R. A. NORLING.

PNEUMATIC MOTOR.

APPLICATION FILED MAR. 7, 1906.

935,537.

Patented Sept. 28, 1909.

3 SHEETS—SHEET 1.

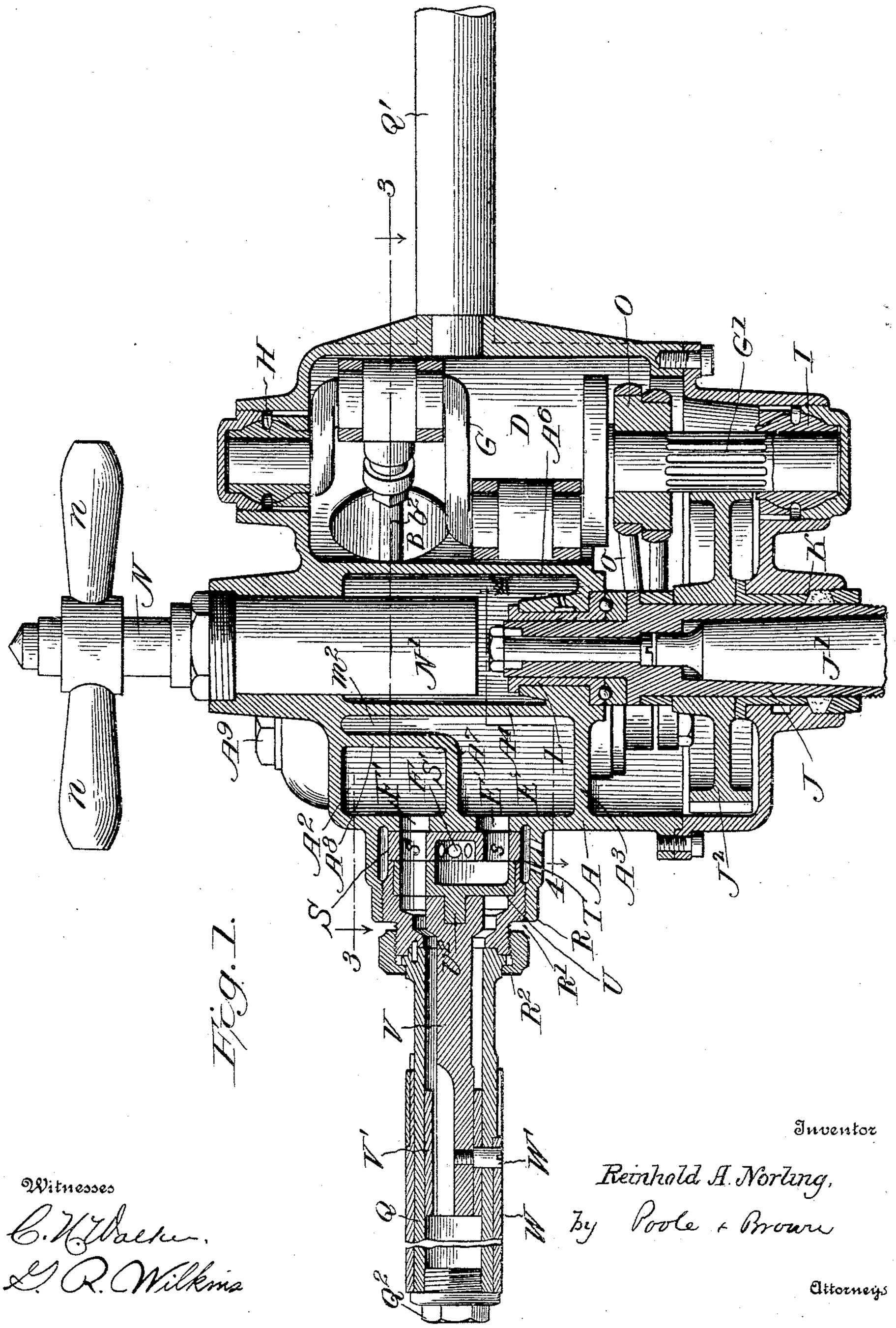


Fig. 1.

Witnesses

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3 SHEETS—SHEET 2.

Fig. 2.

