A.D. 1883, 1st *January*. N° 16.

Calculating Machines.

LETTERS PATENT to Joseph Edmondson of Halifax in the County of York Stuff Printer for an Invention of "IMPROVEMENTS IN CALCULATING MACHINES"

PROVISIONAL SPECIFICATION left by the said Joseph Edmondson at the Office of the Commissioners of Patents on the 1st January 1883.

JOSEPH EDMONDSON of Halifax in the County of York. Stuff Printer. "IMPROVEMENTS IN CALCULATING MACHINES"

This Invention relates to improvements in calculating machines so constructed as to be more compact facilitating work of the operator affording increased range of calculating dispensing with the use of click springs to the number discs

Machines constructed for purpose aforesaid according to this my said invention comprise (by preference) a circular plate free to revolve on a stud or on a vertical spindle working in a footstep the said circular plate has around its face apertures under which the numbers are seen on their respective discs the discs are mounted on spindles.

The driving apparatus comprises a bevel wheel by preference having teeth on its upper and under faces the upper teeth gear with and are operated by a pinion connected with the operating handle the under teeth of the said wheel gear with and operate by means of bevel pinions the calculating stepped drivers—On the several shafts of the stepped drivers are stepped stops corresponding with them. Each stepped driver actuates a pinion on a tube sliding on a shaft and carrying a star wheel gearing with the stepped stop for the purpose of locking its shaft securely in position except when actuated by the driver the said shaft carries gear for working the number disc.

By the use of an additional driver the multiplier and the produce also the dividend and quotient appear in the one line of number discs and the quotient so obtained is in position—to be operated with as a multiplier

The changes from multiplying to dividing and from adding to substracting and *vica versa* are effected by a series of cam slots in a circular or segmental plate free to work around the boss supporting the vertical spindle just referred to.

The erasing in circular machines is effected by means of a toothed rack combined with a stop mounted on a lever, the teeth engaging with pinions on the spindles of the number discs the foot of the said lever operates through a second lever so as to raise and lower the circular plate, being revolved when the eraser is in gear with the aforesaid pinions the number discs are brought to zero.

In machines wherein the number discs are arranged in straight line the eraser is a loose instrument applied by the operator.

[*Price* 1s.]

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Joseph Edmondson in the Great Seal Patent Office on the 30th June 1883.

JOSEPH EDMONDSON of Halifax in the County of York, Stuff Printer. "IMPROVEMENTS IN CALCULATING MACHINES"

This invention relates to improvements in calculating machines so constructed as to be more compact facilitating work of the operator affording increased range of calculating dispensing with the use of click springs to the number discs

Machines constructed for purpose aforesaid according to this my said invention comprise (by preference) a circular plate free to revolve on a stud or on a vertical spindle working in a footstep the said circular plate has around its face apertures under which the numbers are seen on their respective discs the discs are mounted on spindles. The driving apparatus comprises a bevel wheel by preference having teeth on its upper and under faces the upper teeth gear with and are operated by a pinion connected with the operating handle the under teeth of the said wheel gear with and operate by means of bevel pinions the calculating stepped drivers. On the several shafts of the stepped drivers are stepped stops corresponding with them—Each stepped driver actuates a pinion on a tube sliding on a shaft and carrying a star wheel gearing with the stepped stop for the purpose of locking its shaft securely in position except when actuated by the driver the said shaft carries gear for working the number disc—By the use of an additional driver the multiplier and the product also the dividend and quotient appear in the one line of number discs and the quotient so obtained is in position to be operated with as a multiplier—The changes from multiplying to dividing and from adding to subtracting and *vice versa* are effected by a series of cam slots in a circular or segmental plate free to work on the boss supporting the vertical spindle just referred to—The erasing in circular machines is effected by means of a toothed rack combined with a stop loose or mounted on a lever, the teeth engaging with the pinions on the spindles of the number discs of the several studs on the circular plate the foot of the said lever operates through a second lever so as to raise and lower the circular plate—when erasing on circular machine the lever will be put so as that its teeth engage with the teeth of the discs pinion, and on the circular plate being rotated or revolved when the eraser is in gear with the aforesaid pinions the number discs are brought to zero—In machines wherein the number discs are arranged in straight line the eraser is a loose instrument applied by the operator.

Such being the nature and object of this my said invention. I will now proceed to describe the same in detail, and in order that the invention may be fully understood I have hereunto annexed 7 Sheets of drawings illustrative thereof and have marked same with figures and letters of reference, like figures denoting like parts on the several views.

DESCRIPTION OF THE DRAWINGS.

Fig 1—is a sectional elevation about twice full size shewing one of the rays of a circular machine—Fig: 2. is a plan of fig: 1 shewing two rays, one with slide and circular plate removed and one with the slide and circular plate in position (twice full size)—Fig: 3 is a plan of secondary carrying tooth and its stop detached (twice full size)—Fig: 4 is an end elevation of step driver, stops pinion secondary carrying tooth and star wheel in position (twice full size)—Fig: 5 is a front elevation of circular machine (about full size) with the circular number plate raised and the eraser in gear constructed according to my invention—Fig: 6 is a plan—Fig 7 is a sectional elevation—Fig. 8 is plan with circular number plate and its numbers discs removed—Figs 9. 10 are end elevations of first and second drivers—Fig: 11 is side elevation of segmental eraser in position about (twice full size)—Fig: 12 is a front elevation of segmental eraser about twice full size—Fig: 13 is a plan of segmental eraser in position with pinion (about twice full size)—Fig: 14 is elevation of pinion shewing broad tooth (about twice full size)—Fig: 15 is sectional elevation of circular plate—Fig: 16 is plan of circular plate—Fig: 17 is a sectional elevation, shewing circular plate raised to the position for revolving and clear of the eraser—Fig: 18 is elevation of part of machine with supplementary recorder—Fig: 19 is plan of same with circular plate and slide removed—Fig: 20 is plan shewing circular plate and slide in position—Figs 21. 22 are elevation and developement of first driver (A Fig: 8).—Figs 23. 24 elevation and developement of 2nd to 8th drivers (B Fig: 8)—Figs 25. 26. 27 are end and side elevation of 9th driver (C. Fig: 8)—Figs 28. 29 elevation and developement of 10th driver (D. Fig: 8)—Figs 30. 31 elevation and developement of 11th driver (E. Fig: 8)—Figs 32. 33 elevation and developement of supplementary driver—Figs 34 is an end elevation of part straight machine—Fig: 35 is plan of same—Fig: 36 is plan of eraser for straight machine to be worked in direction of arrow—Fig: 37 is end elevation of plate shewing eraser in position Fig: 38 is elevation looking in front of eraser teeth—Fig: 39 is detail of lever and rod for changing from multiplying to dividing

Machines constructed for purpose aforesaid according to this my invention comprise (by preference) a circular plate 1 free to revolve on a stud or vertical spindle 2 working in the boss 8 and resting in a footstep 3 the said circular plate has around its face apertures 4 under which numbers are seen on their respective discs 5 the discs are mounted upon spindle 6. The holes Z in the plate 1 are for the insertion of ivory or other pins to mark the decimal point.

