No. 897,944. PATENTED SEPT. 8, 1908.

F. J. WATERS.

BORING MACHINE.

APPLICATION FILED AUG. 17, 1907.

3 SHEETS—SHEET 1.

FIG. 1.

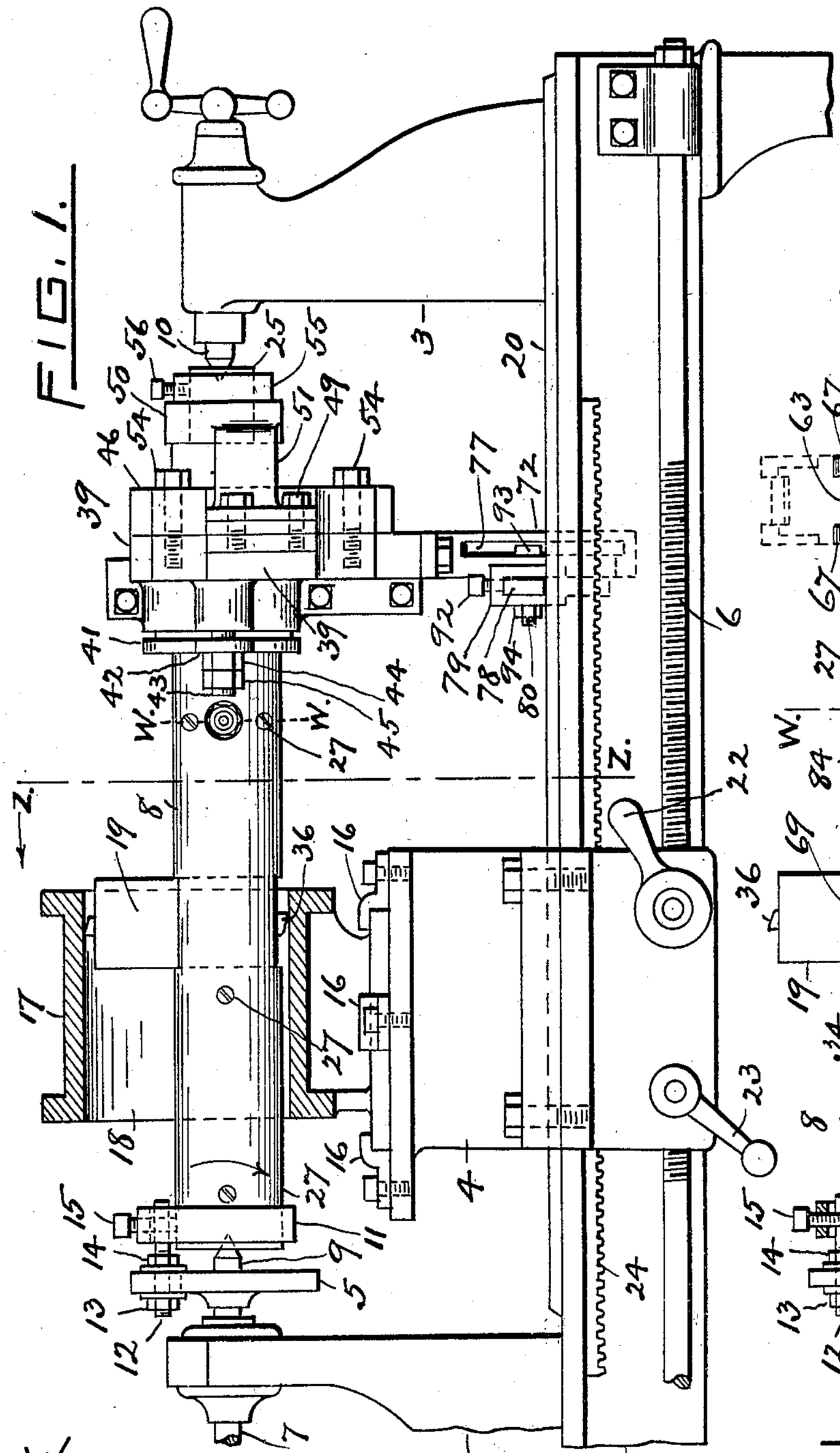
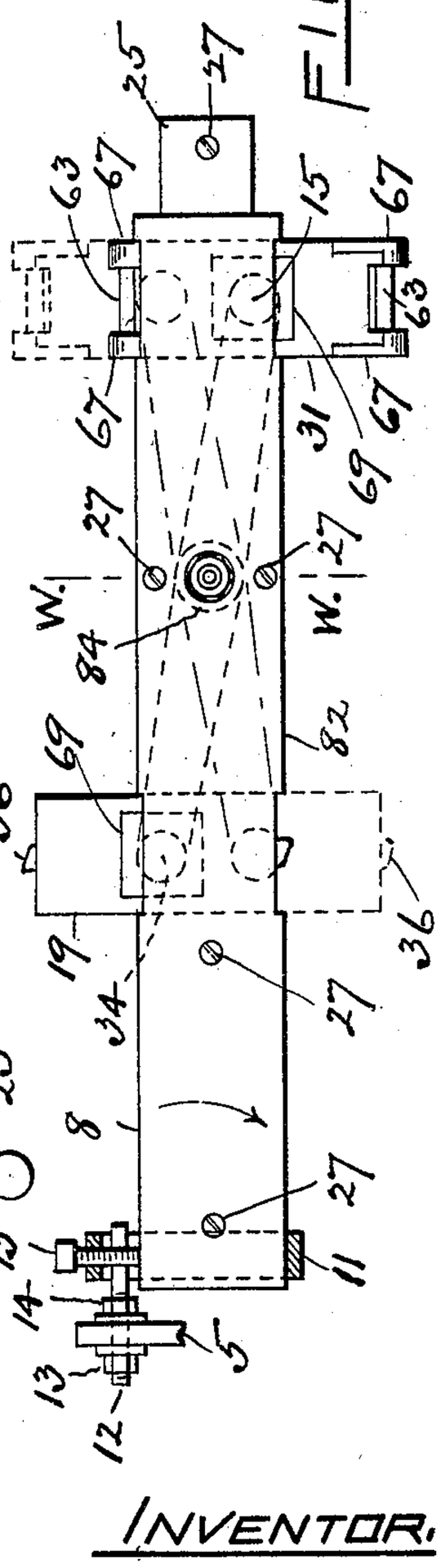


FIG. 2.