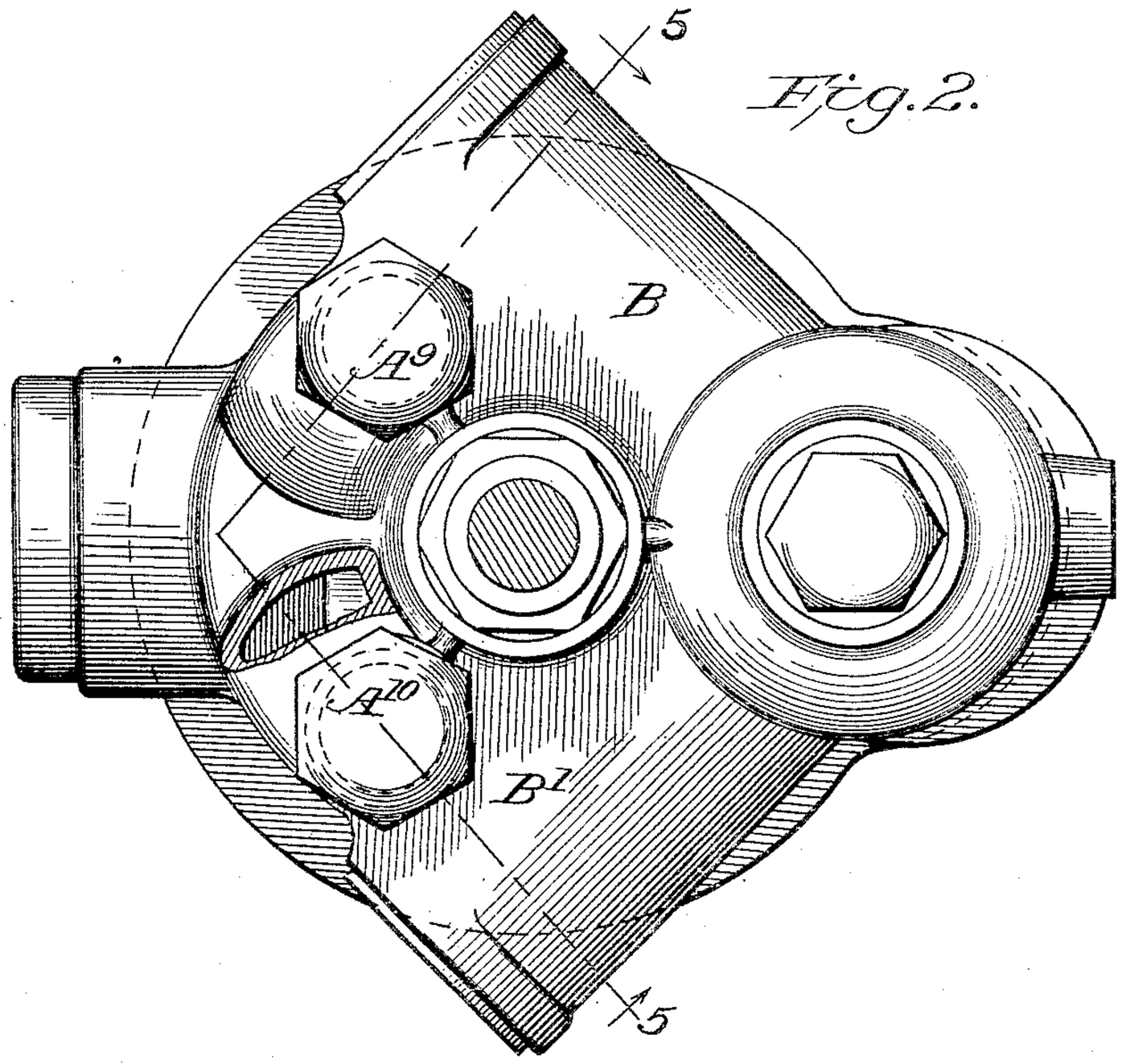
