970,330.

Patented Sept. 13, 1910.

9 SHEETS—SHEET 1.

H. HESS.

METAL WORKING MACHINE.

APPLICATION FILED JULY 18, 1903. RENEWED FEB. 12, 1910.

FIG. 1.

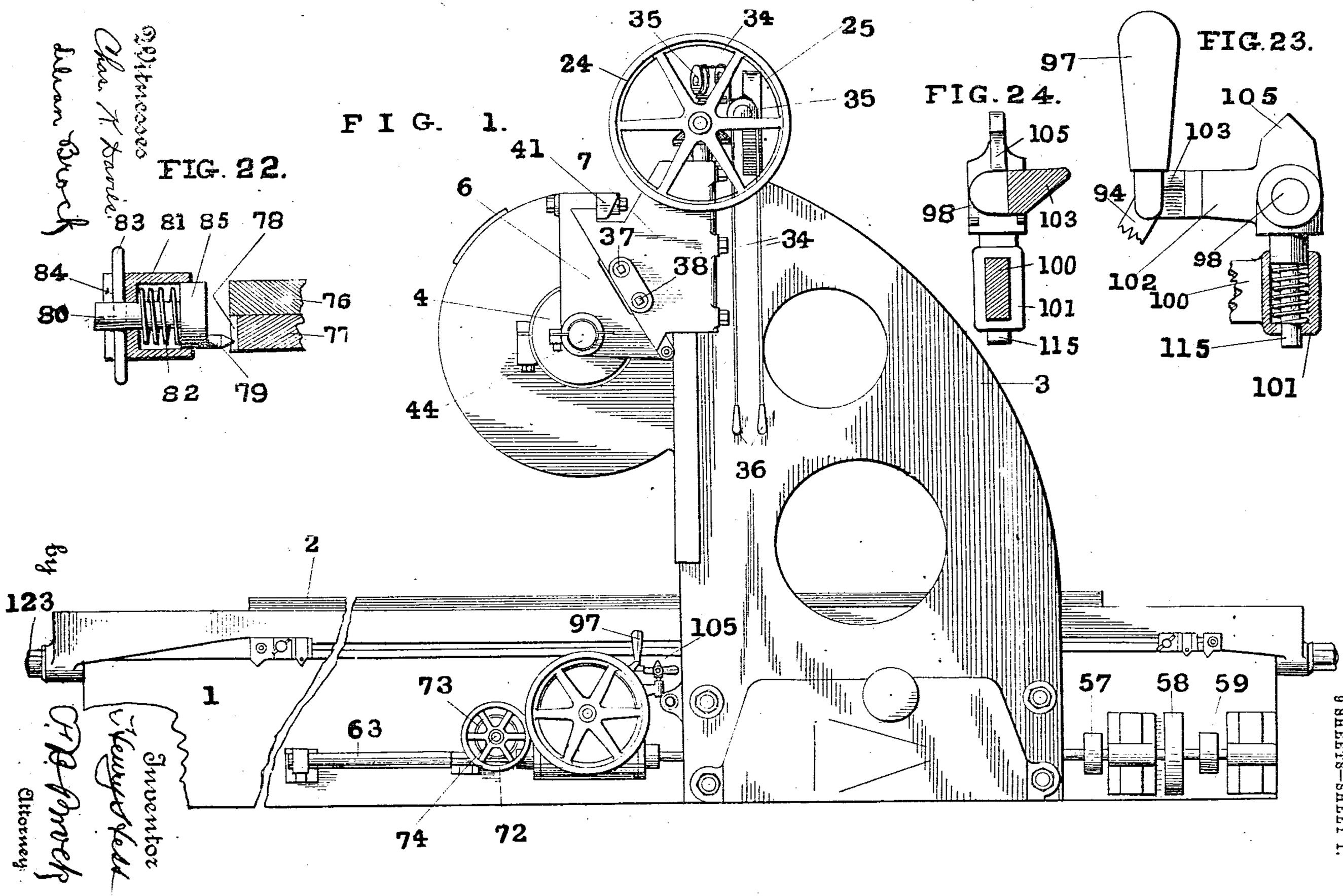

FIG. 22.

FIG. 24.

FIG. 23.

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9 SHEETS—SHEET 2.

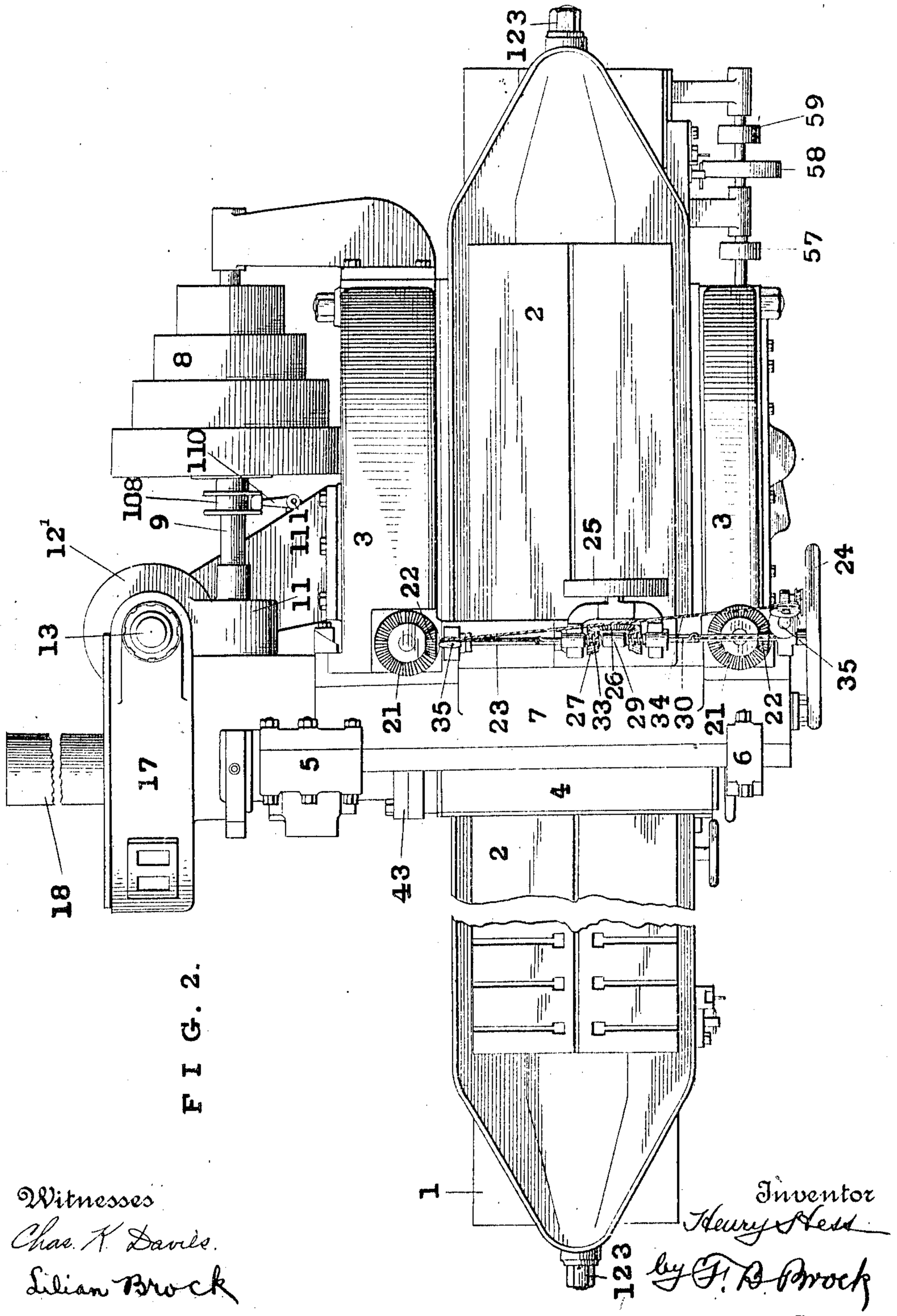

FIG. 2.

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9 SHEETS—SHEET 3.

FIG. 3.

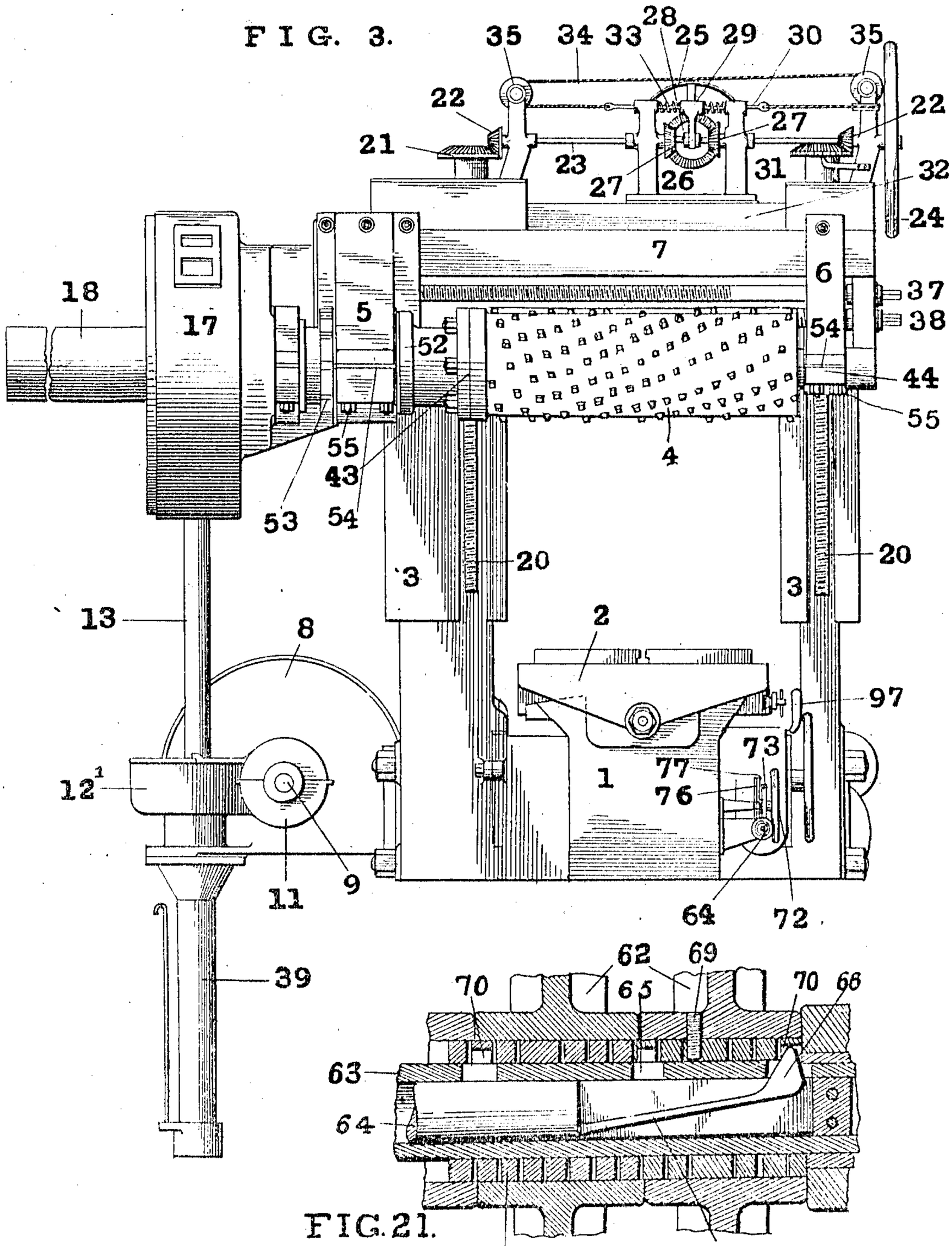

FIG. 21.