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3 SHEETS—SHEET 2.

FIG. 4.

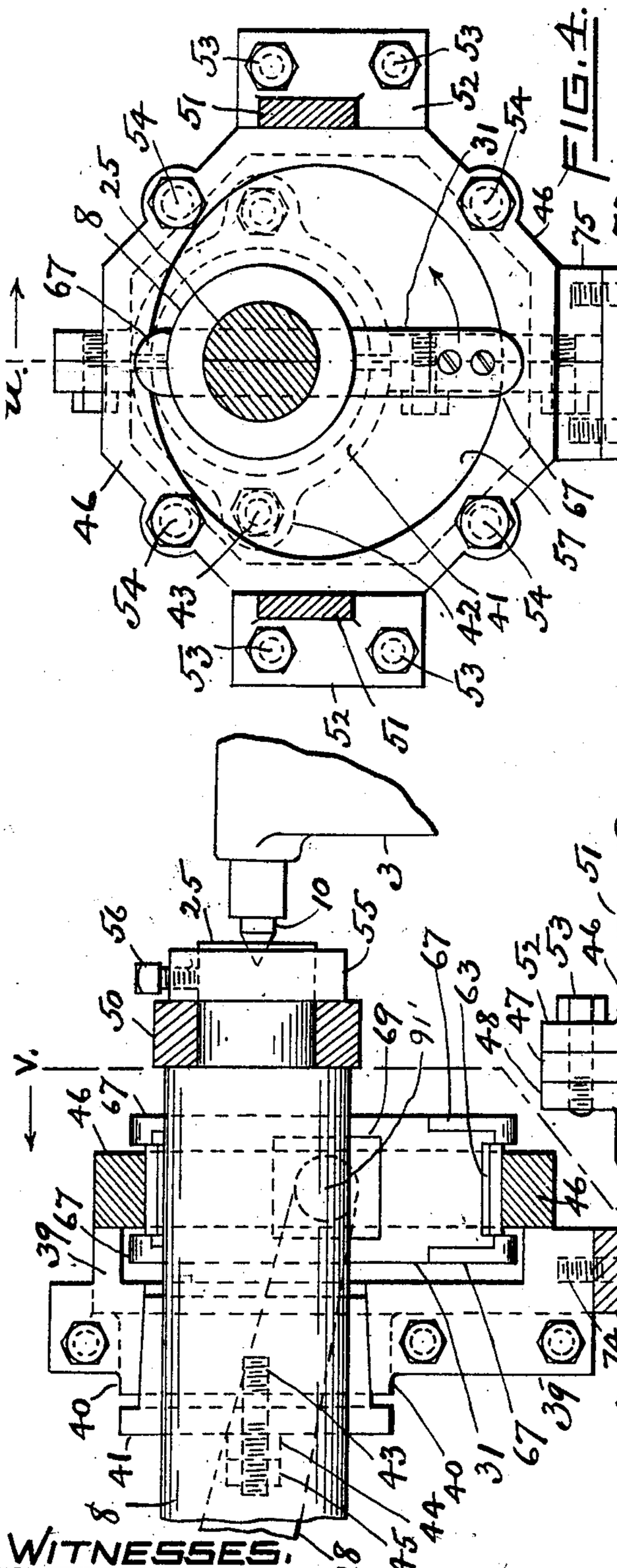

FIG. 5.

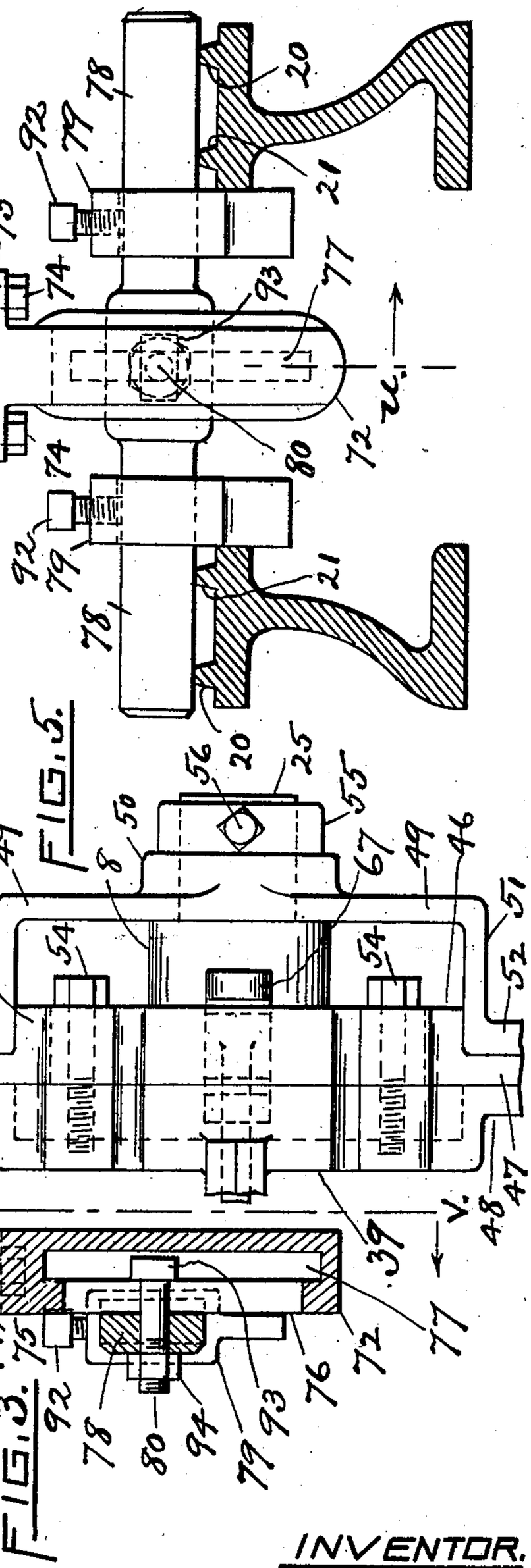

FIG. 3.