The driving apparatus comprises a bevel wheel 7 (revolving on boss 8) the wheel 7 by preference having teeth on its upper 9 and under faces 10 the upper teeth 9 gear with and are operated by a pinion 11 connecting with the operating handle 12 the under teeth 10 of the said wheel 7 gear with and operate by means of bevel pinions 13 the calculating stepped drivers 14 or toothed wheels having teeth of different widths so that they form steps *a. b. c. d. e. f. g. h. i. k.* figs 1. 21. and 22 on which there are respectively 0. 1. 2. 3. 4. 5. 6. 7. 8. 9 teeth—The drivers A and E are set to operate simultaneously on the pinions respectively gearing into them each of the remaining drivers is set to operate on its respective pinion about one tooth later than the one to the right of it. The same remarks apply to the secondary carrying teeth herein fully described—On the several shafts 15 of the stepped drivers 14 are also the stepped stops 16 corresponding with them. On each of the shafts 15 (except first and eleventh) counting from right to left is a secondary carrying tooth 17 and its corresponding stop 18 both free to slide on shaft 15 and having pins 19 received within the holes 20 of the stepped stop 16 and forming a clutch with the same. Each stepped driver 14 actuates a pinion 21 on a keyed tube 22 sliding on a grooved shaft 23. the key of the tube 22 fits into the groove 24 of the shaft 23 the tube 22 also carries the star wheel 25 gearing with stepped stop 16 for the purpose of locking its shaft 23 securely in position except when actuated by the driver 14 or the secondary carrying tooth 17 or when locked only by the star wheel 26 working on the stop 18. There is also a period of the drivers revolution whereon the shaft 23 is locked by both star wheels 25. 26 the shaft 23 carries bevel wheels 28. 29 for working the number discs 5 through the agency of the bevel wheel 30. The wheels 28. 29 are free to slide on the shaft 23 and are provided with a key received within a groove on the shaft 23 and 28 or 29 is put into gear with 30 according to the required direction of rotation of the number disc 5, the latter has on its upper surface the series of numbers required by the notation (decimal or otherwise) for which the machine is constructed. The machine here described is for the decimal notation. The wheels 28. 29 and 30 also the star wheels 25. 26 and the pinions 21. 31 each have the same number of teeth as there are numbers on the disc 5 or multiples of that number—the numbers are so placed on disc 5 that when the shaft 23 is locked as above described one of the said numbers appears through the aperture 4 in plate 1—On the spindle 6 is the primary carrying tooth 32 the said tooth 32 actuates the lever 33 on its fulcrum 34. Its outer arm 35 clips and actuates the pin 36 in the shaft 37—At the end of the latter is a clip 38 fitting the groove 39 of the stop 18 and secondary carrying tooth 17—The changing from multiplying to dividing and from adding to subtracting and *vice versa* are effected by a series of cam slots 40 in a circular or segmental plate 41 to which plate is attached the handle 42 by means of which the said plate is worked from left to right or reverse whereon the cam slots 40 by the pins 43 received within the slots 40 impart sliding or endwise motion to the shafts 44 and by means of the clip 45 moves the wheels 28. 29 respectively into or out of gear with the wheel 30. The plate 41 is mounted and free to work on the boss 8 47 is a spacing collar for wheel 7 and plate 41 and 48 is a holding collar to keep 41 in position—The erasing in circular machine is effected by means of a toothed rack 49 terminating with a stop 50 mounted upon a lever 51 the teeth of the rack 49 engage with pinions 52 on the spindles 6 of the number disc 5 the foot of the lever 51 operates through a second lever 53 and the footstep 3 so as to raise and lower the circular plate 1 and when raised the plate is free to revolve for erasing which is effected (when the flange *a* of the eraser is pressed against the periphery of the plate 1) by means of the segmental rack 49 and pinions 52—On reference to the detail at Figs 11. 13. 14 it will be seen the pinion 52 is provided with a wide tooth 54 and a gap or blank 55 so that when the plate 1 is revolved (in direction of arrow *b* fig: 6) the several pinions 52 will successively be brought into gear with the segmental rack 49 and moved until the blank 55 is reached whereon the broad tooth 54 comes in contact with the plain piece or long stop 56 and so all the number discs 5 are brought to zero.