Witnesses
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9 SHEETS—SHEET 4.

FIG. 4.

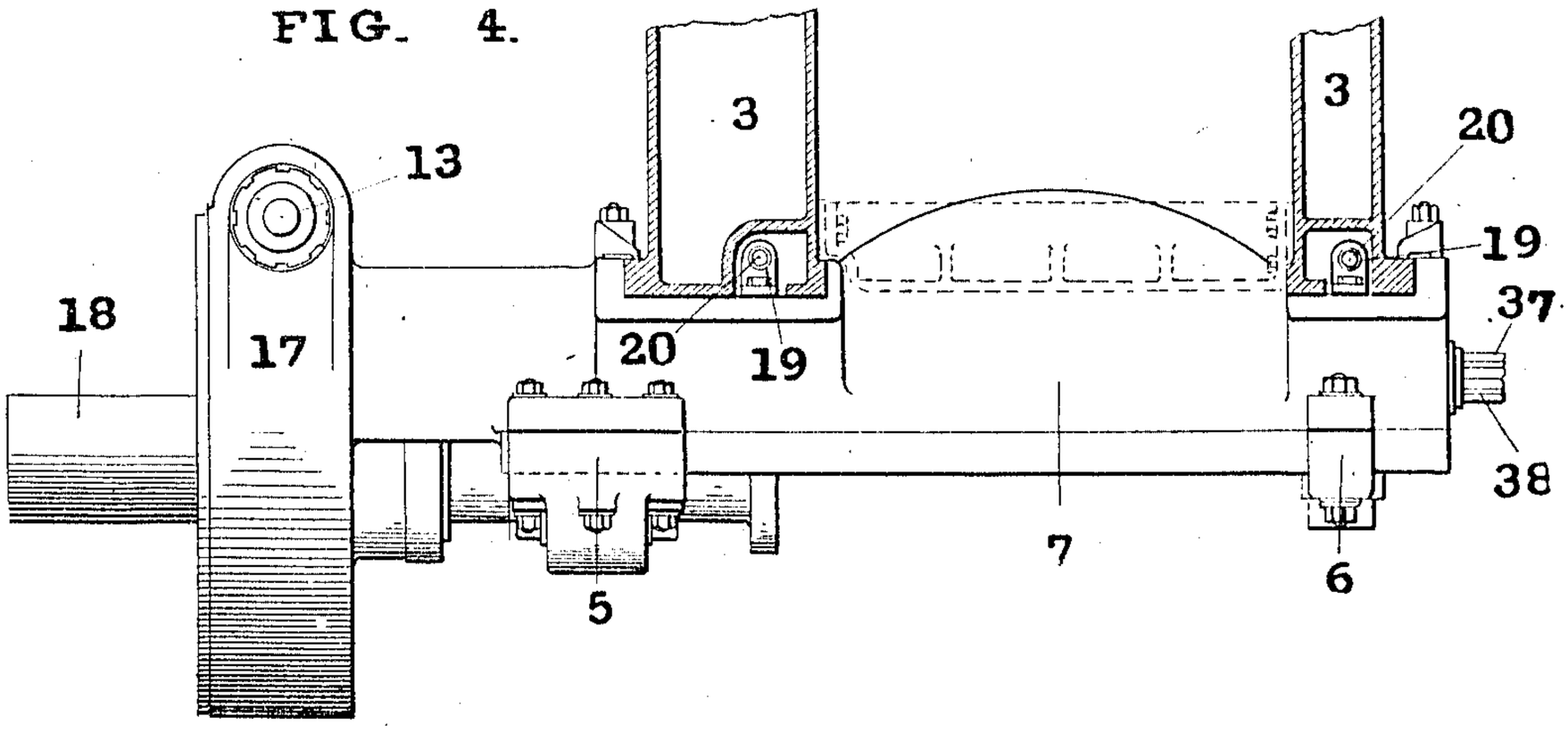


FIG. 5.

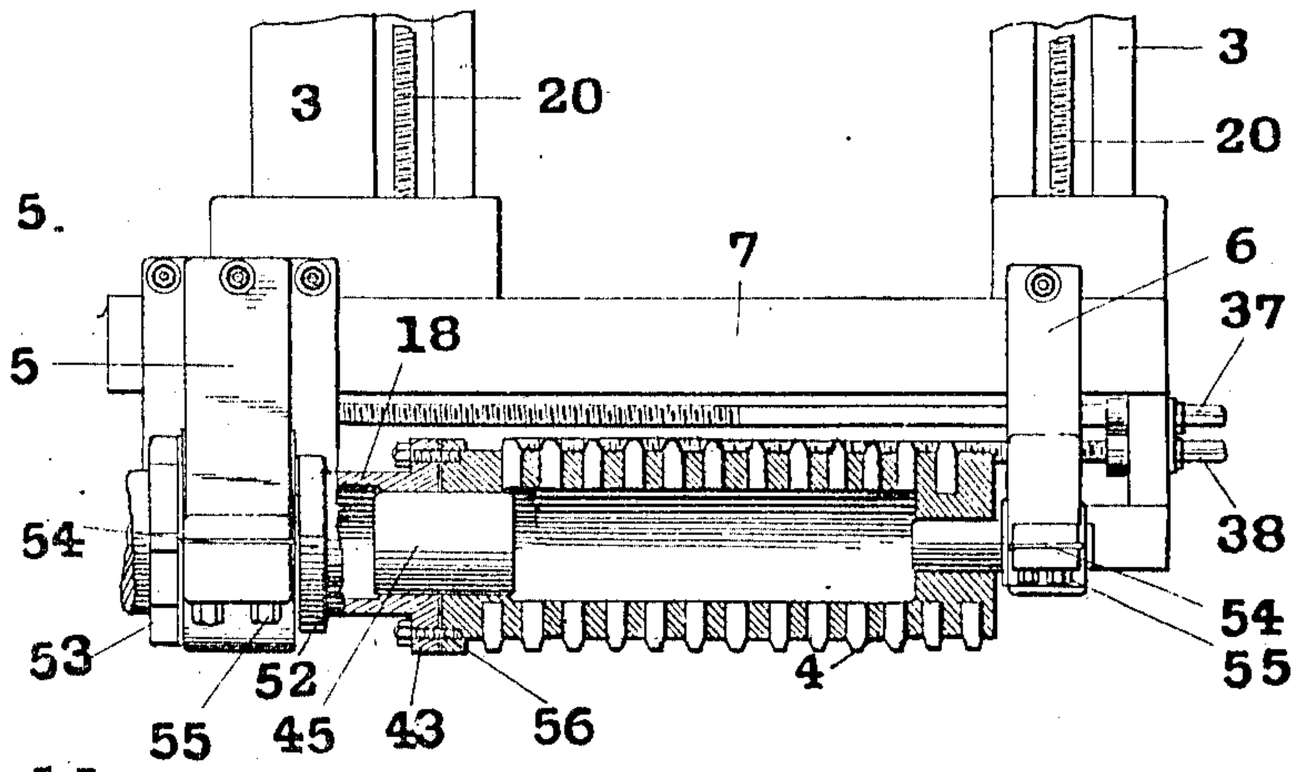
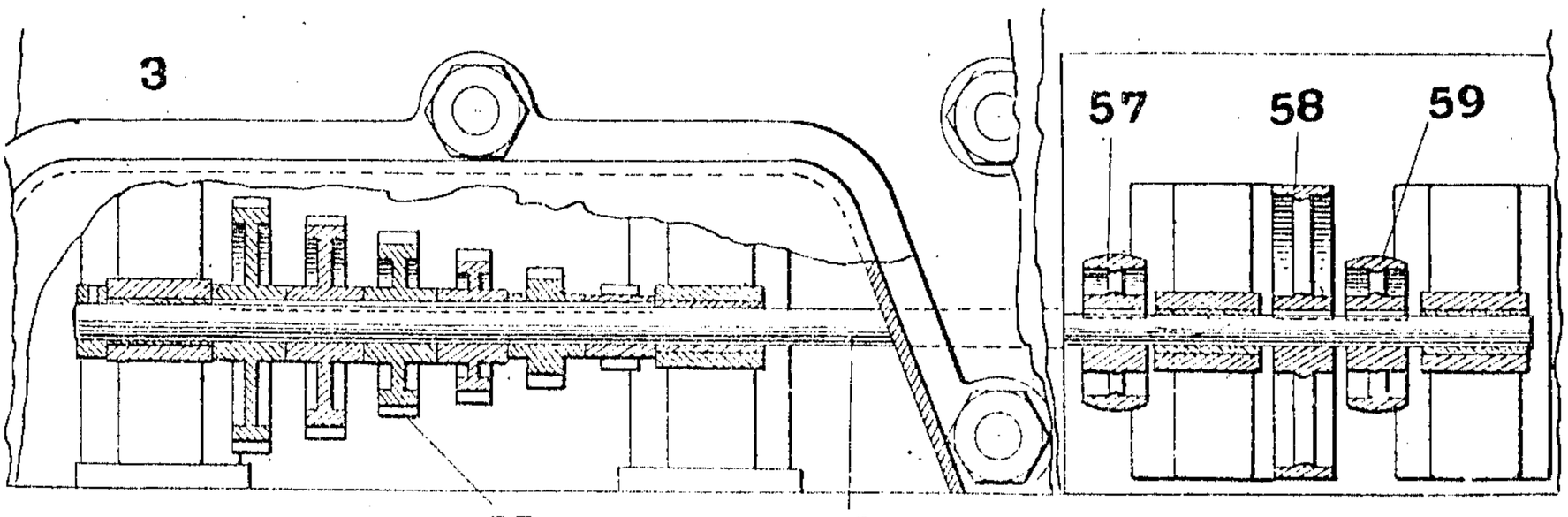


FIG. 11.