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3 SHEETS—SHEET 3.

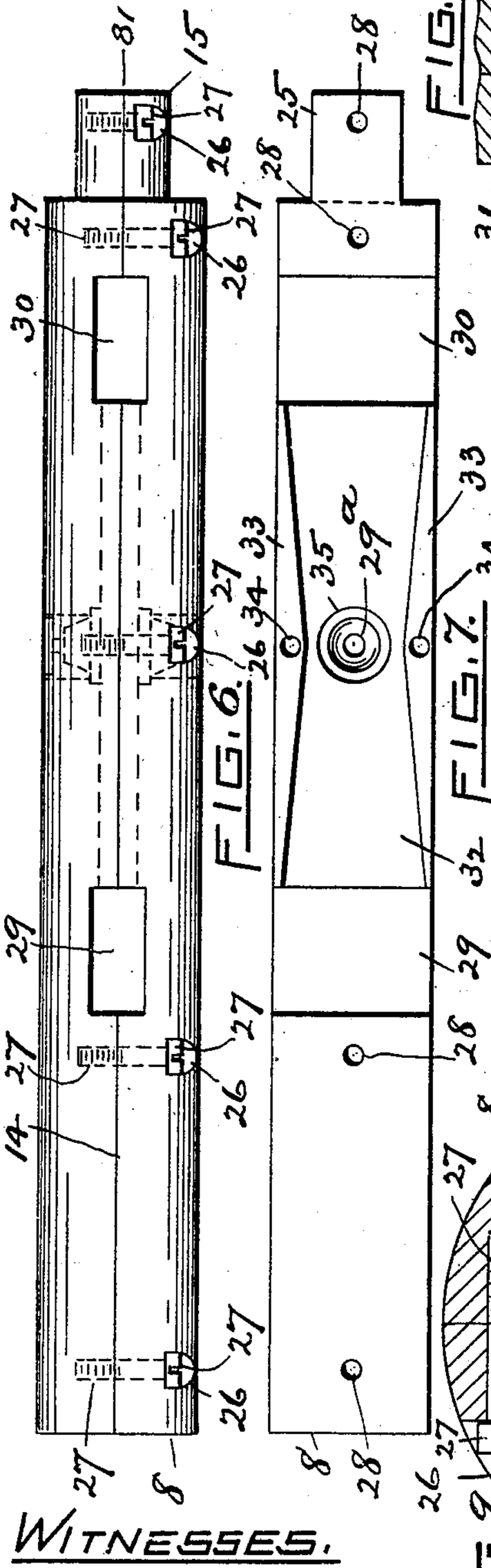

FIG. 6.

FIG. 7.

