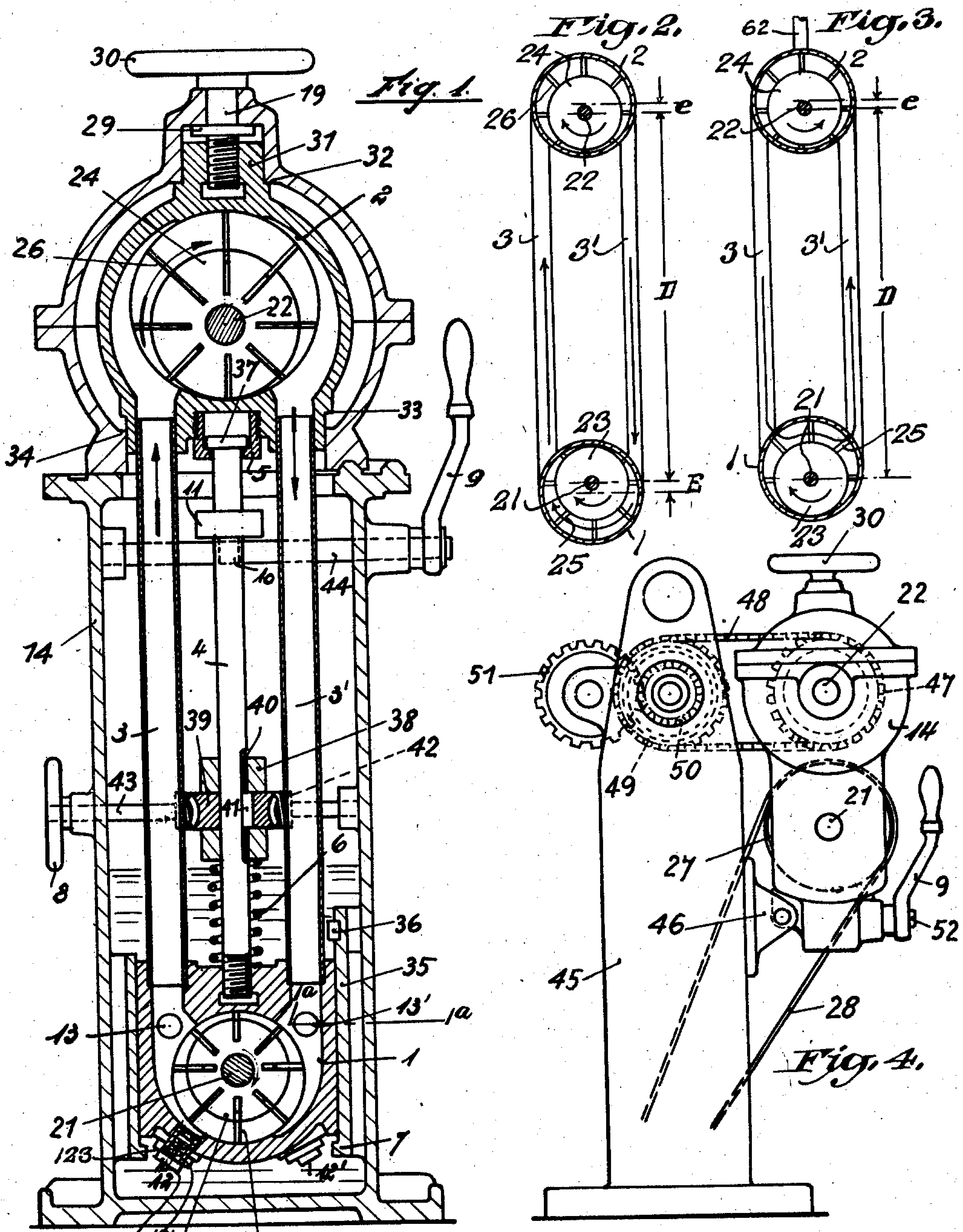
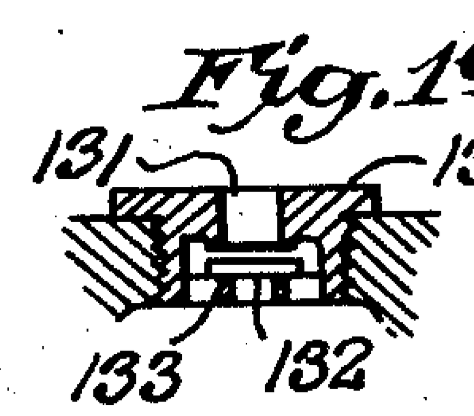
Oct. 7, 1930. W. KÜHN 1,777,851

