

March 9, 1926.

1,575,987

G. H. GILMAN

ROTARY FLUID PRESSURE MOTOR

Filed Sept. 30, 1918

2 Sheets-Sheet 1

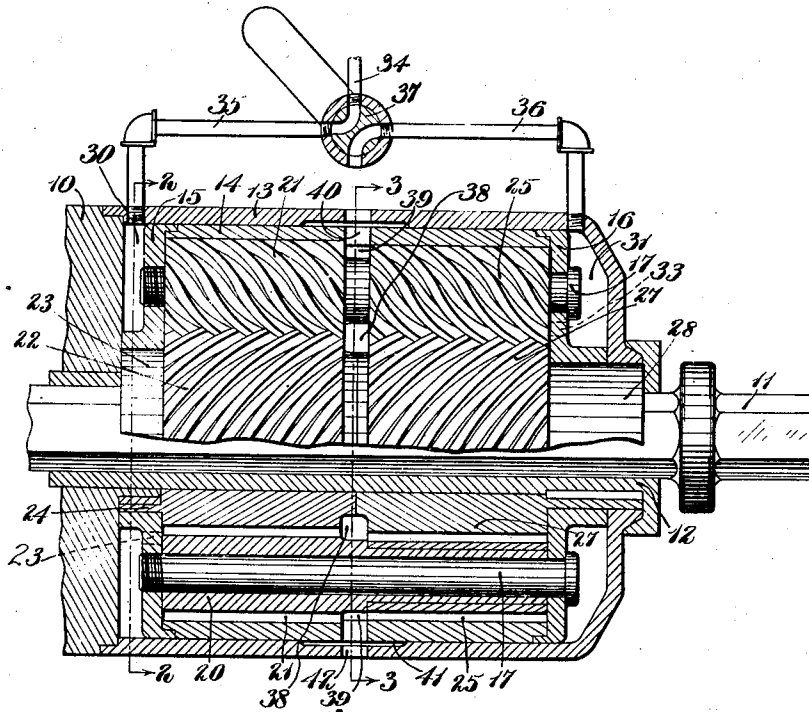


Fig. 1.

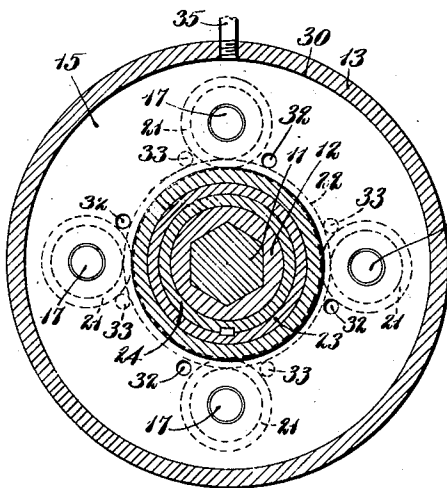


Fig. 2.

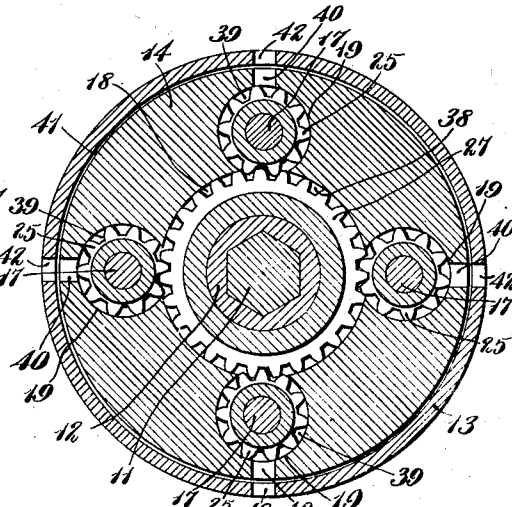


Fig. 3.

