No. 871,939. PATENTED NOV. 26, 1907.

H. J. KIMMAN.

PORTABLE PNEUMATIC DRILL.

APPLICATION FILED JAN. 15, 1907.

2 SHEETS—SHEET 1.

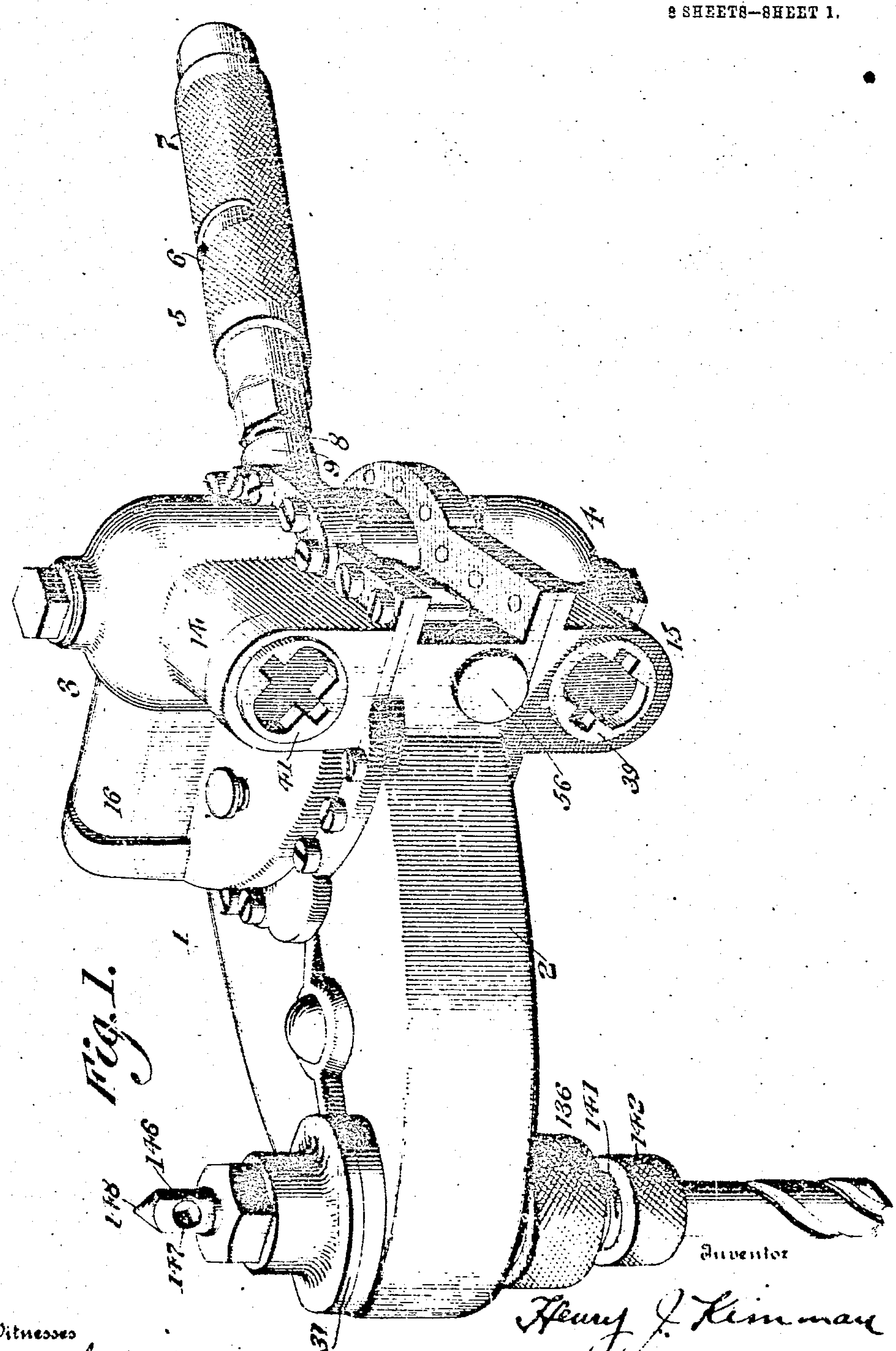

Fig. 1.

Witnesses

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8 SHEETS—SHEET 2.

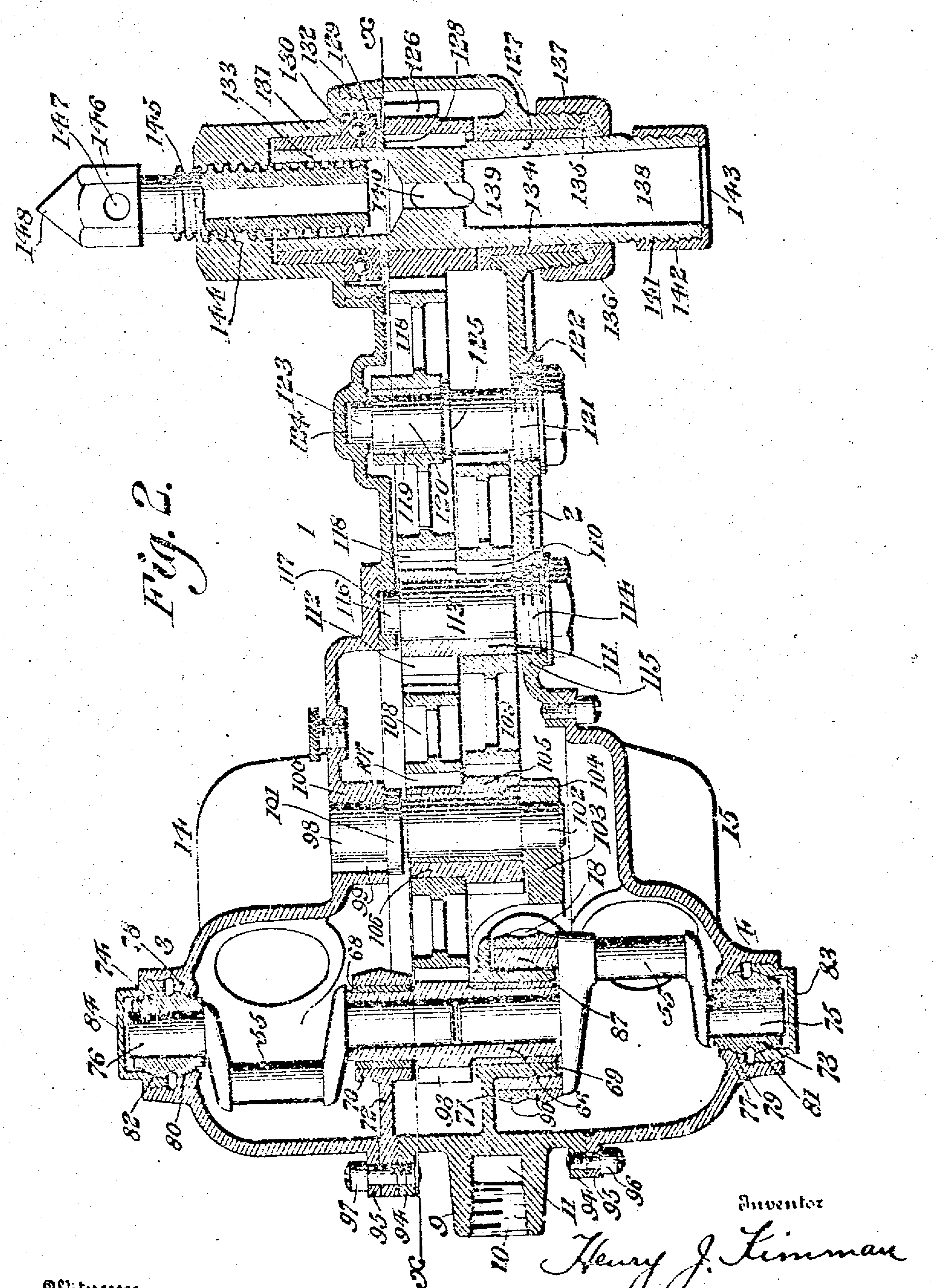

Fig. 2.