HYDRAULIC GEAR

Filed April 14, 1927 2 Sheets-Sheet 1





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HYDRAULIC GEAP

Filed April 14, 1927 2 Sheets-Sheet 2

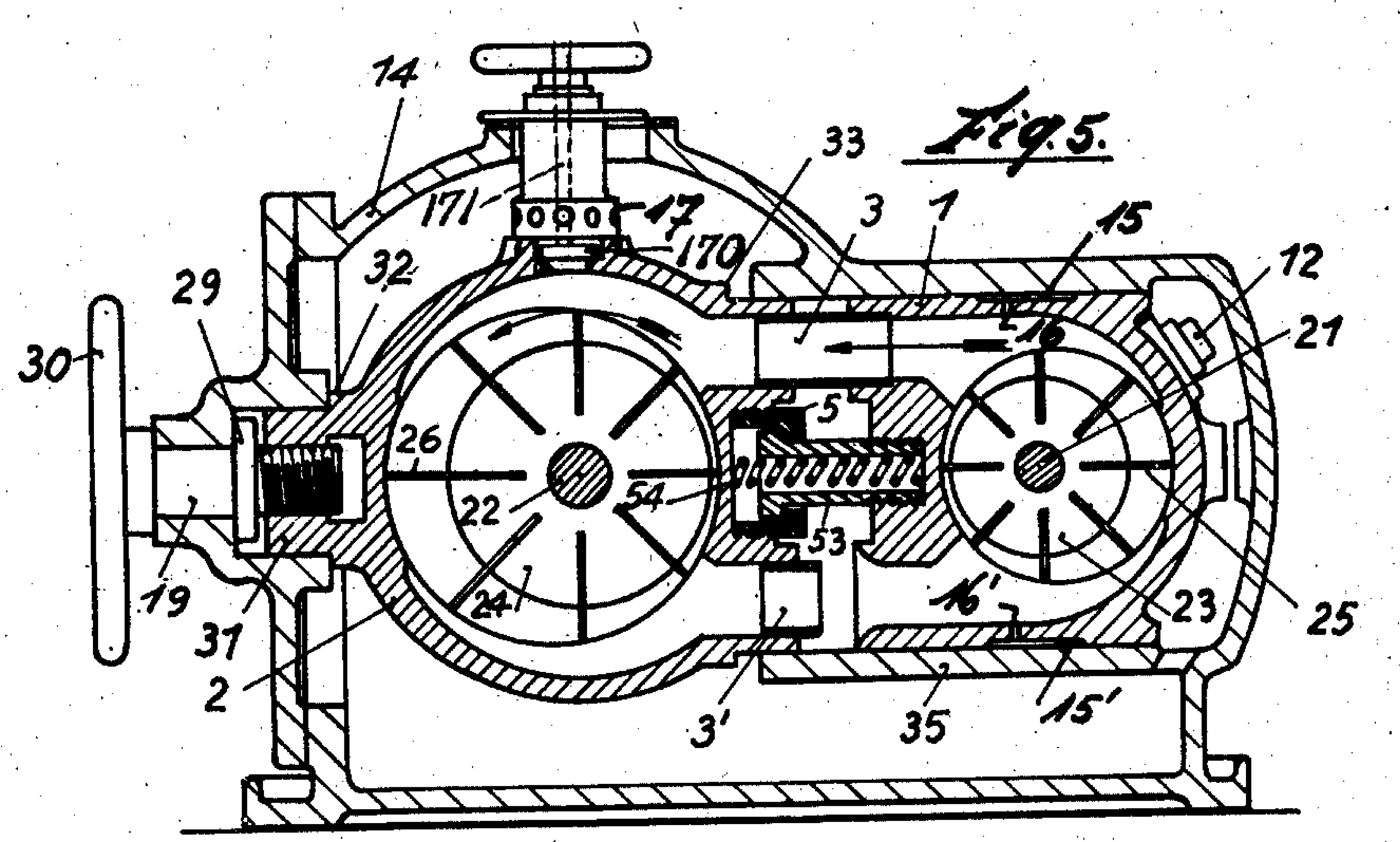

Fig. 5.