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8 SHEETS—SHEET 5.

FIG. 10.

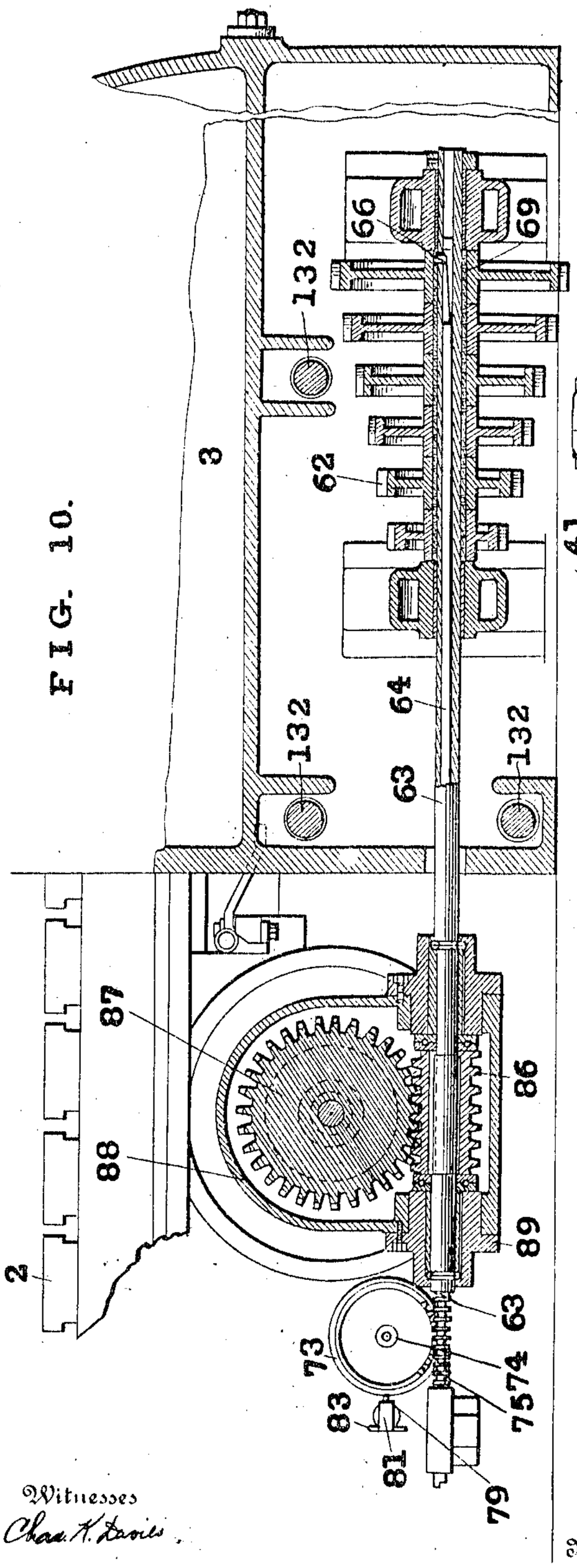


FIG. 9.

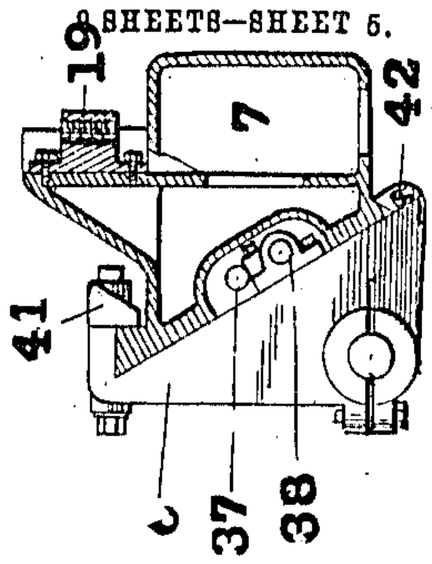


FIG. 8.

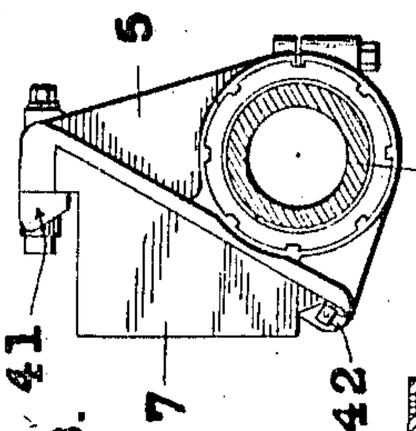


FIG. 7.

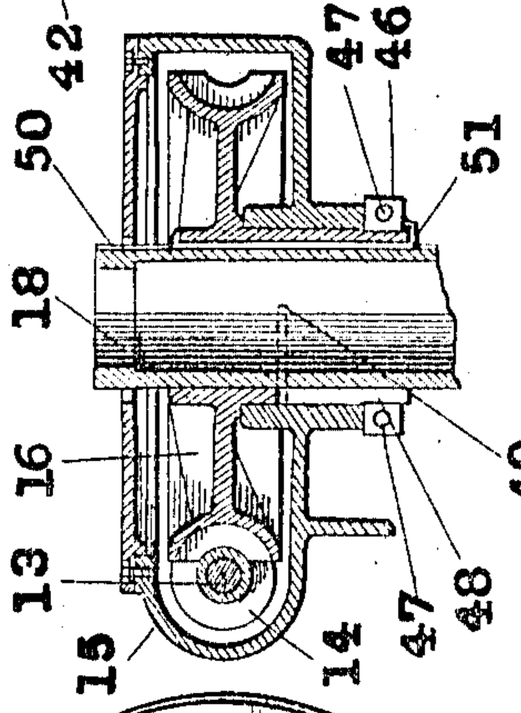
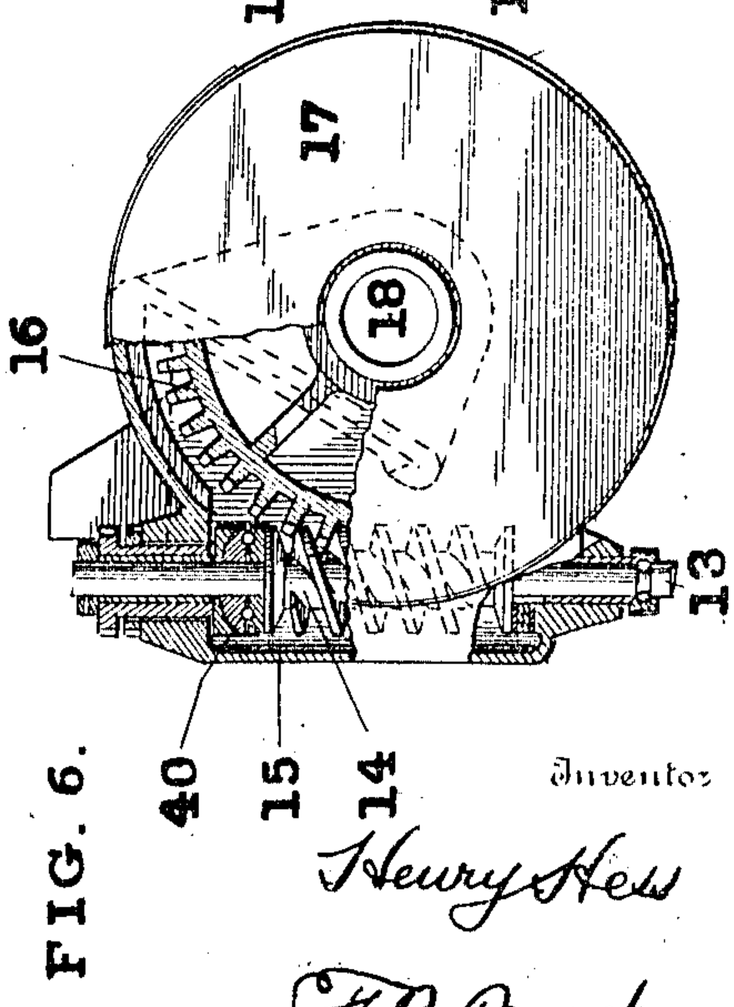


FIG. 6.



Witnesses

Chas. K. Davis

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9 SHEETS—SHEET 6.

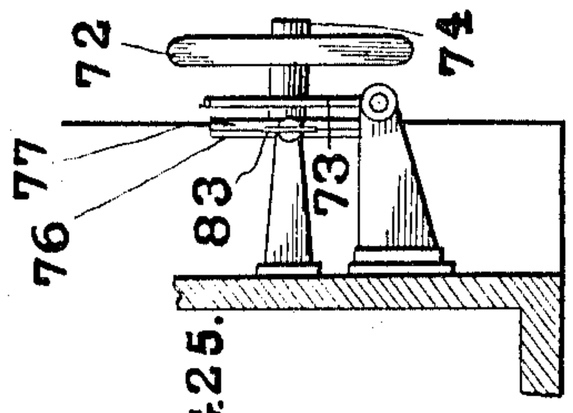

FIG. 25.