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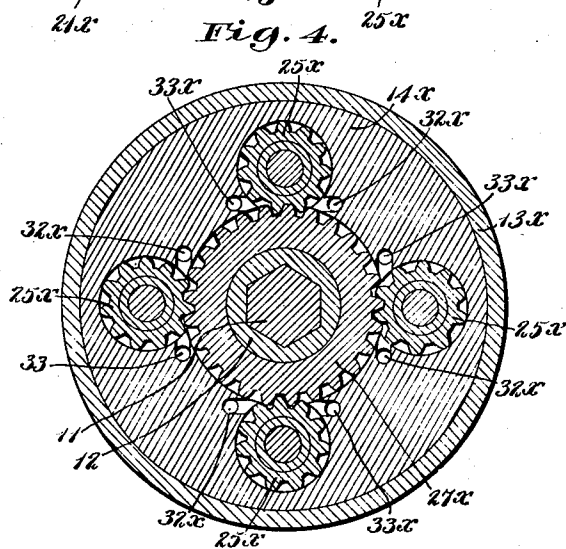
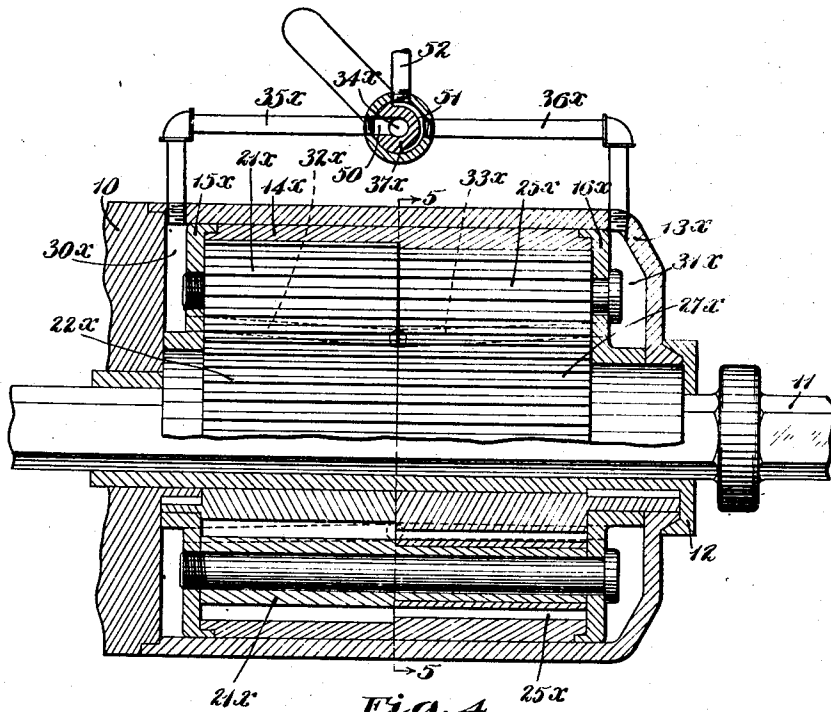
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UNITED STATES PATENT OFFICE.

GEORGE H. GILMAN, OF CLAREMONT, NEW HAMPSHIRE, ASSIGNOR TO SULLIVAN MACHINERY COMPANY, A CORPORATION OF MASSACHUSETTS.

ROTARY FLUID-PRESSURE MOTOR.

Application filed September 30, 1918. Serial No. 256,329.

To all whom it may concern:

Be it known that I, GEORGE H. GILMAN, a citizen of the United States, residing at Claremont, in the county of Sullivan and State of New Hampshire, have invented certain new and useful Improvements in Rotary Fluid-Pressure Motors, of which the following is a full, clear, and exact specification.

This invention relates to rotary fluid pressure motors, and more especially, although not exclusively, to a motor of the type comprising combined power generating and speed reducing mechanism, whereby the motor may be operated at a suitable speed to secure maximum efficiency, and at the same time may be caused to deliver its power at any desired speed, the motor elements being so constructed and arranged that they also act as speed reducing elements, so that no special speed reducing gearing is necessary between said elements and the point of application of the power. As will be seen, however, certain features of the invention are not limited in their utility to use in connection with a motor of this particular type.