On plate 1 are the "knobs" 57 also used for lifting the plate and for rotating same when erasing—The milled ends 58 of spindle 6 are for the purpose of setting any required number on the discs 5 opposite or under the apertures 4 of plate 1. The setting of the numbers on the discs can be only effected when the plate 1 is raised as shewn in Fig: 5 as all the discs are locked when plate 1 is down, because at such time the bevel wheel 30 are either in gear with wheel 28 or 29 on shaft 23 or they are held by the pins 59 the ends of which are so shaped as to form a tooth to gear with the bevel wheel 30—The recesses 60 formed in upper part of the circle 61 are for the purpose of receiving the locking pieces 62 which lock the plate 1 (when down) in a position in which the centre of the wheels 30 on the spindle 6 are directly over the central line of the radial shafts 23—The stud 63 is the index or dead point from which the handle 12 is to be started or at which it is to be stopped—On the radial arms of the plate 64 are the number plates 65 having the slide pieces 66 attached—On the lower end of the slide pieces are the forks 67 which are received within the grooves 68 and are held in position by the springs 69 in the grooves 70 formed in the rays 64—As the slide 65 is moved by the thumb piece 71 the figures are brought immediately in front of the edge of the segmental rule 72 (see Figs 1 and 2) in which the number plates 65 are set with the figures 9 immediately in front of the rule 72—It will be seen that the spring 69 is in the groove of the radial plate nearest to the outer end of the ray 64 and that the pinion 21 is opposite that part of the stepped driver 14 in which there are nine teeth, the star wheel 25 is on the corresponding step of its stepped stop—The grooves or notches 70 are at distances apart equal to the length of the several steps of the stepped driver 14 and stepped stop 16 the radial arm shewn in Figs 1 and 2 illustrates one of the seven rays G Fig: 6 the ray H is merely a "carrying ray" and is without a slide. L is a recording or indicating ray, K is a ray for both carrying and indicating or recording—It will be seen that the sliding plates 65 on the rays K and L are without numbers but have pointers set to the apertures 74 or 75 or to the * between them as may be required—The apertures 74 and 75 with bevelled edges in the plate 76 between the rays K and L are for displaying the signs +. −. × or ÷ indicating the arithmetical operation for which the machine is set. The signs +. −. ×. ÷ are on the plate 77 underneath the plate 76—Under the plate 77 is a pin 78 received within a slot in the lever 79 which has its fulcrum at 80 the other end 81 is slotted and receives the pin 82 at the end of the sliding shaft 44 so that the motion of plate 41 and its slot 40 by the connections just described moves the index plate 77 and changes the signs displayed in apertures 74. 75 from ÷ and − to × and + respectively or *vice versa*—It will be seen on reference to Figs 7. 21. and 22 that the driver A (Figs 8 and 31) is without carrying tooth but that the stepped stop is prolonged to form a stop for the fixed star wheel on the shaft above it. This star wheel is without a pinion—The driver E Figs 8, 30 and 31) is also without carrying tooth and has it stepped stop prolonged in the same manner and for the same purpose as that of the driver A—The fixed star wheel on the shaft above the driver E is without pinion similarly to that of the shaft above the driver A.—The driver E Figs 7. 8. 29. and 30 it will be seen is shewn as having nine teeth and one detached tooth and the gaps in the stop correspond therewith. I prefer this arrangement but it is obvious that a like driver to A would answer the purpose—The driver D is of like construction to E except that it has a carrying tooth. I prefer this arrangement but it is obvious that it might be constructed as the drivers B. The driver C contains only a secondary carrying tooth and stop with a boss 83. (Figs 25. 26 and 27) fixed to the drivers shaft 15—Fig 18 is an elevation of supplementary ray which may be applied to circular machine—Fig : 19 is plan of same with number plate 1 removed—Fig : 20 is plan with number plate attached—At 15 is the driver shaft on which is mounted the stepped driver 14 and its stepped stop 16 the stepped driver 14 actuates the pinion 21 on a keyed tube 22 sliding on a grooved shaft 23 the key of the tube 22 fits into the groove in the shaft 23. The tube 22 also carries the star wheel 25 gearing with the stepped stop 16 for the purpose of locking its shaft 23 securely in position except when actuated by the driver 14. On the shaft 23 are the bevel wheels 28. 29 for working the number disc 5 through the agency of the bevel wheel 30. The wheels 28 : 29 are free to slide on the shaft 23 and are provided with a key received within the groove on the shaft 23. 28 or 29 is put into gear with 30 according to the requisite direction of number discs 5—The change from multiplying to dividing is effected by cam slot 40 in plate 41 to which is attached the handle 42 by which the plate 41 is operated or worked whereon the cam slots 40 by the pin 43 imparts sliding or endwise motion to the shaft 44 and by means of the pin 84 moving the index plate 85 on which are marked the signs − + + − the slide 85 having the signs is on the underside of plate 86 through which are the holes or apertures of plate 87. 88 so that the operator will be enabled to see the signs corresponding to the position of the handle 42. The slide 89 is similar to the one described herein and shewn at Figs 5 & 6.

The several figures on sheet 7 illustrate like construction of machine having a straight instead of a circular number plate, like letters of reference refer to like parts and it will be understood that in lieu of the circular bevel wheel 7 the shaft and bevel wheels 90 are employed and in lieu of the disc or plate 41 for the purpose of changing from multiplying to dividing from adding to subtracting or *vice versa* I employ a vertical lever 91 mounted on stud 92 and a connecting rod 93 attached to the lever 91 by stud 94. The other end of the connecting rod 93 is attached to the lever 95 on the shaft 96—On the shaft 96 are a series of pins 97 passing through plate 98 which is between the bevel wheels 28. 29 for purpose of moving the wheel 28 or 29 in or out of gear with 30. The number plate 99 is provided with lugs 100 and rod 101 free to move without the lugs 102 attached to the plate 99 so that the latter may be raised slided or moved laterally for purpose of setting the number plate apertures opposite the various number slides The eraser for the straight machine is shewn at Figs 36. 37 and 38. The latter figure illustrates the eraser applied to plate 99 (which has been raised into a vertical position) and wheel 52 in position for erasing or bringing the number discs to zero. The plate 103 with bevilled edge supports the spindles 6 of the wheels 30 and 52 and also serves to guide the eraser in its motion.

Before commencing to use the machine—1st. Set all the discs on the plate (1) to zero—2nd. Set all the slides on the rays F. G to zero—*i.e.* with the figure 0 immediately in front of the curved rule (72)—3rd. Set the slides on the rays K. L to point to the aperture (75)—4th. See that the eraser (49) is set back from the plate (1) and that the latter is down upon the frame and with its four pins (62) in four of the slots cut in the frame for their reception in Fig: 7.

The figures to be operated on must be "set on to" the slides or the circular number plate as may be required. For the former the slides must be pushed back till the required digits appear immediately in front of the curved rule (72). For the latter the circular plate must be lifted up and the milled head of each disc turned till the required digit appears in the aperture above it—When working, the handle (12) must always be turned in the direction of the arrow (→) and must always be started from and stopped at the position shewn in Figs 5 and 6—To perform addition—1st "Set on to" the circular plate (1) the first line of figures to be added—2nd. "Set on to" the slides the second line of figures to be added—3rd Bring the units digit on the circular plate opposite the units digit on the slides—4th By means of the handle (42) bring the signs × and + into the apertures (74) and (75) respectively—5th Give the handle (12) one turn and the sum of the two lines will appear in the apertures (4) on the circular plate. (1.)—6th. "Set on to" the slides the third line of figures to be added give the handle one turn, and the sum of the three lines will appear in the apertures (4) on the plate (1) Repeat this 6th operation for each succeeding line of figures

To perform subtraction—1st "Set on to" the circular plate the figures of the minuend—2nd "Set on to" the slides the figures of the subtrahend—3rd. Bring the units digit on the circular plate opposite the units digit on the slides—4th Bring the signs ÷ and − into the apertures (74) and (75) respectively—5th Give the handle one turn and the difference will appear in the apertures (4) on the plate (1.)

To perform multiplication—1st. "Set on to" the plate (1) the figures of the multiplier—2nd. "Set on to" the slides the figures of the multiplicand—3rd. Set the units digit of the multiplier opposite the ray K or L. The ray so selected I call the "indicating" or "recording" ray—4th. Set the pointer of the slide on the indicating ray to the apertures (74)—5th. Bring the signs × and + into the apertures (74) and (75) respectively—6th. Turn the handle until the units digit of the multiplier is brought to zero. Note—The number of turns required will be that of the digit—7th. Set the tens digit of the multiplier opposite the indicating ray and repeat the 6th operation—8th Proceed with the remaining digits as in the 7th operation and when all the digits have been brought to zero the product will appear in the apertures (4) on the plate (1.)