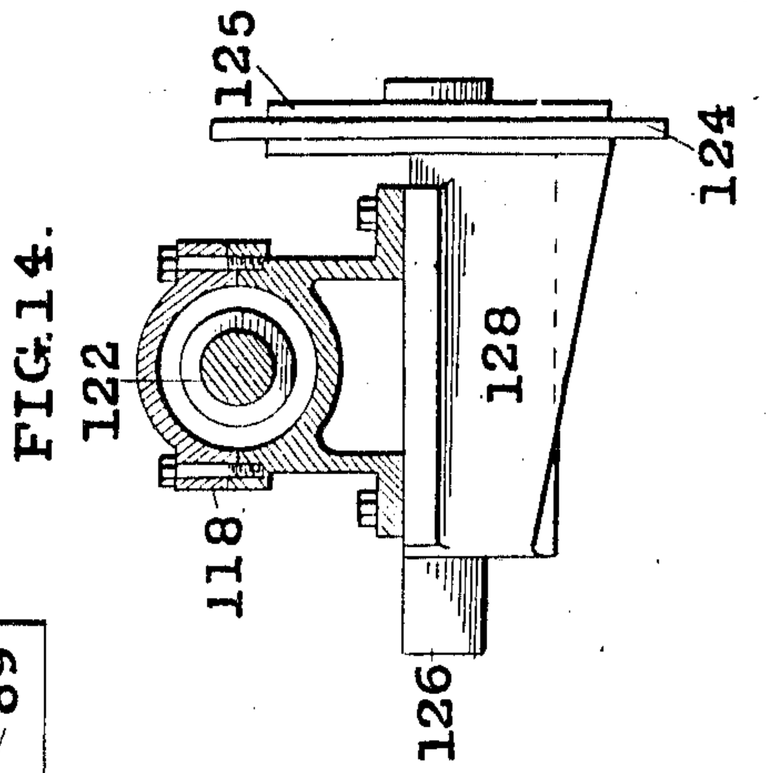

FIG. 14.

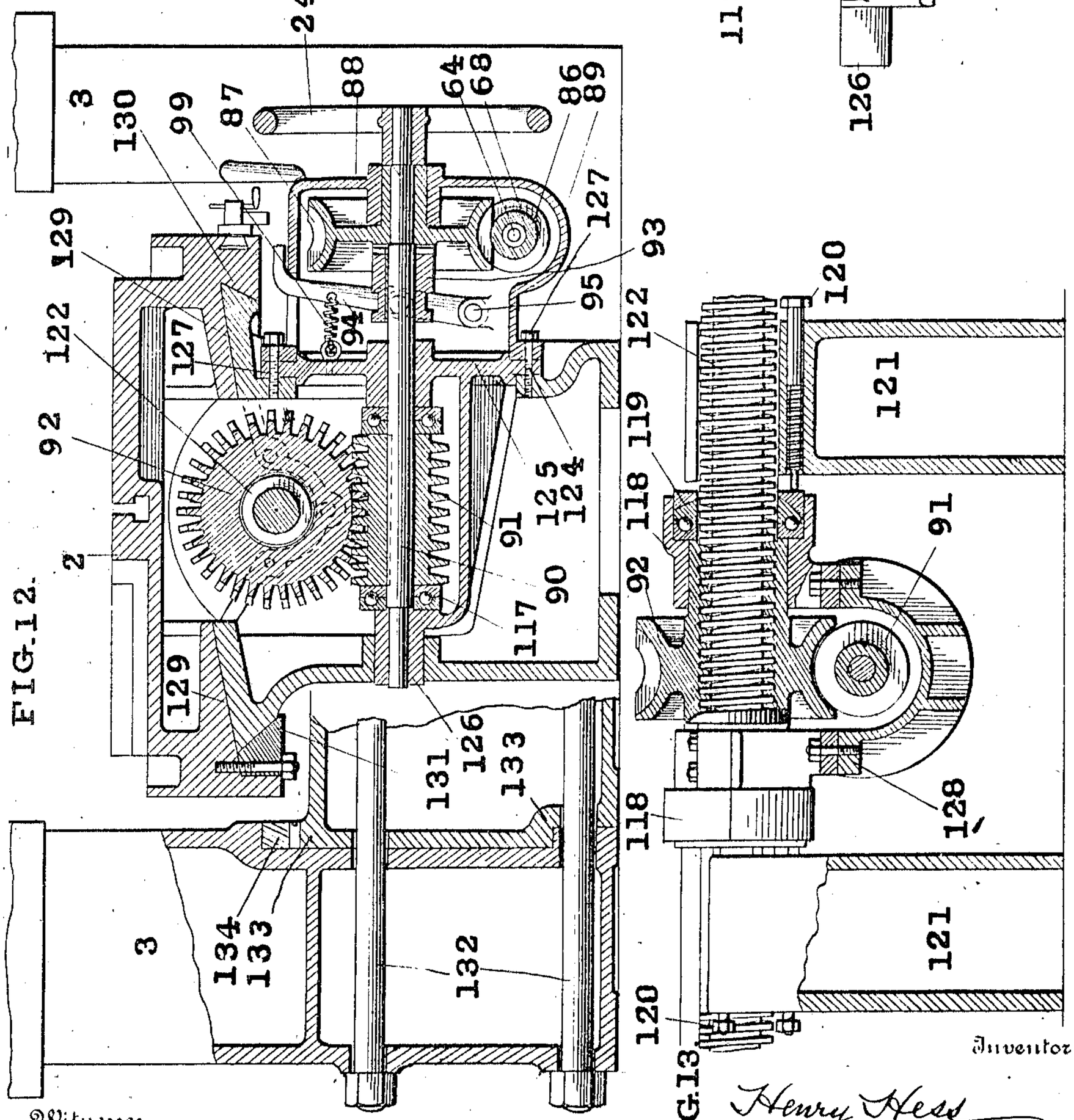

FIG. 12.

Witnesses

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9 SHEETS—SHEET 7.

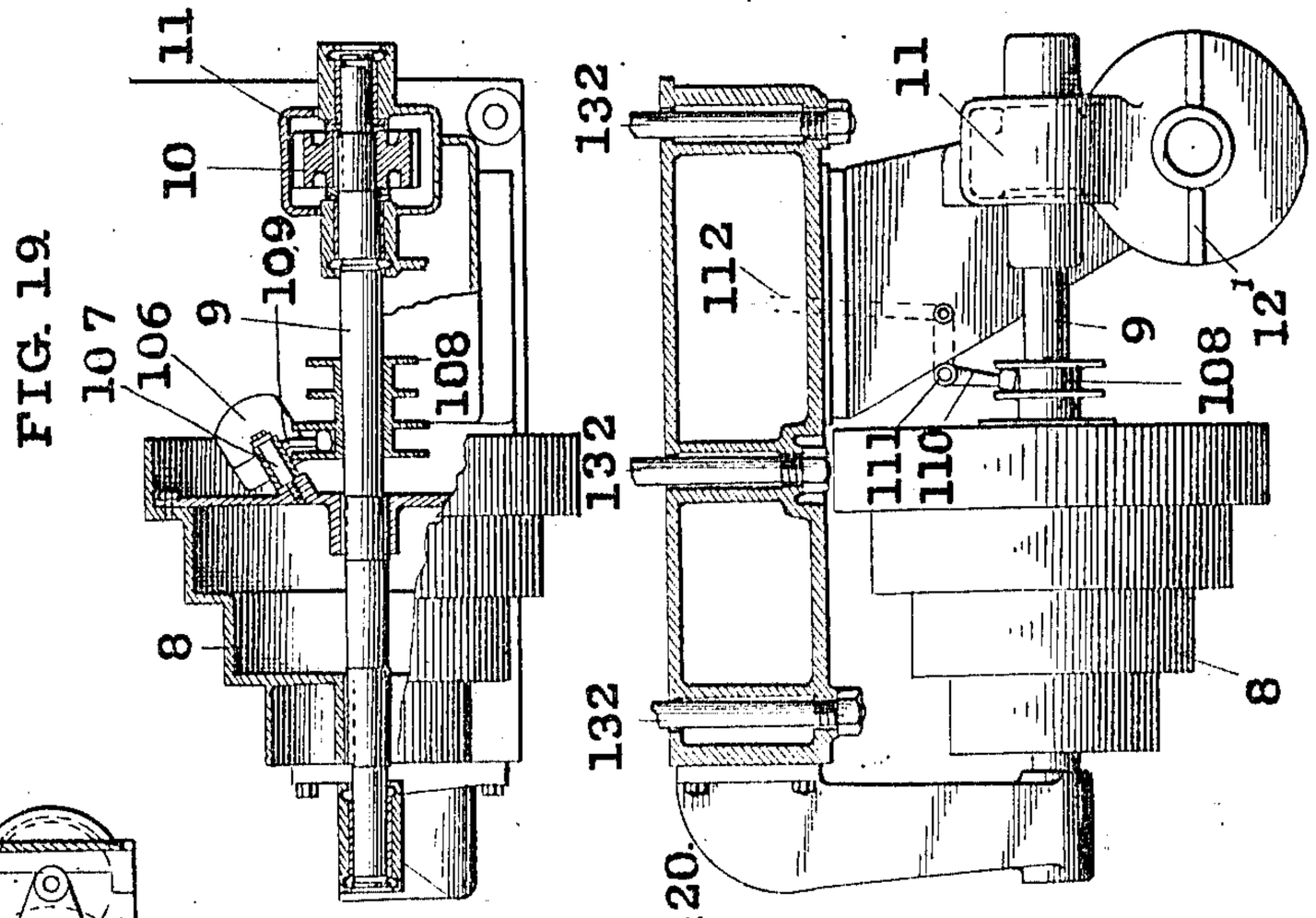

FIG. 19.

FIG. 20.