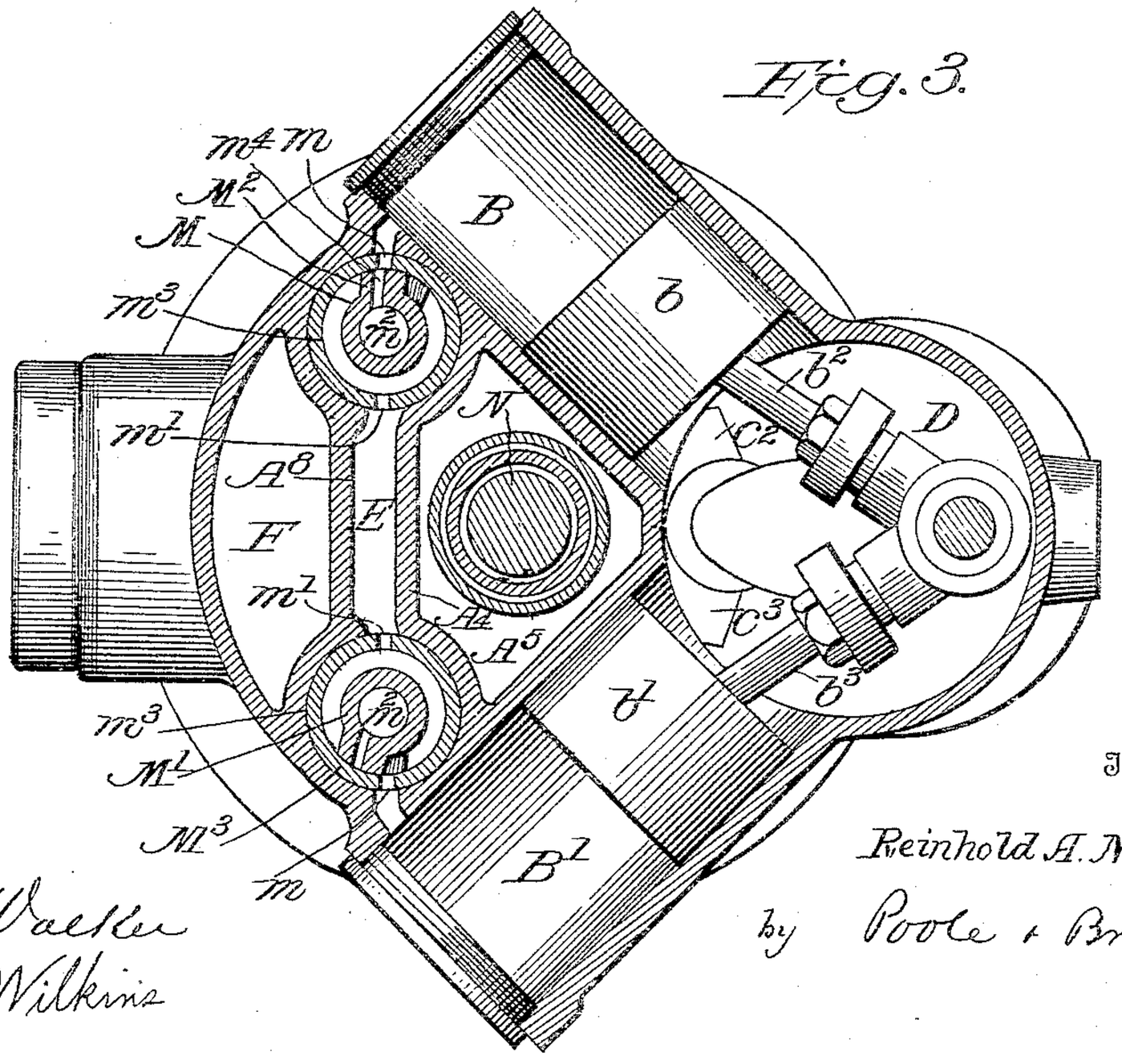



Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 4.

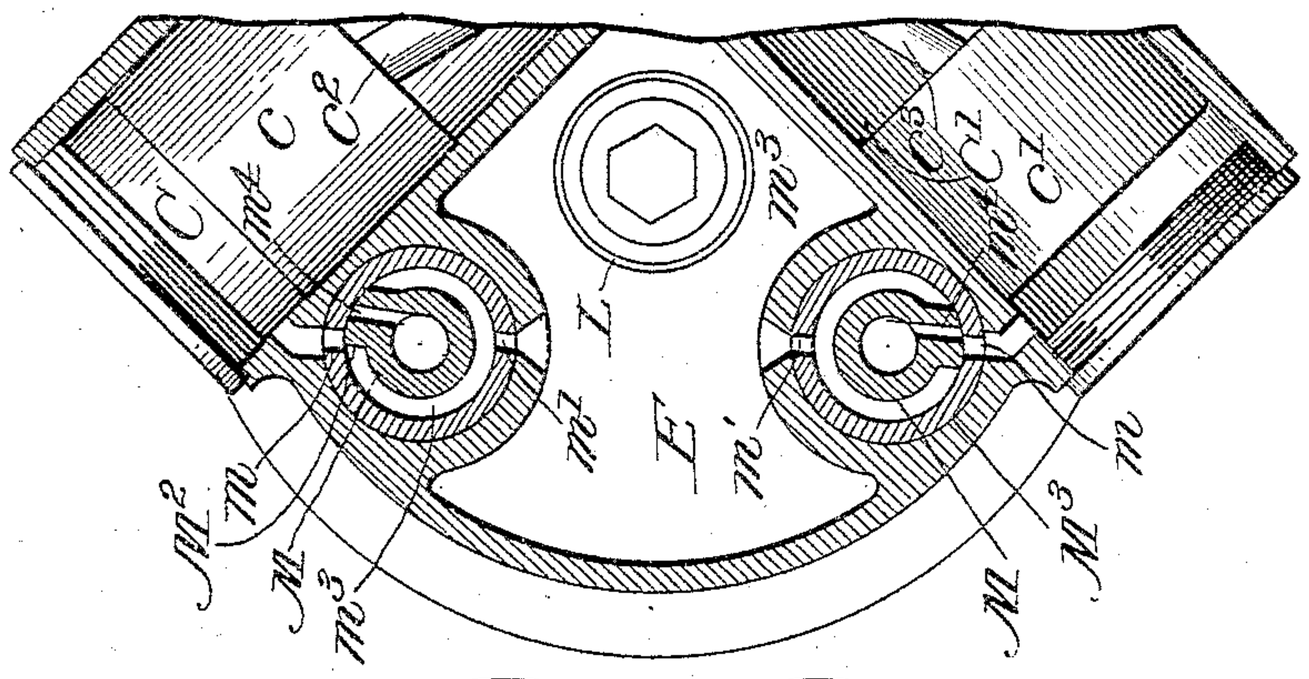
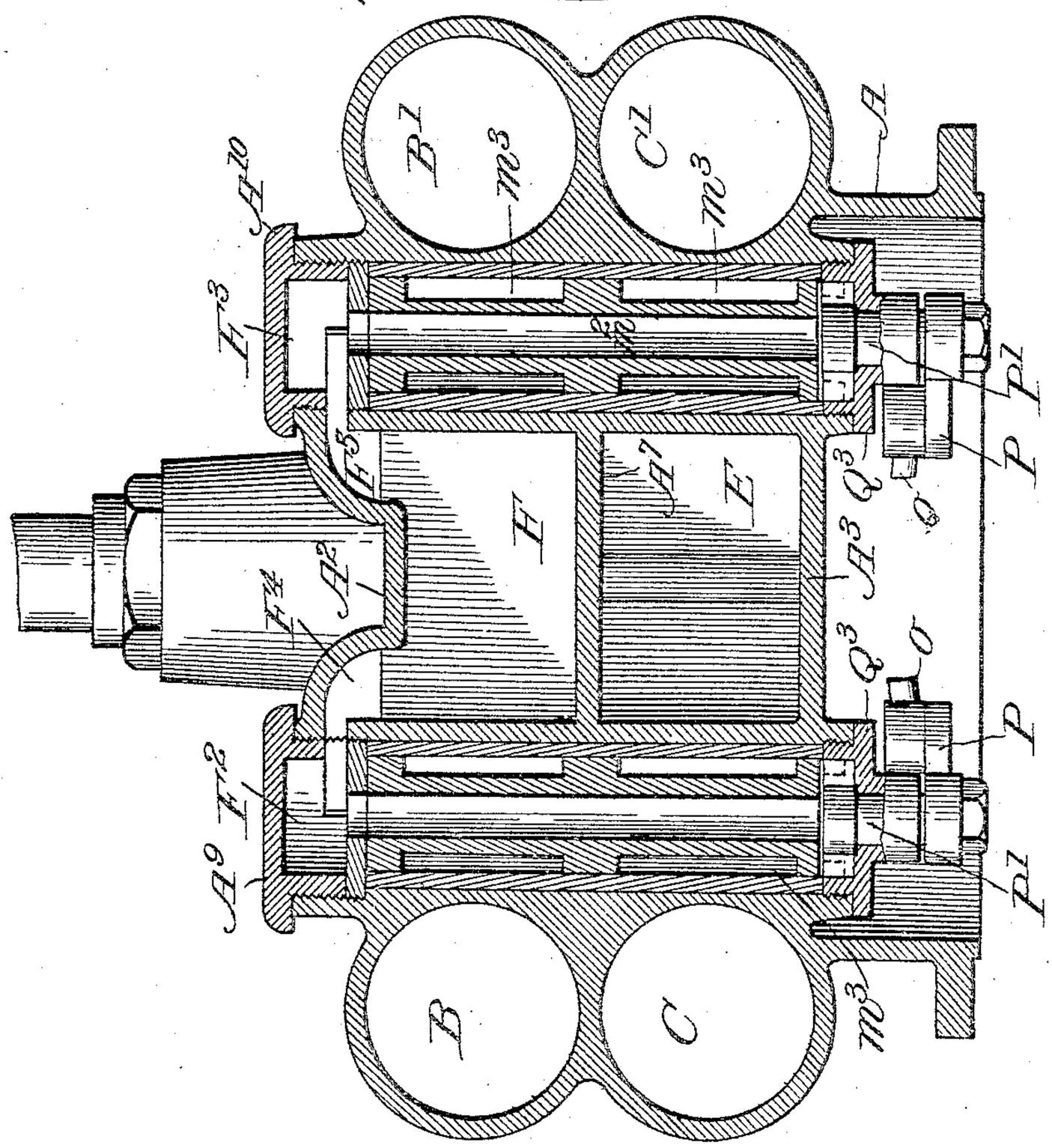



