No. 751,980. PATENTED FEB. 9, 1904.

R. W. FUNK.

MOTOR.

APPLICATION FILED MAY 10, 1902. RENEWED JULY 14, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 2.

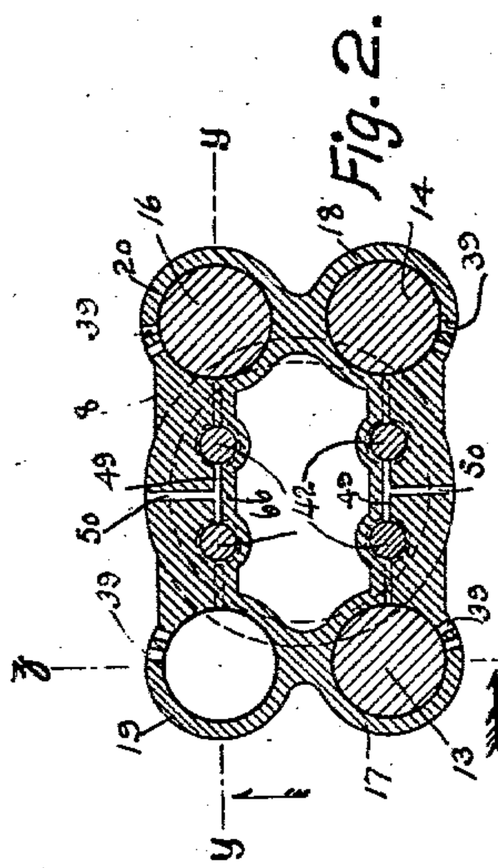


Fig. 3.

