does not come opposite to the rear portion 9 of the tappet, thereby allowing said portions 7 and 9 to pass by each other and permitting said tappet to freely rotate, even though the portion 7 of said hammer is as near to the axle 6 as is the portion 9 of said tappet. The portions 7 and 10 of said hammer, however, come opposite to the portions 8 and 9, respectively, of said tappet, so that when the hammer is in approximate juxtaposition to said tappet the rotation of the latter in either direction will be prevented.

The setting-wheel 11 is rigidly secured to the axle 6, so that the rotation of the tappets is transmitted to said setting-wheel, and said setting-wheel is provided with teeth for engaging and causing the rotation of the correspondingly-toothed indicators 12 12. The tappets 4 are set at different angles upon the axle 6, corresponding to the value of the key by which any given tappet is operated. For example, the tappet operated by key No. 9 ro-

tates the indicator through an angle nine times as great as does key No. 1. The zero-tappet is so set as to impart no rotation to the indicator, but locks the axle 6, while causing the shifting of the indicator-carriage, as hereinafter described.

The key-hammers 5 cause the axle 6 to rotate in only one direction, and the returning of said axle to its initial position is accomplished by the returning-lever 13 operating upon the returning-tappet 14. Said tappet 14 is similar in construction and operation to the tappets 5, except that its effect upon the axle 6 is to rotate the same in a reverse direction. The returning-lever 13 is also similar in construction and operation to the keys 1, except that it is rigidly secured to and operated by the bar 2, which forms the key-fulcrum.

The hammer 15 of the returning-lever approaches its tappet 14 in a direction opposite to the direction of approach of the hammers 4 to their tappets 5. The parts are so constructed and assembled that when the keys 1 approach said tappets 5 the lever 13 recedes from and releases the tappet 14, thereby permitting the rotation of the axle 6.

It is necessary that the axle 6 and setting-wheel 11 return to their initial position after each character is set up—that is, after the operation of each and every one of the keys 1. This returning of the axle 6 is accomplished by means of a yoke, which consists of the yoke-bar 16, carried at the extremities of the yoke-arms 17 17. Said arms are rigidly secured to the fulcrum-bar 2, and the yoke-bar 16 extends transversely to the keys 1 in proximity thereto in such a manner that the motion of any one of said keys in a direction to operate the tappets 5 will move said bar 16 and cause the rotation of said fulcrum-bar 2. As the yoke-bar 16 and figure-keys 1 are pivoted upon the same axis, there will be no sliding action of said bar upon said keys, friction between the parts being thereby substantially eliminated.

A spring 18 is attached to each one of the keys 1, so that said keys tend to assume and remain in their initial position. A spring 19 is also attached to one or both of the yoke-arms 17, so as to cause the yoke to return to its initial position, thereby causing the returning-lever 13 to actuate the returning-tappet 14 and bring the setting-wheel 11 back to the initial position thereof. Said springs 18 and 19 are also attached to the bars 18^a and 19^a, respectively, which latter are fixed at their extremities in the frame or casing of the machine.

The indicators and related parts.—The fixed shaft 20 extends in a direction parallel to the axle 6 and fulcrum-bar 2 and forms a support for the indicators 12. Said indicators are loosely mounted, so as to be revoluble independently of each other upon the sleeve 21 of the indicator-carriage, as best shown in Figs. 7, 8, 9, 10, 19, and 20. The indicators consist of disks or wheels having a portion of their peripheries toothed, so as to engage with the teeth of the setting-wheel 11. In the preferred form of indicator the periphery is divided into portions, one of which is the toothed portion extending through a slight amount more than one-half the circumference of the disk. This toothed portion is cut away, so that the face or width of the teeth is slightly less than half the width of the indicator, while the face or width of the teeth of the setting-wheel 11 is approximately equal to the width of the indicator-teeth. By this construction when the indicators are translated—that is, shifted laterally—the setting-wheel 11 may become unmeshed from an indicator and occupy a position between two adjacent indicators without interference with the same. The remainder of the periphery of the disk is equally divided into two portions, upon one of which is marked the figures "0" to "9" for indicating to the operator the figure set up. The last portion of the disk is provided with type forming the figures "0" to "9," which are adapted to print upon paper in any suitable manner. A form of printing device is indicated in Fig. 1 of the drawings, wherein 22 represents a roll of paper which is led over the type above mentioned and pressed upon the proper type-figure at the proper time by means of a pressing device 23.

The indicators 12 are subject to two motions—one of rotation, due to the setting-wheel 11, and the other of translation, due to the lateral shifting of the carriage. It is the translation of the carriage consequent upon the action of the escapement that brings the indicators successively into engagement with the setting-wheel 11 and gives the place value to the figures set up.

The indicator-carriage consists of the sleeve 21, shiftable longitudinally upon the shaft 20, above mentioned, and has the side arms 24 24, which extend in the same direction from said sleeve and are located at such a distance apart as to hold the indicators 12 in close proximity to each other without preventing the free and independent rotation of said indicators. In order to prevent the rotation of the indicator-carriage about the shaft 20, the outer extremities of said side arms 24 are constructed to slide upon the fixed guide-bar 25. It is important that the rotation of the indicators 12 be confined within definite limits, and as a suitable means of limiting such a rotation the said indicators are provided with an aperture 26, as best shown in Figs. 1 and 7. The fixed guide-bar 25 extends through said apertures 26 and serves as a stop for said indicators when the portions 27 and 28 at the upper and lower extremities, respectively, of said aper-

tures are rotated into contact with said bar. The translation of the carriage is effected by means of the spiral compression-spring 24ª, which encircles the guide-bar 25 and abuts at one extremity against the side framework or casing of the machine and at the other against the adjacent one of the side arms 24 of the indicator-carriage, thus tending to move said carriage toward the left—that is, in the direction of the arrows, Figs. 10 and 20. The movement of the carriage toward the left is permitted at the proper times by the operation of the carriage-escapement, which consists of the ratchet 29, held by the pawl or pallet 30. Said ratchet 29 is rigidly secured to the indicator-carriage and is provided with teeth 31, as shown in detail in Figs. 27, 28, and 29. The working faces of said teeth are set toward the left, or in the direction of the travel of the carriage, while said pawl 30 is provided with two teeth 32, whose working faces are opposed to the faces of said ratchet-teeth 31. Said pawl-teeth are located in different planes one above the other and at such a distance apart in a horizontal direction that when said pawl is rotated in one direction about the shaft 33 one of said pawl-teeth is released from the contiguous ratchet-tooth 31, permitting the ratchet to escape the detaining-tooth of the pawl. The rotation of the pawl, however, causes the second one of the pawl-teeth 32 to engage one of the ratchet-teeth 31 after the ratchet 29 has moved a half-step toward the left—that is to say, a distance equal to half the distance between the ratchet-teeth 31.