Witnesses

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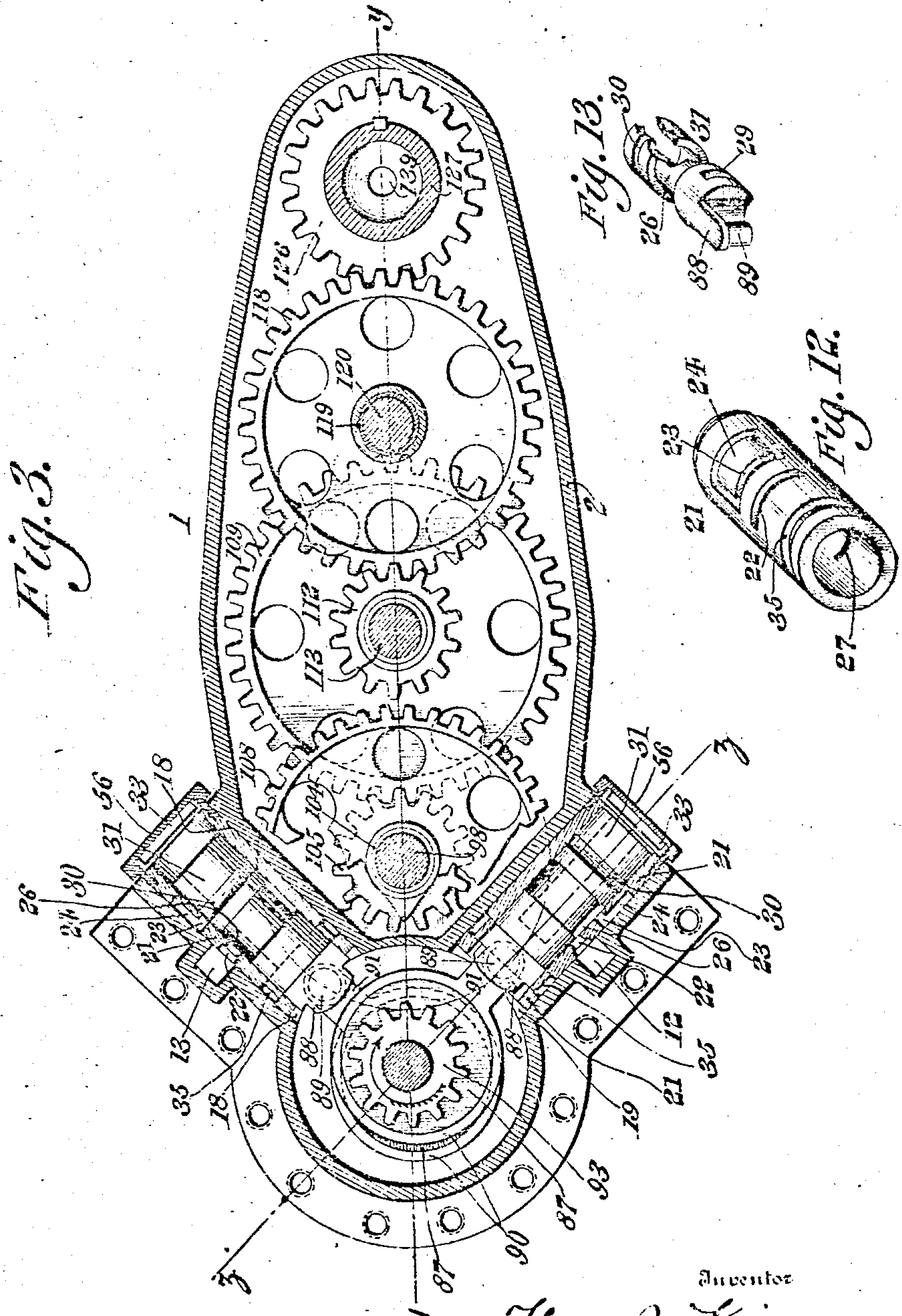

Fig. 3.

Fig. 13.

Fig. 12.

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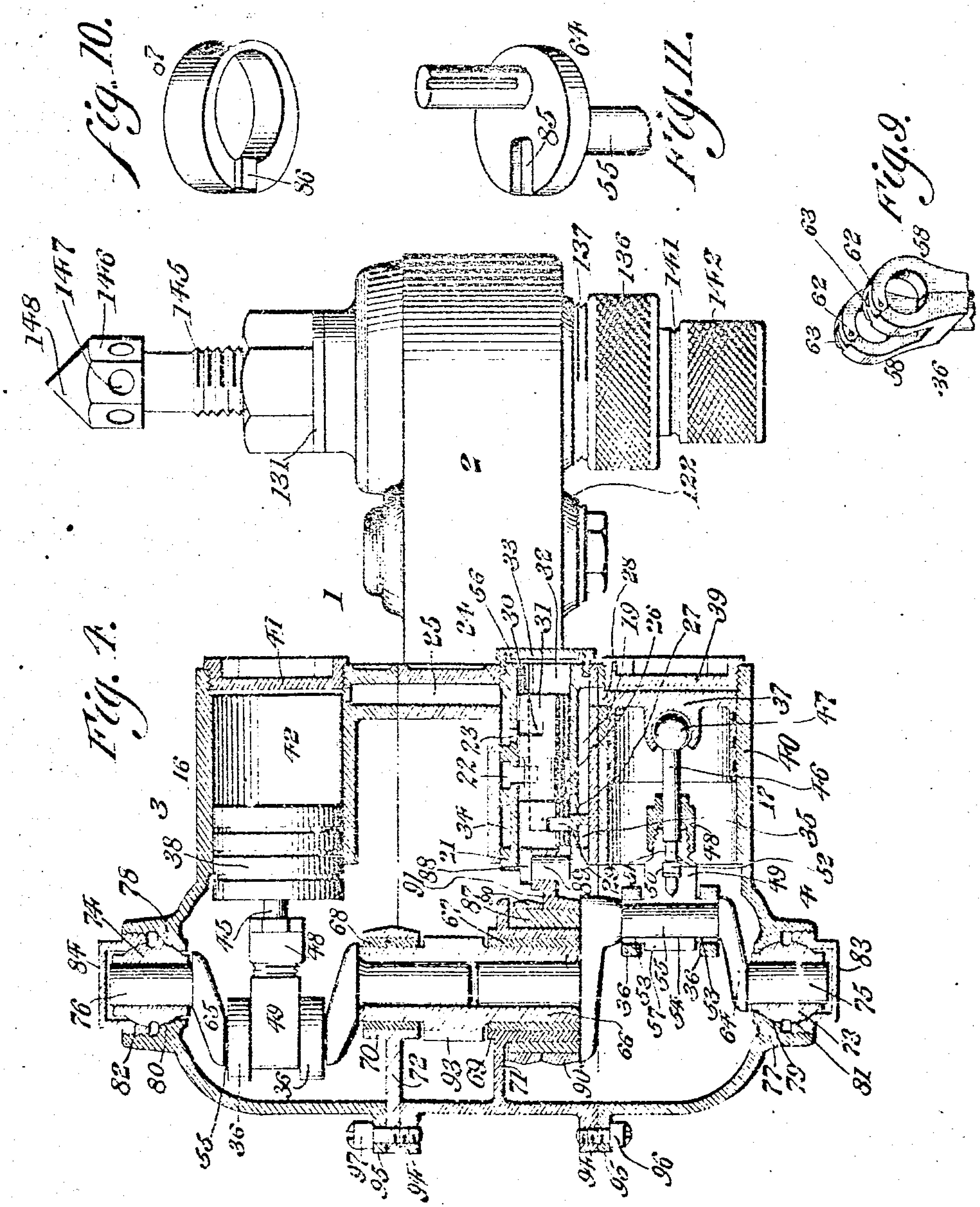

Witnesses

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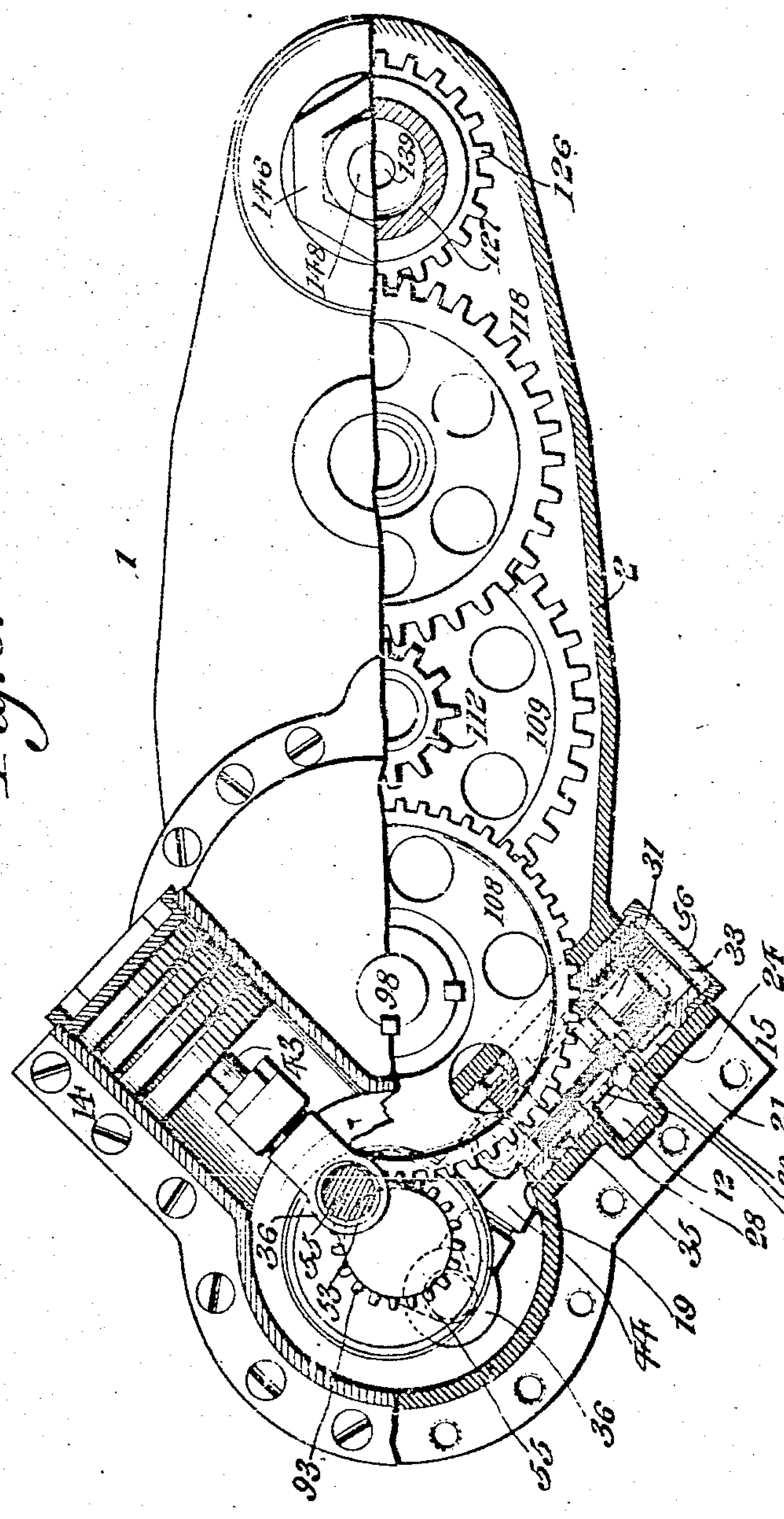
8 SHEETS—SHEET 5.