To perform division—1st "Set on to" the plate the figures of the dividend—2nd. "Set on to" the slides the figures of the divisor. 3rd. Set the first or highest digit of the dividend opposite the first or highest digit of the divisor—4th Set the pointer of either of the rays K or L to the aperture (74) the ray whose pointer is so set being termed the "indicating" or "recording" ray. 5th Bring the signs ÷ and − into the apertures (74) and (75) respectively—6th Turn the handle till the number remaining on the discs opposite the rays is less than the divisor. The number of the turns by which this has been done will then appear in the apperture opposite to the "recording" ray and will be the first or highest digit of the quotient—7th. Bring the next aperture to the right of the first digit of the quotient opposite to the recording ray and repeat the 6th operation. The second digit of the quotient will then appear in the aperture opposite to the recording ray—8th Proceed as in number 7 step by step for each succeeding digit of the quotient

In certain cases it is preferable when multiplying, to record on the plate the digits of the multiplier instead of first setting them on to the plate and bringing them to zero in the process as above described To do this it is only necessary to see that all the discs in the plate are set to zero and the pointer of the slide on the "indicating" ray is set to the * between the apertures 74 and 75 and then in other respects to proceed as already described for multiplication—In many cases however, it is needful thus to record the digits of the multiplier at a greater distance from the product than the use of the ray K or L would allow. The supplementary ray then comes into use as the "indicating or recording ray—To use the supplementary ray—1st Set the pointers of the slides on the rays K and L to the apertures (75). 2nd. Set the pointer of the slide on the supplementary ray to the aperture in which the sign + appears. 3rd Proceed in other respects as already described for multiplication—The digits of the multiplier will then be recorded in the apertures successively coming opposite the supplementary ray, at the same time that the product is being formed opposite the rays F. G—The supplementary ray may also be used instead of the ray K or L to bring the digits of the multiplier to zero: in which case its pointer must be set to the aperture in which the sign − appears, the pointers on the slides of the rays K and L being set to the aperture (75.) When the supplementary ray is not in use the pointer must be set midway between the apertures (87) and (88) Fig 20

It will be observed that by the use of a circular plate compared with a longitudinal or straight plate, a dividend of an infinite number of digits may be operated upon by taking note of the quotient when the plate is filled and inserting in its place the figures of the dividend following those already operated upon.

The numbers in the circular number plate are also arranged in a more convenient position under the eye of the operator than they are in a straight or longitudinal plate—The use of the stepped stops corresponding with the stepped drivers makes it possible to dispense with the click springs hitherto used to steady or lock the number discs.

Having thus fully described the nature and particulars of this my said invention, together with the manner in which the same is to be or may be performed or carried into practical effect I would have it understood that I claim as my invention.

Firstly—The use of the circular plate 1 combined with and carrying number discs 5

Secondly—The use of a revolving plate 1 rotating upon its axis carrying number discs 5 and operating wheels, as herein fully described and illustrated by drawings

Thirdly—The stepped stops combined with the stepped drivers as and for the purpose herein described and illustrated

Fourthly—The stepped drivers stepped stops arranged radially and combined with circular plate 1 as described and illustrated

Fifthly—The erasers 49 having tooth rack and stops as described and illustrated by Figs—11. 12—13 and 14

Sixthly—The plate 41 cam slots 40 cut or formed therein and pins 43 combined and operating as and for purpose herein described

Seventhly—The apparatus for raising the circular number plate 1 comprising levers 51. 53 footstep 3 and spindle 2 as described and illustrated

Eightly—The combination of eraser 49. levers 51. 53 and footstep 3—as described and for purpose herein set forth

Ninthly—The construction of machine wherein by the use of drivers such as D. and E Fig 8 and N° 14 Fig 18 for indicating or recording as herein described, the multiplier and product or the dividend and quotient may be worked and recorded on one and the same series of number discs

Tenthly—The general construction arrangement and combination of mechanism for purpose set forth and substantially as illustrated by the drawings.

In Witness whereof I the said Joseph Edmondson have hereunto set my hand and seal this twenty seventh day of June in the year of our Lord one thousand eight hundred eighty three.

JOSEPH EDMONDSON (L.S.)

Witness
WALTER BRIERLEY
Patent Agent
Halifax Huddersfield & Blackburn

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1883.

FIG. 1.

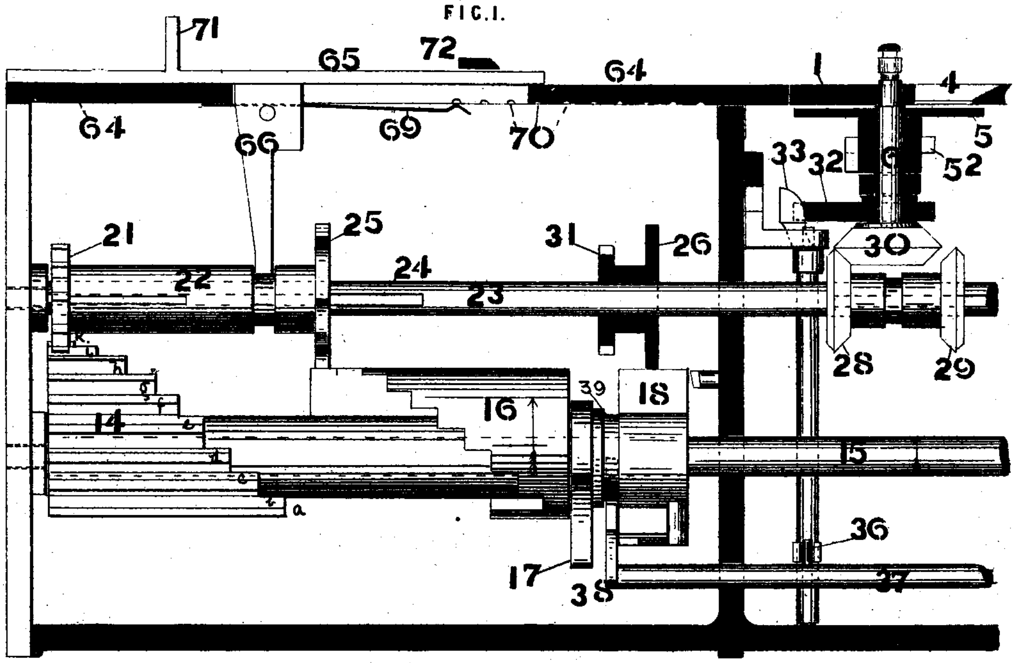


FIG. 4.