Fig. 5.




Witnesses

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# UNITED STATES PATENT OFFICE.

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## PNEUMATIC MOTOR.

935,537. Specification of Letters Patent. Patented Sept. 28, 1909.

Original application filed July 20, 1904, Serial No. 217,372. Divided and this application filed March 7, 1906. Serial No. 304,694.

*To all whom it may concern:*

Be it known that I, REINHOLD A. NORLING, a citizen of the United States, of the city of Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Pneumatic Motors; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in portable pneumatic drills or mechanisms of that kind embracing a fluid pressure engine of portable form applied to operate a drill or like tool, such for instance as is illustrated and described in United States Letters Patent, No. 762,932, granted to me on the 21st day of June 1904.

The invention relates to improvements in machines of the kind above described designed to make the same reversible or capable of giving to the tool driven thereby rotary motion in either direction at the will of the operator.

The invention consists in the matters hereinafter set forth and pointed out in the appended claims.

In the accompanying drawings illustrating my invention: Figure 1 is a sectional view of a machine embodying my invention taken on a plane passing through the central axis of the tool actuating spindle and the crank-shaft thereof. Fig. 2 is a plan view of the engine. Fig. 3 is a sectional view thereof, taken upon line 3—3 of Fig. 1 but showing the pistons and piston rods in elevation. Fig. 4 is a partial section, taken on the line 4—4 of Fig. 1. Fig. 5 is a sectional view through the casing of the machine taken on the plane indicated by the indirect line 5—5 of Fig. 2.

As shown in said drawings, A indicates the main casing of the machine which contains four power cylinders B $B^1$ C $C^1$, a crank chamber D, and air chambers E and F. To the bottom of the main casing A is attached a cap or auxiliary casing $A^1$. The cylinders B $B^1$ C $C^1$ are arranged in pairs with the two cylinders B C and $B^1$ $C^1$ constituting each pair parallel with each other; the air chambers E and F being located in the sector-shaped space between the pairs of cylinders. Within the crank chamber D is a crank-shaft G which engages at its upper end a bearing H in the top wall of the main casing and at its lower end a crank bearing I in the auxiliary casing or cap $A^1$. The pistons $b$ $b^1$ $c$ $c^1$ within said cylinders are connected by connecting rods $b^2$ $b^3$ $c^2$ $c^3$ with the cranks of the crank-shaft G.