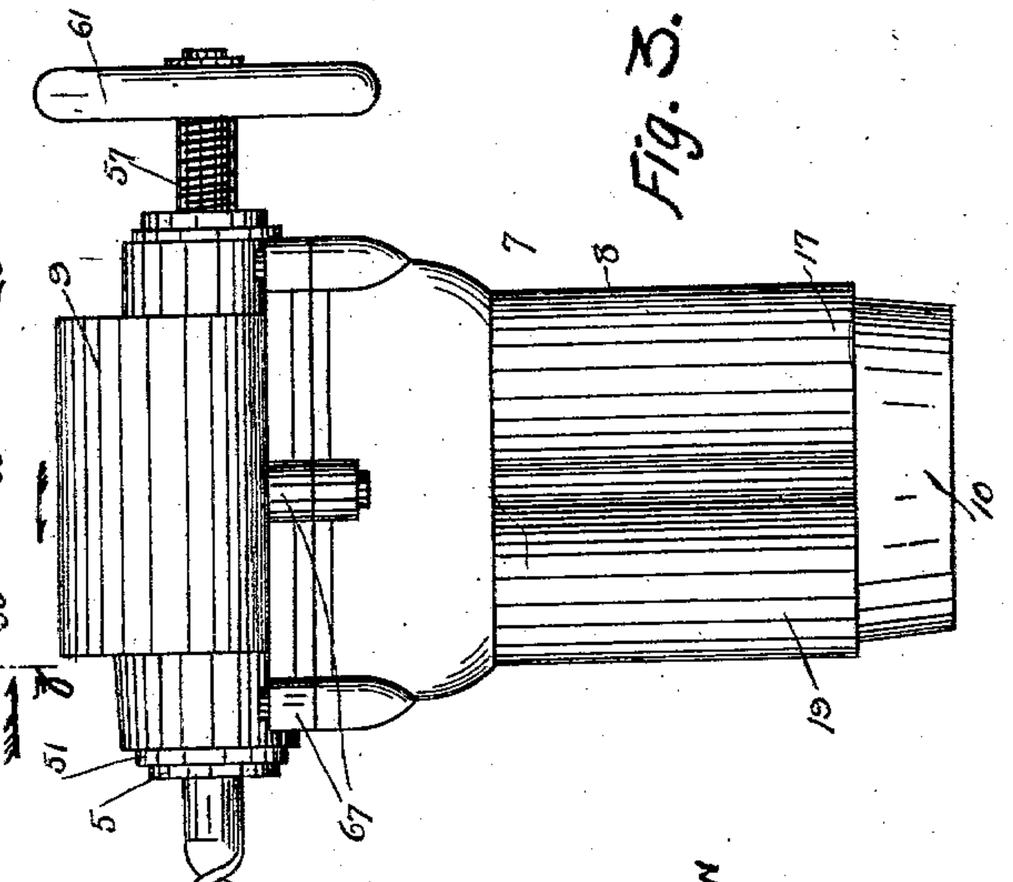
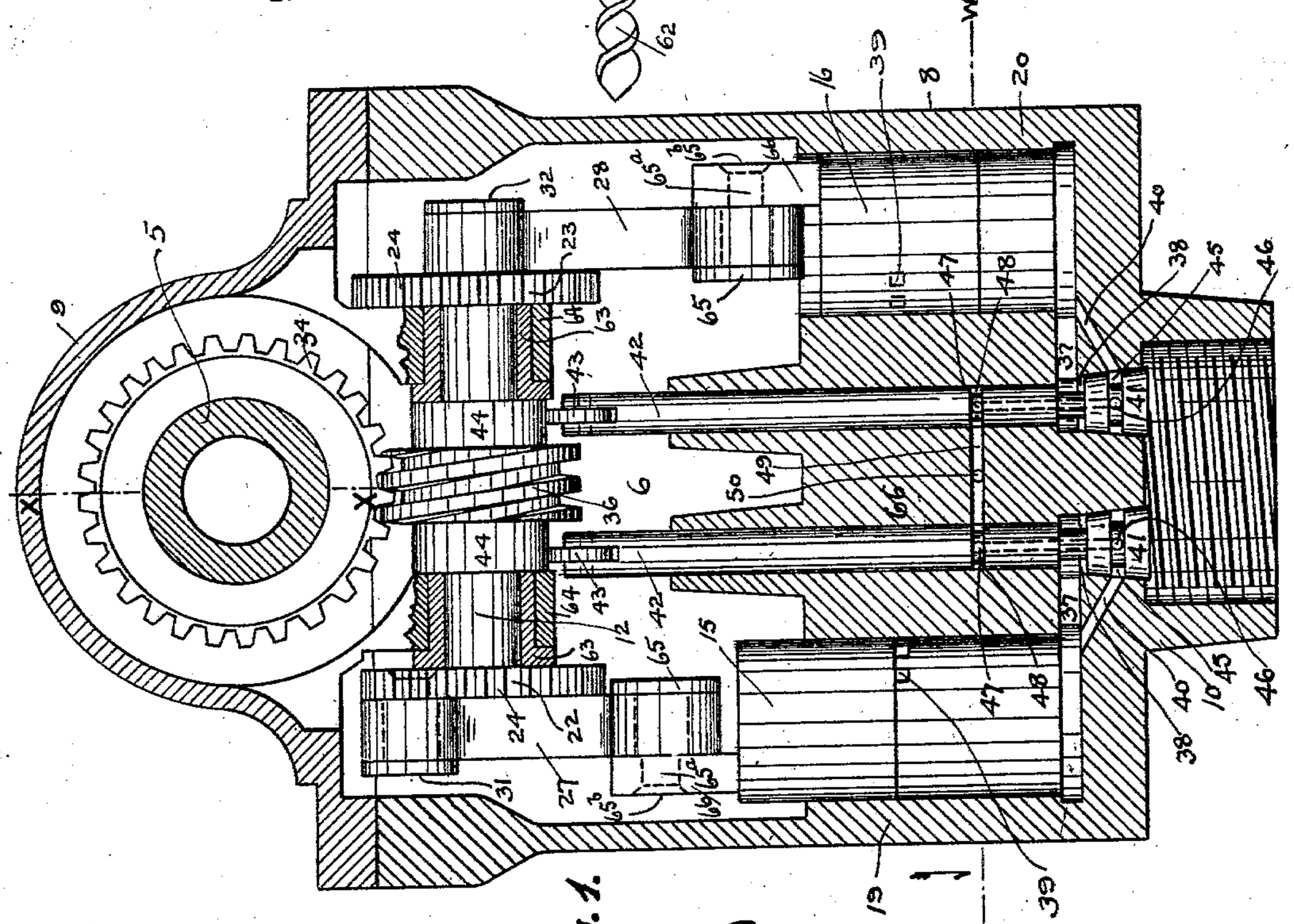


Fig. 1.