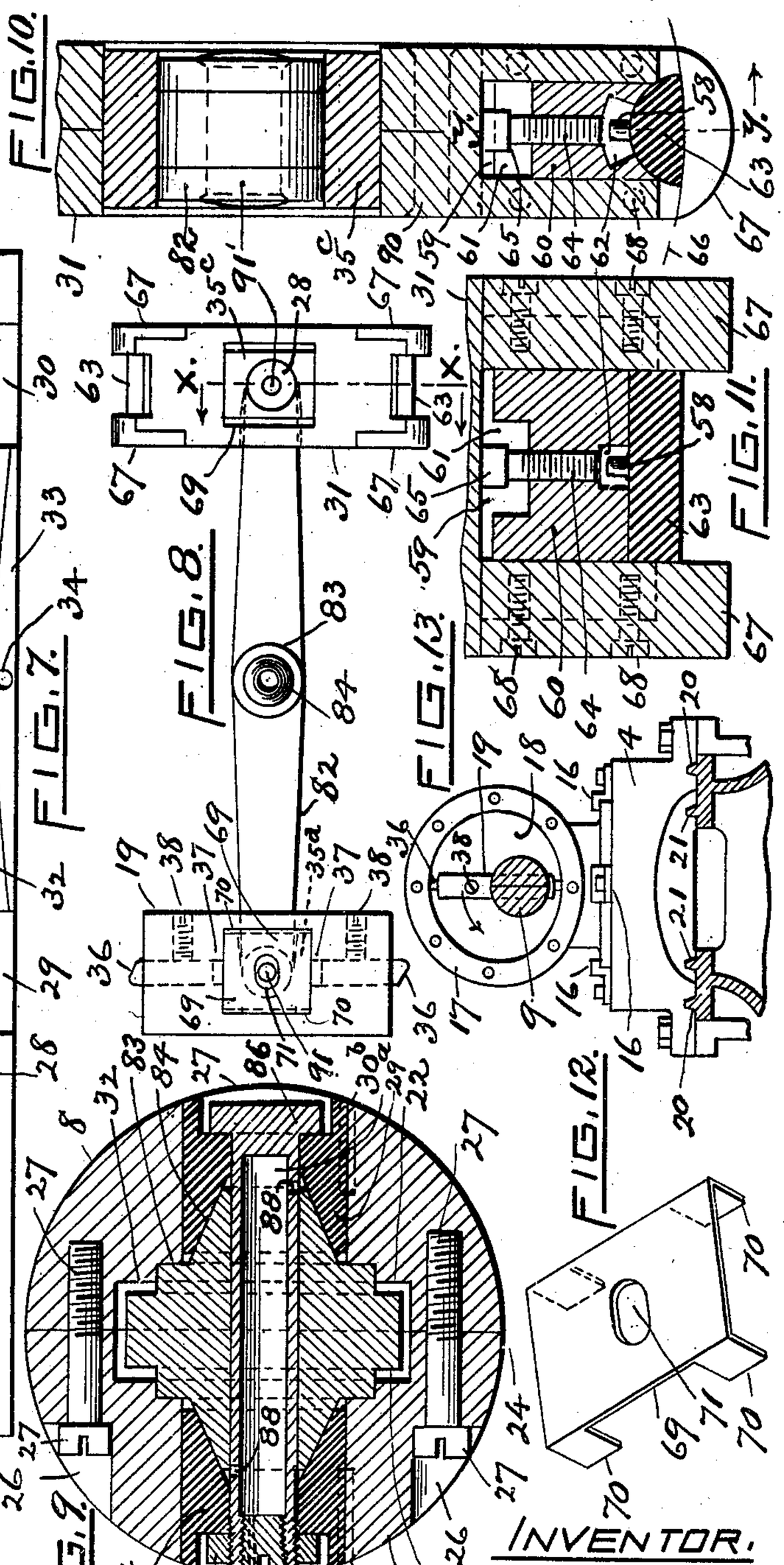

FIG. 8.

FIG. 9.

FIG. 11.

FIG. 12.

FIG. 13.

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UNITED STATES PATENT OFFICE.

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BORING-MACHINE.

No. 897,944. Specification of Letters Patent. Patented Sept. 8, 1908.

Application filed August 17, 1907. Serial No. 389,058.

To all whom it may concern:

Be it known that I, FRANK J. WATERS, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Boring-Machines, of which the following is a specification, reference being had therein to the accompanying drawings.

Like reference numerals indicate like parts.

Figure 1 is a view in front elevation of my improved boring machine. Fig. 2 is a view in front elevation of the boring shaft, in which the pattern bar and the cutter bar are mounted. Fig. 3 is a view, partly in elevation and partly in vertical section on line *u u* of Fig. 4, showing the tail-stock, the boring shaft, mounted near one end within the pattern holder, together with the means of adjusting said holder upon the machine frame. Fig. 4 is a view in vertical section as seen on line *v v* of Fig. 3. Fig. 5 is a top plan view of the pattern, pattern holder and saddle, the latter being mounted on the boring shaft. Fig. 6 is a view in top plan of the boring shaft. Fig. 7 is an inside face view of one of the halves of the boring shaft. Fig. 8 is a view in front elevation of the rocking arm or lever, together with the pattern bar and the cutter bar at its respective ends. Fig. 9 is a sectional view (on an enlarged scale) of the boring shaft, as seen on line *w w* of Figs. 1 and 2. Fig. 10 is a central, vertical section of the pattern bar (on an enlarged scale), as seen on line *x x* of Fig. 8. Fig. 11 is a sectional view of one end of the pattern bar, as seen on line *y y* of Fig. 10. Fig. 12 is a perspective view of one of the shields to protect the cutter bar. Fig. 13 is a view, partly in end elevation on line *z z* of Fig. 1, showing the engine cylinder in position upon the lathe carriage and the boring shaft and cutter bar within said cylinder, during the boring operation.

My invention relates to boring machines and is intended for the boring of holes of irregular or varying cross sections, but of uniform eccentric diameters.

It consists of the novel construction, combination and arrangement of the several parts as hereinafter described and claimed.

In the drawings my improved machine is represented as cutting the irregularly curved bore of the cylinder of a rotary steam engine, such as is particularly specified in my pending application for Letters Patent, filed herewith, being Serial No. 389,057.

In Fig. 1 is shown a lathe of usual construction, having a central longitudinally-slotted bed or frame 1, a head-stock 2, a tail-stock 3, carriage 4, face plate 5 and feed screw 6, all made and operating in the common and well-known manner. The shaft 7 is mounted in the head-stock 2 and is rotated by a pulley (not shown) and turns the face plate 5, as usual. The boring shaft 8 is mounted axially upon the center or spindle 9 of the head-stock 2 and upon the center or spindle 10 of the tail-stock 3. A collar 11 supports the end of the boring shaft 8 adjacent to the head-stock 2. The face plate 5 has the usual radial slot, through which the dog 12 extends, being clamped thereto by the nuts 13, 14, which engage the threaded portion thereof. The opposite end of the dog 12 is transversely bored or tapped for the reception of a set screw 15, which passes also through the collar on one side thereof and bears against the boring shaft 8, as seen in Figs. 1 and 2.

The carriage 4 has clamps 16 screwed thereto and supports and holds in place the cylinder 17, through which the irregularly curved bore 18 is to be formed by the cutting tools in the cutter bar 19. This carriage 4 travels on ways 20 upon the upper surface of the bed of the lathe, and the movable tail-stock 4 travels on other ways 21, parallel to the ways 20, as usual. The carriage 4 moves automatically along the feed screw 6, which is rotated by gearing (not shown) and is thrown into or out of engagement with the feed screw 6 by the handle 22, in the usual manner. The handle 23 moves the carriage 4 along the feed rack 24, but these carriage movements, not being any part of this invention need not be further described, as they are well-known.

The boring shaft 8 is separately shown in Fig. 2, and on an enlarged scale in Figs. 6 and 7, and on a still larger scale in Fig. 9. It is made in two halves abutting along the diametrical plane, indicated by the longitudinal line 81 in Fig. 6, each half being semi-circular in cross section, as seen in Fig. 9, with the inner face substantially plane, as shown in Figs. 7 and 9. The boring shaft 8 is concentrically reduced at one end (adjacent to the tail-stock 3 of the lathe), as represented at 25. One half or longitudinal section of the

boring shaft 8 is cut away at intervals on its periphery, as illustrated at 26 in Fig. 9, for the reception of the bolts 27, by which the two halves or sections thereof are fastened together, the other half or section being tapped for the threaded end of each bolt 27 as seen at 28. By cutting the sockets or recesses 26 of sufficient depth, the heads of the bolts 27, when in holding position, lie wholly within the peripheral line of the boring shaft 8.