In order to permit the return of the carriage for resetting, the pawl 30 is pivotally mounted in the pawl-box 34 in such a manner as to be withdrawn from the path of the rack-teeth when the ratchet 29 is retracted, as shown in Fig. 28. Said pawl is pivoted upon the pin 35 in said pawl-box and tends to return to its normal position by reason of the spring 36, attached to said pin. The pawl-box 34 is supported by and rigidly secured to the rock-shaft 33 above mentioned. The mechanism for rotating said rock-shaft 33 is best shown in Figs. 5, 9, and 10 of the drawing, wherein 37 represents a rocking arm, one extremity whereof is rigidly secured to said rock-shaft. The other extremity of said arm carries a projecting pin 38, adapted to be engaged by the hooks 39 39, formed at the free extremity of the escapement-lever 40.

The lower extremity of the lever 40 is rigidly secured to the fulcrum-bar 2, thereby receiving a rocking or vibratory motion when any of the keys 1 is struck and the said bar 2 rotated. It is evident that a complete stroke of the arm 37 in one direction permits the escapement of the indicator-carriage one half-step toward the left, while a complete stroke of said arm in the return direction permits the escapement of the carriage a second half-step toward the left. The hooks or prongs 39 are so constructed and the lever 40 is so set upon the bar 2 that said hooks engage the pin 38 only toward the end of the stroke of the said lever 40. The purpose of such construction is that the first half-step of the escapement or translation of the carriage may take place after the rotation of the indicator has been accomplished by the setting-wheel 11 and that the second half-step may take place after the said setting-wheel has returned to its initial position. The length of a full step, or the distance between the teeth 31 of the ratchet 29, is equal to the width of the indicators 12, and the parts are so related that the order of occurrence of the several operations is as follows: First, the setting-wheel 11 is in engagement with one of the indicators 12 and rotates said indicator the proper distance from the initial position, at the same time positively locking it; second, by the operation of the escapement the carriage and indicator are translated one half-step to the left, which motion releases the indicator from the setting-wheel; third, the setting-wheel is rotated backward to its initial position and positively locked; fourth, the indicator-carriage is translated a second half-step toward the left, thereby bringing the next one of the indicators 12 into engagement with the setting-wheel 11.

When the indicator-carriage has completed its travel toward the left, it is returned to its initial position by the carriage-shifting mechanism, consisting of a series of levers actuated by a cam 41, rigidly set upon the operating-axle 42, as shown in Figs. 19, 20, and 21. The shifting lever 43 is rigidly secured at one extremity to the shaft 44 and at its free extremity is adapted to work against a convenient portion of the escapement-ratchet 29. Said shaft, which is pivotally supported in the bearings 44ª, extends to a point near the axle 42 and is provided with an arm 45, extending substantially at right angles to said shaft. At its free extremity said arm carries a friction-roller 46 for working upon said cam 41. The parts are so assembled that when the cam 41 operates upon the roller 46 the arm 45 causes the shaft 44 to rotate in such a direction that the arm 43 forces the carriage to its original position.

It is evident that not every indicator is used for every number set, a number having three figures using but three indicators, and so on, and the total number of indicators determining the greatest number of figures that may be set at one time—that is to say, in any one horizontal line. For convenience of description those of the indicators 12 which have been operated upon by setting-wheel 11 in the setting of any number will be referred to as "active" indicators, while the remaining ones thereof will be referred to as "reserve" indicators.

In order that all of the indicators shall be

in the zero position when coming into engagement with the setting-wheel 11 at the zero position, the reserve indicators are prevented from rotating by a fixed locking-bar 47. (Shown in Figs. 1, 7, 8, and 20.) Said bar 47 does not extend completely to a point opposite the setting-wheel, for the reason that the indicator which at any time is in engagement with said setting-wheel is suitably controlled by the latter.

A movable locking-bar 48 is provided for maintaining the active indicators in the position to which they have been brought by the setting-wheel. Said bar 48 is of such extent as to receive and lock the active indicators immediately upon the translation of said indicators from the setting-wheel. Said bar 48 is hung by means of arms 49 49, rigidly attached to the shaft 50 in such a manner that the rocking of said shaft moves said bar into and out of engagement with the teeth of the indicators 12. Said shaft 50 is supported at its extremities in the side frames of the machine, as shown in Fig. 2. The indicators are released only when the indicators are to be reset to the zero position, as will hereinafter more fully appear.

The rocking of the shaft 50 is accomplished by means of the arm 51, which is rigidly set upon said shaft 50 at one extremity and at the other bifurcates, so as to form the prongs 52 and 52ª. (Shown in detail in Fig. 41.) Said prongs inclose the cam 53, set upon the operating-axle 42. The rotation of said cam, the construction whereof is explained below, imparts a reciprocating motion to the pronged extremity of said arm 51, which is transformed into the swinging motion of the locking-bar 48.

The operating-axle 42 above mentioned is encircled by and may rotate the operating-sleeve 54. (Best shown in Figs. 43, 47, and 48.) Said axle 42 extends, preferably, across the machine and is rotated by means of the handle 55 or in any other suitable manner. As will hereinafter appear, when a number has been incorrectly set upon the indicators the indicators and indicator-carriage may be replaced in their initial position without affecting the previously-obtained total by operating the axle 42 without operating the said sleeve 54. The independent or the simultaneous rotation of said parts 42 and 54 is governed by the clutch 56, which is so constructed that when said clutch is set the parts 42 and 54 rotate together, but when the clutch is released the axle 42 rotates without affecting said sleeve 54. The precise construction of said clutch will be referred to in connection with the cams and other cycle-completing parts operated by said handle 55.

The erasing or resetting mechanism.—After the indicators 12 have been rotated to various positions consequent upon the setting up of the number to be added said indicators may all be returned to their initial or zero position preparatory to setting up another number by means of the erasing or resetting mechanism, which comprises a bar 57, supported at its extremities and suspended from the shaft 20 by means of the arms 58 58. Said arms are rigidly secured to said shaft at such a distance apart as to permit the travel of the indicator-carriage, and preferably in such positions as to form stops to confine said travel within the proper limits.

The bar 57 extends through the apertures 26 in the indicators 12 and is adapted to come into contact with the portions 27 and 28 at the extremities of said apertures. During the setting up of a number the erasing-bar 57 occupies a position adjacent to the carriage guide-bar 25, so as not to interfere with the rotation of the indicators; but when a number is to be erased the rotation of the shaft 20 in the proper direction raises the erasing-bar 57, thereby bringing said bar into contact with the upper portions 27 of said indicators. This rotates said indicators toward the zero position until further motion is prevented by the portions 28 of the indicators coming into contact with the guide-bar 25, at which time the indicators regain the zero position.