J indicates the main driving spindle of the machine through which motion is transmitted to the rotative tool or other part to be driven. $J^1$ indicates the shank of a drill inserted in a socket in said spindle J. Said spindle J passes through the cap $A^1$, having a bearing K therein and into the main casing, which is provided with a bearing L for the inner end of the said spindle. The driving spindle J is actuated from the crank-shaft G by means of a pinion $G^1$ on the crank-shaft which intermeshes with a gear wheel $J^2$ on the spindle.

M $M^1$ indicate oscillating cylindric valve plugs which are arranged with their central axes or axes of rotation transverse to the cylinders B $B^1$ and C $C^1$, and which turn in cylindric seats or chambers formed therefor in the main casing A. Each of the oscillating valve plugs is arranged to operate in connection with one pair of the cylinders, the valve M being arranged to operate in connection with the cylinders B C, while the valve $M^1$ operates in connection with the cylinders $B^1$ $C^1$. The said valve chambers are formed in the casing A between the pairs of cylinders B C and $B^1$ $C^1$ and extend across the outer ends of said cylinders, the valves being interposed between the outer ends of said cylinders and the chambers E and F which latter occupy the central space in the casing between the outer ends of said cylinders and extend between the top wall $A^2$ of the casing and a wall or diaphragm $A^3$ which forms the bottom of the air chamber E. The inner wall of the said air chamber E is formed by a partition $A^4$ which extends from the diaphragm $A^3$ upwardly to the top wall $A^2$ and separates the air chamber E from a central space or chamber $A^5$ located adjacent to the crank-chamber, between the inner ends of the cylinders, and separated from the said crank-chamber by a partition $A^6$. A feed screw N is arranged in alinement with the driving spindle J and

is mounted in a sleeve $N^1$ which is attached to the top wall $A^2$ of the casing and extends into said chamber $A^5$; said feed screw N having radial handles *n* by which it may be operated. The air chamber F is located adjacent to the top wall $A^2$ of the casing and the chamber E is located adjacent to the bottom wall $A^3$ thereof. Said chambers E and F are separated from each other by a horizontal diaphragm or partition $A^7$, arranged about midway between the top wall $A^2$ and the bottom wall $A^3$, and by a vertical partition $A^8$ which joins the rear edge of the partition $A^7$ and rises to the top wall $A^2$, said wall $A^8$ being located between the partition $A^4$ and the front wall of the casing and extending between the upper parts of the valve chambers, as clearly seen in Fig. 3. The air chambers E and F constitute either air supply or exhaust chambers, according to the direction in which the motor is running.

The valve seats or chambers are shown as provided with bushings or cylindric tubular linings $M^2$ $M^3$ which form the bearing surfaces for the valve plugs, and which are provided with slots or openings which constitute inlet and outlet ports and coöperate with the ports or passages in the valve plugs; the said bushings and the valve plugs having each two sets of ports and passages one for each of the two cylinders with which the valve is associated. The ports in said valve casings $M^2$ $M^3$ are lettered alike in the drawings for all four cylinders, those affording communication between the interior of the valve seats and the cylinders being marked *m*, while those which communicate with the air chamber E are marked $m^1$.

The valve plugs M $M^1$ are like those illustrated and described in United States Letters Patent, No. 762,934, granted to me June 21st, 1904. The several sets of ports and passages of said valve plugs are lettered alike in the drawings. Each plug is provided with a longitudinally centrally arranged passage $m^2$, with two external recesses $m^3$ $m^3$, one for each cylinder, which extend partially around the plug and form passages adapted to connect the outer ends of the cylinders with the air chamber E and with two transverse ports or passages $m^4$ $m^4$ which extend from the central passage $m^2$ to the side face of the plug at points between the ends of the external recesses $m^3$ $m^3$. When the plug is turned in the position to bring one end of one of said passages $m^3$ opposite one of the cylinder ports *m*, communication will be established between the cylinder and the air chamber E; the said recess $m^3$ being always in communication with the supply port $m^1$. The said ports $m^4$ $m^4$ are adapted to bring the central passage $m^2$ into communication with the cylinder ports *m m* when the valve plug is turned to bring one or the other of said ports into register with said cylinder ports. The sets of passages and ports $m^3$ $m^4$ in each plug are arranged at an angle to each other so that when the plug is turned to bring one port $m^4$ into register at its end with one of the cylinder ports, thereby bringing the central passage $m^2$ into communication with the outer end of one of the cylinder ports, the other port $m^4$ in the plug will be out of register with its associate cylinder port, and the latter will be in communication with the recess $m^3$.