The boring shaft 8 has the diametrical slot 29 (one half of said slot being in each half section of the shaft), through which the cutter bar 19 is mounted slidably and also has a diametrical slot 30 (one half thereof being in each half section), through which a pattern bar 31 is slidably mounted.

Each half section of the boring shaft 8 has the peculiarly-shaped longitudinal recess or slot 32, shown in plan in Fig. 7 and in cross section in Fig 9, the longitudinal sides of this recess or slot 32 are angularly inclined in the manner and for the purpose presently explained. Each flange 33 of the recess or slot 32 is tapped, as represented at 34, for the reception of bolts 27, which with the other bolts 27, previously described, serve to fasten the two half-sections of the boring shaft 8 together.

Each half-section of the boring shaft 8 has a central, radially-directed circular aperture 35, in which is mounted, adjacent to each hub, a bronze bearing 29^a, whose peculiar form in cross section is illustrated on an enlarged scale, in Fig. 9. Each bearing 29^a has a conical seat at its inner end and a circular socket at its outer end and also a circular concentric bore. A key 30^b secures each bearing 29^a in position in the boring shaft 8.

A lever or oscillating arm 82 has a centrally located hub 83 on each side, extending at a right angle. A trunnion 84 extends axially from each of the hubs 83 and fits rotatably in the conical seat of the bearing 29^a. This bearing 29^a may be channeled for the passage of oil to lubricate the trunnion 84. The oscillating arm 82 and each hub 83 and trunnion 84 thereof are bored, as shown in Fig. 9, and a tubular pivot 85, having one end closed, and there provided with a head 86 extends diametrically through the boring shaft 8, the oscillating arm 82 and the hubs and trunnions thereof. The opposite end of the tubular pivot 85 is open and screw-threaded both on its outer and inner surfaces. A nut 87 engages with the exterior screw threads of the tubular pivot 85 and is contained within the adjacent circular socket of the bearing 29^a. A screw plug 89 engages with the interior screw threads of the tubular pivot to close the same at that end. The screw plug 89 is not headed and its exposed end is made to conform in surface to the peripheral curvature of the boring shaft 8, as illustrated in Fig. 9. The screw plug 89 has a longitudinal oil duct through it, indicated by dotted lines. The tubular pivot 85 has two openings 88 through it on one side. Oil introduced at the outer end of the oil duct of the screw plug 89 passes therefrom into the tubular pivot 85 and thence, through the two openings 88 into the space between the bearing 29^a on each side, and so lubricates each trunnion 84 of the oscillating arm 82. The cutter bar 19 is pivotally connected at 91 with the oscillating arm 82. A cutting tool 36 is mounted at each end of the cutter bar 19 in a longitudinal slot 37 thereof, shown in dotted lines in Fig. 8, and is held therein in adjusted position by the set screw 38.

The right-hand end 25 of the boring shaft 8 is held by the center or spindle 10 of the tail-stock 3. The boring shaft 8 is also supported loosely by the pattern holder 39, which has a collar 40, whose bore is beveled, as shown in Fig. 3. A bushing 41, made in two semi-circular sections, has its external surface tapered, but its inner surface cylindrical, to surround the boring shaft 8. This bushing 41 extends through the collar 40 and serves both to center the boring shaft 8 in position and to take up the wear. Each half section of this split bushing has an integral ear 42, which is tapped for the passage of a screw 43, the latter entering the pattern holder 39. Two nuts 44 and 45, the latter being a check nut, hold each half-section of the bushing 41 in position.

The pattern 46 has a flange 47, shown in Fig. 4 as octagonal in form, by which it is secured to the flange 48 of the pattern holder 39. A saddle 49 has a collar 50, through which the reduced end 25 of the boring shaft 8 passes rotatably. The saddle 49 has two bent sides 51, which terminate in flanges 52, respectively. Bolts 53 fasten the flanges 52 of the saddle to the flanges 48 of the pattern holder 39. Bolts 54 fasten the flanges 47 of the pattern 46 to the flanges 48 of the pattern holder 39. A collar 56 is mounted on the reduced end 25 of the boring shaft 8 in snug contact with the saddle collar 50, and is held in adjusted position by the set screw 56.

The pattern 46 has a bore 57 through it, represented by the irregular curved line in Fig. 4. This pattern bore 57 has the same diameters and curvatures as the bore 18 which is to be cut in the engine cylinder 17.

The pattern bar 31 is shown in Figs. 2, 4 and 8, but most plainly and on an enlarged scale in Fig. 10. It is made in two longitudinal sections, fastened together by screws or rivets 90.

The pattern bar 31 has a slot 59 at each end in which a block 60 is slidably mounted. The block 60 has a central socket or recess 61 at its upper end and also a screw-threaded bore, as seen in Figs. 10 and 11. The lower edge of the block 60 is formed into a concave seat, seen in Fig. 10, and also has a slot 62.

A shoe 63, having in cross section a peripheral surface approximately 180° in extent, is mounted loosely in said concave seat. The longitudinal sides of the slot 62 extend in directions radial to the center or axis of curvature of the oscillating bearing or shoe 63, as shown in Fig. 10. A screw 64 has a threaded shank, by which it engages the block 60, and also a head 65, whose upper surface is in contact with the upper surface of the slot 59. The shoe 63 has a radially-extending stud 58, which projects up into the recess 62 of the block 60 to limit the oscillation of the shoe 63. The outer surface of the shoe 63 has a curvature approximating the curvature of the pattern, which latter is indicated by the line 66 in Fig. 10.