The rotation of the shaft 20 for resetting the indicators is accomplished by actuating devices. (Best shown in Figs. 7 and 8.) The link 59 is pivotally connected at one extremity to one of the arms 58 at a point removed a suitable distance from the center of the shaft 20. The other extremity of said link 59 is pivotally connected to the upper extremity of the lever 60, said lever having the prongs 61 and 61ª at its lower extremity operated by the cam 62. Said lever 60 is supported between its extremities by means of the fulcrum 63, which latter is mounted in the bracket 63ª, secured to the rear wall of the casing of the machine. The cam 62 is rigidly set upon the operating-axle 42, and the parts are so related that the rotation of the cam 62 causes the proper movement of the erasing-bar 57, as above mentioned and more fully described hereinafter.

The registers and related parts.—The registers 64 consist of disks of similar configuration and size mounted side by side upon the shaft 65, so as to rotate thereon independently of each other. The width of the said registers is equal to the width of the indicators 12. The teeth 66 of the registers are for the purpose of engaging the teeth of the indicators 12 and occupy a portion only of the width of said registers, the remaining cylindrical portion 67 having marked thereon the figures "0" to "9" in one or more series for registering the totals in the manner usual in such machines. Said teeth 66 are some multiple of ten in number and occupy a position

upon the right of the register when looking from the front of the machine—that is, in the direction of the arrow, Fig. 2.

The points of the teeth 66 preferably do not project beyond the cylindrical portion 67 of the registers, but are substantially flush with the same. As shown in detail in Figs. 30 and 31, the tens-carrying teeth 68 are formed at one or more points in the cylindrical portion 67 of the registers for the purpose hereinafter described. The point at which said teeth are located corresponds to a zero-point on the register, there being as many sets of teeth 68 as there are series of figures upon the register. Said teeth 68 are formed at the left portion of the register and preferably project slightly beyond the cylindrical face thereof.

The rocking frame, which constitutes the mountings for the registers, is best shown in Figs. 1, 22, 23, and 38. Said frame consists of the side bars 69 69, which support the register-shaft 65 and are pivoted on the rocking-frame fulcrum 70. Said fulcrum 70 consists of a shaft having a fixed position in the machine, but revoluble upon its own axis. In order to stiffen the frame, said bars 69 are also connected by the cross-rod 71. One of said bars 69 has an extending arm 72, forming a lever for rocking said frame upon the fulcrum 70. Said lever is operated by a cam 73, which works within the prongs 74 and 74[a], formed upon said lever. Said cam is rigidly set upon and rotated by the operating-sleeve 54, as described in connection with the cycle-completing mechanism hereinafter.

The parts are so related that when the rear pronged extremity of the lever 72 is depressed by said cam the bars 69 are rocked about the fulcrum 70, thereby bringing the registers 64 into mesh with the indicators 12. Said registers are brought into mesh with said indicators only when a number is to be transferred from the indicators to the registers. Except during the carrying of the tens each of the registers when out of mesh with the indicators is locked in position by a locking-lever 75, pivoted upon the fulcrum 76. Said fulcrum 76 is supported at one extremity by the standard 76[a], rising from the bottom of the machine, near the central portion thereof, and said fulcrum is fixed at its other extremity in the adjacent side wall of the machine, as shown in Fig. 23. Each of the levers 75 is operated by a cam 77, which is loosely mounted upon the shaft 78 and forms a component part of the tens-storing wheel 79 hereinafter described. Said shaft 78 is fixed at its extremities in the side bars 69 of the rocking frame. Said locking-levers are provided with working surfaces 75[a], upon which the cams 77 operate, as shown in Fig. 38. Said surfaces 75[a] are so formed that when the registers are out of mesh with the indicators and the cams 77 are in their normal position (which they occupy at all times except during the carrying of the tens) said surfaces 75[a] are concentric with the fulcrum 70. Now as the shaft 76 is stationary and as the rocking motion of the rocking frame causes the cams 77 to move in a path concentric with the shaft 70 and, moreover, as the surfaces 75[a] of the locking-levers are also concentric with said shaft 70 it follows that unless the cams 77 are rotated upon their own axis 78 the rocking motion of the rocking frame will have no effect upon said locking-levers 75 to move the same. Therefore said locking-levers remain stationary at all times independently of the position of the rocking frame, and said levers move only when during the carrying of the tens the cams 77 rotate individually upon the shaft 78. By this construction the locking-levers become virtually stationary and the moving of the registers 64 into mesh with the indicators 12 results in the moving of said registers away from and out of mesh with said locking-levers. In other words, when the registers are in mesh with the indicators they are not in mesh with said locking-levers, the purpose in making the locking-levers movable being to provide means for permitting the carrying of the tens.

When the registers are moved by the rocking frame toward the indicators, one or more of said registers are engaged by a corresponding number of indicators, depending on the lateral position of said indicators. In order to prevent the rotation of the remaining registers, there is provided a register-retaining bar or rack 80. Said bar or rack has a motion corresponding to the motion of translation of the indicator-carriage, so as to engage only such of the registers as are not engaged by the indicators, said bar or rack preferably forming a component part of said carriage.

The tens-carrying mechanism.—By "tens-carrying mechanism" is signified the correlated devices whereby at the proper time a ten upon any given register is transferred so as to register a unit upon the next higher register. In the present machine the simple transferring of figures from the indicators 12 to the registers 64 occurs simultaneously, and to get a correct total it is necessary that the tens which have been completed on any one register shall be subsequently transferred to the next higher register.

In the carrying of the tens the registers are actuated by the tens-storing wheels 79, (shown in detail in Figs. 15 to 18,) said wheels being in turn actuated by the carrying-disk 81. In the preferred construction the tens-storing wheel 79 consists of three portions or parts 77, 82, and 83, which may be formed separately and subsequently brazed or otherwise secured together or may be constructed of a single piece. For convenience of description the said parts are shown separately, Fig. 17 representing the cam 77, above described, and Figs. 15 and 16 representing the parts 82 and

83, respectively. Said part 82 consists of a toothed wheel mutilated by having a portion of the teeth thereof cut away, the remaining teeth being adjacent and preferably two in number. Said part 83 consists of an arm projecting beyond the point-circle of the wheel 82 and extending in a different direction from the teeth of said wheel.

A suitable construction of the tens-storing wheel as assembled is shown from the side in Fig. 18, said figure showing a mutilated five-toothed wheel having but two teeth remaining and the arm 83 extending on a radius angularly advanced from one of said teeth approximately three-tenths of a circumference. The assembled wheel 79 is shown in top or plan view in Fig. 30, the mutilated gear being interposed between the cam 77 and arm 83. The relation of the parts is such, however, that the lever 75, operated by the cam 77, operates upon the same register as does the arm 83 of the storing-wheel, the periods of operation being such that the lever 75 is released from any given register only while the said arm 83 is rotating such register, as will hereinafter appear. The storing-wheel is so located with respect to the registers 64 that the teeth of the mutilated gear 82 may mesh with the teeth 68 of said register and may also make contact with the surface 67 thereof. The arm 83 is so located as to engage the teeth 66 on the next higher register.