Witnesses
B. F. Sparr
E. Anderson

Richard W. Funk Inventor,
By his Attorney
Raymond Boardman

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NO MODEL. 2 SHEETS—SHEET 2.

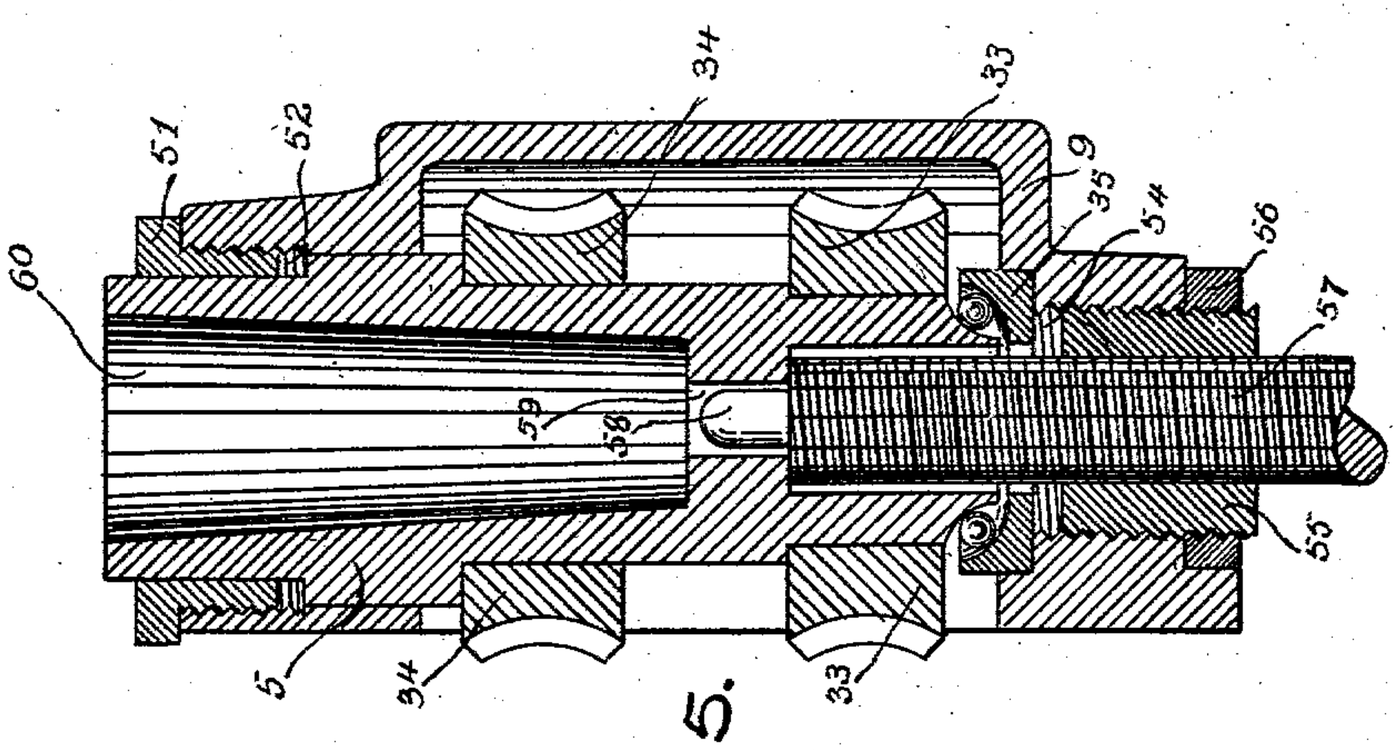

Fig. 5.