At each end of the pattern bar 31 on the opposite sides thereof are the ears or plates 67, L-shaped in cross section, and secured to the respective half-sections of the pattern bar 31 by the screws 68. These ears 67 are rounded at the bottom, as shown in Fig. 10, and extend beyond the shoe 63, whose ends abut them on both sides, as seen in Fig. 11.

At the center of each pattern bar 31, a bronze bearing block 35^c is inserted in a rectangular slot of said bar. It has a circular aperture, which serves as a bearing for the pivot 91′ of the adjacent end of the lever or oscillating arm 82. The bearing block 35^c is a little narrower than the rectangular slot made for its reception, and there is thus formed a clearance to allow a slight lateral play or movement of the block 35^c in said slot, to facilitate the pivotal action of the pattern bar 31 upon the oscillating arm 82 in the slot 30 of the boring shaft 8.

In Fig. 12 is shown one of the shields 69 used on the opposite sides of the cutter bar 19. Each shield 69 is made of thin sheet metal and has four bent ears 70 at its corners and also an oblong central slot 71. These shields are placed as shown in Figs. 2, 3, and 8. As seen in Fig. 8, the oblong slot 71 is of a size and has such location as to furnish a clearance for the pivot 91. The purpose of these shields 69 is to protect the pivot hole for the pivot 91 from becoming clogged with the chips of the boring operation.

The pattern holder 39 is made in two half-sections and is provided with flanges, which are held together by bolts, as seen in Fig. 3. There is an octagonal inner edge or rim for the pattern holder 39, indicated by the dotted line in Fig. 4, and in whatever position the pattern bar 31 may be, its ends or ears 67 are always within said inner edge of the aperture of the pattern holder, as illustrated in Fig. 4.

The pattern holder 39 has a standard or tail piece 72, which by its flange 73 is fastened by bolts 74 to the bottom flange 75 of the pattern holder. The standard or tail piece 72 extends down through the central aperture of the lathe, as seen in Figs. 1 and 4. The standard 72, has a vertical slot 76, enlarged at 77. A cross bar 78 rests slidingly on the ways 20, 21, of the bed of the lathe, as best seen in Fig. 4, and through its center, which is somewhat enlarged, a hole is tapped for the reception of a bolt 80. The head 81 of the bolt 80 extends into the enlarged slot 77, as seen in Fig. 3 and shown in dotted lines in Fig. 4. Two sliding dogs 79, each having a rectangular aperture loosely surround the cross bar 78. When the pattern holder 39 is properly adjusted lengthwise of the cross bar 78, as in Fig. 4, these dogs 79 are slid on the cross bar 78 until they come into abutment with the sides of the central aperture of the bed of the lathe and then the set screws 92 are tightened up and hold the pattern holder 39 in said adjusted position. A nut 94 on the outer end of the bolt 80 secures the bolt 80, tail piece 72 and cross bar 78 together.

Having thus described the several parts of my invention, I will now explain its operation.

The result to be accomplished by the operation of the machine is the shaping of the bore 18 of a cylinder 17 to exactly correspond to the shape of the bore 57 of the pattern 46. It is seen that in the case shown in the drawing (Fig. 4) the line, which indicates the outline of the pattern bore is made up of arcs of different lengths and of different radii, thus producing an irregularly curved bore. The bore shown in Fig. 4 is intended to be the same as that represented in the cylinder shown in my said pending application for Letters Patent, to which reference is hereby had, but it may here be defined as a cylinder, whose walls are equally distant from each other on every line passing through a given point which is exterior to the geometrical center of the cylinder bore. It is desired to make the bore of the cylinder 17 of exactly the same diametrical size and curvatures as the bore of the pattern 46. This work is done on a lathe, as shown in Fig. 1. The cylinder 17, is mounted and secured in position upon the carriage 4, which serves as a work-holder, supporting the cylinder, which is to be bored, and, by means of the feed screw 6, advancing said cylinder to the cutting means for the progressive boring operation.

As shown in Fig. 3, the pattern bar 31 is thicker from front to back than the width of the pattern 46, and the outer ends or ears 67 of the pattern bar 31 extend beyond the pattern 46, both in front and in the rear, and upon both ends.

As seen in Fig. 10, the outer surface of each shoe 63 is in constant contact with the curved surface 66 of the bore 57 of the pattern 46, such contact being established and maintained by the screw 64, whose head 65 abuts the inner end of the slot 59 of the pattern bar 31. Each end of the pattern bar 31 has such a shoe 63. The oscillation of the shoes 63 is

due to the fact that the outer peripheral surface thereof follows the curvatures of the pattern 46. Thus, when the radius of the curvature of the pattern bore is less at any given point therein than that of another given point which the shoe 63 has just passed, the pattern bar 31 is slid in the slot 30 of the boring shaft 8, and so at every diameter of the pattern bore the bar 31 is pushed in one longitudinal direction or the other by the varying curvatures of the bore, the bar 31 being, of course, always of the same length, but sliding in the slot 30 of the boring shaft 8, as it is compelled to do by the varying diameters of the pattern bore. Such movements of the pattern bar 31 cause the oscillating arm 82, which is pivotally connected thereto at 91′, to rock upon its tubular pivot 85 to an equal degree. The rocking of the oscillating arm 82, causes the cutter bar 19 to move in the slot 29 to the same degree. As the oscillating arm 82 is pivotally mounted at 29ª, exactly in the center thereof, the sliding movements of the cutter bar 19 are exactly the same in length as those of the pattern bars 31, but are in directions opposite to the movements of the pattern bar 31.