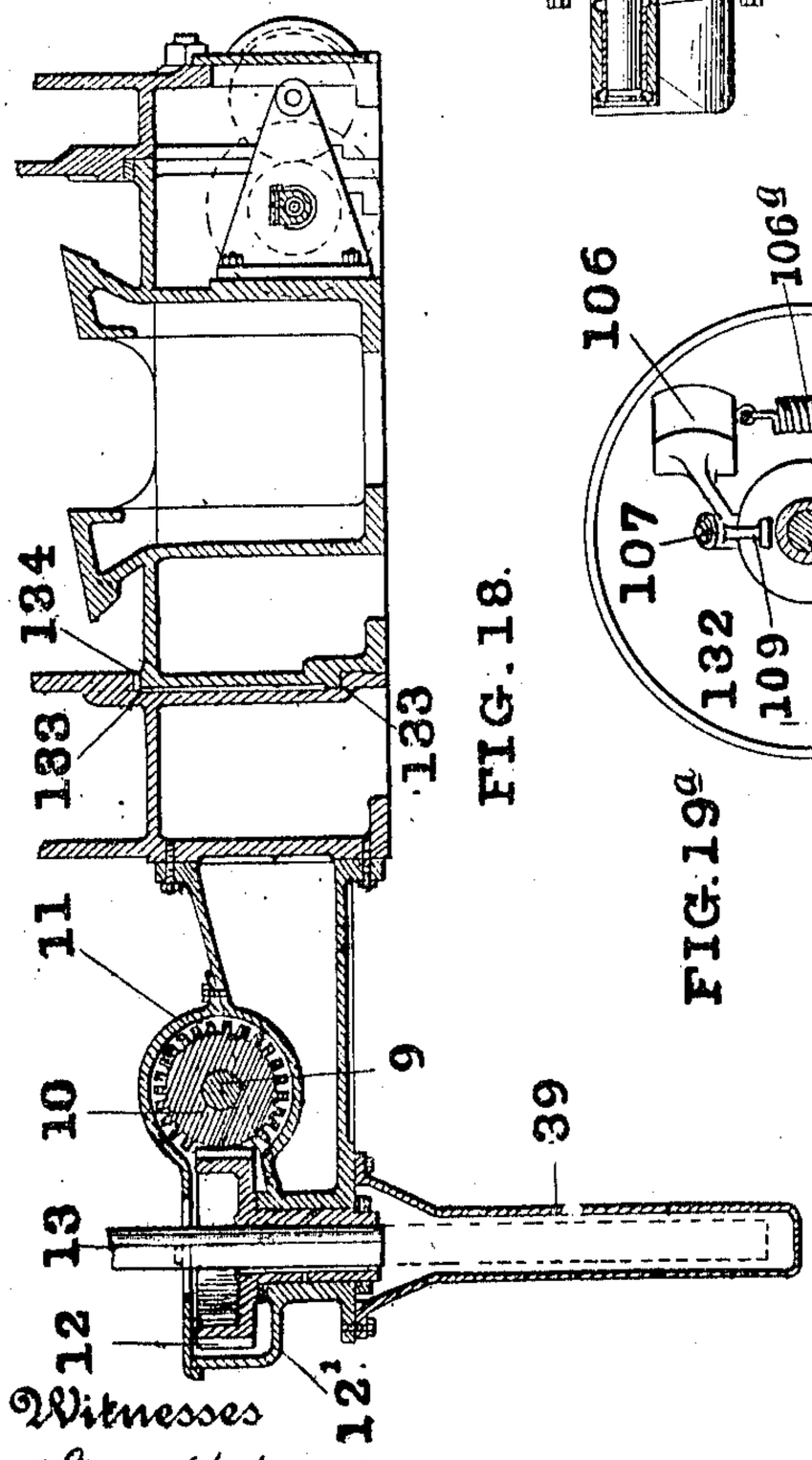

FIG. 18.

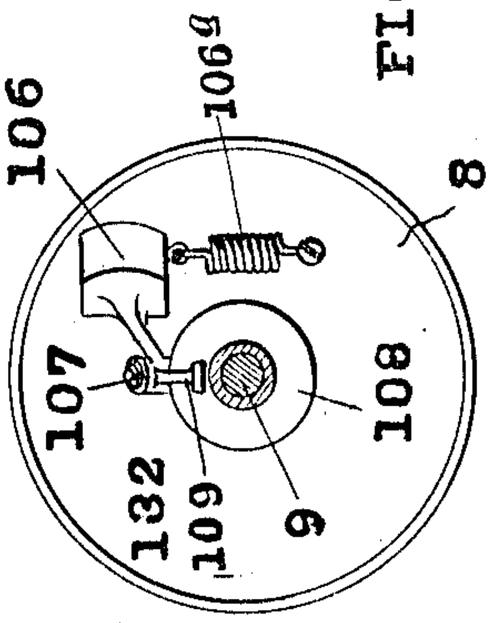

FIG. 19a.

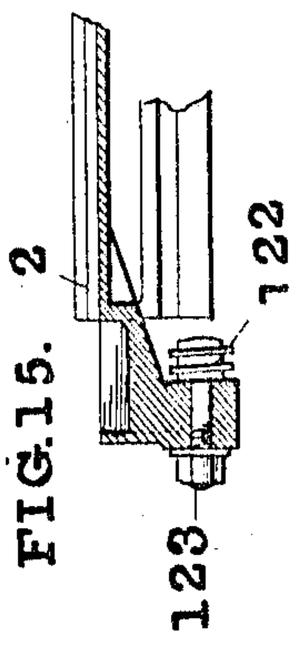

FIG. 15.

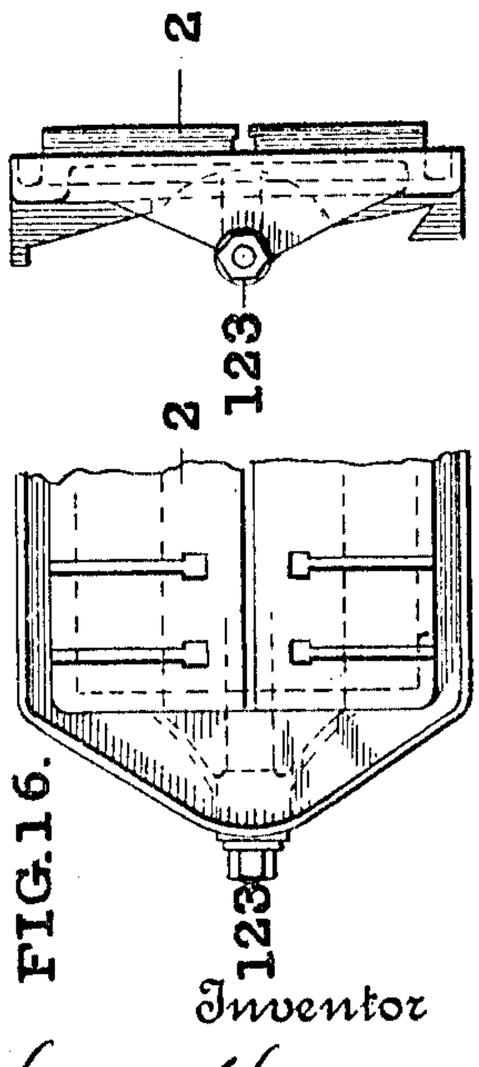

FIG. 17.

FIG. 16.

Witnesses

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METAL WORKING MACHINE.

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9 SHEETS—SHEET 8.

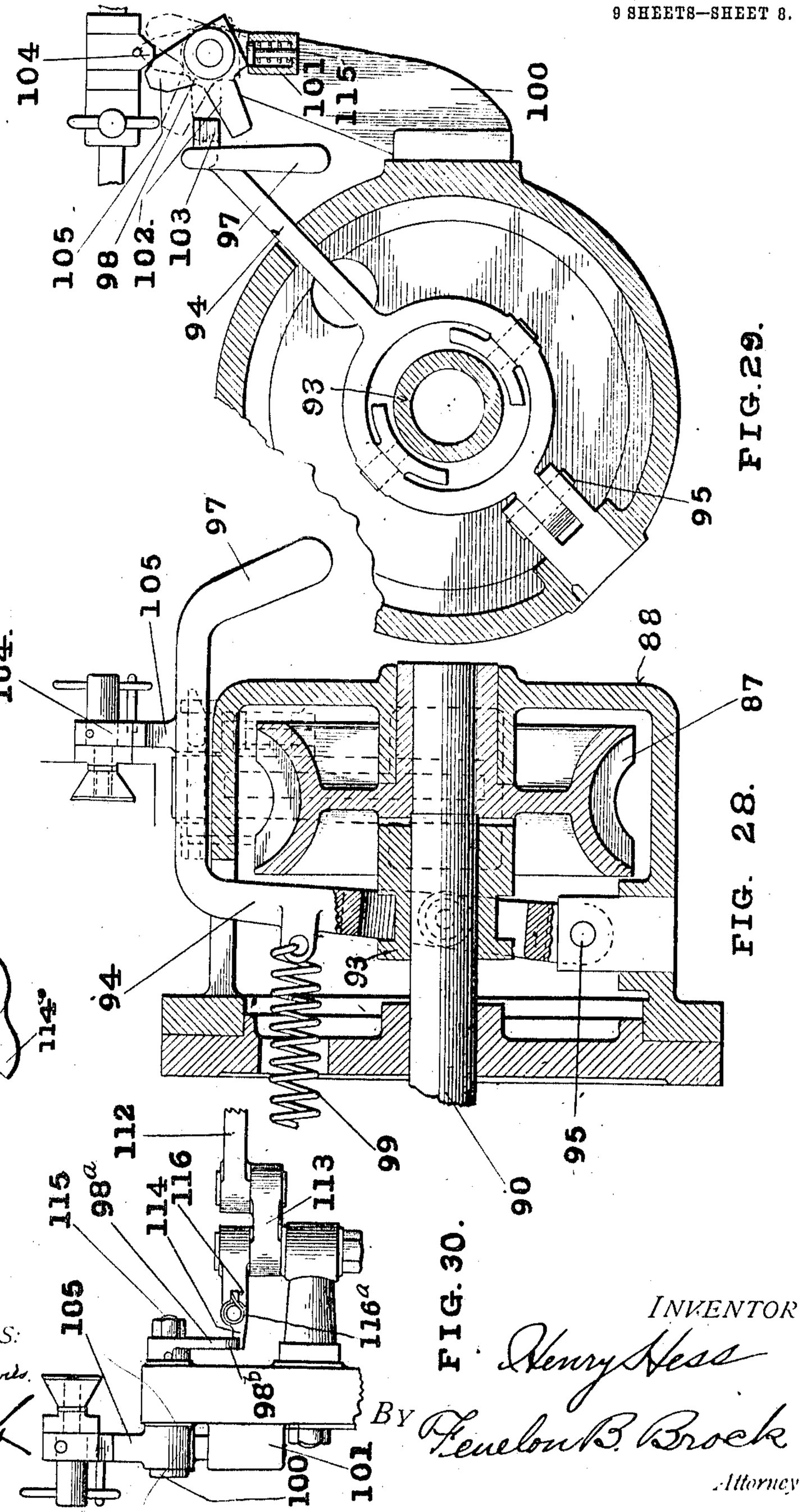

FIG. 29.

FIG. 28.

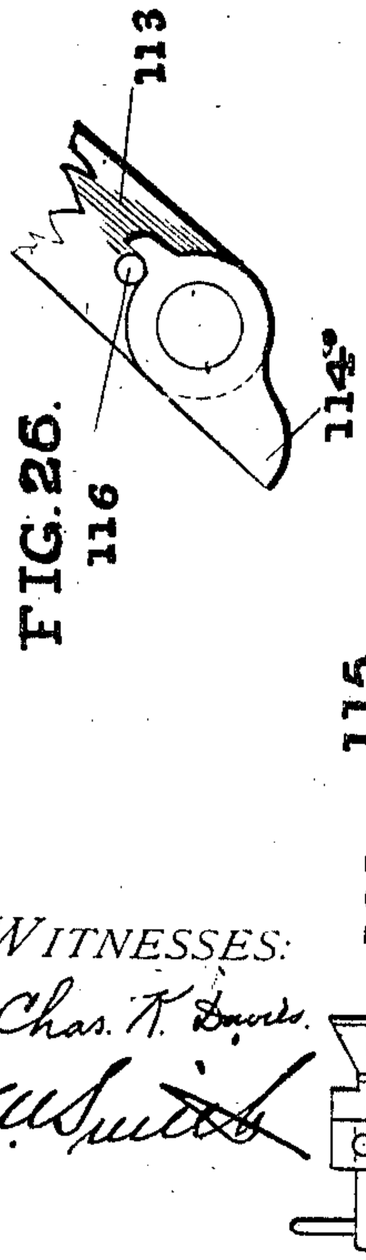

FIG. 26.