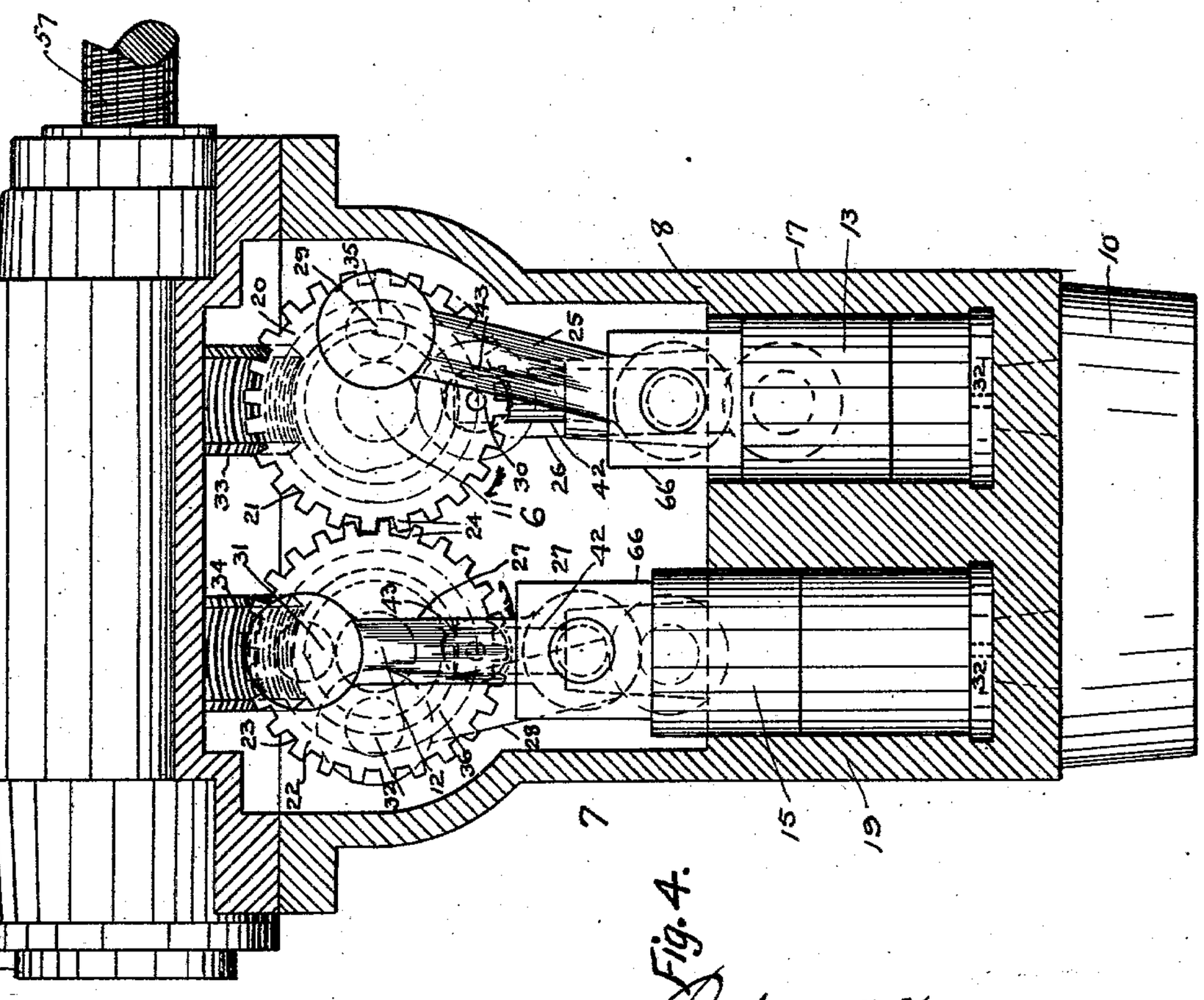

Fig. 4.

Witnesses
B. F. Sparr
E. Underwood

Richard W. Funk Inventor,
By his Attorneys Richmond Dorsey Blakeslee.

No. 751,980. Patented February 9, 1904.