The tens-storing wheels are loosely mounted upon the shaft 78, so as to rotate independently thereon, and the distance between the curved surface 67 of the register 64 and the axis of the tens-storing wheels 79 is less than the radius of the point-circle of the gear-wheel 82. By this construction the teeth of the said part 82 abut against said surface 67 and prevent the rotation of said tens-storing wheel. The arm 83 extends in such a direction and is of such length as not to interfere with the registers 64 when the teeth of the part 82 are locked between said registers and the carrying-disks 81, the relation of the parts being indicated in Fig. 36.

The tens-carrying disks 81 above mentioned are rigidly set upon the axle 70 and are provided with teeth 84 for gearing with the toothed part 82 of the tens-storing wheels 79. The teeth 84 do not occupy the full circumference of said disks, and the remaining portion 85 of the circumference is a curved surface of revolution, preferably cylindrical. Said curved surface 85 approaches the axis of the tens-storing wheel 79 to within a distance less than the radius of the point-circle of the part 82 of said wheel, thereby preventing the rotation of said wheel when said curved surface is in conjunction with the teeth thereof, but rotating said wheel when the teeth 84 are in mesh with the teeth upon the part 82.

Located preferably upon the side of the disk 81, but in such a position as to engage the arm 83 of the storing-wheel, is the arm or lug 86, so placed as to occupy a position in front of the teeth 84 with respect to the direction of rotation of said disk 81. The purpose of the arm 86 is to insure the engagement of the teeth 84 with the teeth of the part 82 of the storing-wheel 79.

The registers 64, tens-storing wheels 79, and the disks 81 are so constructed and placed that said wheel 79 is locked by the curved surfaces of the said adjacent members; but if the teeth 68 of the register engage the said storing-wheel the latter is rotated to such a position as to be engaged by the teeth 84 and arm 86 of said disk 81. Moreover, the rotation of said storing-wheel 79 by said disk 81 causes the said arm 86 to rotate the next higher register one figure, thereby carrying the ten.

The carrying-disks 81 are arranged in a series upon the axle 70 and constitute the carrying-drum of the machine. The teeth 84 are so set in the carrying-drum as to constitute a helix or screw, thereby causing the rotation of the tens-storing wheels 79 *seriatim*, so as to carry from unit's place first, highest place last. The gear-wheel 87 is rigidly fixed on the axle 70 and is driven by the gear-wheel 88. (Shown in Fig. 26.) Part of the teeth upon the peripheries of each of said wheels is substituted by a cylindrical portion, the cylindrical portion 89 upon the wheel 87 being concave and locking upon the convex cylindrical portion 90 upon the wheel 88. As a result, the wheel 87 is locked during a portion of the period of rotation of the wheel 88. Said wheel 88 is driven by a train of gear-wheels 91 91. (Shown in Figs. 2, 43, 44, and 45.) One of said gears is concentric with and fixed to said wheel 88, and a second thereof is concentric with and driven by the operating-sleeve 54. The intermediate one of the gear-wheels 91 is loosely mounted upon the stud-shaft 91[a], fixed in the adjacent side wall of the machine. Said wheel 88 is similarly mounted upon the stud-shaft 88[a].

The framework of the machine is constructed in any suitable form and manner. In the framework shown in Figs. 1 and 2 of the drawings 92 forms the bottom and 93 93 the sides of the machine. The front 94 is provided with an aperture 95 for the passage of the sheet upon which has been printed the numbers set. The sight-orifices 96 and 97 are also provided for permitting the figures upon the indicators and registers, respectively, to be read. 98 represents the back or rear wall of the machine.

I will now refer to the cycle-completing mechanism, which comprises the shaft 42 and parts mounted thereon. As before stated, it is necessary sometimes to erase a number from the indicators without transferring it to the registers, and for this purpose the sleeve 54 is provided and so constructed that the parts directly concerned in said transferring may

remain stationary while the other resetting and cycle-completing parts are operated. The parts directly concerned in said transferring or adding are the tens-carrying devices and the rocking frame. Said sleeve 54 therefore carries the driving gear-wheel 91, which actuates the carrying-disks, and said sleeve also carries the cam 73, which actuates the rocking frame. Said sleeve, which is best shown in Figs. 43, 47, and 48, is loose upon the axle 42, but is prevented from lateral motion thereon by means of the screw-pin 99, which is fixed in said sleeve and projects into the slot 100, cut circumferentially in the axle 42, as shown in Fig. 48. Said pin fits loosely in said slot, so as not to prevent the independent rotation of the sleeve 54 and axle 42. Integral with said sleeve at the extremity thereof is the disk 101 of the clutch 56, above mentioned. Said disk is provided with a notch or slot 102 for receiving the corresponding projection 103 upon the second clutch-disk 104. Said disk 104 is loose upon the axle 42, but is prevented from rotating thereon by means of the spline 105. (Shown in Figs. 46 and 47.) The disk 104 is circumferentially grooved to receive the shifting collar 106, which has a slotted link-and-pin connection with the shifting yoke 107. The bracket 108, secured to the rear wall 98, forms a support for the shifting lever 109, which is integral with said yoke and is pivoted so as to effect the horizontal motion thereof.

The yoke 107 has a branch 110, adapted to engage the notched periphery of the disk 101 when the disk 104 is out of engagement therewith. By means of said branch the sleeve 54 is prevented from rotating when the clutch is released. The lever 109 projects through a slot in the rear wall 98 and terminates in a handle 111. A spring 112 is attached to the lever 109 and to the wall 98 in such a manner as to normally keep the clutch in a set position—that is, with the disks 101 and 104 in engagement.

Under normal conditions the first action of the cycle-completing mechanism is to cause the rocking frame to move the registers 64 into mesh with the indicators 12. This is accomplished by lowering the rear extremity of the arm 72 by means of the cam 73. (Shown in detail in Fig. 39.) Said cam for greater accuracy comprises two working parts, each provided with separate working surfaces, the part 113 actuating the prong 74 and the part 114 actuating the prong 74[a].

In Figs. 39 to 42, inclusive, the pointer X, traveling upon the reference-circle Y, indicates the angular progress of the axle 42 from its initial position. The cam 73 is so constructed that the arm 72 commences to lower immediately upon the commencement of the rotation of the shaft 42 and reaches its lowest position at the end of thirty degrees of rotation. The said cam holds said arm in the low position during a period of one hundred and fifteen degrees, as hereinafter pointed out. The next step in the completion of the cycle is the removal of the locking-bar 48 by means of the cam 53. (Shown in Fig. 41.) Said cam is analogous in construction to cam 73 and has the parts 115 and 116 operating upon the prongs 52 and 52[a], respectively. The removal of the said bar is accomplished by raising the arm 51, and said cam is so constructed as to commence such raising at the end of the first thirty degrees of rotation of the shaft 42. By the time said bar is removed said axle has rotated sixty-five degrees. The erasing-bar 57 must next be operated to return the now free indicators to their initial position, and this operation is accomplished by moving the lower extremity of the lever 60 toward the rear. Said motion of the lever 60 is effected by the cam 62 (shown in Fig. 42) and commences after the axle 42 has rotated sixty-five degrees. The construction of the cam 62 is analogous to that of the cams 73 and 52, the parts 117 and 118 operating upon the prongs 61 and 61[a], respectively. Said parts are so proportioned that an additional rotation of the axle 42 through fifty degrees causes the indicators to reach their initial position and subsequently causes the erasing-bar 57 to return. The axle 42 has now rotated one hundred and fifteen degrees, and the cams 73 and 53 operate, respectively, to lower the rocking frame and return the locking-bar 48. These return motions are accomplished in a further rotation of ten degrees. The cam 41 now commences to lower the roller 46 and arm 45, thereby causing the indicator-carriage to be moved toward the right into the initial position, the resetting being accomplished in one hundred and twenty-five degrees or at any period within the complete rotation of the axle 42.