FIG. 30.

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APPLICATION FILED JULY 18, 1903. RENEWED FEB. 12, 1910.

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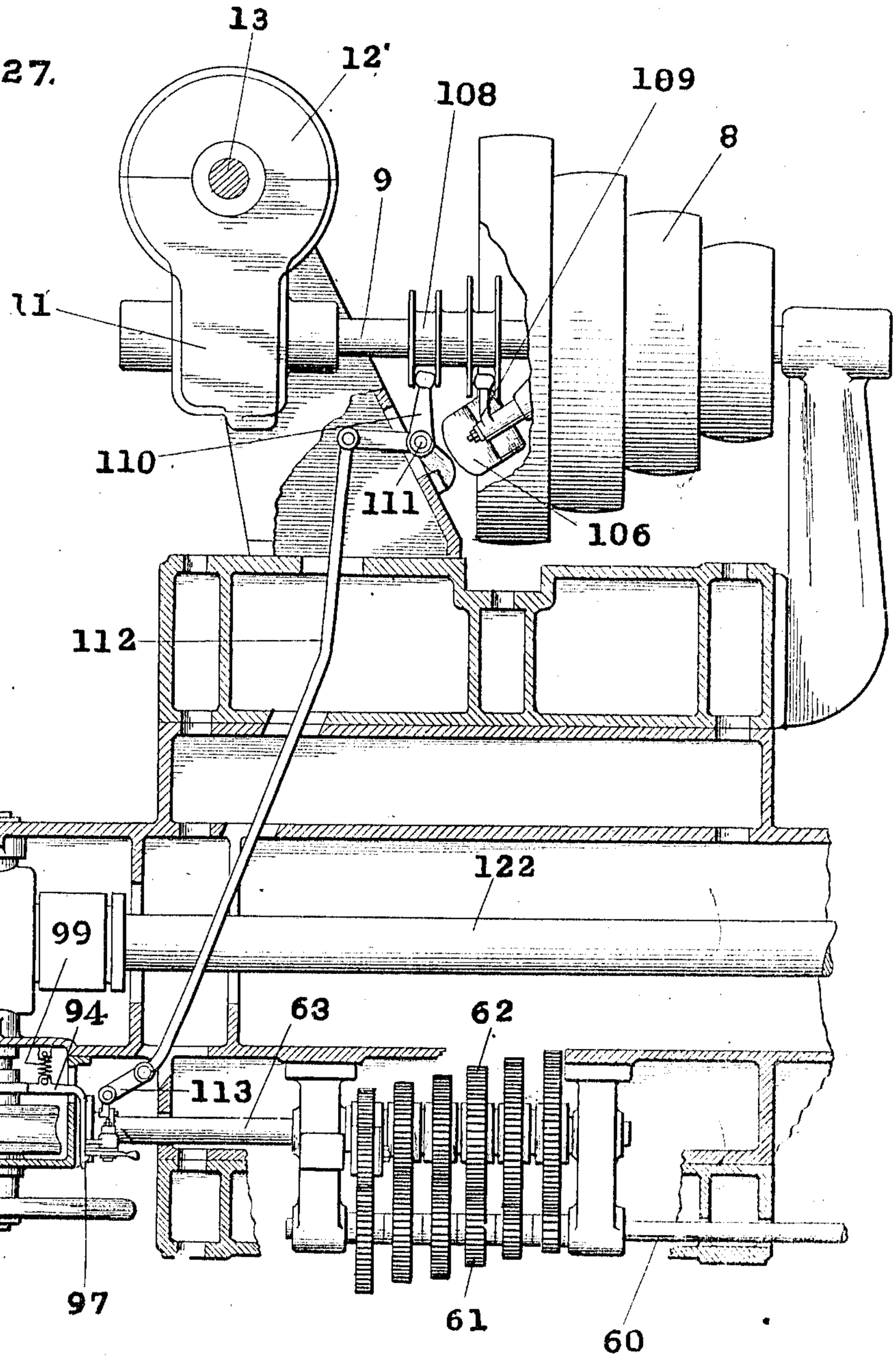
9 SHEETS—SHEET 9.

FIG. 27.



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UNITED STATES PATENT OFFICE.

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METAL-WORKING MACHINE.

970,330. Specification of Letters Patent. **Patented Sept. 13, 1910.**

Application filed July 18, 1903, Serial No. 166,201. Renewed February 12, 1910. Serial No. 543,555.

To all whom it may concern:

Be it known that I, HENRY HESS, of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Metal-Working Machines; and I do hereby declare the following is a full and clear description thereof.

My invention relates to metal working machines and is especially adaptable to milling machines.

An object of the invention is to provide a milling machine adapted to make deep and wide cuts and which may therefore be used in place of slower tools such as planers and shapers. It is important in milling machines to be able to regulate the cutting speed to meet different conditions. These conditions vary with the character of the metal to be cut, the dimensions of the work, depth of cut, etc. The cutting speed depends upon the surface speed of the cutter in relation to the table feed movement, and the surface speed of the cutter depends upon its angular velocity and diameter. The angular velocity of the cutter remaining constant, any change in its diameter varies the cutting speed, and it is necessary to provide means for correcting these variations as well as adjusting the machine to different conditions of work. For this purpose I provide independent power drives for the cutter and the table feed, and interpose change speed gearing of a conveniently operated type in the table drive. By adjusting the change speed gearing the rate of table movement may be varied easily to correspond with the surface speed of the cutter in use. Change speed devices may be also provided, if desired, in the cutter drive. When independent drives for the cutter and table feed are employed it becomes necessary to provide means for stopping the table drive to prevent injury to the cutter or other parts in case the cutter drive is interrupted. This interruption might occur for example, if the cutter is driven by a belt, by breakage of the belt. If the table continued to move contact of the work with the cutter teeth would break them or injure other parts of the machine. I provide automatic means controlled by the cutter drive and acting when the speed of the cutter is decreased below a certain point or the drive is interrupted to discontinue the table drive. This mechanism may be arranged to act substantially instantaneously.

Broadly considered, my invention is not confined to a machine tool like a milling machine in which there is a rotating cutter and a table feed. The cutter is not necessarily a rotating tool and the cutting and feeding movement need not be imparted to different elements; for instance, the tool may have two movements, one of which is a cutting and the other a feeding movement, each of the two separate power drives above mentioned being arranged to effect one of the movements stated. In its broader aspect similarly the automatic throw-off mechanism is controlled by the cutting movement and acts on interruption or retardation thereof to discontinue the feeding movement.

An exemplifying structure which is the best embodiment of my invention which I have up to this time devised will now be described, it being understood that wide variations therein may be made within the spirit of the invention.

Figure 1 represents a side elevation of a milling machine to which I have applied my improvements. Fig. 2 is a plan view of the same. Fig. 3 represents an elevation of the front end of the machine. Fig. 4 is a plan of the cross-rail, and some of the connected parts, with the housing or standard partially broken away and shown in section. Fig. 5 is a side elevation of the cross-rail showing in section a cutter and means for mounting same. Fig. 6 is an elevation and partial section of the gear and worm for driving the cutter spindle. Fig. 7 represents a central sectional view of the same. Fig. 8 represents an end elevation of the cross-rail, one of the cutter heads, and a cross-section of the cutter spindle. Fig. 9 is a cross-section of the cross-rail and end elevation of one of the cutter heads. Fig. 10 is a sectional view through a portion of the housing showing some of the feed and change-speed gears. Fig. 11 is a detail view with parts broken away of a portion of the change-speed table-feed gearing. Fig. 12 is a transverse section of the housing, bed, table, feed-gear and clutch mechanism. Fig. 13 is a sectional view of the housing and a portion of the feed-screw gear. Fig. 14 is a detail section showing the feed-screw, its bearings and attached parts. Fig. 15 is a

longitudinal section of one end of the bed showing the table thereon. Fig. 16 is a plan of one end of the bed and table. Fig. 17 is an end view of the same. Fig. 18 is a cross-section through the housing and bed showing a portion of the cutter drive gearing in section, and also showing the shouldering of the housing on the bed-cheek. Fig. 19 is a longitudinal sectional view, with parts broken away and in elevation, of the cone drive for the spindle and means for driving the feed-train independently of the spindle. Fig. 19ª is a detail view of the automatic throw-off mechanism associated with shaft 9, showing said shaft in section and looking toward cone pulley 8. Fig. 20 is a plan of Fig. 19 showing the housing in section. Fig. 21 is a detail longitudinal sectional view of the change-gear clutch mechanism. Fig. 22 is a detail sectional view of part of the mechanism employed in reversing the clutch mechanisms of the change gears. Fig. 23 is a detail view of a portion of the mechanism for throwing out the feed-drive. Fig. 24 is another view of the mechanism of Fig. 23. Fig. 25 is a detail elevation and section of the feed-selecting operating wheel, and some of its attachments. Fig. 26 is a detail view of lever 113 and nose 114. Fig. 27 is a plan view in section, showing all parts of the automatic throw-off mechanism in proper relation, also portions of the spindle drive mechanism and the table drive gearing in assembled relation. Fig. 28 is an end sectional elevation taken through the housing of the spiral gear 87, and showing clearly the throw-off clutch, hand lever, table-trip, and operating mechanism. Fig. 29 is a side elevation of the mechanism of Fig. 28. Fig. 30 is a detail, showing especially a portion of the automatic trip mechanism.

In the drawings the bed 1 carries the table 2 adapted to reciprocate thereon. At the sides of the bed are standards 3 which carry the milling spindle.