The invention has for an object the provision of a generally improved motor in which the power generated is relatively great in proportion to the bulk and weight of the apparatus, and in which the pressure fluid is admitted to and exhausted from the motor elements in a convenient and efficient manner.

A more particular object of the invention is to provide a motor of the character above referred to which may be readily reversed so as to deliver its power in the form of rotary motion in either direction.

The foregoing and other objects of the invention together with means whereby the same may be carried into effect will best be understood from the following description of certain illustrative embodiments thereof shown in the accompanying drawings.

In said drawings,—

Fig. 1 is a longitudinal central section of a motor constructed in accordance with the invention, the rotors being shown partly in elevation, and the fluid pressure controlling means being illustrated diagrammatically.

Figs. 2 and 3 are transverse sections taken substantially on the lines 2—2 and 3—3, respectively, Fig. 1.

Fig. 4 is a view similar to Fig. 1 showing another form of the invention.

Fig. 5 is a transverse section taken substantially on the line 5—5, Fig. 4.

The invention is herein illustrated as applied to and embodied in the drill bit rotating motor of a percussive rock drill. Said rock drill is not fully shown herein, as it may be of any usual or well known type and, specifically, forms no portion of the present invention. Referring to Figs. 1 to 3, 10 denotes the forward end of the main casing of the percussive motor of the rock drill, said motor usually comprising a hammer piston (not shown) which cooperates with the rear end of a drill steel 11 mounted in a chuck 12 in such a manner as to rotate therewith while being capable of longitudinal movement therein, as by forming said drill steel with a non-circular end which is received in a correspondingly formed opening in said chuck. The chuck 12 is rotatably mounted at its rear end in the main casing 10 and at its forward end in the rotating motor casing 13, which is secured at its rear end by any suitable means to the forward end of said main casing.

For rotating the chuck 12, and consequently the drill steel 11, there is provided a rotary fluid pressure motor embodying the present invention. Within the casing 13 is a rotary element or casing forming a part of the motor and comprising a cylindrical portion 14 and two end heads or disks 15 and 16 held in assembled relationship by means of bolts 17 extending parallel to the axis of the drill steel 11. Extending centrally through the casing members 14, 15, and 16, is a cylindrical chamber 18 (see Fig. 3) arranged coaxial with the drill steel 11. The member 14 is further provided with a plurality (herein four) of cylindrical rotor chambers 19 coaxial with the bolts 17 and disposed symmetrically about the axis of the chamber 18 and with their axes parallel thereto. Located within each of the chambers 19 and rotatably mounted upon the corresponding bolt 17, is a sleeve 20 having formed at one end a planet rotor or gear 21 provided with spiral teeth which mesh with correspondingly formed teeth on a fixed sun gear 22, said sun gear having a hub 23 which is keyed to a cylindrical extension 24 on the forward end of the main casing 10, and on

which hub 23 the member 15 of the rotary casing is rotatably mounted. Fast upon the opposite end of each of the sleeves 20 is a second planet gear or rotor 25 having spiral teeth inclined in the same direction as the teeth of the rotors 21, the teeth of each of the gears 25 meshing with correspondingly formed teeth on a rotating sun gear 27 having a hub 28 journaled in the forward end of the casing 13 and upon which the casing member 16 is rotatably mounted, said hub 28 being keyed to or otherwise connected with the chuck 12 for rotation in unison therewith. The ratio of the number of teeth on each of the gears 21 to the number of teeth on the gear 22 is different from the ratio of the number of teeth on each of the gears 25 to the number of teeth on the gear 27, so that, as will be seen the whole constitutes a compound planetary gear train by which rotation of the gears 21 is transmitted to the gear 27 at a greatly reduced speed.