Fig. 5.



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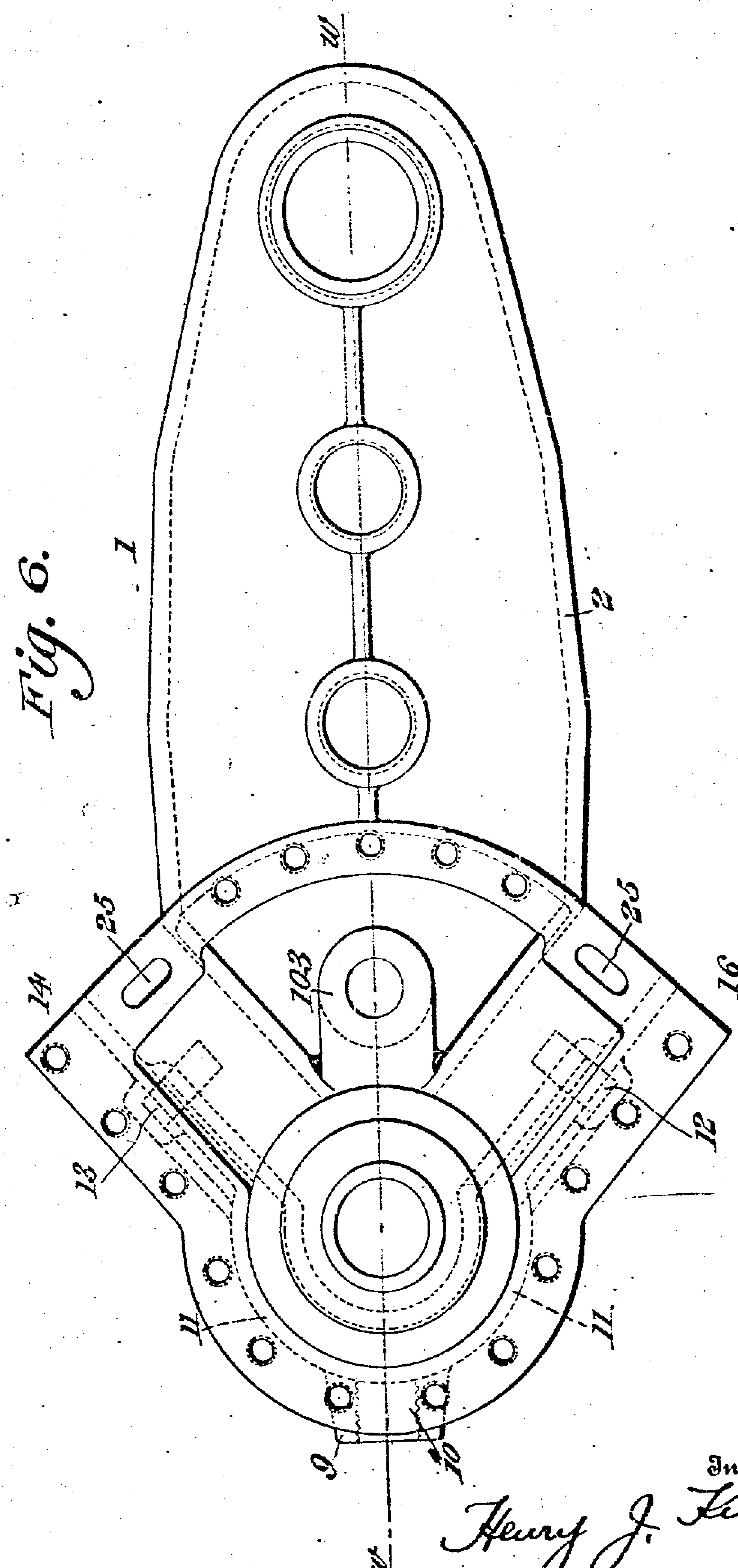
8 SHEETS—SHEET 6.

Fig. 6.



Witnesses

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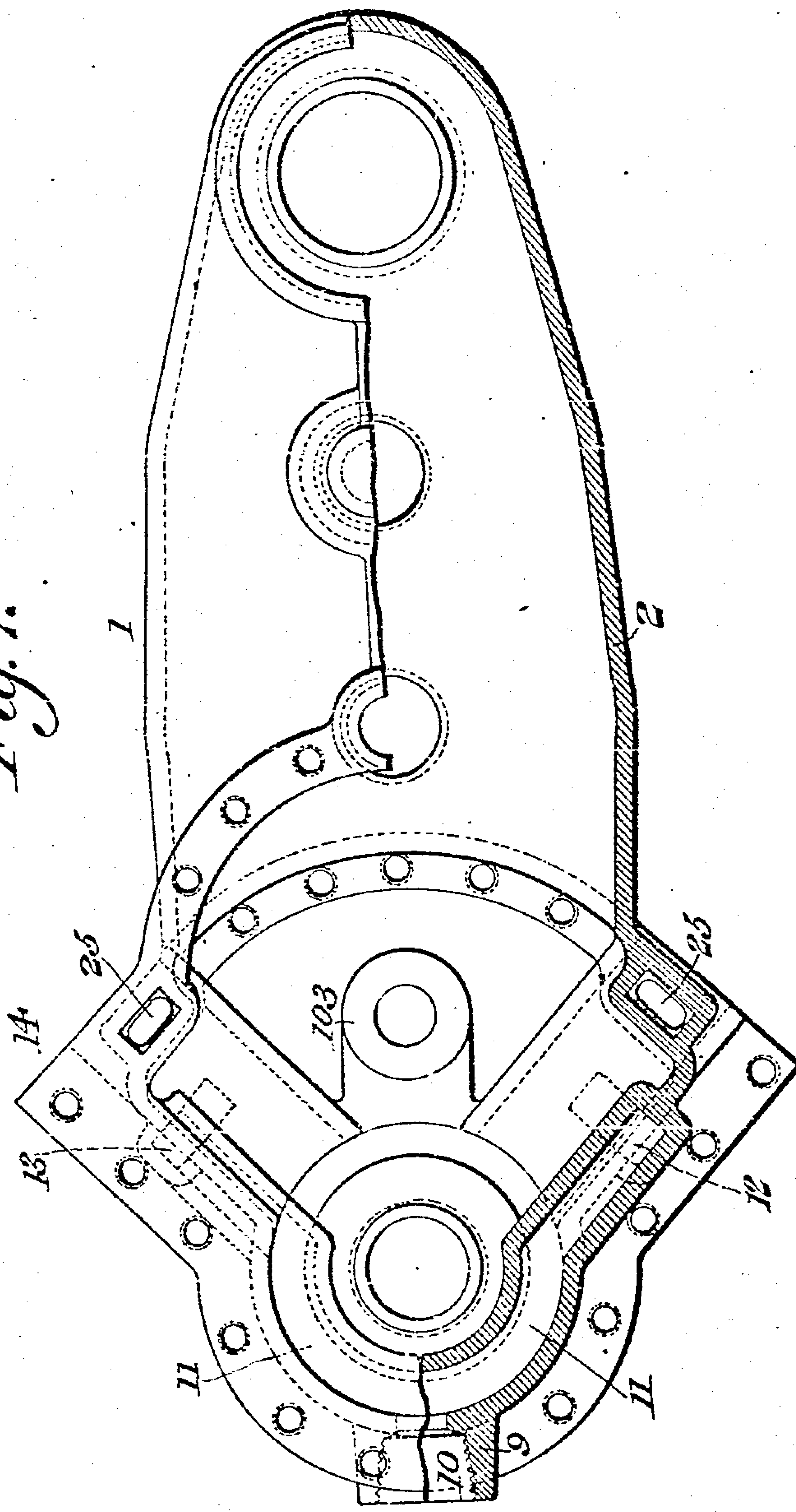
8 SHEETS—SHEET 7.

Fig. 7.



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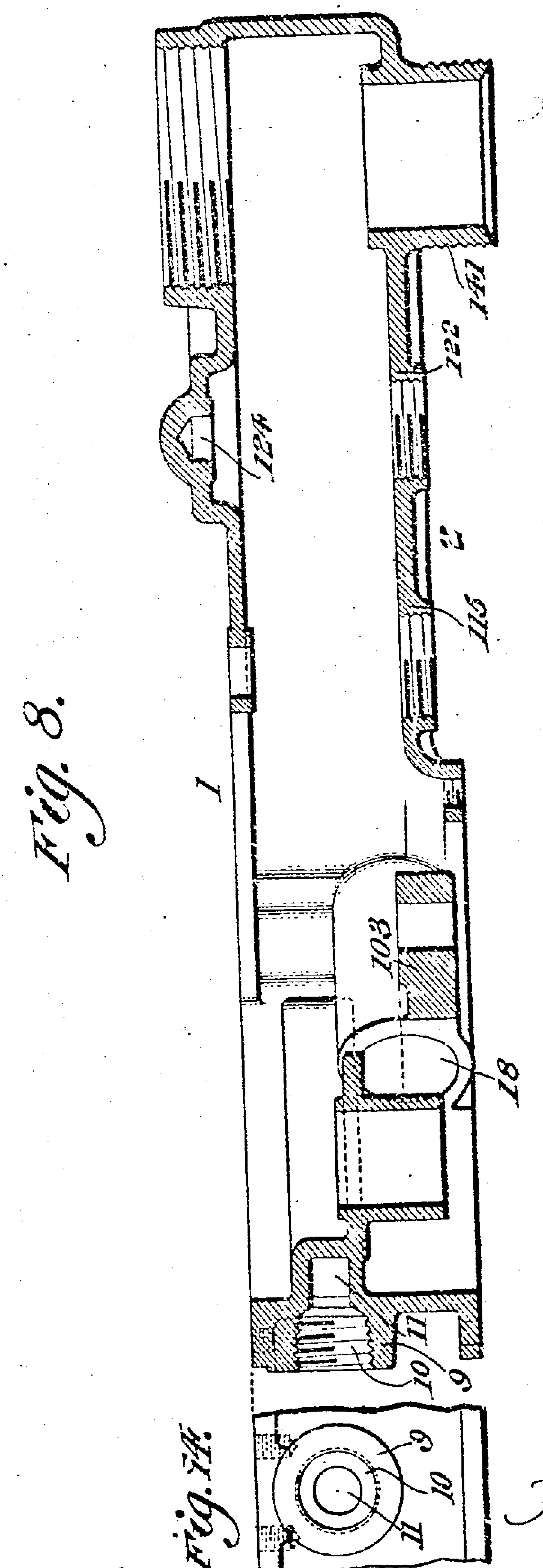
8 SHEETS—SHEET 8.