The milling cutter 4 is carried by heads 5 and 6 secured to a cross-rail 7 capable of vertical adjustment upon the standards 3. The milling cutter 4 is driven by a cone 8 on a shaft 9 having a spiral pinion 10 inclosed in a housing 11 which meshes with a spiral gear 12 fast on a vertical shaft 13 and inclosed in a housing 12′. The upper end of shaft 13 is provided with a worm 14 inclosed in a housing 15 which meshes with a worm-gear 16, in a housing 17, fast on the spindle 18. Spindle 18 is carried in the heads 5 and 6 on the cross-rail 7, and carries the cutter or milling tool 4.

The cross rail 7 and the parts carried by it constitute in effect a holder for the milling cutter or tool 4; and in certain of the claims herein when reference is made to a "tool holder" it is intended to designate the rail 7 and parts carried thereby with the exception of the cutter 4; and similarly when the "tool" is referred to it is intended to designate the milling cutter 4. The vertical adjustment of cross-rail 7 is had by means of the nuts 19 bolted to the cross-rail, through which pass vertical screws 20 journaled in housing 3, and carry at their upper ends bevel gears 21 meshing with bevel pinions 22 mounted on shaft 23. The hand adjustment of the cross-rail is effected through hand wheel 24 fast on shaft 23, which rotates the screws 20 in either direction through the gearing just described. The power adjustment of the cross-rail is provided for by the pulley 25 fast on a shaft carrying the reversing bevel gear 26 which meshes with a pair of gears 27 normally loose on the shaft 23. Slidably mounted on shaft 23 is a clutch spool 28 adapted to be shifted into engagement with either one of the loose gears 27 for the purpose of engaging either gear and causing that gear to rotate with the shaft 23. The clutch spool 28 is shifted by means of a sliding arm 29 carried on a rod 30 slidably mounted in the standards 31 on the top rail 32 of the housing 3. Springs 33 hold the clutch spool 28 normally disengaged from the gears 27. Ropes 34 are secured to each end of the rod 30 and pass over pulleys 35 and terminate at the side of the housing in handles 36 by means of which the spool clutch 28 may be shifted either way against the springs 33 and cause the rotation of the screws 20 in either direction, for the purpose of raising or lowering the cross-rail 7 and the spindle 18. Upon releasing the tension of either handle 36 the springs 33 cause the disengagement of either gear 27 with the spool clutch 28 and arrest the adjustment of the spindle at the proper point.

From the foregoing description it will be seen that the spindle is provided with a powerful and positive drive, even when using cutters of the maximum length and diameter, enabling the cutter to take deep cuts steadily and without chattering.

The adjustments of the heads 5 and 6 on the rail 7 are secured by the screws 37 and 38 and provide for the insertion of different sizes of cutters 4.

In raising the cross-rail 7 through either the hand or power-drive, the vertical shaft 13 is raised or lowered with the spindle by reason of the engagement of the worm 14 with the worm-gear 16, the worm being fast on shaft 13. Shaft 13 slides up and down in the shaft-box 39 disposed below the machine-bed, spiral gear 12 being splined to shaft 13 to permit of such adjustment. The thrust of shaft 13 is taken up by bearings 40 which are preferably ball-bearings, the bearings and shafts being provided with the adjustments shown in Fig. 6.

The heads 5 and 6 are preferably secured to the cross-rail 7 by means of gibs 41 adjustably set for wear, the inner contacting faces of the heads and rail being inclined, as shown in Figs. 8 and 9. The lower connecting points are preferably bolt and slot connections 42 which permit the adjustment of the heads upon the rail.

Spindle 18 terminates in the flange 43 to which the cutter 4 is clamped, the other end of the cutter being journaled in head 6 in bearings 44.

Fig. 5 shows in section a cutter connected with the spindle. The cutter is centered by a plug 45 which may be an integral part of spindle 18 or separate therefrom.

The endwise adjustment of the worm-gear 16 upon the cutter spindle 18 is secured by means of a halved or split collar 46, which is drawn together over the hub of the gear by means of bolts 47 and firmly grips the hub of the gear on the spindle. In order to secure the necessary resiliency to the hub at the point where the clamping is effected, it is split longitudinally at 48 and transversely at 49. The spindle is splined at 50 in which a key 51 takes which permits the adjustment of the spindle in the worm-gear 16.

In milling machines subjected to great strain the above described method, or its equivalent, of securing the worm-gear to the spindle, is necessary.

The spindle 18 is secured in the head 5 on the cross-rail by means of a fixed collar 52 on one side thereof, and an adjusting nut collar 53 on the opposite side. The nut and collar hold the spindle against endwise movement on the rail. Both the bearings in the heads 5 and 6 are split at 54 and provided with adjusting bolts 55 for taking up wear. Screws 56 connect the cutter-head with the drive spindle. The table feed drive is through the pulleys 57, 58 and 59 which are fast on the shaft 60. One of these pulleys is adapted to be driven by a crossed belt to give reverse motion, the other two giving different speeds.

An important feature of my invention is the provision of change speed gearing intermediate the table and its source of power by means of which the rate of feed in relation to the surface speed of the cutter may be readily adjusted. This change speed gearing will now be described.

Upon feed shaft 60 is located a feed gear-nest 61, in this instance comprising six different rates of speed. The complemental gear nests 62 are mounted upon a shaft 63 which transmits the motion to the feed nut which will presently be described. The mountings of the two sets of feed gear-nests are preferably in the housing 3, it being shown broken away in Figs. 10 and 11 for the purpose of illustrating the same. The loose gears 62 are each provided with a clutch mechanism and a feed selecting device by means of which any one gear of the nest may be locked to the shaft 63 for the purpose of putting in operation the desired feed. This selective feed clutch mechanism will now be described:

The shaft 63 is tubular and through it passes a rod 64 adapted to reciprocate within the shaft. Shaft 63 is provided with slots 65 at intervals adjacent to the hubs of the gears 62. Upon the outer end of the sliding rod 64 is a feather 66 which is secured to the end of the rod 64 by a spring 67 so as to be free to enter any one of the slots 65 or recede therefrom as the rod 64 is reciprocated within the shaft 63.

The hub of each loose gear 62 of the nest is provided with a coil spring 68 secured to the hub at an intermediate point of its length by pin 69 and having coils at either side of the point of fastening 69 adapted to form a portion of the clutch mechanism in either direction of motion of the gears 62. To secure this result the outer ends of the springs 68 are formed with an eccentric cut 70 which terminates at one end in an abutment 71 adapted to be engaged by the feather 66. As rod 64 slides along within the shaft 63 the feather 66 will enter any one of the slots 65 when it comes opposite the same and the outer end of the feather will, during the same period of revolution of the shaft, enter the eccentric cut or opening 70 and traverse the same until it comes squarely up against the abutment 71. The feather will then take the spring with it and gradually coil it up upon the shaft 63 until the coil takes a firm grip upon the shaft and the shaft and gear revolve together. If it is desired to drive the gear in the opposite direction, the rod 64 is moved along the shaft, the inclined edges of the feather causing it to be drawn out of the slot 65 when it will enter the slot at the opposite end of the coil 68 so that the gear may be moved in the reverse direction as before described. The feather preferably works in a slot in the end of rod 64 which slot serves to steady the movement of the feather 66.

The feed of the particular gear is selected by means of a hand device comprising a hand-wheel 72 mounted at the side of the bed and carrying a gear 73, both on a shaft 74. The gear 73 meshes with the rack 75 on the rod 64, the rod being projected beyond the worm which drives the feed nut train of gears.

Mounted on shaft 74 are disks 76 and 77 shown in detail in Fig. 22, each of which is provided with a series of notches 78 indicating the particular gears of the gear train nests 61 and 62 which are desired to be driven. These notches on disks 76 and 77, corresponding to the desired gear, are

brought into proper position and held by a spring dog 79. This dog is mounted on a stem 80 in a box 81 mounted on the bed or housing and is pressed toward the notches by a spring 82. Dog 79 is mounted at one side of the stem 80, on a head 85, the stem being oscillated by an arm 83 resting in a notch 84 in box 81. By giving the stem a half turn the dog may be thrown into engagement with the notches on either disk 76 or 77, one of the disks showing positions of engagement of the feed train in one direction and the other disk for the reverse motion.

Mounted on shaft 63 is a worm 86 meshing with worm gear 87 in housing 88 alongside or under the table 2. Worm 86 is preferably provided with ball bearings to take up the end thrust, and the housing 89 of the worm, supports the housing 88 of the worm gear 87. The worm gear 87 is loose on a shaft 90 journaled in the bed transversely of the machine. This shaft 90 carries a worm 91 fast on the shaft which meshes with worm gear 92 which is the main feed nut of the machine. Worm gear 87 is provided with a clutch device by means of which it is normally made fast with shaft 90 so as to rotate therewith. For this purpose the hub of worm 87 is provided with teeth within which a sliding splined clutch 93 engages. The clutch is operated by a lever 94 pivoted at 95 and trunnioned at 96 to the clutch 93 and having an operating handle 97. Lever 94 holds the clutch in engagement by a dog 98, and a spring 99 throws the clutch 93 out of engagement with the gear 87 whenever the dog is released. In its normal position the gear 87 is clutched to the shaft 90.

The dog 98 is mounted on a projecting bearing 100 having a jack-in-the-box 101. The dog is provided with a horizontal projecting arm 102 which engages normally a nose 103 on the lever 94, having an inclined face, and holds the clutch in engagement. An adjustable trip 104 on the table is adapted to operate the dog 98 and throw out the feed within any desired limits of table traverse in either direction. This is accomplished by providing the dog 98 with an upwardly projecting arm 105. As the trip 104 passes the arm 105, it depresses the jack-in-the-box 101 and the arm 102, thereby withdrawing the latter from contact with the inclined nose 103 on the lever 94, and permitting the spring 99 to throw the clutch 93 out of engagement with the gear 87.

The feed train is driven independently of the spindle drive. With this arrangement breakage would result were the spindle drive to be interrupted. To provide against such a contingency the following device is provided which will throw out the feed whenever the spindle stops

On the front face of the driving cone 8 is pivoted at an angle one or more weights 106 provided with arms 109 pivoted angularly to the cone in bearings 107. When the cutter is checked so that it falls below a certain speed of rotation or stops, stepped pulley 8 is correspondingly retarded and the lessened centrifugal force exerted on weights 106 permits them to be pulled toward shaft 9 by contractile spring 106ª. This causes arms 109 to swing in an angular plane and to move sleeve 108 longitudinally on shaft 9.