The gears for driving the fulcrum-shaft 70 are so timed as to rotate said shaft subsequently to the first one hundred and twenty-five degrees of rotation of the axle 42.

Operation: When any of the figure-keys 1 is struck, the hammers 4 thereon strike the corresponding tappet 5 and thereby cause the rotation of the axle 6 and setting-wheel 11 through an arc corresponding to the key struck, the construction of the hammer and tappet locking the setting-wheel in position. The striking of the key moves the yoke-bar 16 and shaft 2, and this in turn withdraws the returning-lever 13 from the returning-tappet 14, thereby unlocking said tappet and permitting the axle 6 to be rotated. Toward the end of the first or positive stroke of the figure-key the escapement-arm 40 engages the rocking-arm 37, so as to move the pawl 30 and permit the escapement of the indicator-carriage one-half step. The setting-wheel 11 when being rotated in a forward or positive direction is in such mesh with one of the indicators 12; but the half-step escapement of

the carriage translates the indicators so that said setting-wheel becomes out of mesh therewith and occupies a position between two adjacent indicators. The second or return stroke of the key struck withdraws the hammer 4 from its tappet 5, thereby unlocking the setting-wheel 11. As the yoke-bar 16 is now free to return, the force of the spring 19 causes the yoke to move the returning-lever 13 so as to operate the returning-tappet 14 and bring the setting-wheel back to a zero position and lock the same in such position. The return stroke of the yoke operates the carriage-escapement similarly to the manner described and permits the carriage to be moved a second half-step, thereby bringing the next indicator into mesh with the setting-wheel 11. This completes the cycle dependent upon the motion of the figure-keys 1. The indicators when not engaged by the setting-wheel 11 are locked by the fixed bar 47 and movable bar 48, the latter engaging the active indicators. When a number is to be added or transferred from the indicators 12 to the registers 64, the latter are moved by means of the bars 69 of the rocking frame into mesh with said indicators. Said motion of the registers releases the same from the locking-levers 75, which remain stationary during the transferring of the number. After the indicators and registers are in engagement the further rotation of the operating-axle 42 causes the erasing-bar 57 to reset the indicators to the zero position. This erasing or resetting of the indicators causes the rotation of the registers, and thereby transfers the number thereto from said indicators. The registers are then disengaged from the indicators and returned by the rocking frame to the original position, where they are locked by the levers 75. In the transferring of the number to the registers it is possible that one or more of said registers have been rotated past a zero-point—that is, past a series of figures—a ten being thereby completed, which must be transferred or carried as a unit onto the next higher register. This carrying is accomplished by the rotation of the operating-sleeve 54, which drives the axle 70 of the tens-carrying drum. Such of the registers as have completed a ten have by means of the teeth 68 rotated the tens-storing wheel 79 from the locked position shown in Figs. 32 and 33 to the position shown in Fig. 34, said last-mentioned position being such that the arm 83 of the tens-storing wheel will be engaged by the arm 86 of the disk 81 when the latter is rotated. The rotating of the arm 83 by the arm 86 throws the teeth of the part 82 into mesh with the teeth 84 of said carrying-disk, thereby causing said tens-storing wheel 79 to be still further rotated until the storing-wheel again assumes the original position and becomes locked therein between the register and disk. These last two steps are illustrated in Figs. 34 and 35. The last of the above-described steps in the operation of the storing-wheel causes the arm 83 to rotate the next higher register one figure, which completes the carrying of the ten. Subsequent rotations of the carrying-disk 81 will have no effect upon the storing-wheel 79 until the register 64 has first completed another ten and again started the rotation of said wheel. The rotation of the cam 77 of the storing-wheel causes the lever 75 to momentarily release the higher register while the arm 83 is actuating the same. The resetting of the indicator-carriage takes place at any suitable time between the setting up of two consecutive numbers and results from the rotation of the operating-axle 42.

As it may be desirable to reset a number without transferring it to the registers, the carriage-resetting mechanism, the erasing mechanism, and the locking-bar 48 may be operated without disturbing the tens-carrying mechanism and registers by releasing the clutch 56, so that the operating-axle 42 shall rotate without rotating the operating-sleeve 54. In general, however, the clutch 56 will be set so that both axle and sleeve will rotate together, and a single rotation of the handle 55 will add the number on the indicators to the number previously shown on the registers and at the same time reset all parts in readiness for setting up a new number.

Although I have described my machine in its preferable form, it is evident that details of construction may be greatly varied without departing from my invention. For example, the rotation of the shaft 6 may be transmitted to the indicators 12 by means of a reciprocating member or rack in lieu of the rotating setting-wheel 11. The printing device and the connections between the operating-axle and the parts actuated thereby may also be subject to great modification and still embody the spirit of my present invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a calculating-machine, the combination of a member revoluble about a fixed axis, and a second member for actuating the same, one of said members having a working surface and the other of said members having a portion for working against said surface; said members when in conjunction, making sliding contact at points on said revoluble member on opposite sides of a line passing through the axis thereof at right angles to a line joining the extreme points of contact of said members, whereby said revoluble member is locked when said parts are in conjunction, but said actuating member is free to move in either direction.

2. In a calculating-machine, the combination of a revoluble tappet having parts lying on opposite sides of the axis of rotation there-

of, and a key for actuating and for locking said tappet, one of said members having a working surface and the other of said members having parts for working upon said surface, said members when in conjunction making sliding contact at points, at least two of which lie on opposite sides of a line passing through the axis of rotation of the tappet at right angles to a line joining the extreme points of contact of said tappet and key, the tappet being thereby locked, but the key being at the same time free to move in either direction.

3. In a calculating-machine, a key and a pivoted tappet, each of said members having at least two working points at which one member may make contact with the other member, and all of said working points lying substantially upon a circle concentric with the key-pivot, the plane of said circle being transverse to the axis of said key-pivot.

4. In a calculating-machine, the combination of a pivotally-supported key, a segmental portion upon said key concentric with the pivot thereof, and a tappet having a segmental portion adapted to receive said segmental portion of said key.