As the pattern 46 is fixed in position, being adjustably set by the proper movement of the pattern holder 39, but the boring shaft 8 rotates by means of the lathe pulleys; the shoes 63 of the pattern bar 31 accurately follow the pattern line in each rotation of the boring shaft 8. Consequently, the cutters 36 give a corresponding and equal shape to the bore 18 of the cylinder 17. The inclination of the sides 33 of the recess or slot 32 of the boring shaft 8, shown in Fig. 7, is such as to correspond to the angular directions of the oscillating arm 82 in its extremes of travel, as illustrated in Fig. 2.

The washer or nut 87 draws the head 86 of the tubular pivot 85 and thus seats the trunnions 84 of the oscillating arm 82 in the bearing 29ª within the boring shaft 8.

This machine is adapted to bore any rounding hole of irregular shape, which has equal diameters intersecting each other eccentrically. The oscillation of the shoes 63 enable it to follow the contour of the pattern bore, but the stud 58 serves, by its abutting the radially directed sides of the recess 62, as a stop device to prevent excessive oscillation.

It is obvious that if the boring shaft 8 were held stationary and the pattern 46 were revolved the result would be the same, and as this would be a mere reversal of the arrangement hereinbefore described and embody the same mechanical principle, such a construction would be within the scope of my invention. It is also obvious that instead of using a lathe, as described, an ordinary horizontal boring mill may be used, in which case the boring bar would feed instead of the work, and the tail piece 72 would travel in the slot of the boring mill.

I claim as a novel and useful invention and desire to secure by Letters Patent:—

1. In a boring machine, the combination of a rotatable boring shaft having two diametrical slots and a central longitudinal recess or slot extending between and opening into said diametrical slots; an oscillatory arm centrally pivoted to the boring shaft in said longitudinal slot; a pattern bar slidably mounted in one of said diametrical slots and pivotally connected to the oscillating arm at one end thereof; a cutter bar slidably mounted in the other of said diametrical slots and pivotally connected to the oscillatory arm at the opposite end thereof; a cutting tool mounted in the cutter bar; and means for giving a reciprocating movement to the pattern bar.

2. In a boring machine, the combination of a rotatable boring shaft, having two diametrical slots; a pattern bar slidably mounted in one of said slots; a cutter bar, slidably mounted in the other of said slots; a cutting tool on said cutter bar; means for giving a reciprocating movement to the pattern bar; and a lever centrally pivoted on said boring shaft and operated by the pattern bar to give a reciprocating movement to the cutter bar.

3. In a boring machine, the combination of a lathe having a head stock and a tail stock; a rotatable boring shaft axially mounted in said head stock and tail stock; a pattern bar carried by said shaft and capable of a reciprocating movement thereon transversely of the shaft; a cutter bar carried by the shaft and capable of a reciprocating movement thereon transversely of the shaft, which cutter bar is provided with a cutting edge; means for communicating said motion from the pattern bar to the cutter bar equally and to the same extent; and a pattern having a bore made in different arcs transversely thereof, but continuous of each other *seriatim*, with the surface of which bore the pattern bar is consecutively in contact, said shaft having its axial line parallel with and eccentric to the axial line of said bore.

4. In a boring machine, the combination of a boring shaft made in two longitudinal half-sections, each semi-circular in cross section and each abutting the other on the plane sides thereof, respectively, said sections being made each with two slots and an intermediate communicating recess and said slots and recess of one section registering with those of the other section; screws connecting said two sections and having their heads contained in sockets, respectively, so as to be below the peripheral surface of said shaft; a pattern bar mounted slidably in one of said registering slots; a cutter bar

mounted slidably in the other of said registering slots; and an oscillating arm or lever in said intermediate registering recess pivotally mounted therein and pivotally connected to the pattern bar and cutter bar at its respective ends.

5. In a boring machine, the combination of a shaft having a diametrical slot; a lever pivotally mounted on the shaft; a cutter bar mounted slidably in said slot and pivotally mounted on the end of the lever; and a cutting tool on the cutter bar.

6. In a boring machine the combination of a pattern having a pattern bore; a pattern bar; and an oscillating shoe loosely mounted on each end of the pattern bar and adapted to contact slidingly with the pattern bore.

7. In a boring machine, the combination of a pattern having a pattern bore; a pattern bar thicker than the depth of said pattern bore; an oscillating shoe mounted loosely in each end of the pattern bar and adapted to contact slidingly with the pattern bore and whose length is equal to the depth of the pattern bore; and two ears at the opposite sides of each end of the pattern bar adapted to move slidingly along the rim of the pattern and to project radially beyond the adjacent shoe and to hold said shoe against longitudinal displacement.

8. In a boring machine, the combination of a pattern having a pattern bore; a pattern bar having a slot in each end; a tapped block mounted movably in said slot and having a concave seat at its outer end; a shoe mounted loosely in said seat and in sliding contact with the pattern bore; a screw passing through the tap of said block and having a head at its inner end in contact with the closed end of said slot; and two oppositely arranged ears at each end of the pattern bar in abutment with the ends of said shoe and projecting beyond the same.

9. In a boring machine, the combination of a pattern having a pattern bore; a pattern bar having a slot at each end; a tapped block mounted movably in said slot of the pattern bar and having a concave seat on its outer end together with a central recess; a shoe having a convex surface and loosely mounted in said concave seat and in sliding contact on its outer surface with the pattern bore; a stud extending from the convex side of said shoe into said recess of the block; a screw passing through the tap of said block and having its head in contact with the closed end of the slot of the pattern bar; and two oppositely arranged ears at each end of the pattern bar in abutment with the ends of said shoe and projecting beyond the same.

10. In a boring machine, the combination of a boring shaft having a diametrical slot; a bar mounted slidably in said slot; a bearing block inserted centrally through said bar and having a central aperture; two washers centrally bored and mounted respectively on the outer surfaces of said bearing block; a lever, whose outer end passes through said aperture of the bearing block; a pivot connecting said lever and bar in the said bearing block; and a pivot passing through said washers and lever to constitute the fulcrum of the lever.