UNITED STATES PATENT OFFICE.

RICHARD W. FUNK, OF NEW YORK, N. Y., ASSIGNOR TO HUDSON MACHINE AND PNEUMATIC TOOL CO., OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 751,980, dated February 9, 1904.

Application filed May 10, 1902. Renewed July 14, 1903. Serial No. 165,527. (No model.)

To all whom it may concern:

Be it known that I, RICHARD W. FUNK, a citizen of the United States, residing at New York, county and State of New York, have invented certain new and useful Improvements in Motors, of which the following is a specification.

This invention relates to motors, and more particularly to pneumatic motors; and it has for its object to provide an improved motor which shall be superior in point of speed and smoothness of operation, economy of power, inexpensiveness, and durability of construction, compactness of form, and general efficiency and adaptability to varying conditions of use.

The present invention relates more particularly to tool-operating pneumatic motors; but the several features of improvement may be equally advantageously embodied in motors of other types.

In the drawings, Figure 1 is a vertical transverse sectional view of the improved motor, taken upon the line Y Y, Fig. 2, and looking in the direction of the appended arrow. Fig. 2 is a transverse horizontal sectional view taken upon the line W W, Fig. 1, and looking in the direction of the appended arrow and of the arrow at the top of Fig. 3. Fig. 3 is a side elevation of the improved motor. Fig. 4 is a vertical longitudinal sectional view taken upon the line Z Z, Fig. 2, at right angles to the section-line upon which Fig. 1 is taken and looking in the direction of the appended arrow. Fig. 5 is a detail longitudinal sectional view taken upon the line X X in Fig. 1 and showing the driven shaft of the motor, together with the mountings and operative connections of the same.

Corresponding parts in all the figures are denoted by the same reference characters.

Referring to the drawings, the improved motor embodies a tool or driven shaft 5, whereby the power is applied, and operating means 6, whereby said driven shaft 5 is operated under the actuation of the compressed air or other motive power. The several particular features comprised in the above-recited elements or members are housed within a suitable casing 7, of compact form, which preferably comprises a base member 8 and a top member or cap 9, whereby assembling of the parts and access to the same may readily be performed and obtained. When pneumatic power is employed for the operation of the motor, the base member 8 of the casing is formed into or provided with a connection-socket 10, whereby the compressed-air supply may be coupled up with the motor.

To operate the driven shaft 5, I preferably employ a plurality of drive-shafts, of which two are illustrated in the drawings, 11 and 12, respectively, said drive-shafts being geared together to operate in fixed relation, and each of said drive-shafts 11 and 12 is operated by a plurality of pistons, of which two, 13 and 14, respectively, are provided for the shaft 11 and two, 15 and 16, respectively, are provided for the shaft 12. Said pistons 13, 14, 15, and 16 are operatively mounted in cylinders 17, 18, 19, and 20, respectively, which are formed in the base member 8 of the casing 7. The shaft 11 is provided at each end with a crank-disk 20 and 21, respectively, and the shaft 12 is provided at its ends with corresponding crank-disks 22 and 23, respectively. The drive-shafts 11 and 12 are arranged in parallelism, and the crank-disks 20, 21, 22, and 23 are provided each with gear-teeth 24, whereby the crank-disk 20 meshes with the crank-disk 22, and the crank-disk 21 meshes with the crank-disk 23, causing a joint opposite revolution of the drive-shafts 11 and 12. The pistons 13, 14, 15, and 16 are provided with connecting-rods 25, 26, 27, and 28, whereby the several pistons are operatively connected, respectively, with the crank-disks 20, 21, 22, and 23 by means of cranks 29, 30, 31, and 32, respectively. The cranks 29 and 30 are connected with the crank-disks 20 and 21, respectively, at points ninety degrees apart, and the cranks 31 and 32 are connected with the crank-disks 22 and 23, respectively, at points ninety degrees apart, the relative arrangement of all four cranks being such that when one of the pistons is at the completion of its outward stroke another piston will be at the comple-

tion of its inward stroke and the remaining pistons will be at half-stroke.