FIG. 3.

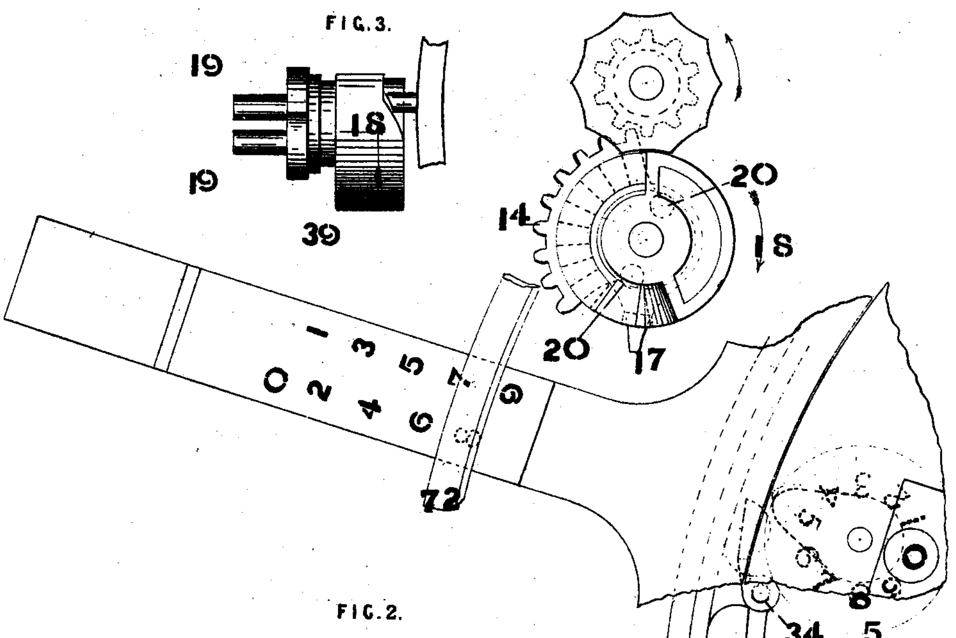
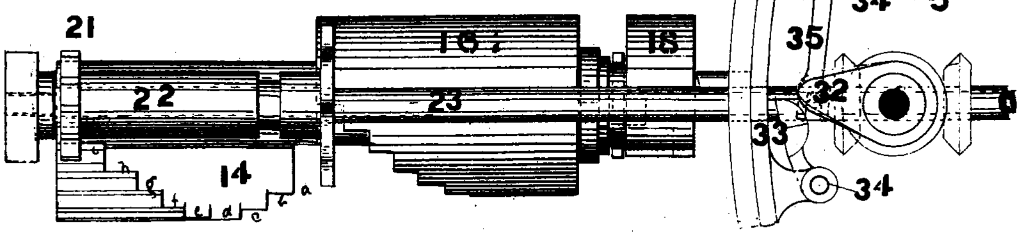


FIG. 2.



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(7 SHEETS)
SHEET 2

FIG. 5.

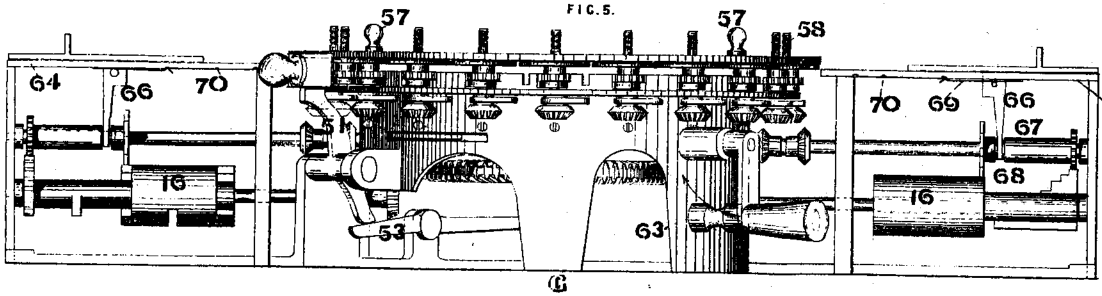


FIG. 6.

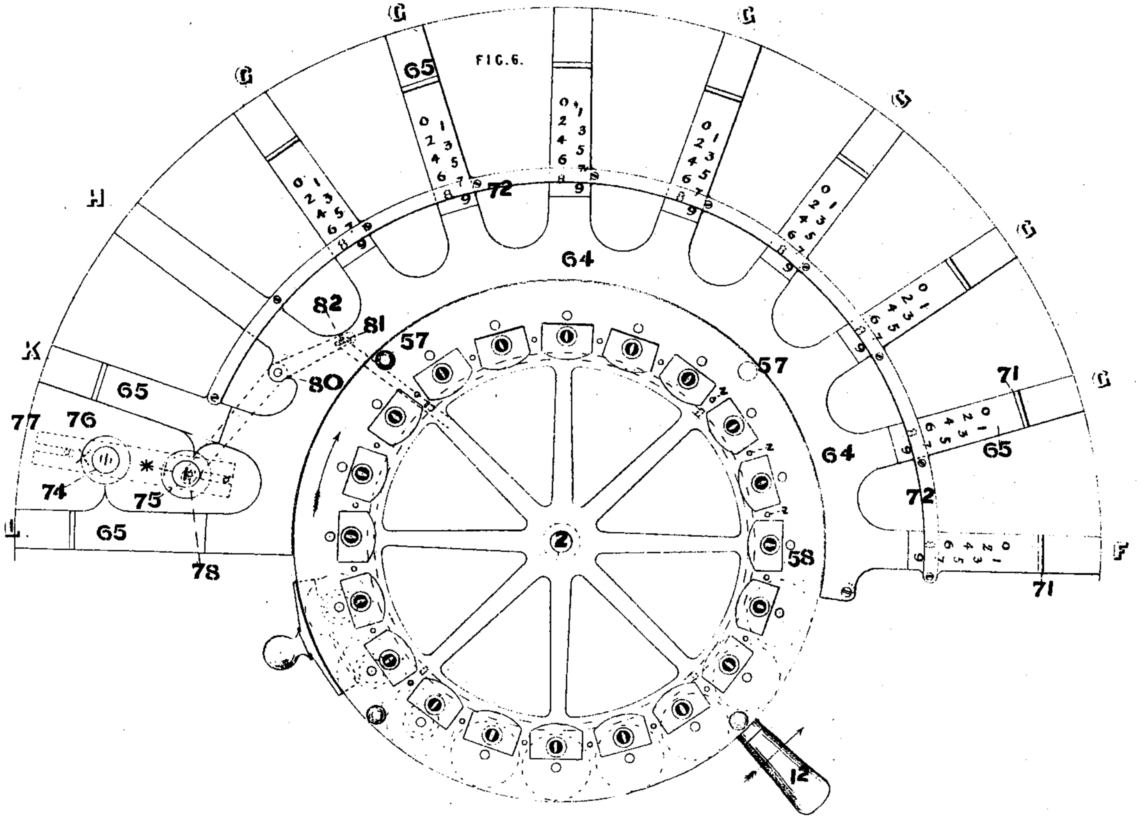
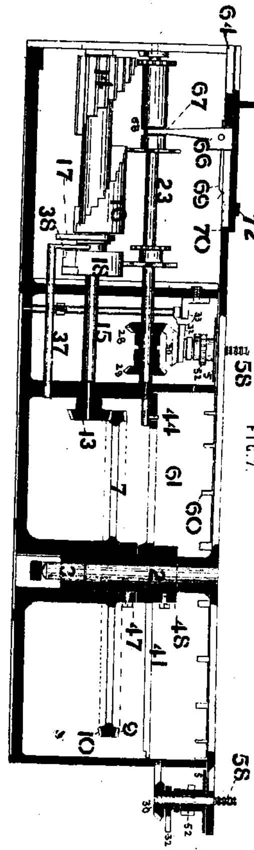