Within the flange or sleeve 108 rests one arm of the bell-crank lever 110 pivoted at 111, the other end of which is pivotally connected to a rod 112. This rod is pivoted to another pivoted lever 113 having a nose 114 adapted to engage the dog 98 and thereby free the clutch 93 in the manner before described. The dog 98 for this purpose is provided with an arm 98ª projecting downwardly from the rear of the dog spindle 115 which is operated by the nose 114 of the lever 113. The nose 114 is pivoted to the lever 113 and provided with a stop 116 which holds the nose rigidly when the dog is operated and permits the nose to repass the dog for the purpose of being reset, a spring 116ª urges nose 114 to normal position against stop 116.

The worm 91 on clutch shaft 90 is preferably provided with ball bearings 117 to take up the end thrust of the shaft. The feed nut or worm gear 92 is housed in a bearing 118 provided with ball bearings 119 at each end to take up the end thrust. These bearings 119 are adjustably set by a series of screws 120 in the cross ties 121 on both sides of the gear. The hub of gear 92 is elongated to give a steady rigid bearing to the gear or nut. The feed screw 122 is fixed and bolted at each end at 123 to the ends of the table 2. The hubs of both gears 91 and 92 are carried by the bearings 118 and 119.

The casing 88 which houses the clutch worm and gear 86 and 87 is attached by a circular flange 124 to a seat turned on the face of plate 125. This plate 125 carries the journals of the worm 91 and is centered by a hole bored out in the web of the bed and secured to a circular seat by bolts 127. The rear journal box 126 of shaft 90 fits a hole bored in the bed which serves to both support and aline it. The seats 128 (Fig. 13) formed on the oil casing or housing of worm 91 serve as supports for the bearings 118.

The bed-ways 129 have a slight inclination from the horizontal, which imparts to the table 2 a tendency to slide cross-wise of the bed, the effect bringing the wear against the gib 130. The adjustable gib 131 of the pair I prefer to locate at the low side of the bed-ways 129, it being easier to adjust in that position.

The housings are bolted to the bed by

bolts, as 132, which reach from side to side. It is usual to connect each housing to the side of the bed only. Each housing is shouldered both at the top and bottom, as at 133, on the bed-cheek, while rigidity is further secured by the interposition of a wedge gib 134, see Fig. 18, preferably held in place by a screw and washer.

In the vertical adjustment of the spindle-drive and its cross-rail, it is preferred to provide the clutch gears 27 with springs similar to the springs 68 of the feed-gear nest, for the purpose of taking up the motion of the power-drive pulley 25 gradually and without shock, the same function being performed by the clutch devices of the feed-gear nest.

While this invention has been described in connection with the particular mechanism illustrated in the drawings accompanying this specification, it should be distinctly understood that the invention is not confined to the special devices shown and described. The invention is of much broader application and embraces all mechanism covered by the following claims.

By the employment of the circular plate 125, seating upon the circular flange 124 I am enabled to assemble the shaft 90, the worm 91, the worm-wheel 87, and the housing 88 carrying the clutch devices so that all this portion of the machine may be assembled and placed as a unit in its proper position whereby the parts are quickly alined and the construction standardized.

What I claim is,—

1. In a machine tool having elements to receive a cutting movement and a feed movement, a power drive for the cutting movement, an independent power drive for the feed movement, and means controlled by one of the drives and arranged to act on its retardation to stop the other drive.

2. The combination of a reciprocable table, a tool holder, a revoluble tool carried by said holder, a power drive for said tool, a separate power drive for said table, and automatic means controlled by the tool drive and arranged to act to immediately stop said table drive when the tool drive is interrupted.

3. The combination of a reciprocable table, a tool holder, a revoluble tool carried by the holder, a power drive for said tool, a separate power drive for said table, and means controlled by the tool drive and arranged to immediately stop the table drive upon reduction of the speed of the tool below a certain point.

4. The combination of a reciprocable table, a tool holder, a revoluble tool carried by the holder, a power drive for the tool, a separate power drive for the table, and automatic means controlled by the tool drive and arranged to act upon interruption of the tool drive to immediately stop the table drive.

5. The combination of a reciprocable table, a tool holder, a tool revoluble therein, driving mechanism for impelling said tool, independent driving mechanism including change speed gearing for impelling said table, and automatic mechanism intermediate the tool and table driving mechanism constructed and arranged to act upon interruption of the tool drive to immediately stop the table drive.

6. In a machine tool comprising a work holder and a tool which is to be given a cutting movement and a feed movement in relation to the work, a power drive for the cutting movement, a power drive for the feed movement, a clutch interposed in one of said drives and means controlled by the other drive and arranged to act immediately upon interruption of said drive to disconnect the clutch.

7. In a machine tool having a work holder and a tool which is to be given a cutting movement and feed movement in relation to the work, a power drive for the cutting movement, an independent power drive for the feed movement, a clutch interposed in the power drive, a trip device for disengaging said clutch member and centrifugal means controlled by the cutting drive and connected with the trip and arranged to act on interruption of the cutting drive to actuate the trip.

8. The combination of a reciprocable table, a tool holder, a revoluble tool carried thereby, driving means for impelling said tool, independent driving means for impelling said table, a clutch intermediate said table and said table-impelling means for connecting and disconnecting said table and impelling means, means tending continually to disengage said clutch, a detent normally retaining said clutch in engagement, and mechanism controlled by the tool driving means and constructed and arranged to release the detent and permit disengagement of the clutch upon interruption of said tool driving means.

9. The combination of a reciprocable table, a revoluble tool, a power drive for the tool, an independent power drive for the table, a clutch interposed in the table drive, means tending continuously to disengage the clutch, a detent normally retaining the clutch in engagement, a trip adjustably mounted on the table for releasing the detent, and mechanism controlled by the tool drive constructed and arranged to act upon interruption of the tool drive to release the detent.

10. In a machine tool, the combination of a reciprocable carriage, a feed-screw connected with the carriage, a worm gear on the screw, a drive-shaft, a drive-nut on the

shaft engaging the worm gear, thrust bearings for said worm gear and a housing comprising journals for said shaft and abutments for said thrust bearings, secured as a unit in the bed.

11. In a milling machine the combination of a reciprocating table, a non-rotating main screw carried by the table, a main rotating feed nut upon the main feed screw, a worm meshing with said nut, a shaft upon which said worm is mounted, a gear loosely mounted upon said shaft, a clutch device upon said shaft, a worm for driving said loose gear, a shaft upon which said last-mentioned worm is carried, a gear nest connected to said shaft, means for rotating said gear nest, means for operating the clutch device mounted on the frame, and a trip upon the table adapted to operate the clutch operating means.

12. In a milling machine, the combination of a milling cutter, drive mechanism therefor, feed mechanism, and means controlled by the cutter drive constructed and arranged to arrest the feed mechanism immediately upon stoppage of the cutter drive.

13. In a milling machine, the combination of a reciprocating table, a main feed screw, a main feed nut, a worm meshing with said nut, a shaft upon which the worm is mounted, a circular plate having bearings for said shaft at its mid-length, inner bearings for said shaft carried by said plate, and outer bearings concentric with said circular plate.

14. In a milling machine, the combination of a frame having a recess formed therein, a circular plate fitting said recess, provided with a bearing, said frame having a second bearing concentric with said recess and a housing having a shaft bearing concentric with the other bearings and secured to said plate.

15. In a milling machine, the combination of a frame having a comparatively large recess on one side and a comparatively smaller recess upon the opposite side, a casting having bearings for a shaft and adapted to fit said recesses, a shaft in said bearings and a worm upon the shaft between the bearings and said recesses.

16. In a milling machine, the combination of a frame having a comparatively large recess on one side and a comparatively smaller recess upon the opposite side, a casting having bearings for a shaft and adapted to fit said recesses, a shaft in said bearings, a driving member upon the shaft between the bearings and said recesses and a gear housing carrying a bearing secured to said casting concentric with the bearings therein.

17. In a milling machine, the combination of a base, a reciprocating table carrying a feed screw, a main feed nut provided with a gear thereon, a worm and shaft for driving said nut, a housing constituting an independent unit secured in the base, bearings in said housing for supporting said shaft, bearings for the feed nut and connections between the feed nut bearings and the housing of said shaft for supporting the bearings of the feed nut.

18. In a milling machine, the combination of a base, a reciprocating table having a feed screw attached thereto, a housing constituting an independent unit secured in the base, a feed nut provided with a gear, adjustable end-thrust bearings for the feed nut carried by said housing and adjusting means mounted upon the frame at each end of the feed nut bearings.

19. In a milling machine, the combination of a cutter spindle drive, a fixed arm or support carried thereby, a weight movably secured to said support, a sleeve movable upon the cutter spindle drive, an arm connected to the weight and sleeve, a feed mechanism, a clutch in the feed mechanism for throwing it out of engagement, and means interposed between the sleeve and the clutch for operating the latter when the cutter spindle stops.

20. In a milling machine, the combination of a cutter drive spindle, a cone pulley fast thereon, a centrifugal weight journaled to the cone pulley, a feed mechanism having a clutch therein and means interposed between the centrifugal weight and the clutch whereby the feed is arrested when the cutter drive spindle stops.

21. In a milling machine, the combination of a feed mechanism, a clutch in said mechanism, a cutter drive spindle, a support fast thereon, a centrifugal weight mounted upon an arm pivoted upon said support, a slidable sleeve upon the cutter drive, an arm engaging said sleeve and connected to said centrifugal weight, a lever adapted to operate the clutch, a bell-crank lever connected with said sleeve, and a link connecting said levers whereby the feed is arrested by the stopping of the cutter drive.

22. In a milling machine, the combination of a reciprocating table, a trip thereon, a feed mechanism having a clutch therein, a bed, a lever having a clutch element thereon and a jack-in-the-box mounted on the bed adapted to engage the table trip and the lever of the clutch mechanism.

23. In a milling machine, the combination of a bed, a jack-in-the-box mounted thereon, having an upwardly projecting arm and a horizontally projecting arm provided with an inclined face, a reciprocating table having a trip and feed mechanism and a lever having a clutch device and an arm in contact with said inclined face.

24. In a milling machine, the combination of a bed provided with upper and lower horizontal bed-cheeks, housings shouldered

upon said cheeks, tie rods passing through the housings and bed from side to side, and gibs interposed between the shoulders and the cheeks.

25. In a milling machine, the combination of a drive spindle, a flange thereon, a milling cutter having a flanged hollow hub adapted to be secured to said spindle flange, and a centering plug serving to center the hollow hub of said cutter with a recess formed in said spindle.

In testimony whereof I have affixed my signature in the presence of two witnesses.

HENRY HESS.

Witnesses:
WINFIELD S. KOLB,
FANNIE V. KURTZ.