The driven shaft 5 is provided with two spaced worm-wheels 33 and 34, respectively, with which respectively mesh right and left hand worms 35 and 36, which are rigidly mounted or formed upon the drive-shafts 11 and 12, whereby upon opposite rotation of the shafts 11 and 12 in the directions denoted by the arrows in Fig. 3 the driven shaft 5 is operated in the required direction.

Each of the cylinders 17, 18, 19, and 20 is provided at its base with a laterally-extending feed-port 37, which communicates with a separate inlet-port 38, the latter constituting a valve-seat and being of conical formation. The inlet-ports 38 all communicate with the air connection 10. Each of the cylinders is also provided with an exhaust-port 39, which is pierced through the base member 8 of the casing and communicates with the outer air. Each of the cylinders also has separate communication with its inlet-port 38 by a supplementary air-passage 40, which latter communicates with the respective cylinder at its lower end and with the respective inlet-port at a point beneath or exterior of the point of connection of the respective ports 37 and 38. Each of the inlet-ports 38 and the corresponding feed-port 37 and supplementary air-passage 40 is controlled by a conical valve 41, which fits the conical formation of the inlet-port 38 and is mounted upon the lower end of a cut-off rod 42. Each of the cut-off rods 42 is provided at its upper end with a roller 43, which is acted upon by an eccentric 44, keyed to or formed upon the respective drive-shaft 11 or 12, there being two such cut-off rods and eccentrics for each of the shafts 11 and 12 and mounted at either side of the respective worm 35 or 36. Each of the supplementary air-passages 40 is designed to effect an air-pressure relief upon the return of the respective piston. To this end each of the valves 41 is provided with an annular exterior groove 45, designed to communicate with the respective air-passage 40 when the respective valve is in seated position and the respective feed-port 37 is closed. Each of the cut-off rods 42 is provided at its lower end with an interior bore or duct which opens at its lower end in communication with the respective groove 45, as at 46, and opens at its upper end, as at 47, in communication with an annular exterior groove 48, formed upon the respective cut-off rod 42, and said annular grooves 48 of the cut-off rods 42 of each set of valves 41 of each set of cylinders 17 and 18 and 19 and 20 are arranged to be brought into communication with a duct 49, formed in the bottom member 8 of the casing, communicating with the outer air by means of a port 50.

In the preferred form of construction the driven shaft 5 is mounted at its outer end in a bushing 51, which has a threaded connection with the upper member or cap 9 of the casing 7 at a suitable opening 52, formed at one end thereof. The inner end of the shaft 5 bears upon and is mounted in a suitable ball-bearing end-thrust 53. The rearward end of the cap 9 is provided with an opening 54 opposite to the opening 52, said opening being closed by a threaded bushing 55, which is locked in position by a nut 56 bearing upon the cap 9. An adjusting screw-shaft 57 is mounted in the bushing 55 and provided at its inner end with a reduced end piece 58, which lies within an opening 59, communicating with the tool-socket 60, which is formed in the shaft 5. The adjusting-shaft 57 is provided with a hand-wheel 61 at its rearward end, and this hand-wheel may be manipulated to force the tool 62 from its seat in the tool-socket 60. The drive-shafts 11 and 12 are mounted in bushings 63, which are supported in blocks 64, formed integrally with the cap, said bushings extending between the eccentrics 44 and the respective crank-disks 20 and 21 and 22 and 23 and maintaining the parts in proper relative arrangement. The connecting-rods 25, 26, 27, and 28 are connected with the respective pistons 13, 14, 15, and 16 by means of headed pins 65, which are provided with reduced end portions 65^a, which latter pass through cheeks 66, formed upon the respective pistons, said reduced end portions 65^a being headed exteriorly of said cheeks, as at 65^b. By this means of operative connection of the connecting-rods with the pistons a free running bearing condition is obtained. The cut-off rods 42 are operatively mounted in a continuous web 66, formed interiorly of and integrally with the bottom member 8 of the casing. The bottom member 8 and the top member 9 are detachably connected, as at 67, by means of suitable securing-bolts, and the entire interior of the casing 7 is designed to contain an oil-bath to insure proper operation of the parts at the high speed required of a motor of the type described.