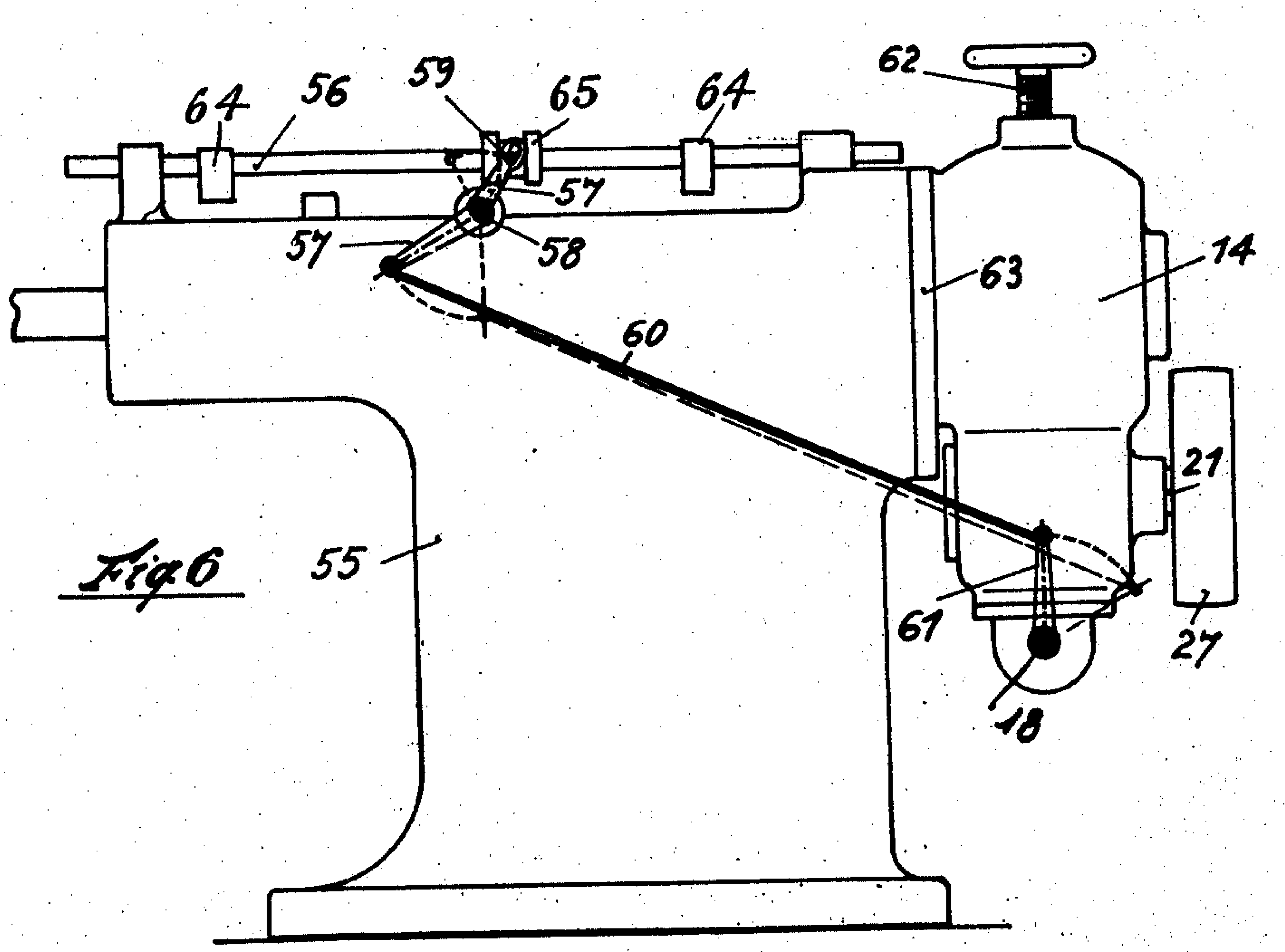

Fig 6

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UNITED STATES PATENT OFFICE

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HYDRAULIC GEAR

Application filed April 14, 1927, Serial No. 183,751, and in Germany May 25, 1926.

My invention relates to hydraulic gears comprising a pump unit and a motor unit, each unit being equipped with a rotor and radial vanes in the rotor. In such gears it has been proposed to vary the volume of the operative spaces in the cylinders by varying the eccentricity, that is, the relative position of the rotor axis and the axis of the cylinder in each unit. It is an object of my invention to improve a gear of this type with a view to increasing its range of applicability.

To this end I provide a connecting element between the two units by which the displacement of one unit is transferred onto the other unit, but in which separate adjustment of the other unit independently of the first unit is also possible.

By these means the applicability of hydraulic gears is increased to such an extent, that they are now applicable under operating conditions and for purposes for which they were not suitable heretofore.

In a preferred embodiment of my invention I provide means for displacing the cylinder of the motor unit. The connecting element is constructed as a rod connecting the two units and adapted to transmit the motion of the motor unit to the pump unit, but not vice versa. Preferably the range of eccentricity of the motor unit exceeds that of the pump unit so that a comparatively small displacement of the motor unit effects a considerable variation in the eccentricity of the pump unit.

The connecting element permits independent adjustment of one of the units, in the present instance of the pump unit, so that the eccentricity of the pump unit may be varied even after the motor unit has reached its limit of adjustability. Similarly, it is also possible to so adjust the connecting element that it will become operative only after the unit by which the connection is operated, has been displaced through a given distance. Another advantage of the connecting element is that it permits the pump unit to be rendered inactive by reducing its eccentricity to zero, that is, placing the axes of the rotor and the cylinder in concentric position, independently of the position which the motor unit assumes at the time.