The valve seats or chambers for the valve plugs M $M^1$ open at their upper ends into spaces or chambers $F^2$ $F^3$ formed by means of upward extensions of the top wall $A^2$ and preferably closed by means of removable caps $A^9$ $A^{10}$. Said chambers $F^2$ $F^3$ communicate with the exhaust chamber F by means of laterally and downwardly directed passages $F^4$ $F^5$ leading from the upper ends of the valve chambers into the top of the said chamber F, as clearly seen in Figs. 2 and 5. Said chamber F, being separated from the chamber E by the horizontal diaphragm or partition $A^7$, extends downwardly from the top wall $A^2$ only about one-half the length of the valve chambers, but the rear or inner part of the chamber E extends practically the full length of said valve chambers, the space between the partitions $A^4$ and $A^7$ constituting a part or upward extension of the chamber E so that both ports $m^1$ $m^1$ of both the valve chambers are in communication with said chamber E, as clearly seen in Figs. 3 and 4.

From the above it will be understood that if air be supplied under pressure to the chamber E it will pass from said chamber to either one of the cylinders, when the valve plug is turned to the required position, through one of the ports $m^1$, the external passage $m^3$ and the cylinder port *m* to the cylinder, while exhaust air from the said cylinder will pass outwardly from said cylinder port *m* through the port $m^4$ to the central exhaust passage $m^2$ and from the upper end of said exhaust passage through the chamber $F^2$ and passage $F^4$ to the chamber F, which is in this case the exhaust chamber.

The above describes the passage of the air when the engine is running in its normal or usual direction, but when the direction of rotation of the driving spindle is reversed through the reversing valve hereinafter described, the air will enter the chamber F, will pass from said chamber through the passages $F^4$ $F^2$, then through the central passage $m^2$ of the valve plug, and thence through the port $m^4$ to the cylinder port *m*, while the exhaust air from said cylinder will pass through said cylinder port *m*, the ex-

ternal passage $m^3$ and the port $m^1$, from which it will enter the chamber E which in this case becomes the exhaust chamber.

The valve plugs M $M^1$ are given oscillatory movement from a double eccentric O mounted on the crank-shaft G between the gear pinion $G^1$ and the cranks, through the medium of two eccentric rods *o o* which are connected with crank-arms P P attached to rock-shafts $P^1$ $P^1$ which have bearing in caps $Q^3$ $Q^3$, which caps are attached to the wall $A^3$ and close the lower ends of the valve chambers, said rock-shafts being connected with the lower ends of said valve plugs, so as to turn the same. These parts are like the corresponding features of the engine shown in my prior patent Number 762,934, hereinbefore referred to.

Q indicates a tube which is rigidly attached to the casing A and forms one of the handles of the tool, and through which compressed air is supplied to drive the motor. Another handle $Q^1$ is shown as attached to the casing A at the side thereof opposite said tube Q. The tube Q is provided at its outer end with a nipple $Q^2$ by which a flexible air supply pipe or hose may be connected therewith.