FIG. 7.



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(7 SHEET.
SHEET 3.

FIG. 8.

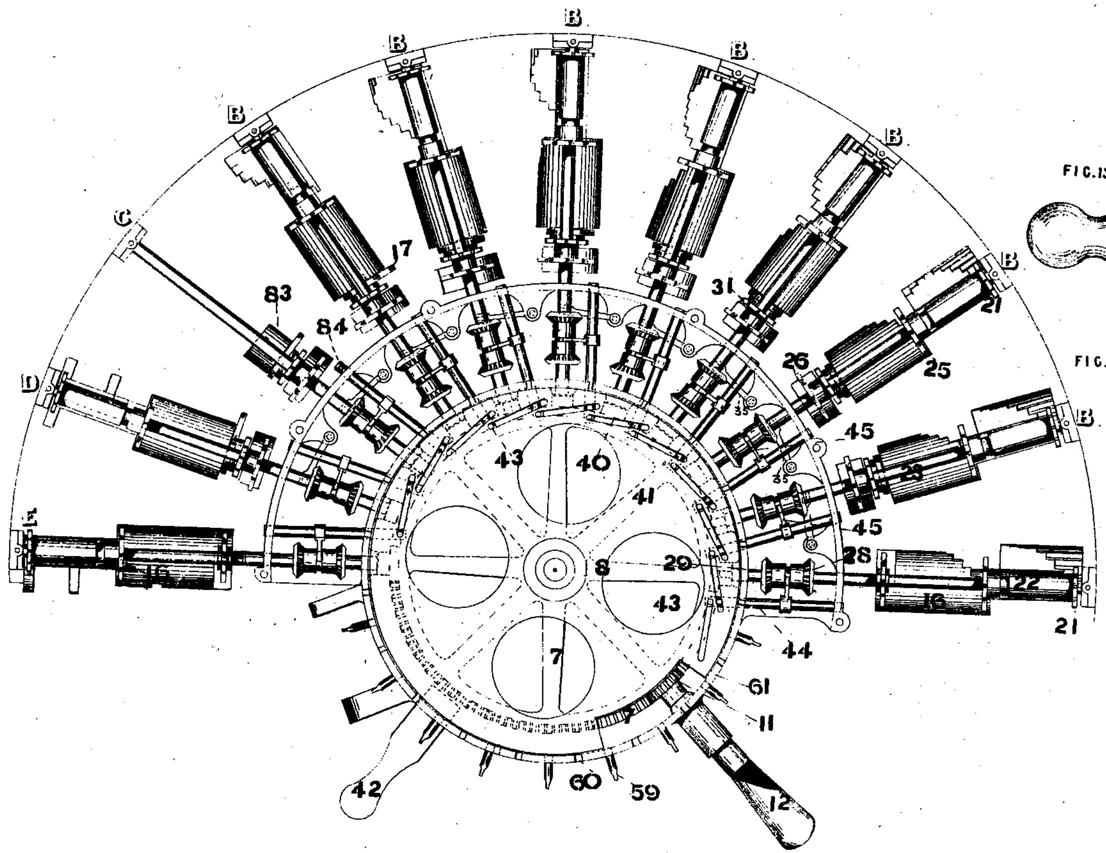

FIG. 11.

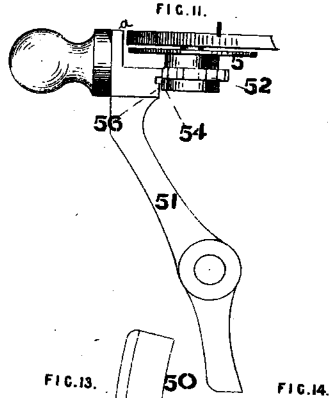

FIG. 12.

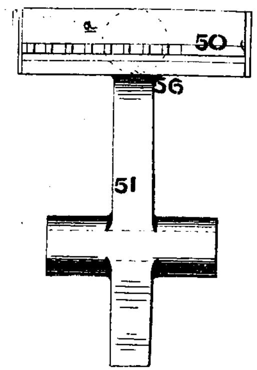

FIG. 13.

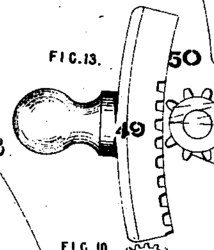

FIG. 14.

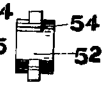

FIG. 10.

FIG. 9.

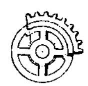

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FIG. 15.