11. In a boring machine the combination of a boring shaft having a diametrical slot; a bar mounted slidably in said slot and having a rectangular opening; a bearing block inserted slidingly in said rectangular opening but narrower than said opening, which block has a central aperture, a lever, whose outer end passes through the aperture of the bearing block; and a pivot connecting the lever and bar in said bearing block.

12. In a boring machine, the combination of a boring shaft in two longitudinal half-sections, having two diametrical slots and an intermediate longitudinal recess opening at its ends into said slots, respectively; a pattern bar slidably mounted in one of the slots; a cutter bar slidably mounted in the other of said slots; a lever connected pivotally at its ends, respectively, with the pattern bar and the cutter bar and extending and movable in said longitudinal recess; and a pivot extending through a central aperture of said lever and through registering apertures of said two half sections of the boring shaft.

13. In a boring machine, the combination of a boring shaft in two longitudinal half sections, having two diametrical slots, and an intermediate central recess which opens into said slots, respectively, and a central diametrical bore; two bearing blocks each having a central aperture and a conical seat; a pattern bar slidably mounted in one of the slots; a cutter bar slidably mounted in the other of said slots; a lever connected pivotally at its ends, respectively, with the pattern bar and cutter bar and extending and movable in said longitudinal recess; a centrally perforated trunnion on each side of the lever rotatable in said conical enlargement of the central diametrical bore; and a pivot passing through the said bore, through said trunnions and through a central aperture of said lever.

14. In a boring machine, the combination of a boring shaft made in two longitudinal half-sections and having two diametrical slots; a pattern bar mounted slidably in one of said slots; a cutter bar mounted slidably in the other of said slots; a transverse bore in the boring shaft; two bearing blocks inserted in said bore and each having a central perforation and a conical seat; a lever connected at its ends with the pattern bar and cutter bar, respectively, and having at its center on each opposite side a hub and a trunnion extending from said hub, which

lever, hubs and trunnions have one continuous circular aperture therethrough, said lever, hubs and trunnions being mounted in a recess in said half-sections of the boring shaft, which opens into said diametrical slots, respectively, and is of a shape adapted to allow an oscillation of the lever; and a pivot passing through a central diametrical bore of said half-sections of the boring shaft and through the circular aperture of said lever, hubs, trunnions and bearing blocks.

15. In a boring machine, the combination of a split boring shaft, having a diametrical bore and a longitudinal recess; a centrally perforated lever mounted in said recess and having on each side a centrally bored trunnion shaped like a cone frustum; a tubular pivot having two oil passages and extending through the diametrical slot of the boring shaft and through said apertures of the lever and trunnions; a bearing having a seat shaped like a cone frustum surrounding each trunnion on its tapering sides; a head on one end of the tubular pivot constituting a closed end thereof; exterior and interior screw-threads at the open end of the tubular pivot; a pattern bar mounted crosswise of boring shaft; a cutter bar mounted crosswise of the shaft; a pivotal connection between said lever and pattern bar and cutter bar, respectively; a washer engaging said exterior screw-threads; a screw plug engaging said interior screw threads; and an oil duct through said screw plug, all arranged so that oil introduced into the duct of the screw plug flows into the tubular pivot and through the oil openings of said pivot between said trunnions and the cup bearings thereof.

16. In a boring machine, the combination of a boring shaft having a slot; a cutter bar mounted slidably in said slot; a lever pivotally mounted on the boring shaft; a pivot connecting said lever and bar; and a shield covering said cutter bar at said pivotal connection thereof.

17. In a boring machine, the combination of a boring shaft having a slot; a bar mounted slidably in said slot; a bearing block having a central aperture and mounted in a slot of said bars, a lever pivotally mounted on the shaft and pivotally connected with said bearing block; and a shield having a central aperture and a plurality of ears, the latter being inserted between said bearing block and bar and extending over the bearing block.

18. In a boring machine, the combination of a rotatable boring shaft having two diametrical slots; a central recess intermediate said slots lengthwise of said shaft; a pattern bar mounted slidably in one of said diametrical slots; a cutter bar mounted slidably in the other diametrical slot; a lever pivotally mounted in the boring shaft in said central recess; a pivotal connection of said lever with the pattern bar and the cutter bar, respectively; means for supporting said boring shaft axially; a pattern having a pattern bore and provided with flanges; a collar on the boring shaft near one end thereof; a saddle integral with said collar and having flanges; a stationary pattern holder having flanges; bolts fastening the saddle flanges, pattern flanges and pattern holder flanges together; a movable collar at the end of the boring shaft in contact with the saddle collar; a set screw holding the movable collar in an adjusted position; and means for rotating the boring shaft, said pattern bar being arranged within the pattern bore and adapted to rotate with said shaft with its ends in constant contact with the pattern bore.

19. In a boring machine, the combination of a rotatable boring shaft; a pattern bar carried by the shaft rotatable therewith but slidable thereon; a pattern having a pattern bore with which the pattern bar at its ends is in constant contact; a pattern holder surrounding the pattern and having a circular opening with a tapering bore; a bushing made in two half-sections having a straight bore in which said shaft is rotatably supported and also having a tapering exterior surface to fit slidably into the tapering bore of the circular opening of the pattern holder; and means for holding said divided bushing in position.

20. In a boring machine, the combination of a lathe having a longitudinally slotted bed; a pattern; a pattern holder having a standard or tail piece provided with a vertical slot and extending through the slot of the lathe bed; a cross bar extending across the lathe bed from side to side and having a central threaded aperture; two dogs slidable upon the cross bar into contact with the sides of said lathe slot and surrounding the cross bar; a set screw through each dog bearing upon the cross bar; a bolt passing through said cross bar and standard with its head in the slot of the standard; and a washer upon the opposite end of said bolt.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK J. WATERS.

Witnesses:
HOWARD A. LAMPREY,
WARREN R. PERCE.