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UNITED STATES PATENT OFFICE.

HENRY JAMES KIMMAN, OF CLEVELAND, OHIO, ASSIGNOR TO CHICAGO PNEUMATIC TOOL COMPANY, A CORPORATION OF NEW JERSEY.

PORTABLE PNEUMATIC DRILL.

No. 871,939. Specification of Letters Patent. Patented Nov. 26, 1907.

Application filed January 15, 1907. Serial No. 352,413.

To all whom it may concern:

Be it known that I, HENRY J. KIMMAN, a citizen of the United States, residing in the city of Cleveland, county of Cuyahoga, State of Ohio, have invented a new and useful Portable Pneumatic Drill, of which the following is a specification.

In prior patents granted to me August 8th, 1899, No. 630,357, and July 10th, 1900, No. 653,248, I have shown, described and broadly claimed a novel construction of fluid pressure engines or motors portable in their nature and adapted for the operating of drills, reamers and other tools and mechanisms for use in assisting hand labor and minimizing the cost of construction and production of structural appliances and devices.

In my prior patents I employed at least two sets of fluid pressure cylinders arranged in parallel lines, a reciprocating piston in each cylinder, a rotatable crank shaft connected with the piston, a reciprocating valve for each line of parallel arranged cylinders and a drill holding mechanism connected with the crank shaft and arranged to be driven thereby.

In my present invention, while employing some of the general features of my prior patents referred to, I have in addition, reorganized and modified the principal coacting elements so that by assembling the valves and pistons and their coacting devices in a novel and more compact manner, I am enabled to reduce the thickness and weight of the tool, and by the employment of a novel construction of elongated casing, I am enabled to provide a gear casing and train of gearing which is adapted to actuate an eccentrically located drill spindle having bearings in the extreme end of the casing, whereby I am enabled to utilize my novel drill for drilling in close quarters and particularly in corners where it has heretofore been customary to perform the drilling, reaming operations and the like manually or by hand, it being apparent that since the spindle of my novel tool is driven by gears instead of on the ratchet principle, a steady, constant and uniform rotation of the spindle is insured and all the parts are self contained in a neat and compact casing, which, although readily accessible at all times for the purpose of inspection and repairs, protects the mechanism and all moving parts from injury.

To the above ends my invention consists broadly in the present instances, of four single acting cylinders arranged in pairs one above and one below, with the valves located between said cylinders and preferably in line therewith, each pair of cylinders being arranged at approximately ninety degrees with the other.

By reason of my novel construction and correlation of the parts, I am enabled to employ a divided crank shaft having a double throw with its pins set opposite to each other and each one of a pair of pistons is coupled to one of these pins. By reason of this construction, a perfect balance of the reciprocating parts is insured, since the pistons thus connected always move in opposite directions, one to the other, and inasmuch as each pin has two pistons connected to it and as these pistons are set at ninety degrees, it is impossible for the motor to stop on the dead center, since by this arrangement one piston at least is always under full pressure of the motive fluid. I further locate the center of the shafts within the cylinder so that the center is provided with an eccentric, set in proper position to give the correct distribution of the motive fluid to the desired points, said eccentric being provided with two straps, each of which is connected to one of the valves.

It further consists of a novel manner of supporting and actuating the eccentric, with respect to the cranks, whereby the cranks, pistons, valves and their adjuncts can be assembled in a very small compass.

The invention further consists of other novel features of construction, all as will be hereinafter fully set forth, and particularly pointed out in the claims.

For the purpose of illustrating my invention, I have shown in the accompanying drawings one form thereof which has been found in practice to give satisfactory and reliable results, although it is obvious that the various instrumentalities of which my invention consists can be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities, as in the embodiment herein shown.

Figure 1 represents a perspective view of a portable pneumatic drill embodying my invention. Fig. 2 represents a longitudinal section on line y—y Fig. 3. Fig. 3 represents a section on line x—x Fig. 2. Fig. 4 represents a section on line z—z Fig. 3. Fig. 5 represents a plan view of the casing, showing certain portions broken away for the sake of clearness of illustration. Fig. 6 represents a plan view of the casing, showing certain portions as the upper cylinders and their adjuncts, removed. Fig. 7 represents a plan view of the casing partly in section. Fig. 8 represents a sectional view through the gear casing with the gearing removed. Fig. 9 represents a perspective view of the eccentric straps in detached position. Figs. 10 and 11 represent perspective views of one of the cranks, the eccentric therefor and their adjuncts. Fig. 12 represents a perspective view of one of the valve bushings in detached position. Fig. 13 represents a perspective view of one of the valves employed, partly broken away to show the hollow exhaust portion of the same. Fig. 14 represents an end view of Fig. 8.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings. In its broad aspects my novel drill embodies a central casing in which the gearing and valve mechanism are contained, side engine casings containing a pair of engines, each set at substantially right angles and at one end a combined handle and inlet connection for the motive fluid and a drill socket with a feed therefor at the end opposite said handle. The engines are so placed as to form pairs, the two pairs of engines thus occupying two planes at substantially right angles, each pair within a plane being actuated by a single intermediate distribution valve. The train of gearing is also arranged between the engines and so combined with the valves as to afford a maximum of strength with a minimum of torsion and with a minimum length of fluid passages between each valve and the engines controlled thereby. At the same time, the crank shafts are made separable for the several engines upon the same side of the gear casing and all parts are readily accessible.

1 designates my novel drill having the gear casing 2 and the upper and lower engine casings 3 and 4. The handle 5 which is located preferably at the extreme end of my mechanism from the drill chuck thereof and at right angles thereto is used as an air inlet tube, the supply of air for which is controlled by the sleeve 7 acting upon the pin 6 by means of an eccentric slot, said handle being threaded at 8 into a boss 9 connecting the handle with the central casing or frame 2. The passage 10 in the boss leads into passages 11, which supply motive fluid to the engine cylinders through two tubular valves hereinafter described and best illustrated in Figs. 3 and 13. The passages or channels 11 conduct the motive fluid into the openings 12 and 13 respectively in the two valve chambers from whence the fluid is distributed by means of the valves as will be described.

The engines of my drill are preferably four in number arranged in two casings 3 and 4, one upon the upper and the other upon the lower side of my gear casing, one engine in each of these casings being parallel with an engine in the other casing. The valve controlling these two parallel engines lies in the plane between; thus with respect to the valve mechanism, the engines are divided differently from the division in their several casings and two engines from different casings, but lying within the same plane, form a pair controlled by an intermediate valve, this pair being duplicated by the other two engines in a plane at approximately right angles to the first plane named. There are thus two planes of engines at substantially right angles, each controlled by a single intermediate valve and acting upon the same crank mechanism but at opposite ends thereof. I have indicated these engines by numbers 14, 15, 16 and 17, of which 14 and 15 constitute one pair controlled by a valve chamber 18, while the engines 16 and 17 constitute the other pair and are controlled by a valve chamber 19, the relation between the two pairs being as stated right-angular, thus avoiding a dead center under all conditions. The valves for the two sets of engines are substantially alike and comprise preferably the cylindrical chambers 18 and 19, within which I preferably locate bushings 21, through which are formed passages 22 and 23 permitting passage of motive fluid to the interior of the bushing. The passage 22 is connected with the supply passage or channel 12 and admits live fluid to the center of the bushing at this point, the live fluid being distributed therefrom according to requirements. The groove 24 in the bushing 21 leads from the passage 23 to the passage 25, by which live and exhaust motive fluid are transmitted to the cylinder shown in Fig. 4 as cylinder 16 of the pair 16 and 17 there illustrated. The groove 26 in the valve connects an opening 27 preferably in the opposite side of the casing 21 from the openings 22 and 23 with the passage 28, by which live and exhaust fluid are transmitted to and from the engine 17. The openings or ports 29 and 30 in the piston valve 31 connect with the hollow center or exhaust portion of this valve 31, which is open from the point 29 to the opposite end from the eccentric, in order to permit free flow of the exhaust through these openings 29 or 30 according to the engine exhausting into the space 32 at the end of the valve chamber from which the exhaust is freely carried to the atmosphere by the port 33. In practice I recess the casing or bushing 21, as at 34 and 35, in order to lighten the same.

It will be evident that with live motive fluid in the passage 22 and the valve in the position shown in Fig. 4, there will be free access of live fluid around the valve 31 at its groove or circumferential recess 26 through passages 27 and 28 into the cylinder of engine 17 forcing the piston 37 thereof to the left of the position seen in Fig. 4 or outwardly. At the same time, the piston 38 of engine 16 will be moving toward the piston head and exhaust of the motive fluid in said engine 16 will take place through the passages 25, 24, 23, port 30, the center of the valve 31, the spaces 32 and the exhaust aperture 33 in the cap 56.