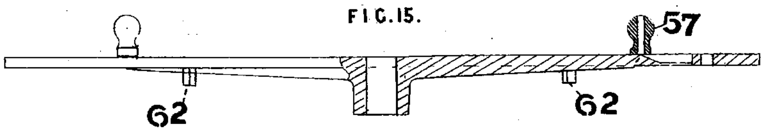
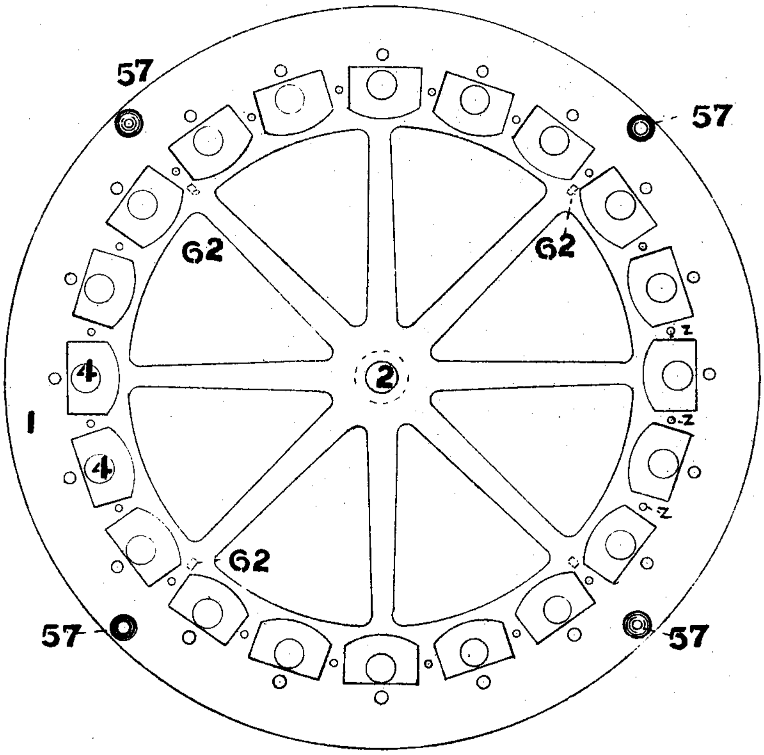
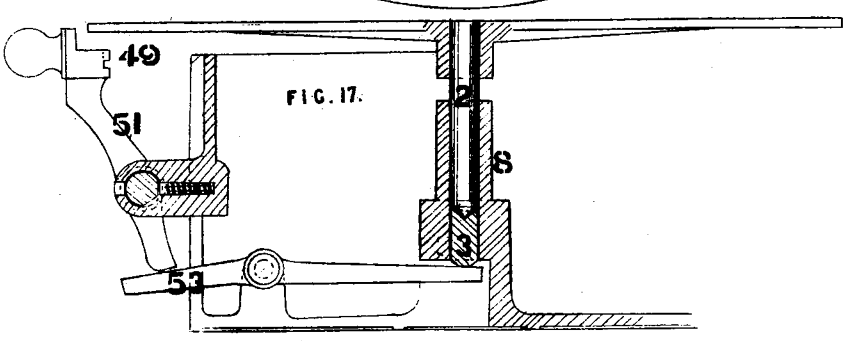


FIG. 16.





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(7 SHEETS)
SHEET 5.

FIG. 18.

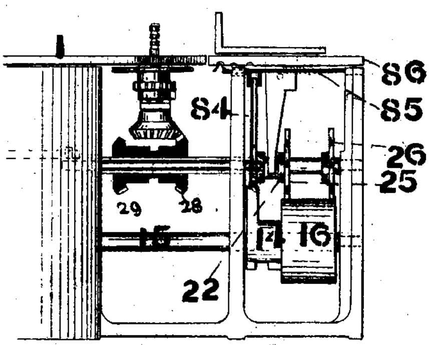


FIG. 19.

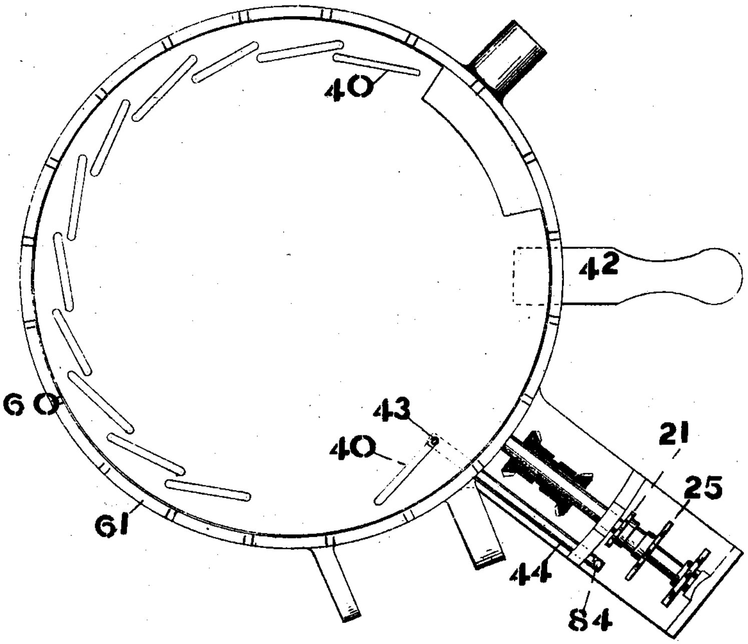
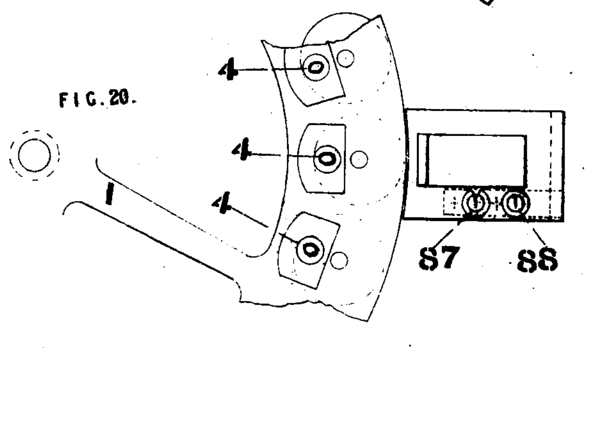


FIG. 20.



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(7 SHEETS)
SHEET 6

FIG. 21.

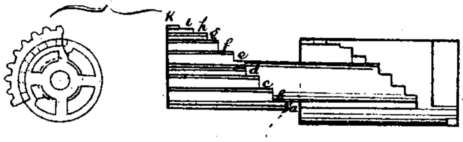


FIG. 23.

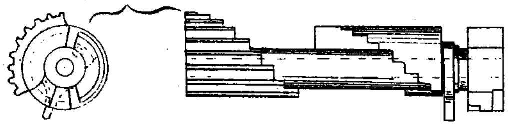


FIG. 22.

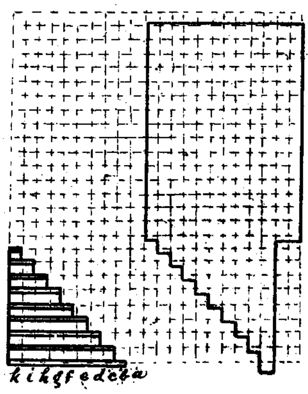


FIG. 24.