Moreover, each pair of gears 21, 25 forms with the gears 22, 27, a spiral rotary motor couple of familiar form, whereby, by admitting fluid pressure at suitable points to the teeth of the gears or rotors of each couple, said gears or rotors may be caused to rotate with respect to each other in opposite directions. For so supplying pressure fluid to each of the gears or rotors 21, 25, and for controlling the direction of relative rotation of said gears and the gears 22, 27, and thereby the direction of operation of the motor as a whole, the following connections are provided:

The casing 13 is formed of a length sufficiently greater than the length of the rotary casing 14, 15, 16, to provide, at the opposite ends of the latter, fluid pressure chambers 30 and 31. Said fluid pressure chambers 30 and 31 communicate with the spaces between the teeth of the compound rotor or gear 22, 27 and the teeth of the several compound rotors or gears 21, 25, at the ends of said rotors or gears, through ports 32 and 33, respectively. The port 32 for each rotor couple is located at the opposite side of the plane passing through the axes of the rotors of the couple from the corresponding port 33, so that by admitting fluid pressure alternatively to either the ports 32 or the ports 33, the motor may be caused to operate in one direction or the other. For alternatively supplying fluid pressure to the chambers 30 and 31, and consequently to the ports 32 33, any suitable means, including a score of fluid pressure, valve means carried by the drill or motor casing, and suitable ports and passages in either or both of said casings, may be provided. As illustrative of such means there is herein illustrated a fluid pressure inlet 34 communicating with any suitable source of fluid pressure, inlet pipes or con-

duits 35 and 36 communicating with the chambers 30 and 31, respectively, and a valve 37 adjustable to different positions to admit fluid pressure from the inlet 34 to the conduits 35 and 36 alternatively.

By the foregoing means, fluid pressure is admitted to the several rotor couples at one end or the other thereof, depending upon the adjustment of the valve 37, thereby causing operation of said rotor couple, and consequently of the motor as a whole, in one direction or the other. The fluid pressure is exhausted from the motor couples at points midway the length thereof irrespective of the end at which the pressure fluid is admitted and the direction of operation of the motor. To this end an exhaust groove 38 is formed between the sun gears 22 and 27, and a corresponding exhaust groove 39 formed between the planet gears 21 and 25 of each pair. The casing member 14 is provided with ports 40 communicating with each of the rotor chambers 19 at points opposite the exhaust grooves 39 and extending to the exterior of said casing member. Opposite the exhaust ports 40 the casing 13 is formed with an annular groove or exhaust chamber 41 with which communicate ports 42 leading through the wall of said casing to the atmosphere. It will thus be seen that pressure fluid admitted to the ports 32 or 33 will pass longitudinally of the rotors, actuating the latter, to the exhaust grooves 38 and 39, thence from said grooves through the ports 40 to the annular chamber or groove 41, from which said air will be exhausted to the atmosphere through the ports 42, such exhaust being freely permitted irrespective of the angular position of the rotary casing 14, 15, 16.

In operation, fluid pressure admitted through either the ports 32 or the ports 33 will cause relative rotation of the element 21, 25 of each rotor couple with respect to the cooperating element 22, 27. Considering first the action of the members 21, 22, the rotation of the planet gears 21 upon their axes will cause said planet gears to revolve or travel bodily about the fixed sun gear 22, carrying with them the rotary motor casing 14, and thereby causing rotation of said casing about the axis of said sun gear. A similar action will simultaneously take place between the planet and sun gears 25 and 27. Since, however, the gear 27 is not fixed but is free to rotate, and since the ratio between the numbers of teeth on the gears 25 and 27 is different from the ratio between the numbers of teeth on the gears 21 and 22, while the movement or revolution of the gears 21 and 25 with the casing 14 is the same, the gear 27, which carries with it the chuck 12 and drill steel 11, will be caused to rotate at a speed corresponding to the proportion between said two ratios, and in a direction de-

pending upon the position of the valve 37, and consequently the admission of fluid pressure through the ports 32 or through the ports 33.