The operation and advantages of my improved motor will be fully understood by those skilled in the art to which it pertains. Compressed air is continuously admitted to the motor through the connection 10 and normally maintains the valves 41 in seated position by direct pressure upon the same, cutting off the supply of air to the several cylinders. The four cylinders are successively supplied with compressed air consequent upon the successive operation of the several eccentrics 44, which cause the successive unseatings of the valves 41. When any one of the said valves is unseated, the air passes through the respective inlet-port 38 and its feed-port 37 into the respective cylinder, also passing through the respective supplemental air-passage 40. At the proper moment in the actuation of each piston the respective eccentric 44 permits the air-pressure to seat the respec-

tive valve 41, cutting off the air-supply, and the air within the respective cylinder is exhausted through the respective exhaust-port 39, controlled by the piston. The operation of the motor is, however, at such a high speed that the exhaust in any particular cylinder is not completed through its exhaust-port, and the air-cushion otherwise consequently formed within the respective cylinder upon the instroke of the piston is dissipated by the escape of the air in the cylinder through the respective supplemental air-passage 40, and thence through the annular groove 45 in the respective valve 41 and through the ports 46 and 47 in the respective cut-off rod to and through the duct 49 in the casing and the port 50, which communicates with the open air. This dissipation of the air remaining within the cylinders after the exhaust through the exhaust-ports is permitted by the position of the parts immediately following the seating of the valves 41, which brings, in connection with any one cylinder, its respective air-passage 40 and groove 45 and groove 48 and duct 49 into communication. As soon as any one of the valves 41 is unseated by the respective cut-off rod 42 the respective groove 48 is moved out of communication with the respective duct 49, and escape of air through the port 50 is cut off. The relative arrangement of the several cranks 29, 30, 31, and 32 is such that one of the four pistons is always under actuation, a positive and uniform operation of the drive-shafts 11 and 12 being thus obtained.

The provision of the several parts and features as above set forth for the dissipation of the air-cushions within the cylinders upon the instrokes of the pistons produces a much higher efficiency in the motor with a given supply of motive power than is otherwise possible. The formation of the casing 7 in two parts and embodying the mountings for the several elements of the construction, as described, permits of inexpensive manufacture, together with the required rigidity for positive operation. All of the operative parts are continually subjected to an oil-bath, which furnishes the lubrication required by a motor of the high speed obtained by the construction described.

I do not desire to be understood as limiting myself to the particular features of construction and relative arrangement of parts as above described, but reserve the right to vary the same in adapting the device to varying conditions of use without departing from the spirit of the invention and the terms of the following claims.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. In an improved motor, a driven shaft, a plurality of drive-shafts geared to the driven shaft and geared one to the other, a plurality of cylinders, pistons in the cylinders and operatively connected with the drive-shafts, feed-ports and exhaust-ports for the cylinders, valves for the feed-ports, and means controlled by said valves for releasing the pressure in said cylinders after exhaust.

2. In an improved motor, a frame, a cylinder mounted in the frame, a piston operating in the cylinder, a feed-port and an exhaust-port for said cylinder, a cut-off valve and rod mounted in said frame and controlling said feed-port, a supplemental passage communicating with said cylinder, a duct formed in said frame and communicating with the outer air, and a duct in said cut-off rod arranged for communication with said duct in said frame and said supplemental passage when said valve is in position to close said feed-port.

3. In an improved motor, a cylinder, a piston operating in said cylinder, a feed-port and an exhaust-port for said cylinder, a supplemental passage communicating with said cylinder, and a conical valve for said feed-port provided with an annular groove and with an interior duct communicating with said annular groove at one end and opening outwardly at the other end, the relative arrangement and construction of parts being such that when said conical valve is in seated position to close said feed-port said annular groove is in communication with said supplemental passage and said interior duct is in communication with the outer air.

In testimony whereof I have signed my name in the presence of the subscribing witnesses.

RICHARD W. FUNK.

Witnesses:
E. ANDERSON,
JOHN H. WELCH.