When the valve is reversed in position, which will occur at the opposite ends of the stroke with piston 37 in its farthest position from the head 39 of its cylinder 40 and the piston 38 in proximity to the head 41 of its cylinder 42, the valve will assume a position with its end in proximity to the cap 56. The motive fluid from passage 22 will then pass through the circumferential groove 26 to the opening or port 23, thence through openings 24 and 25 to cylinder 42 bringing live motive fluid pressure upon the piston 38, while the motive fluid in cylinder 40 will be in position to exhaust through passages 28, 27, 29, the center of the valve 31, chamber 32 and the exhaust aperture 33. The other pair of engines 14 and 15 with their common valve will operate in the same manner but will be timed approximately a quarter of a stroke differently from the two engines which have just been considered, so that one of the four single acting engines will be operating at each of the four quarters.

The pistons are preferably of a single acting type, hollow and connected with the piston rods 43, 44, 45 and 46 by means of the same type of ball and socket connection or its equivalent 47. The connection of each piston rod with the crank in a given pair in the same plane is the same, but the connection of two piston rods or engines in the same engine casing as engines 14 and 16 varies somewhat. One pair of connections will be described, taking engines 15 and 16 as a type, which are connected substantially as engines 14 and 16. The connecting rods 45 and 46 are connected by means of a screw cap 48 and lock nut with a split coupling or bearing composed of two like straps or parts 49, each having a recess 50 and aperture 51 by which connection is made with the enlargement 52 of the rods 45 or 46, in order to prevent longitudinal movement thereof. The two portions of this coupling or bearing have each extensions in opposite directions as at 53, which are externally cylindrical and the aperture 51 passes through these connections in such form as to encircle the crank 55 through the normal length of the strap 49 and also the extension 53.

As just pointed out, the like parts 49 are united and held in contact with the rod 45 or 46 by means of the screw cap 48 with the parts surrounding the crank 55. They are held at the end at which they surround the crank in another manner, making the junction between these parts firm and secure and avoiding movement thereof. This is done by means of a yoke 36 connected with each of the piston rods 43 and 44, the yoke 36 upon the piston rod 44 surrounding the extensions 53 secured to the piston rod 46, whereas the yoke 36 secured to the piston rod 43 surrounds the extensions 53 secured to piston rod 43. The yoke 36 straddles the main portion 57 of the bearing of the strap formed by parts 49 and maintains the extensions 53 thereof in close contact. The yoke 36 is also formed of two like parts 58, see Fig. 9, which are split in the plane of the crank pin and which are united at their ends nearest the piston by a screw cap connection 48 and are held from longitudinal movement with reference to the piston rod by means of enlargement 52 upon the piston rod fitting into a recess 50 within the meeting parts. At the outer end of the yoke, the parts are united by pins 62 through overlapping flanges or ears 63 upon the like yoke parts. It will thus be seen that the yoke connection of one of the piston rods with the crank straddles and supports the connection of the other and that each of these different types of connection of the piston rods of engines within the same gear casing is securely fastened to the piston rod of its engine while it is readily separated therefrom.

The crank shafts are two in number making one continuous crank. They consist of two shafts 64 and 65 which are keyed to a common sleeve 66 which lies between the engine casings and within my central casing which I have termed a gear casing. This sleeve 66 is supported at opposite ends by bushings 67 and 68 in supports 69 and 70, which in turn are held by brackets 71 and 72 attached to the gear casing. The sleeve 66 with the cranks which are keyed therein rotates within these bushings 67 and 68, being supported at the inner ends thereby and at the outer ends being supported by bearings in the engine casing, which I have illustrated as of the same construction in each case. These bearings consist of balls 73 and 74 affording cylindrical bearing upon their inner surfaces for the ends 75 and 76 of the two crank shafts and resting at their outer spherical surfaces in spherical bearings 77 and 78 formed by recesses 79 and 80 in the engine casings themselves and coöperating recesses 81 and 82 in caps 83 and 84 which are screwed into the engine casings at this point. The two shafts 64 and 65 carry the crank pins 55 which are alike and which are connected with the respective engines of the two pairs in the manner already described.

Upon one of the crank shafts as 64 at the end in proximity to the support or ring 69, I form a recess 85 which coacts with a recess 86 upon an eccentric 87, see Figs. 10 and 11, which is mounted to rotate upon the exterior surface of the ring or bearing 69, with the result that while this support and its bushing 67 are stationary, the sleeve 66 rotates inside of both and the eccentric 87 rotates outside of both in accordance with the rotation of the crank shafts. I preferably place the two valves in the valve chambers 18 and 19 in the same plane, so that they may be acted upon by the same eccentric.

Each piston valve 31 is preferably provided with an extension 88 from which projects laterally a pin 89, as will be understood from Fig. 13. Upon this pin is provided an eccentric strap 90 by means of an apertured extension 91 therefrom.

I have placed my valves between the engines where each can most advantageously serve both engines of its pair and where a single eccentric about one of the central supports of my crank shaft will serve both valves and I have also placed the gear 93, by which the motion of the cranks is transmitted, in approximately the central plane between my engines, whereby I am enabled to economize space and derive great advantage as regards torsion upon the shafts and uniform distribution of weight and turning moment in my drill. The gear 93 is preferably made a part of the sleeve 66, but may evidently be secured thereto, if so desired.

The casings containing respectively the engines 14 and 16 and the engines 15 and 17 are united by any suitable fastening devices as by flanges 94 and 95 upon the central casing and the engine casings respectively and screws 96 and 97 coacting therewith. I have shown the support 72 as clamped between the flanges 94 and 95 upon this side of the construction, preferably in a recess therebetween and for this purpose have shown the screws 97 as having a greater length than the screws 96. The bracket 72 may be integral with the gear casing if so desired.

In my gear casing 2 and at a suitable distance from the gear 93, I have placed a stud 98 which I have shown as keyed at 99 into an inwardly projecting hollow boss 100 and enlarged at 101 to secure is rigidly therein. This stud is supported at its opposite end 102 in a bracket 103 secured to my gear casing. The stud 98 is surrounded by a sleeve 104 within a gear 105 which is extended at 106 in the form of a sleeve, keyed at 107 to a surrounding gear 108, which meshes with a gear 93. This construction causes gear 93 to transmit its motion to gear 108 which rotates uniformly with gear 105. The gear 105 in turn transmits its motion to a gear 109, which is keyed at 110 to an extension 111 of a gear 112, whereby the gear 112 and the gear 109 rotate together about a stud 113 on which said gear 112 is mounted. The stud 113 is screwed at one end 114 into a boss 115 of the gear casing and is supported at its other end 116 in an aperture 117 in the opposite side of the gear casing. The gear 112 in turn meshes with a gear 118, which in this construction serves merely as an idler and said gear 118 is lined by a sleeve or bushing 119 having bearing upon a stud 120 which stud is screwed at 121 into a boss 122 in one side of the casing and its reduced end 123 has a bearing in an aperture 124 in the opposite side of the gear casing. The stud 120 is provided with a collar 125 by which the gear 118 is maintained in its position longitudinal of the stud. The idler 118 meshes with a gear 126 which is mounted upon the sleeve or tool socket 127, the latter serving as a drill spindle. This tool socket 127 is flanged at 128 to support the lower half 129 of a ball race, whose upper half 130 is seated in the sleeve 131 which is screwed at 132 into an aperture in the gear casing. The socket 127 is extended at 133 within the upper portion 130 of the ball race and rotates therewithin. The socket 127 at its opposite end from the ball race is adapted to rotate within a bushing 134 and any suitable packing 135 held to place by a cap 136 screwed at 137 upon an external thread at the outer extremity of the gear casing. The socket 127 is provided at its lower end with a preferably tapered opening 138 adapted to receive a reducing socket or a drill and is further provided with a longitudinal opening 139 and a transverse aperture 140 thereby providing for the reception of the flattened end of the drill and for the ejection of said drill by means of a drift. At its outer end, the sleeve 127 is exteriorly threaded at 141 for the attachment thereto of any suitable chuck and I have shown a threaded cap 142 apertured at 143 intended to normally occupy this exteriorly threaded portion in the absence of a chuck, in order to prevent any injury to the external threads.

The sleeve 131 is internally threaded at 144 and with this threaded portion the feed screw 145 coacts, said feed screw being provided with faces 146 and an aperture 147, in order that the same may be readily actuated when desired, it being noted that the outer end of said screw is tapered, as at 148, in the usual manner.

I wish to call special attention to some of the novel features of my invention by the employment of which I am enabled, without decreasing the efficiency of the drill, to produce a construction of minimum size which may be employed in a small working space. The different sets of piston casings are located on opposite sides of the gear casing and owing to the employment of a divided crank shaft, said piston casings may be readily removed for the purpose of inspection or repairs. In the present construction, as seen in Fig. 4, I have shown the bracket 72 as being separate from the casing for convenience in assembling. I seat it between the piston and gear casings.

By the employment of a driving gear keyed to the separate crank shafts, I am enabled to form a continuous crank shaft to which is imparted a continuous rotation owing to the novel arrangement and correlation of the different pistons which are operatively connected therewith. It will be apparent to those skilled in this art that the piston rods carried by the pistons in each casing are operatively connected with the crank shaft in such a manner as to prevent any improper movement thereof and to take up very little room within the casing.

The distribution valves are so located that they do not interfere with the employment of suitable gearing, so that the tool operating mechanism will be accurately and positively actuated under all conditions. Since the valve mechanism is operatively connected with and actuated by the crank shaft, the passage of the motive fluid to actuate the different pistons will be accurately controlled at all times.

It will now be apparent to those skilled in this art that I have devised a novel and useful construction of a portable pneumatic drill which embodies the features of advantage enumerated as desirable in the statement of invention and the above description and while I have in the present instance shown that embodiment thereof which has been found in practice to give satisfactory and reliable results, it is to be understood that it is susceptible of modification in various particulars without departing from the spirit and scope of the invention or sacrificing any of its advantages.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a portable pneumatic drill, a divided casing, separable crank shafts having their inner ends juxtaposed and in alinement with each other, driving mechanism therefor, extensions on said casing, bearings in said extensions for the juxtaposed ends of said shafts, and tool operating mechanism driven from said crank shafts.