From the foregoing it will be seen that, by reason of the construction and arrangement of the parts above described, the members 21, 22, 25, and 27 serve not only as rotor elements of a reversible fluid pressure motor, but also as transmission elements of a train of reduction gearing, whereby the resultant speed developed by the motor is greatly reduced within the motor itself with respect to the normal speed of relative rotation of the motor elements, and may, in designing the motor, be widely varied in accordance with requirements by a simple variation in the relative number of teeth on the several rotors of the set. In this manner the speed of relative rotation of the rotors may be made as great as desirable for reasons of efficiency, while the resultant speed may be as slow as desirable for the purposes to which it is put, and the direction of rotation of the driven part reversed at will, these results being accomplished by the use of a single set of rotors which perform the triple function of motor elements, speed reducing elements, and direction reversing elements, thereby doing away with the necessity usually encountered of providing reduction gearing and reversing gearing in addition to the motor mechanism.

In the modified form of the invention shown in Figs. 4 and 5, the general construction and arrangement of parts is substantially the same as in the construction shown in Figs. 1 to 3 and comprises the drill casing 10, the drill steel 11, chuck 12, outer motor casing 13*, inner rotary motor casing 14*, 15*, 16*, fixed and rotary sun gears 22*, and 27*, and compound planet gears 21* and 25*. In this form of the invention, however, the gears 21*, 22*, 25*, and 27*, are formed with straight instead of spiral teeth, and the casing 14* is formed with inlet passages for supplying fluid to, as well as exhausting the same from, the several motor couples at points intermediate their ends. To this end the casing members 14*, 15* are formed with longitudinal passages 32* leading from the fluid pressure chamber 30* to substantially central ports communicating with the teeth of the rotors of each couple at one side of the plane of the axes of said rotors, while the casing members 14*, 16* are provided with similar passages 33* leading from the chamber 31* to similar ports communicating with the teeth of the rotors at points on the opposite sides of said axial planes. Thus the passages 32* may be employed as inlet passages and the passages 33* as exhaust passages, or vice versa, causing relative rotation of the motor elements in one direction or the other by ad-

mitting fluid pressure to one of the chambers 30* or 31* and exhausting fluid pressure from the other. As illustrative of means for doing this, there is shown in Fig. 4 a pair of fluid pipes or conduits 35*, 36* communicating, respectively, with the chambers 30* and 31* and controlled by a valve device 37*. Said valve device, as shown, is formed with an axial fluid pressure inlet 34* which may be supplied from any source of fluid pressure, with a port 50 by which said inlet 34* may be placed in communication with either of the pipes 35* or 36*, and with a cavity 51 by means of which the other of said pipes or conduits may be connected with an exhaust conduit 52 discharging to the atmosphere. By a suitable adjustment of the valve 37, either of the chambers 30* or 31* may be supplied with fluid pressure from the inlet 34*, the other of said chambers being simultaneously exhausted to the atmosphere through the cavity 51 and exhaust conduit 52.

The operation of the mechanism last described is quite similar to that of the mechanism shown in Figs. 1 to 3 and will, it is thought, be fully understood without further explanation.

While I have in this application specifically described two embodiments which my invention may assume in practice, it will be noted that the particular constructions and adaptations described and shown have been chosen for illustrative purposes merely, and that the invention as defined by the claims hereto appended may be otherwise practised without departing from the spirit and scope thereof.

What I claim as new and desire to secure by Letters Patent is:

1. A fluid pressure motor comprising a compound gear reduction consisting of a plurality of cooperating elements having a different number of teeth, and means for supplying motive fluid to said elements in different ways to cause operation of said gear reduction in either direction.

2. A fluid pressure motor comprising a central element, a rotary element constantly co-operating therewith, said elements having interengaging peripheral teeth and each being mounted for normally rotating about the axis of said central element, and means for supplying motive fluid to said elements, said means being adapted to admit fluid to cause relative movement of said elements selectively in different directions.

3. A fluid pressure motor comprising compound reduction gearing including fixed and rotatable sun gears, rotary planet gears mounted to revolve about the axis of said sun gears, and means for supplying motive fluid to said gears in different ways to cause revolution of said planet gears in either direction.