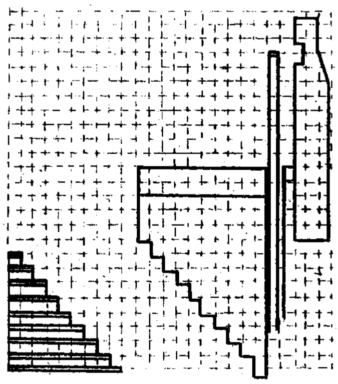


FIG. 26

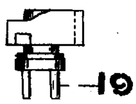


FIG. 25.

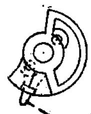


FIG. 27.

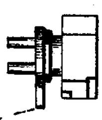


FIG. 30.

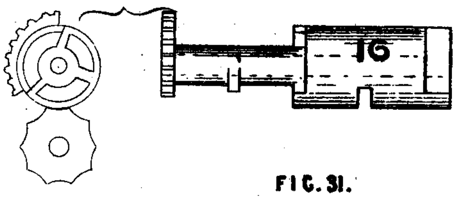


FIG. 28.

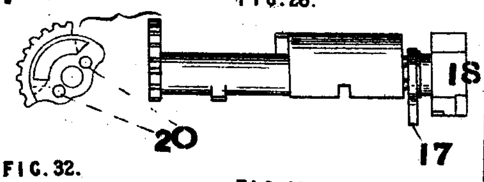


FIG. 31.

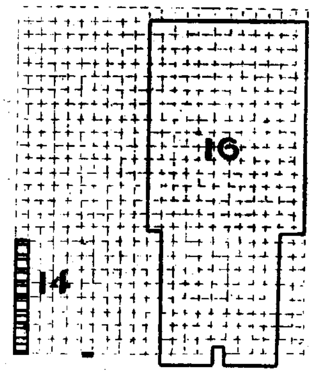


FIG. 32.

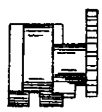


FIG. 33.

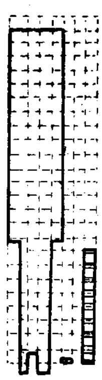
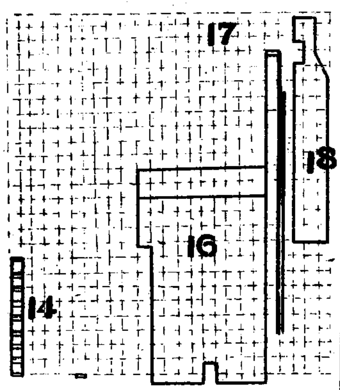


FIG. 29.



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SHEET 7.

FIG. 34.

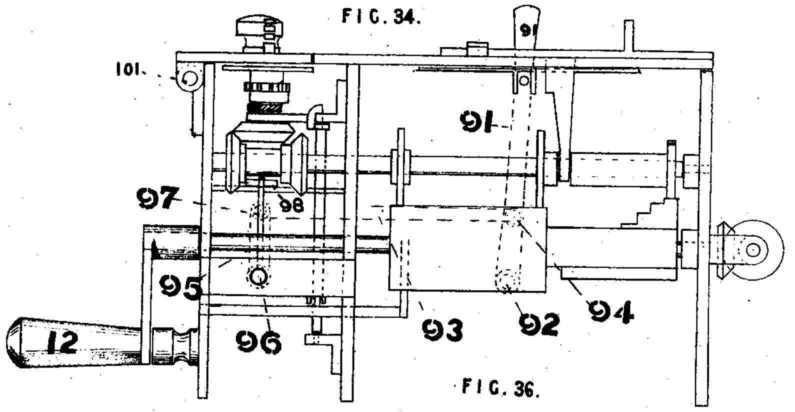


FIG. 36.

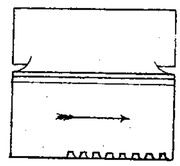


FIG. 37.

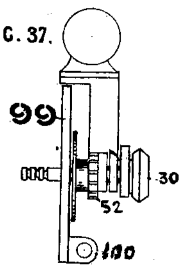
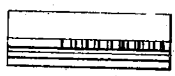


FIG. 38.



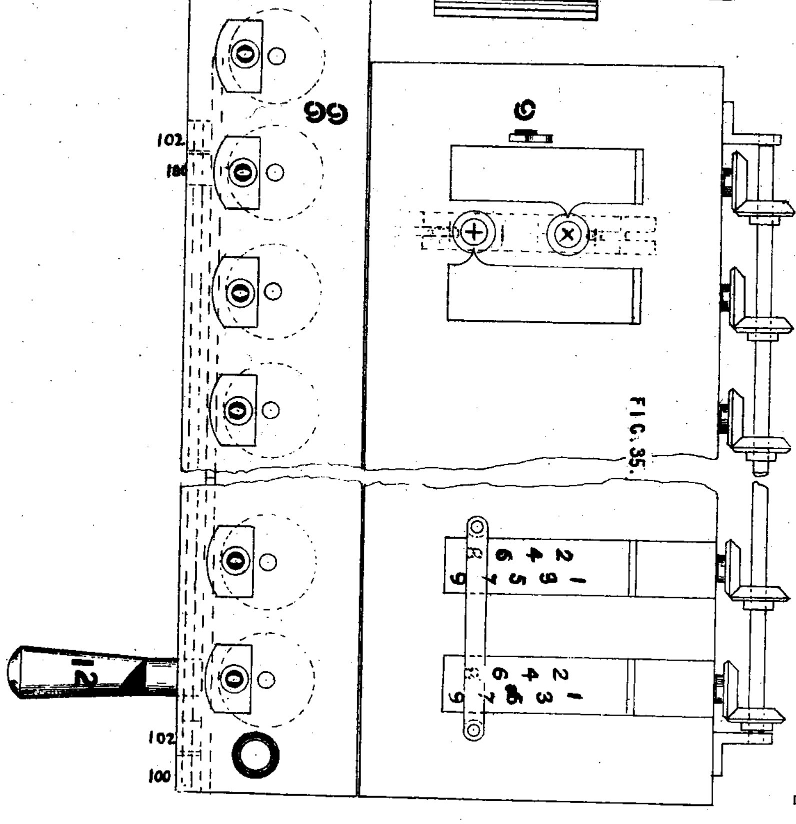


FIG. 35.

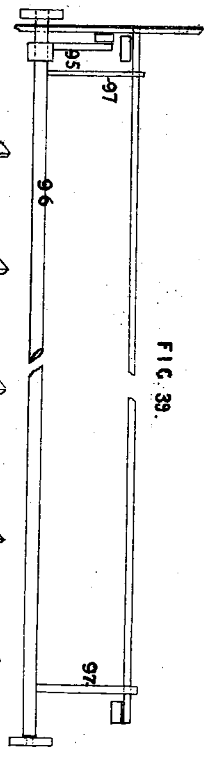


FIG. 39.

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