2. In a portable pneumatic drill, a divided casing, separable crank shafts having their ends juxtaposed and in alinement with each other, driving mechanism therefor, connecting means for the juxtaposed ends of said crank shafts, a gear carried by said connecting means, and tool operating mechanism driven by said gear.

3. In a portable pneumatic drill, a divided casing, separable crank shafts having their ends juxtaposed and in alinement with each other, driving means therefor, a gear connecting the juxtaposed ends of said crank shafts, a train of gears driven thereby, and a tool operating mechanism actuated by the end gear of said train of gears.

4. In a portable pneumatic drill, a divided casing, separable crank shafts having their ends juxtaposed and in alinement with each other, driving mechanism therefor, connecting means for the juxtaposed ends of said crank shafts, a train of gears driven thereby, a tool operating mechanism actuated by the end gear of said train of gears, and controlling mechanism for said driving mechanism located intermediate the same.

5. In a portable pneumatic drill, a divided crank shaft having its inner ends juxtaposed and in alinement with each other, driving means therefor, a gear uniting the juxtaposed ends of said shaft, tool operating mechanism driven by said gear, an eccentric actuated by said crank shaft, and valve mechanism for said driving means actuated by said eccentric.

6. In a portable pneumatic drill, a divided casing, a drill spindle eccentrically located in bearings at one end thereof, a divided crank shaft located in the opposite end of said casing and having its juxtaposed ends journaled in extensions within said casing, driving means for said crank shaft, a gear operatively connecting the juxtaposed ends of said crank shaft, power transmission devices intermediate said gear and spindle for driving the latter, and valve mechanism controlled by said crank shaft and controlling said driving means.

7. In a portable pneumatic drill, a gear casing, upper and lower piston casings carried by said gear casing, separable crank shafts having their inner ends juxtaposed and in alinement with each other and adapted to be suitably driven, the outer ends of said shafts having bearings in said piston casings, a gear constituting a connecting means for the juxtaposed ends of said crank shafts, driving means actuated by said connecting means, and tool operating mechanism driven by said driving means.

8. In a portable pneumatic drill, a gear casing, upper and lower piston casings carried by said gear casing, a drill spindle eccentrically located in bearings at the extreme end of said gear casing, a separable crank shaft having its juxtaposed ends journaled in bearings within said casing, gearing operatively connecting said shaft and spindle, driving means for said crank shaft, and valve mechanism actuated by said shaft and controlling said driving means.

9. In a portable pneumatic drill, an elongated casing, upper and lower piston casings carried thereby, a drill spindle eccentrically located in bearings at one end of said gear

casing, separable crank shafts having their juxtaposed ends journaled in bearings within said casing, a gear uniting said shafts, a train of gearing coacting with said gear and operatively connected with said spindle, driving means for said crank shafts, and valve mechanism controlling said driving means.

10. In a portable pneumatic drill, a casing, a divided crank shaft journaled in one end thereof and having a double throw with the pins thereof set opposite to each other, two sets of engines arranged in pairs in different planes at approximately right angles with each other and operatively connected with the adjacent pin, a driving gear uniting said crank shafts, and a tool operating mechanism journaled in said casing in the end opposite said crank shaft and driven by said driving gear.

11. In a portable pneumatic drill, the combination of a gear casing, piston casings secured on opposite sides th reof, a crank shaft journaled in said casings, a pair of piston cylinders in each of said piston casings arranged approximately at right angles with each other, pistons within said piston casings and operatively connected with the crank shaft, and a pair of valves in said gear casing operatively connected with said crank shaft, each of said valves controlling the passage of motive fluid to actuate the pistons in the same vertical plane.

12. In a portable pneumatic drill, an elongated casing, a tool operating mechanism eccentrically located in bearings at one end thereof, a crank shaft journaled in the opposite end thereof and adapted to drive said tool operating mechanism, said crank shaft having a recess in the head thereof, an eccentric having a projection adapted to engage said recess, driving means for said crank shaft, and valve mechanism located intermediate said driving means and actuated by said eccentric for controlling said driving means.

13. In a portable pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at the extreme end thereof, a divided crank shaft journaled in the opposite end thereof and having a double throw with the pins thereof set opposite to each other, four cylinders arranged in pairs in different planes, each pair of cylinders being arranged at approximately right angles with each other, pistons within said cylinders, each one of a pair being coupled to the adjacent pin, a gear uniting said shafts, gearing coacting with said gear and operatively connected with said spindle, and means for controlling the passage of motive fluid to actuate said pistons.

14. In a portable pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at the extreme end thereof, a divided crank shaft journaled in the opposite end thereof and having a double throw with the pins thereof set opposite to each other, four cylinders arranged in pairs in different planes, each pair of cylinders being arranged at approximately right angles with each other, pistons within said cylinders, each one of a pair being coupled to the adjacent pin, a gear uniting said shafts, gearing coacting with said gear and operatively connected with said spindle, and means actuated by said crank shaft for controlling the passage of motive fluid to actuate said pistons.

15. In a portable pneumatic drill, a gear casing, piston casings detachably secured on opposite sides thereof, a divided crank shaft mounted in said casings, a gear uniting said shafts, an eccentric carried by one of said shafts, a pair of straps mounted on said eccentric, separate valve mechanisms actuated by said straps, and pistons operatively connected with said shafts and controlled by said valve mechanisms.

16. In a portable pneumatic drill, the combination of a gear casing, piston casings secured thereto, a divided crank shaft journaled in said casings, a gear uniting said crank shafts, an eccentric, a strap mounted on said eccentric, a valve mechanism carried by said gear casing and actuated by said strap, a second strap on said eccentric, a second valve mechanism carried by said gear casing and actuated by said second strap, a pair of pistons arranged at right angles in each of said piston casings and operatively connected with the adjacent crank shaft, and fluid ports and passages controlled by said valve mechanisms.

17. In a portable pneumatic drill, a gear casing, piston casings secured thereto on opposite sides thereof, a set of pistons arranged approximately at right angles in each of said piston casings, a separable crank shaft journaled in said casing, a piston rod operatively connected with each of said pistons, a valve mechanism located intermediately of said piston mechanism for controlling the passage of motive fluid to actuate said pistons, and tool operating mechanism driven by said crank shaft.

18. In a portable pneumatic drill, a gear casing having a bearing therein, piston casings secured to said gear casing, separable crank shafts journaled in said piston casings, a gear uniting said crank shafts and having outwardly extending sleeves, one of which is journaled in the bearing of said gear casing, a removable bearing in which the other of said sleeves is journaled, an eccentric mounted on the bearing in said gear casing and adapted to interlock with one of said crank shafts, a plurality of straps mounted on said eccentric, a valve mechanism connected with each of said straps, a pair of piston cylinders arranged at right angles in each of said piston casings, pistons

within said cylinders operatively connected with the adjacent crank shaft, fluid ports and passages communicating with said cylinder and said valve mechanism, a train of gears driven by said uniting gear, and tool operating mechanism actuated by said train of gears.

19. In a portable pneumatic drill, the combination of a gear casing, piston casings removably secured thereto, a pair of piston cylinders in each of said piston casings arranged substantially at right angles to each other, separable crank shafts mounted in said casings, the pins of which are set opposite to each other, a gear having sleeves extending therefrom for uniting said crank shafts, bearings with which said sleeves engage, an eccentric mounted on one of said bearings and adapted to interlock with the adjacent crank shaft, a pair of valve mechanisms carried by said gear casing adapted to be actuated by said eccentric, pistons mounted in said cylinder and operatively connected with the adjacent crank shaft, ports and passages communicating with said cylinders and valve mechanisms, each of said valve mechanisms being adapted to control the pistons in the same vertical plane, a train of gears driven by said uniting gear, and a tool operating mechanism actuated by said train of gears.

20. In a portable pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at the extreme end thereof, separable crank shafts journaled in the opposite end of said casing, a gear keyed to said shaft, gearing operatively connecting said gear and said spindle, cylinders arranged in pairs in different planes, each pair of cylinders being arranged at approximately right angles to each other, pistons within said cylinders and operatively connected with the adjacent crank shaft, intermediate distribution valves for actuating each pair of pistons within the same vertical plane, an eccentric carried by one of said shafts, a strap for each valve mounted on said eccentric and operatively connected with its respective valve, valve casings for said valves, fluid ports and passages communicating with said piston cylinders and said valves, and exhaust ports leading from said valves.

21. In a portable pneumatic tool, an elongated gear casing, piston casings detachably secured on opposite sides at one end thereof, separable crank shafts journaled in said casings, a drill spindle eccentrically journaled at the opposite end of said gear casing, a gear uniting said crank shafts, a gear mounted on said drill spindle, intermediate gearing coacting with said gears, piston cylinders arranged in pairs in said piston casings, each pair of cylinders being arranged at approximately right angles with each other, pistons within said cylinders, a piston rod pivoted to each piston, and independent valve mechanisms controlling the passage of motive fluid to the pistons in the same vertical plane.

22. In a portable pneumatic drill, the combination of a gear casing, piston casings secured on opposite sides thereof, separable crank shafts having their juxtaposed ends journaled in extensions of said gear casing, a gear uniting said crank shafts, tool operating mechanism driven by said gear, and driving means for said crank shafts.

23. In a portable pneumatic drill, a gear casing, a train of gears therein, a tool socket having a shoulder rotatably mounted in said casing, a gear carried by said socket and coacting with said train of gears, a chambered cap removably secured to said casing, a ball bearing between said cap and shoulder and having a sleeve extending within said cap, a feed screw engaging said cap, and means for actuating said train of gears.