5. In a calculating-machine, the combination of a pivotally-supported key provided with a working surface, a key-receiving device revolubly supported in the plane of rotation of said key, and an axle for supporting said receiving device, the extremities of said receiving device extending a distance from said axle greater than the distance between said axle, and the path of the working surface of said key; and said key, when in conjunction with said receiving device making sliding contact therewith at points on opposite sides of the axle thereof, thereby locking said receiving device, but being at the same time free to move in either direction.

6. In a calculating-machine, a tappet revolubly supported upon a shaft or axle and having portions extending in different directions therefrom; and a key having a portion adapted to operate upon one separately and also on both simultaneously of the said extending portions of said tappet, one of the extending portions of said tappet being offset relatively to a portion of said key said offset portion of said tappet passing freely by said offset portion of said key but said tappet making contact with said key at at least two points, at a time when said key is in contact simultaneously with both of said extending portions of said tappet.

7. In a calculating-machine, a number-setting axle, means for rotating said axle in the direction for setting up a number, a returning-tappet on said axle and a returning-lever actuating said returning-tappet for returning the axle to a zero or initial position.

8. In a calculating-machine, the combination of a tappet-axle, tappets secured to said axle for rotating the same, driving-keys for rotating said axle in one direction, and a returning-lever for rotating said axle in the opposite direction.

9. In a calculating-machine, a yoke operated by the figure-keys of the machine, a returning-lever actuated by said yoke, and a returning-tappet actuated by said lever for returning the number-setting mechanism to a zero position.

10. In a calculating-machine, the combination of a revolubly-supported member having arms extending approximately radially therefrom, and other members making sliding contact with said arms for actuating the same to rotate said revoluble member, said parts when in conjunction making sliding contact at points on opposite sides of a line passing through the pivotal axis of said arms at right angles to the path of contact, thereby locking said revoluble member, but at the same time permitting the motion of said other members in either direction.

11. In a calculating-machine, the combination of a revolubly-supported setting-wheel and mechanism for rotating the same, said rotating mechanism comprising tappets set at various angles upon a shaft or axle and extending in different directions therefrom, connections between said tappets and said setting-wheel; and means for actuating said tappets comprising a part which, when in conjunction with a tappet, lies opposite to points thereon on different sides of the axis of rotation thereof.

12. In a calculating-machine, the combination of a setting-wheel, a shaft or axle for supporting said wheel, a series of tappets upon said shaft set at different angles thereon, each tappet having portions extending in approximately opposite directions from said shaft or axle, keys for actuating said tappets and rotating said shaft or axle in one direction through an arc corresponding to the angle of inclination of the respective tappets, said keys having portions adapted to make contact simultaneously with portions of said tappets on opposite sides of the shaft or axle thereof thereby locking said tappets and at the same time permitting the motion of said keys; and means for rotating said shaft or axle in the return direction.

13. In a calculating-machine, an indicator consisting of a movable piece having thereon a series of figures for indicating the number set up, and a series of type-figures for printing the number set up; in combination with means for actuating said indicator in the direction of the progression of said figures and means for shifting said indicator in a transverse direction for imparting a place value to said figures.

14. In a calculating-machine, the combination of keys, a key-actuated setting member and indicators meshing with and unmeshing

from said setting member, means for unmeshing said indicators subsequent to the complete forward stroke of said setting member and previous to the end of the forward stroke of said keys and means for remeshing said indicators with said setting member subsequent to the complete return stroke of said setting member and previous to the end of the return stroke of said keys.

15. In a calculating-machine, a number-setting axle, a set of keys for rotating said axle in the direction to set up a number, a universal yoke-bar operative by any one of said keys, and means operated by said yoke-bar for returning said number-setting axle to its original position.

16. In a calculating-machine, the combination of figure-keys, indicators, a laterally-shiftable indicator-carriage, a carriage-escapement, the steps whereof are equivalent to one-half the distance between the centers of said indicators, and a key-operated setting member for setting up said indicators, said setting member being alternately connected and disconnected with said indicators consequent upon the successive positions of the carriage.

17. In a calculating-machine, keys, a laterally-fixed setting member, revoluble indicators ome one of which is normally in mesh with said setting member, a shiftable indicator-carriage, a carriage-escapement, moving one half-step at the end of the downstroke of a key for bringing said indicator out of mesh with said setting member, and said carriage moving another half-step at the end of the upstroke of a key for bringing the next successive indicator into mesh with said setting member.

18. In a calculating-machine, the combination of figure-keys, a revoluble axle, driving-tappets fixed upon said axle for rotating the same in a positive direction, said tappets being operated by said figure-keys, a returning-tappet fixed upon said axle for rotating the same in a return direction to the initial position thereof, a returning-lever for actuating said returning-tappet, said axle occupying its initial position when said returning-lever and returning-tappet are in conjunction, means for normally bringing said returning-lever and returning-tappet into conjunction, a setting member positively connected to said axle, said setting member being thereby reversible or reciprocatory in its action, and figure-indicating mechanism operated by said setting member.

19. In a calculating-machine the combination of figure-keys, a revoluble axle, driving-tappets fixed upon said axle for rotating the same in a positive direction, said tappets being operated by said figure-keys, a returning-tappet fixed upon said axle for rotating the same in a return direction to the initial position thereof, a returning-lever for actuating said returning-tappet, said axle occupying its initial position when said returning-key and returning-tappet are in conjunction, means for bringing said returning-key normally into conjunction with said returning-tappet, a setting member positively connected to said axle, and revolving indicators adapted to gear with said setting member, said indicators being thereby reversible or reciprocatory in their action when in gear with said setting mechanism.

20. In a calculating-machine, a set of revoluble indicators, a laterally-fixed setting member, means for actuating said setting member and other means for laterally shifting the entire set of indicators to bring said indicators into gear with said setting member one at a time for the forward stroke thereof, and out of gear with said setting member for the return stroke thereof.

21. In a calculating-machine, the combination of revoluble indicators, a setting member adapted to gear therewith *seriatim*, means for operating said setting member, a shiftable indicator-carriage, a carriage-escapement the stops whereof are equivalent to one-half the distance between adjacent indicators, and means for shifting said carriage, said setting member becoming alternately in gear with and out of gear with said indicators as a result of the successive positions of said carriage.

22. In a calculating-machine, the combination of indicators consisting of disks having teeth for causing the rotation of said indicators, said indicators bearing upon their peripheries figures for indicating numbers; a laterally-fixed setting member having teeth for gearing with the teeth upon said indicators, and means for laterally shifting said indicators thereby moving said indicators *seriatim* into and out of mesh with said setting member and means for operating said setting member.

23. In a calculating-machine, the combination of a laterally-fixed setting member, laterally-shiftable indicators engaging *seriatim* with said setting member, translating mechanism for shifting said indicators step by step toward the left for imparting a place value to said indicators, said shifting mechanism moving said indicators a distance equal to one-half the distance between the centers of said indicators, said setting members being thereby engaged with one of said indicators during one step, and disengaged from said indicators during the next alternate step, and means for actuating said setting member.