Now referring to the reversing valve illustrated in the drawings, the same is described and claimed in a separate application for patent, Serial Number 217,372, filed by me in the United States Patent Office, July 20th, 1904, and need not be herein described in detail. So far as illustrated said valve embraces parts as follows: R indicates a valve casing which projects from the side wall of the casing A and is located on the said casing A in such manner as to extend above and below the partition $A^7$ which separates the air chambers E and F from each other. Said valve casing R has the form of an outwardly extending cylindric flange on the wall of the casing and is provided with a screw-cap $R^1$. The tube Q is attached at its inner end to the cap $R^1$ by means of a screw-collar $R^2$ having screw-threaded engagement with the outer end of the cap and engaging an annular flange on the inner end of said tube Q, the said tube being held from turning relatively to the cap by means of a pin *c* which engages both of said parts at their meeting edges. Within the valve casing R is located a circular fixed or non-rotative disk S. The outer face of the wall A of the casing, within the valve casing R is made flat to form a bearing surface against which rests the disk S. The said disk S is provided with diametrically opposite valve ports *s* $s^1$ adapted to register with two ports opening severally into the chambers E and F. Within the valve casing R and surrounding the stationary seat disk S is formed an exhaust passage T, which communicates with the outer air through outlet openings and the said valve plate S is provided in its outer or bearing face with a central recess or depression which communicates with said exhaust passage T, by means of radial passages formed in said disk. U indicates a rotative valve disk bearing at its inner face against the stationary seat disk. Said valve disk U is provided on its inner or bearing surface with a central recess which corresponds in position with and is in communication with the central recess $S^1$ of the stationary seat disk S and with radial grooves adapted for communication at their outer ends with either one of the ports *s* $s^1$ of the valve disk S. Said valve disk U is also provided with ports or holes which are adapted to register with the ports *s* $s^1$ of the disk S. Connected with said valve disk U is a longitudinal, rotative, actuating rod or stem V fitting at its outer end in a sleeve $V^1$ within said tube Q. A longitudinal groove is formed in the part of the said stem which enters the sleeve $V^1$, so that air may pass freely from the outer end of the tube Q through said groove to the space surrounding the stem V. W indicates an external, rotative sleeve on the tube A, constituting a hand grip. Said sleeve W is connected with the stem V by means of a stud $W^1$ which passes through transverse slots in the tube Q and sleeve $V^1$. The rotative valve disk U is loosely connected with the stem V by means of a flat sided central lug $U^2$ on the said disk U, which enters a correspondingly shaped socket in the end of said valve stem.

I claim as my invention:—

1. A portable pneumatic motor comprising a casing provided with a plurality of sets of power cylinders, pistons in said cylinders, and a crank-shaft with which said pistons are connected, the cylinders of the several sets having their central axes in planes which are radial with respect to the axis of the crank-shaft, said casing being also provided between the outer ends of the cylinders with two air chambers, and having, between said air chambers and the cylinders, cylindric valve chambers, the central axes of which are at right angles to the axes of the cylinders and parallel with the crank-shaft, said valve chambers being each connected at one end with one of the said air chambers, and each being provided with lateral ports communicating with the other air chamber, and rotative valve plugs located in said chambers, said valve plugs each having a plurality of valve ports and passages, one for each of the cylinders associated therewith, and including a longitudinal passage which extends endwise therethrough and opens into the end of its said valve chamber which is connected with one of the said air chambers.

2. A portable pneumatic motor comprising a casing provided with a plurality of

sets of power cylinders, pistons in said cylinders, and a crank-shaft with which said pistons are connected, the cylinders of the several sets having their central axes in planes which are radial with respect to the axis of the crank-shaft and are at an angle to each other, said casing being also provided with two air chambers located between the outer ends of said cylinders, said air chambers being separated from each other by a partition wall which joins the side wall of the casing at a point between the top and bottom walls thereof, and also having between said air chambers and the cylinders, cylindric valve chambers, the central axes of which are at right angles to the axes of the cylinders and parallel with the crank-shaft, said valve chambers communicating each at one end with one of said air chambers and each having lateral ports, one for each of the cylinders, in communication with the other air chamber, and valve plugs in said valve casing each having a plurality of sets of valve ports or passages, one for each of the cylinders associated therewith and including a longitudinal passage which opens into the end of said valve chamber which communicates with one of said air chambers, said side wall of the valve casing being provided with two ports which extend through said side wall of the casing on opposite sides of the said partition which separates the two air chambers from each other, and which severally communicate with said air chambers.

In testimony, that I claim the foregoing as my invention I affix my signature in presence of two witnesses, this third day of March, A. D. 1906.

REINHOLD A. NORLING.

Witnesses:
JAS. A. NIELD,
WILLIAM O'HANEY.