24. In a portable pneumatic drill, a gear casing, a train of gears therein, a tool socket having a shoulder rotatably mounted in said casing, a gear carried by said socket and coacting with said train of gears, a chambered cap removably secured to said casing into the chamber of which the inner apertured end of said socket extends, a ball bearing between said cap and shoulder and having a sleeve extending within said cap, a feed screw engaging said cap, and means for actuating said train of gears.

25. In a portable pneumatic drill, a gear casing, upper and lower piston casings carried by said gear casing, a separable crank shaft having its juxtaposed ends journaled therein, pistons operatively connected with said shaft, a valve bushing in said casing having an inlet port, discharge ports on opposite sides of said inlet port leading to said pistons, a cap for said bushing having an exhaust port, a hollow valve open at one end having a groove controlling said bushing ports, exhaust ports in said valve registering alternately with said discharge ports, a pin integral with said valve, and an eccentric carried by said crank shaft and operatively connected with said pin.

26. In a portable pneumatic drill, an intermediate gear casing, piston casings secured on opposite sides thereof, separate crank shafts having their inner ends juxtaposed and in alinement with each other, a gear mounted thereon and to which the inner juxtaposed ends of said crank shafts are secured, said casings having a bearing, for the outer ends of said shafts, pistons operatively connected with said crank shaft, and valve mechanism actuated by said crank shaft and controlling the passage of motive fluid to actuate said pistons.

27. In a portable pneumatic drill, an inter-

mediate gear casing having a bearing therein, piston casings detachably secured on opposite sides of said casing, separate crank shafts, the outer ends of which are journaled in said piston casings, a driving gear uniting the inner ends of said shafts, said gear having a sleeve extending therefrom engaging the bearing of said intermediate casing, a crank head adjacent said bearing having a recess therein, an eccentric mounted on said bearing and having a lug interlocking with said recess, driving means for said crank shaft, and valve mechanism located intermediate said driving means and actuated by said eccentric for controlling the passage of motive fluid to actuate said driving means.

28. In a portable pneumatic drill, a gear casing, a drill spindle mounted in bearings at the extreme end thereof, a stud removably carried by said gear casing, a gear mounted thereon adapted to drive said spindle, a second stud having an outwardly extending sleeve, a gear mounted on said sleeve co-acting with said first gear, a third stud mounted in said casing, a gear thereon co-acting with said second gear, a second gear on said third stud, piston casings removably secured to said casing at the end opposite said drill spindle, a crank journaled in said casings, a driving gear mounted thereon and meshing with one of the gears carried by said third stud, a set of pistons arranged substantially at right angles with each other in each of said piston casings and operatively connected with said crank shaft, and a pair of valves mounted in said gear casing intermediately of said piston mechanism and operatively connected with said crank shaft and controlling the passage of motive fluid to actuate the pistons in the same vertical plane.

29. In a portable pneumatic drill, a casing, a crank shaft having a double throw journaled therein, two sets of piston cylinders arranged at substantially right angles with each other, a driving gear carried by said crank shaft, a train of gears intermediate said piston cylinders and driven by said driving gear, a drill spindle journaled in the extreme end of said casing and actuated by said train of gears, a pair of valves located intermediate said sets of cylinders and operatively connected with said crank shaft and controlling the passage of motive fluid to and from the pistons in the same vertical plane, piston rods for the piston in one vertical plane, straps secured to said rods and said crank shafts, piston rods for the pistons in the other vertical plane, and yokes mounted on said straps and secured to the said last named connecting rods.

30. In a portable pneumatic drill, an intermediate casing, piston casings carried thereby, a pair of pistons arranged at substantially right angles to each other in each of said piston casings, separate crank shafts journaled in each piston casing and operatively connected with the pistons therein, a gear uniting said shafts, tool operating mechanism journaled in the extreme end of said intermediate casing and driven by said gear, and means for actuating said pistons.

31. In a drilling apparatus, a divided casing, a separable crank shaft mounted therein and having its inner ends juxtaposed and in alinement with each other, bearings within said casing for the juxtaposed ends of said crank shaft, a tool socket located eccentrically to said crank shaft and power transmission devices intermediate said crank shaft and tool socket.

32. In a drilling apparatus, a divided casing, a separable crank shaft mounted therein and having its inner ends juxtaposed and in alinement with each other, bearings within said casing for the juxtaposed ends of said crank shaft, piston mechanisms for each section of said separable crank shaft, and a valve mechanism located intermediately of said piston mechanisms.

33. In a device of the character stated, a divided casing, a separable crank shaft mounted therein and having its inner ends juxtaposed and in alinement with each other, bearings within said casing for the juxtaposed ends of said crank shaft, piston mechanisms for each section of said separable crank shaft, a valve mechanism located intermediately of said piston mechanisms, a tool socket and power transmission devices intermediate said socket and crank shaft.

34. In a device of the character stated, an elongated gear casing, an upper and lower engine casing carried by said gear casing, upper and lower piston mechanisms therein, crank shafts having bearings for their juxtaposed ends within said casings, connections from said piston mechanisms to said crank shafts, a valve mechanism carried by said gear casing and located intermediately of said piston mechanisms, a tool socket rotatably mounted in said gear casing at the end thereof opposite to said crank shafts, and power transmission devices intermediate said tool socket and crank shafts, said piston mechanisms being also located intermediately of said crank shafts and tool socket.

35. In a device of the character stated, an elongated gear casing, an upper and lower engine casing removably secured to said gear casing, upper and lower piston mechanisms carried in said engine casings, a separable crank shaft, bearings contained within said casing for the juxtaposed ends of said crank shaft, connections from said piston mechanisms to said crank shafts, a valve mechanism located intermediately of said piston mechanisms, a tool socket rotatably mounted in said gear casing at the end thereof opposite to said crank shafts, a gear located at or near the juxtaposed ends of said crank shafts, and

power transmission devices intermediate said gear and tool socket for rotating the latter.

36. In a device of the character stated, a gear casing, a drill spindle mounted in bearings at one end thereof, a stud removably carried by said gear casing, a gear mounted thereon adapted to drive said spindle, a second stud having an outwardly extending sleeve, a gear mounted on said sleeve and coacting with said first gear, a third stud mounted in said casing, a gear thereon coacting with said second gear, a second gear on said third stud, a separable crank shaft within said casing said shaft having its inner ends juxtaposed and in alinement with each other, extensions within said casing forming bearings for the juxtaposed ends of said crank shaft, a driving gear mounted upon said crank shaft and meshing with one of the gears carried by said third stud, and means for actuating said crank shaft.

37. In a device of the character stated, a divided casing, a separable crank shaft mounted therein, bearings within said casing for the juxtaposed ends of said crank shaft, a gear having an upward and downward extension inclosing said juxtaposed ends, a drill spindle mounted in the extremity of said casing oppositely to said crank shaft and out of alinement therewith pistons for said crank shaft, a valve mechanism, and power transmission devices intermediate said gear and drill spindle.

38. In a device of the character stated, the combination of a gear casing, piston casings secured thereto, a crank shaft journaled in said casings, a gear on said crank shaft, an eccentric, a strap mounted on said eccentric, a valve mechanism carried by said gear casing and actuated by said strap, a second strap on said eccentric, a second valve mechanism carried by said gear casing and actuated by said second strap, pistons in said piston casings, connections between said pistons and crank shaft, and fluid ports and passages controlled by said valve mechanism.

39. In a device of the character stated, a gear casing, a train of gears therein, a tool socket rotatably mounted in said casing, a gear carried by said socket and co-acting with said train of gears, a cap removably secured to said casing, a ball bearing between said cap and tool socket and having a sleeve extending within said cap, a feed screw engaging said cap, and means for actuating said train of gears.

40. In a drill, a casing, a separable crank shaft mounted therein and having its inner ends juxtaposed and in alinement with each other, bearings carried by said casing for said juxtaposed ends, a gear having an upward and downward extension and engaging said juxtaposed ends, a drill spindle mounted in the extremity of said casing oppositely to said crank shaft and out of alinement therewith, power transmission devices intermediate said gear and drill spindle, and a piston and valve mechanism located intermediately of said crank shaft and drill spindle.

41. In a drill, an elongated gear casing, upper and lower engine casings carried by said gear casing, piston mechanisms in said engine casings, crank shafts having their outer ends provided with bearings in said engine casings and their inner ends juxtaposed and in alinement with each other, bearings within said gear casing for said inner juxtaposed ends, a valve mechanism carried by said gear casing, a drill spindle, and power transmission devices intermediate said crank shafts and drill spindle.

42. In a pneumatic drill, a casing, a divided crank shaft journaled in one end thereof and having a double throw with the pins thereof set opposite to each other, two sets of engines arranged in pairs at different planes and at an angle to each other and operatively connected with the adjacent pin, a driving gear uniting said crank shafts, a drill spindle located in the end of said casing opposite to said crank shaft, and a train of gearing intermediate said drill spindle and driving gear.

43. In a pneumatic drill, a casing, a divided crank shaft journaled in one end thereof and having a double throw with the pins thereof set opposite to each other, two sets of engines arranged in pairs at different planes and at an angle to each other and operatively connected with the adjacent pin, a driving gear uniting said crank shafts, a drill spindle located in the end of said casing opposite to said crank shaft, and a train of gearing intermediate said drill spindle and driving gear, in combination with a valve mechanism located intermediately of said sets of engines.

44. In a pneumatic drill, a casing, a divided crank shaft journaled in one end thereof and having a double throw with the pins thereof set opposite to each other, two sets of engines arranged in pairs at different planes and at an angle to each other and operatively connected with the adjacent pin, a driving gear uniting said crank shafts, a drill spindle located in the end of said casing opposite to said crank shafts, and a train of gearing intermediate said drill spindle and driving gear in combination with a valve mechanism actuated from said crank shaft, said valve mechanism and engine mechanism being located intermediately of said crank shaft and drill spindle.