24. In a calculating-machine, the combination of indicators, a laterally-shifting carriage wherein said indicators are mounted, registers adapted to be engaged by said indicators, the lateral position of said carriage determining the number of registers engaged by said indicators, and a locking bar or rack for preventing the rotation of such of said

registers as are not engaged by said indicators, the motion of said locking bar or rack corresponding to the motion of said carriage.

25. In a calculating-machine, the combination of toothed indicators having a shifting or translatory motion for determining the place value of the figure indicated, a laterally-fixed setting member for engaging said indicators *seriatim*, means for translating said indicators thereby causing the engagement of said setting member with said indicators; and a fixed bar for locking said indicators previously to their engagement with said setting member.

26. In a calculating-machine, the combination of toothed indicators having a shifting or translatory motion for determining the place value of the figure engaged, and a laterally-fixed setting member for engaging said indicators *seriatim*, means for translating said indicators step by step, a distance less than the distance between two adjacent indicators, thereby bringing said indicators alternately into and out of mesh with said setting member, and means for locking said indicators subsequently to their engagement with said setting member.

27. In a calculating-machine, the combination of toothed indicators having a shifting or translatory motion for determining the place value of the figure indicated, a laterally-fixed setting member for engaging said indicators *seriatim*, means for translating said indicators thereby causing the engagement of said setting member with said indicators, a removable locking-bar for preventing the rotation of said indicators subsequently to their engagement with said setting member and means for operating said bar.

28. In a calculating-machine, the combination of toothed indicators having a shifting or translatory motion for determining the place value of the figure indicated, a laterally-fixed setting member for engaging said indicators *seriatim*, means for translating said indicators step by step, a distance less than the distance between two adjacent indicators thereby bringing said indicators alternately into and out of mesh with said setting member, a swinging indicator-locking bar and a cam mechanism for operating the same.

29. In a calculating-machine, the combination of independently-revoluble indicators, each revoluble in a positive direction from the zero-point and non-revoluble in a negative direction therefrom; gear-teeth on said indicators; independently-revoluble registers; gear-teeth on said registers for intermeshing with the teeth on said indicators, said registers being movable bodily and simultaneously as a gang radially toward and from said indicators, and said registers being disengaged from said indicators during the positive rotation of said indicators and in engagement therewith during the negative rotation thereof; and a fixed stop in position to engage said indicators to prevent the negative rotation thereof past the zero-point.

30. In a calculating-machine, the combination of laterally-shiftable toothed revoluble indicators; toothed registers normally out of mesh therewith and moving bodily and simultaneously as a gang toward and from said indicators; means for moving said registers radially as a gang toward said indicators to engage the same during the negative rotation thereof; a fixed stop for arresting the indicators at the zero position; and means for preventing the rotation of said registers when out of mesh with said indicators.

31. In a calculating-machine, the combination of indicators, a shifting indicator-carriage wherein the indicators are mounted, an erasing-bar for resetting the indicators, levers for resetting said carriage, a locking-bar for preventing the rotation of said indicators, an operating shaft or axle, cams rigidly set on said shaft or axle, and connections between said cams and each respectively of the erasing-bar, carriage-levers and locking-bar.

32. In a calculating-machine, the combination of a series of keys; a universal bar driven an equal amount by any one of said keys; a number-setting mechanism driven forward by any one of said keys an amount depending upon the numerical value of the key operated, but said keys being inoperative upon said number-setting mechanism during the return stroke of said keys, and said number-setting mechanism being returned to its original position by means of said bar.

33. In a calculating-machine, the combination of a number-setting mechanism; a series of keys driving said mechanism forward different amounts depending upon the numerical value of the key struck, to thereby set up the number, but said keys being inoperative upon said number-setting mechanism during the return stroke of said keys; a universal bar extending all across said keys, and driven an equal amount by any one of them; and connections between said universal bar and said number-setting mechanism for returning the latter to the original position.

34. In a calculating-machine, the combination of a toothed reciprocatory member for setting up the numbers; keys individually operative upon said toothed member for moving the same forward an amount depending upon the numerical value of the key struck; and a universal bar driven the same distance by any one of said keys and operative upon said toothed number-setting member for returning the same to the original position.

35. In a calculating-machine, the combination of a number-setting mechanism; a series of keys operative thereon to move the same forward an amount depending upon the numerical value of the key struck, but said keys being inoperative upon said number-setting mechanism during the return stroke of said

keys; and a universal bar for returning said keys to their original position and simultaneously returning said setting mechanism to its original position, said universal bar having the same amount of motion for all of the keys.

36. In a calculating-machine, a number-setting member, a series of keys, means connecting said keys and said number-setting member for moving said number-setting member forward, a universal bar operated by any one of said keys, and connections between said universal bar and said number-setting member to return the latter to its original position.

37. In a calculating-machine, the combination of toothed revoluble and oscillatory indicators; a rocking frame; registers mounted in said rocking frame, and swinging simultaneously therewith and collectively as a gang and said registers being normally out of mesh with said indicators; means for rocking said frame to thereby throw said registers into mesh with the indicators during the return stroke of the latter; a fixed stop for arresting said indicators at the end of their return stroke at a point corresponding to the zero-point; means for preventing the rotation of said registers when out of mesh with said indicators; and other means for operating said indicators.

38. In a calculating-machine, the combination of toothed, revoluble and oscillatory indicators; a rocking frame; registers mounted in said frame and swinging simultaneously therewith and collectively as a gang, and said registers being normally out of mesh with said indicators; means for rocking said frame to thereby throw said registers into mesh with said indicators during the return stroke of the latter; means for preventing the rotation of said registers when out of mesh with said indicators, and other means for operating said indicators.

39. In a calculating-machine, the combination of laterally-shiftable toothed revoluble and oscillatory indicators; toothed registers normally out of mesh with said indicators and movable bodily and simultaneously as a gang radially toward and from said indicators; means for moving said registers into engagement with said indicators during the return stroke thereof; locking-levers for preventing the rotation of said registers when out of mesh with said indicators; and means for operating said levers.

40. In a calculating-machine, the combination of toothed revoluble and oscillatory indicators; means for shifting said indicators step by step; a rocking frame; registers mounted in said rocking frame and swinging simultaneously therewith and collectively as a gang, and said registers being normally out of mesh with said indicators; means for rocking said frame to thereby throw said registers into mesh with the indicators during the return stroke of the latter; a fixed stop for arresting said indicators at the end of their return stroke at a point corresponding to the zero-point; means for preventing the rotation of said registers when out of mesh with said indicators; and other means for operating said indicators.