4. A fluid pressure motor comprising a central element, a group of spaced rotary elements surrounding said central element and each constantly forming with said central element a motor couple, said central element and group of rotary elements being provided with intermeshing peripheral teeth and each being mounted for rotation about the axis of said central element whereby said teeth cooperate to form expanding pockets, and means for supplying motive fluid to each of said couples, said means being adapted selectively to admit fluid to cause relative movement of said elements in different directions.

5. A combined fluid pressure motor and speed reducing mechanism comprising a compound planetary gear train including a plurality of connected combined gear and motor couples each comprising intermeshing toothed elements, the ratio of the number of teeth of the elements of the several couples being different, and means for supplying motive fluid to one of said elements, said means being adapted selectively to admit fluid to cause relative movement of said elements in different directions.

6. A combined fluid pressure motor and speed reducing mechanism comprising a compound planetary gear train including a plurality of connected combined gear and motor couples each comprising intermeshing toothed elements, the ratio of the number of teeth of the elements of the several couples being different, and means for supplying motive fluid to all of said couples, said means being adapted to admit fluid selectively to cause relative movement of said elements in different directions.

7. A fluid pressure motor comprising central elements, rotary elements, cooperating therewith, said rotary elements and one of said central elements being mounted for rotation about the axes of said central elements, means for supplying fluid to said elements at the ends thereof, and means for exhausting fluid from said elements intermediate their ends.

8. In a fluid pressure motor, in combination, an outer casing, an inner casing mounted to rotate within said outer casing, motor elements carried by said inner casing, said outer casing having pressure fluid chambers at the ends of said inner casing, and said inner casing having ports for admitting fluid from said chambers to said elements, and means for supplying pressure fluid to said chambers.

9. In a fluid pressure motor, in combination, an outer casing, an inner casing mounted to rotate within said outer casing,

motor elements carried by said inner casing, said outer casing having pressure fluid chambers at the ends of said inner casing, and said inner casing having ports for admitting fluid from said chambers to said elements, the ports communicating with the several chambers being arranged to cause operation of said motor in opposite directions, respectively, and means for supplying pressure fluid to said chambers alternately.

10. In a fluid pressure motor, in combination, an outer casing, an inner casing mounted to rotate within said outer casing and having rotor chambers, and motor elements in said chambers, said outer and inner casings being relatively formed to provide pressure fluid chambers communicating with the ends of said rotor chambers and an annular exhaust chamber communicating with said rotor chambers intermediate their ends.

11. A fluid pressure motor comprising a plurality of members having spirally disposed intermeshing teeth cooperating upon relative rotation of said members to form closed pockets which increase in volume as relative rotation takes place, means for admitting motive fluid to said pockets at opposite ends of said members and at opposite sides of the mesh line of the teeth forming the pockets and at points adjacent the inception of said pockets, and common exhaust means for the fluid admitted at either end.

12. A fluid pressure motor comprising a casing, a plurality of members therein having spirally disposed intermeshing teeth cooperating upon relative rotation of said members to form closed pockets increasing in volume as relative rotation progresses, means for admitting fluid to said pockets at opposite ends of said members and at opposite sides of the mesh line of the teeth forming the pockets and at points adjacent the inception of said pockets, and common exhaust means for the fluid admitted at either end comprising an exhaust belt surrounding said rotors midway of the length of said casing.

13. The combination with combined motor and reduction gearing including fixed and rotatable co-axial gears and planet gears meshing respectively therewith, of means for supplying fluid to said gears to effect opposite rotation of said rotatable gear, and a shaft fixed thereto and provided with a socket to receive a device to be oppositely rotated thereby.

In testimony whereof I affix my signature.
GEORGE H. GILMAN.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,575,987, granted March 9, 1926, upon the application of George H. Gilman, of Claremont, New Hampshire, for an improvement in "Rotary Fluid-Pressure Motors," an error appears in the printed specification requiring correction as follows: Page 2, line 58, for the word "score" read *source*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of May, A. D. 1926.

[SEAL.]

WM. A. KINNAN,
Acting Commissioner of Patents.