45. In a pneumatic drill, an elongated gear casing, piston casings on opposite sides thereof, a crank shaft journaled in said casings, a pair of piston cylinders in each of said piston casings and arranged at an angle with each other, pistons within said piston cas-

ings, and operatively connected with said crank shaft, valve mechanisms in said gear casing operatively connected with said crankshaft, a drill spindle journaled in the end of said gear casing opposite to said crank shaft, and power transmission devices intermediate said crank shaft and drill spindle.

46. In a pneumatic drill, an elongated gear casing, piston casings on opposite sides thereof, a crank shaft journaled in said casings, a pair of piston cylinders in each of said piston casings and arranged at an angle with each other, pistons within said piston casings and operatively connected with said crank shaft, valve mechanisms in said gear casing operatively connected with said crank shaft, a drill spindle journaled in the end of said gear casing opposite to said crank shaft, and power transmission devices intermediate said crank shaft and drill spindle, said valve mechanisms and pistons being located intermediately of said crank shaft and drill spindle.

47. In a pneumatic drill, an elongated gear casing, piston casings on opposite sides thereof, a crank shaft journaled in said casings, a pair of piston cylinders in each of said piston casings and arranged at an angle with each other, pistons within said piston casings, and operatively connected with said crank shaft, valve mechanisms in said gear casing operatively connected with said crank shaft, a drill spindle journaled in the end of said gear casing opposite to said crank shaft, and power transmission devices intermediate said crank shaft and drill spindle, said valve mechanisms being located intermediately of said pistons and both said pistons and valve mechanisms being located intermediately of said crank shaft and drill spindle.

48. In a pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at one end thereof, a crank shaft journaled in bearings at the opposite end of said casing, driving means for said crank shaft, said shaft having a recess in the head thereof, an eccentric having an interlocking device for said recess, a valve mechanism located intermediately of said crank shaft and drill spindle and actuated by said eccentric for controlling said driving means, and power transmission devices intermediate said crank shaft and drill spindle.

49. In a pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at one end thereof, a crank shaft journaled in bearings at the opposite end of said casing, driving means for said crank shaft, said shaft having a recess in the head thereof, an eccentric having an interlocking device for said recess, a valve mechanism located intermediately of said crank shaft and drill spindle and actuated by said eccentric for controlling said driving means, and power transmission devices intermediate said crank shaft and drill spindle, said driving means being located above and below said valve mechanism and intermediately of said crank shaft and drill spindle.

50. In a pneumatic drill, an elongated casing, a drill spindle eccentrically located in bearings at the extreme end thereof, a divided crank shaft journaled in the opposite end of said casing and having a double throw with the pins thereof set opposite to each other, driving means for said crank shaft, a gear uniting the sections of said crank shaft, gearing coacting with said gear and operatively connected with said spindle, and a valve mechanism located intermediately of said driving means, said valve mechanism and driving means being located intermediately of said crank shaft and drill spindle.

51. In a pneumatic drill, a gear casing, piston casings on opposite sides thereof, a divided crank shaft mounted in said casings, a gear uniting the juxtaposed ends of said shaft, an eccentric carried by one of the sections of said shaft, a pair of straps mounted on said eccentric, separate valve mechanisms actuated by said straps, pistons operatively connected with the sections of said crank shaft, a drill spindle mounted in said gear casing, and power transmission devices intermediate said crank shaft and drill spindle.

52. In a pneumatic drill, an elongated gear casing, piston casings secured thereto near one extremity on opposite sides thereof, a set of pistons arranged at an angle to each other in each of said piston casings, a divided crank shaft having its outer ends journaled in said piston casings and its inner juxtaposed ends journaled in bearings carried by said gear casing, a drill spindle located in said gearing casing eccentrically to said crank shaft, driving mechanism for actuating said crank shaft, means for controlling the passage of motive fluid to actuate said driving mechanism, and power transmission devices intermediate said crank shaft and drill spindle.

53. In a pneumatic drill, a gear casing, piston casings secured thereto on opposite sides thereof, a crank shaft having bearings for its outer ends in said piston casings, a drill spindle having its bearings in said gear casing and located eccentrically to said crank shaft, driving mechanism for actuating said crank shaft, valve mechanism for controlling the passage of motive fluid to actuate said driving mechanism, and a train of gearing in said gear casing intermediate said crank shaft and said driving spindle.

54. In a pneumatic drill, a gear casing, piston casings secured thereto on opposite sides thereof, a crank shaft having bearings for its outer ends in said piston casings, a drill spindle having its bearings in said gear casing and located eccentrically to said crank shaft, driving mechanism for actuating said crank shaft, valve mechanism for controlling the

passage of motive fluid to actuate said driving mechanism, and a train of gearing in said gear casing intermediate said crank shaft and said driving spindle, said valve mechanism and driving mechanism being located intermediate said crank shaft and drill spindle.

55. In a pneumatic drill, a gear casing, piston casings secured thereto on opposite sides thereof, a crank shaft having bearings for its outer ends in said piston casings, a drill spindle having its bearings in said gear casing and located eccentrically to said crank shaft, driving mechanism for actuating said crank shaft, valve mechanism for controlling the passage of motive fluid to actuate said driving mechanism, and a train of gearing in said gear casing intermediate said crank shaft and said driving spindle, said valve mechanism being carried by said gear casing and being located intermediately of said driving mechanism, and both said valve mechanism and driving mechanism being located intermediately of said crank shaft and drill spindle.

56. In a pneumatic drill, a gear casing, piston casings secured thereto on opposite sides thereof, a divided crank shaft having bearings for its outer ends in said piston casings, the inner ends of said crank shaft being juxtaposed to each other, a gear having extensions thereon for uniting said juxtaposed ends, a drill spindle carried by said gear casing, driving mechanism for said crank shaft, a valve mechanism, and power transmission devices intermediate said gear and drill spindle.

57. In a pneumatic drill, a gear casing, piston casings secured above and below said gear casing near an end thereof, a crank shaft having its outer ends journaled in said piston casings, driving mechanisms for said crank shaft, a valve mechanism located intermediate said driving mechanisms, a drill spindle located at the end of said gear casing opposite to said crank shaft, and a train of gearing in said gear casing located intermediately of said crank shaft and drill spindle for actuating the latter.

58. In a pneumatic drill, a gear casing, piston casings secured above and below said gear casing near an end thereof, a crank shaft having its outer ends journaled in said piston casings, driving mechanisms for said crank shaft, a valve mechanism located intermediate said driving mechanisms, a drill spindle located at the end of said gear casing opposite to said crank shaft, and a train of gearing in said gear casing located intermediately of said crank shaft and drill spindle for actuating the latter, said driving mechanism and valve mechanism being located intermediately of said crank shaft and drill spindle.

59. In a pneumatic drill, a gear casing, piston casings secured on opposite sides thereof, a crank shaft having bearings in said piston casings, driving mechanisms for said crank shaft, a valve mechanism therefor, a stud having one end fixed in one of said piston casings and its opposite end projecting downwardly, a plurality of studs each having one end fixed in said gear casing and their free ends projecting oppositely to said first mentioned stud, a driving spindle, and gearing intermediate said crank shaft, studs, and spindle for operating the latter.

60. In a pneumatic drill, a gear casing, piston casings secured on opposite sides thereof, a crank shaft having bearings in said piston casings, driving mechanisms for said crank shaft, a valve mechanism therefor, a stud having one end fixed in one of said piston casings and its opposite end projecting downwardly, a plurality of studs each having one end fixed in said gear casing and their free ends projecting oppositely to said first mentioned stud, a driving spindle, and gearing intermediate said crank shaft, studs, and spindle for operating the latter, said valve mechanism being located intermediately of said crank shaft and drill spindle.

61. In a pneumatic drill, a gear casing, piston casings secured on opposite sides thereof, a crank shaft having bearings in said piston casings, driving mechanisms for said crank shaft, a valve mechanism therefor, a stud having one end fixed in one of said piston casings, and its opposite end projecting downwardly, a plurality of studs each having one end fixed in said gear casing and their free ends projecting oppositely to said first mentioned stud, a driving spindle, and gearing intermediate said crank shaft, studs, and spindle for operating the latter, said valve and driving mechanisms being located intermediately of said crank shaft and drill spindle.

62. In a pneumatic drill, a gear casing, a drill spindle mounted in one end thereof, a crank shaft located in the opposite end thereof, piston casings secured to said gear casing, driving mechanisms in said piston casing for said crank shaft, valve mechanisms operated by said crank shaft for controlling said driving mechanisms, said valve and driving mechanisms being located intermediately of said drill spindle and crank shaft, and power transmission devices in said gear casing and located intermediately of said drill spindle and crank shaft.

63. In a pneumatic drill, a gear casing, piston casings secured in fixed position on opposite sides thereof, a crank shaft mounted in said casings, a single eccentric carried by said shaft, a pair of straps mounted on said eccentric, separate valve mechanisms actuated by said straps, and pistons operatively connected with said crank shaft and controlled by said valve mechanisms.

64. In a pneumatic drill, a divided casing, a sectional crank shaft mounted therein, a single eccentric carried by said shaft, a

pair of straps mounted on said eccentric, separate valve mechanisms actuated by said straps, and pistons operatively connected with said crank shaft and controlled by said valve mechanisms.

65. In a pneumatic drill, a divided casing, a sectional crank shaft mounted therein, a single eccentric carried by said shaft, a pair of straps mounted on said eccentric, separate valve mechanisms actuated by said straps, and pistons operatively connected with said crank shaft and controlled by said valve mechanisms, in combination with a drill spindle and gearing intermediate said crank shaft and drill spindle.

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