41. In a calculating-machine, the combination of laterally-shiftable toothed revoluble and oscillatory indicators, a rocking frame, registers mounted in said rocking frame and swinging simultaneously therewith, and said registers being normally out of mesh with said indicators; means for rocking said frame to thereby throw said registers into mesh with said indicators during the return stroke of the latter, whereby an established rotated position of an indicator serves as a constant terminus for limiting the amount of forward rotation of the enmeshed register; means for preventing the rotation of said registers when out of mesh with said indicators; and means for shifting and rotating said indicators.

42. In a calculating-machine, the combination of a setting-axle, tappet-arms extending approximately radially therefrom, keys making sliding contact with the arms for actuating the same, said keys and tappets when in conjunction having points of contact lying in two approximately opposite directions from said axle.

43. In a calculating-machine, the combination of a setting-axle; tappets mounted thereon at various angles, each of said tappets extending in two different directions from said axle; keys; and a shaft whereon said keys are pivotally mounted, said keys making sliding contact with said tappets to actuate the same, and said keys when in conjunction making contact with each other at points on opposite sides of a line joining the respective axes of rotation of said tappets and keys.

44. In a calculating-machine, the combination of a setting-axle, driving-tappets mounted thereon and extending in two different directions therefrom; pivoted driving-keys for actuating said tappets and making sliding contact therewith on opposite sides of a line joining the axes of revolution of said tappets and keys; a returning tappet secured to said axle and extending in two directions therefrom; and a pivoted returning lever for driving said returning tappet and axle in a return direction, said returning lever sliding into contact with its tappet, and, when in conjunction therewith, making contact therewith at points on opposite sides of a line joining the center of said axle and the pivot of said returning lever, whereby said returning tappet is locked when in contact with the returning lever, but said returning lever is free to move in either direction.

45. In a calculating-machine, the combination of a fixed shaft; a series of keys pivoted

upon said shaft; arms also pivoted upon said shaft; a universal bar secured to said arms and extending across all of said keys in position to be driven an equal amount by any one of them; a number-setting mechanism moved forward by any one of said keys an amount depending upon the numerical value of the key struck, but said keys being inoperative upon said number-setting mechanism during the return stroke of said keys, and said number-setting mechanism being returned to the original position by said universal bar.

46. In a calculating-machine, the combination of a series of keys pivoted upon a common shaft; a swinging universal bar located in a position to be engaged by any one of said keys and driven an equal amount by any one of them; a number-setting mechanism moved forward by any one of said keys an amount depending upon the numerical value of the key struck, but said keys being inoperative upon said number-setting mechanism during the return stroke of said keys, and said setting mechanism being returned to the original position by said universal bar.

47. In a calculating-machine, the combination of a fixed shaft; a series of keys pivoted upon said shaft; arms also pivoted upon said shaft; a universal bar secured to said arms and extending across all of said keys in position to be driven thereby an equal amount by any one of them; a number-setting mechanism moved forward by any one of said keys an amount depending upon the numerical value of the key operated; but said keys being inoperative upon said number-setting mechanism during the return stroke of said keys, and returned to the original position by said universal bar.

48. In a calculating-machine, the combination of registers; independently-revoluble indicators for rotating said registers in a positive direction during the negative rotation of said indicators, said indicators rotating in a positive direction one at a time, and a fixed stop in position to engage said indicators to prevent the negative rotation thereof past the zero-point.

49. In a calculating-machine, the combination of indicators revoluble in a positive direction from the zero-point and non-revoluble in a negative direction therefrom; registers in engagement with said indicators during the negative rotation thereof only, the negative rotation of said indicators causing the positive rotation of said registers, and the indicators rotating in a positive direction one at a time.

50. In a calculating-machine, the combination of registers, indicators for rotating said registers in a positive direction during the negative rotation of said indicators, means for laterally shifting all of said indicators simultaneously step by step to bring them opposite to said registers, and a fixed stop in position to engage said indicators to prevent the negative rotation thereof past the zero-point, said indicators being laterally shiftable as a gang and rotated in a positive direction one at a time.

51. In a calculating-machine, the combination of simultaneously-shiftable and independently-revoluble indicators for setting up the number, said indicators being revoluble one at a time and in variable amounts in a positive direction, and limited in the subsequent return rotation by a fixed part of the machine.

52. In a calculating-machine, the combination of toothed registers; toothed indicators; a shaft whereon said registers are independently revoluble; a second shaft whereon said indicators are independently revoluble; means for causing one of said shafts to approach the other of said shafts for bringing the registers and indicators into engagement with each other during the negative rotation of said indicators and a stop located in position to engage the indicators at the end of the negative rotation of said indicators, said indicators contacting said stop at a point corresponding to the zero-point of said indicators.

53. In a calculating-machine, the combination of laterally-shiftable toothed and independently-revoluble indicators, toothed registers normally out of mesh therewith and moving simultaneously as a gang toward and from said indicators; means for moving said registers as a gang radially toward said indicators to engage the same during the negative rotation thereof, and a fixed stop for arresting the indicators at the zero position.

54. In a calculating-machine, the combination of indicators, each independently revoluble in a positive direction from the zero-point and non-revoluble in a negative direction from the zero-point; and independently-revoluble registers moving simultaneously as a gang toward and from said indicators to be rotated thereby, said registers being disengaged from said indicators during the positive rotation thereof and in engagement therewith during the negative rotation thereof.

55. In a calculating-machine, the combination of two parallel shafts one of which is movable toward and from the other; a set of toothed indicators mounted on one of said shafts and simultaneously shiftable and independently revoluble thereon; a set of laterally-fixed registers independently revoluble upon the second one of said shafts; and means for moving said shafts toward each other prior to the beginning of the return stroke of the indicators for causing the forward rotation of said registers; said means moving said shafts away from each other after the completion of said return stroke of the indicators.

56. In a calculating-machine, the combination of independently-revoluble indicators each revoluble one at a time in a positive direction from the zero-point and non-revoluble in a negative direction therefrom; independ-

ently-revoluble registers movable bodily and simultaneously as a gang toward and from said indicators during the positive rotation of said indicators and in engagement therewith during the negative rotation thereof; and a fixed stop in position to engage said indicators to prevent the negative rotation thereof past the zero-point.

57. In a key-operated calculating-machine, the combination of registers; indicators for rotating said registers in a positive direction during the negative rotation of said indicators; means for rotating said indicators one at a time in a positive direction an amount corresponding to the numerical value of the key struck; means for rotating the indicators in a negative direction; and stationary means for preventing a negative rotation exceeding the positive rotation of said indicators.

58. In a calculating-machine, the combination of registers; indicators for rotating said registers in a positive direction during the negative rotation of said indicators, and a fixed stop in position to engage said indicators to prevent the negative rotation thereof past the zero-point, said indicators and said registers having gear-teeth interlocking during the engagement of said registers with the indicators, whereby the stopping of said indicators at their zero-point causes the locking of the registers at the completion of the forward rotation of said registers, said indicators being simultaneously shiftable and individually rotatable in the positive direction.

HYMAN ELI GOLDBERG.

Witnesses:

ARTHUR M. COX,

SADIE WOLF.