I may also reverse the direction in which the motor unit rotates, by displacing the pump unit so as to reverse the direction in which it delivers liquid to the motor unit.

In the following specification I shall describe in the first place change speed gears in which the motor unit is displaced and entrains the pump unit, but it is understood that this arrangement may be reversed without departing from my invention, as will be described further on.

In the drawings affixed to this specification and forming part thereof change speed gears embodying my invention are illustrated diagrammatically by way of example.

In the drawings

Fig. 1 is a transverse section of a reversible vertical gear.

Fig. 1ª is a section on the line 1ª—1ª in Fig. 1, drawn to a larger scale,

Figs. 2 and 3 are diagrams illustrating the reversing of the motor by displacing the pump cylinder,

Figs. 4 and 6 illustrate, somewhat diagrammatically, the arrangement of the gear in connection with the frame of a machine tool, and

Fig. 5 is a transverse section of a horizontal non-reversible gear.

Referring now to the drawings, and first to Fig. 1, 14 is the casing of the gear in which the cylinder 1 of the pump unit and the cylinder 2 of the motor unit are adapted to be displaced. The units are equipped with the usual shafts 21 and 22, rotors 23 and 24, and vanes 25 and 26, respectively. Rotation is imparted to the shaft 21 of the pump unit by any suitable means, for instance a pulley 27 and a belt 28, as indicated in Fig. 2.

19 is a spindle which is supported rotatably in a bearing at the top of the casing 14 but held against axial displacement by a flange 29 and a hand wheel 30, and engaging a boss 31 at the top of the motor cylinder 2 with its threaded end so that by rotating the hand wheel 30 the cylinder 2 of the motor unit is displaced in the casing. Fig. 1 illustrates

the position of the cylinder in which the eccentricity of the motor unit is a maximum. In this position a shoulder 32 of the boss 31 abuts against a corresponding shoulder in the casing. The limit in the opposite direction is constituted by a shoulder 33 at the lower end of the cylinder which in the lower final position of the cylinder 2, corresponding to minimum eccentricity, abuts against a shoulder 34 in the casing.

The motor and pump units are connected by a delivery pipe 3 and a discharge pipe 3′ and it will appear from Fig. 1 that clockwise rotation is imparted to the rotor 24 of the motor unit. The pipes 3, 3′ are secured in corresponding holes of the cylinder 1 and are slidable in similar holes of the cylinder 2 so as not to interfere with the relative displacement of the units.

The cylinder 1 of the pump unit is slidably supported in a parallel guide 35 in the base of the casing 14 and its stroke is limited by abutments 7 and 36 at the lower and upper ends of the guide.

4 is a rod which is inserted in a threaded hole in the top of the pump cylinder 1, 37 is a flange or dog at the upper end of the rod 4, and 5 is a shouldered sleeve or abutment screwed into a threaded hole in the base of the motor cylinder 2. The range of the connecting element, that is, the distance through which the cylinders 1 and 2 may be displaced with respect to each other, is determined by the clearance between the flange 37 and the corresponding face at the base of the motor cylinder. A spring 6 which is inserted between the top of the pump cylinder 1 and a transverse bar 38 of the casing 14 tends to hold the flange 37 engaged with the shoulder of the sleeve 5. Consequently, the relative distance of the cylinders 1 and 2 in the direction in which the connecting element operates, is determined by the length of the rod 4, and the effective length of the rod may be varied by turning the rod in its threaded hole at the top of the pump cylinder 1. Rotation of the rod 4 may be effected by any suitable means. In the present instance the transverse bar 38 is divided and a worm gear 39 is inserted therein and connected with the rod 4 by a spline 40 and a key 41. Rotation is imparted to the worm gear 39 by means of a worm 42 on a shaft 43 in the casing 14 which is rotated by a hand wheel 8. In this manner the rod 4 may be screwed out of, or into, its hole in the cylinder 1 as desired, and its effective length varied.

Means may be provided for rendering the pump inoperative at any time and independently of the adjustment of the motor cylinder 2. In the present instance, this is effected by a handle 9 on a shaft 44 and a cam 10, also on the shaft 44, which engages a collar 11 on the rod 4.

The pump illustrated in Fig. 1 is adapted to rotate in either direction and therefore is provided with safety valves 12 and 12′ and make-up valves 13, 13′ on both sides. The safety valve 12 is shown in section in Fig. 1. 121 is a valve casing which is inserted in the bottom of the pump cylinder, 122 is the spindle of the valve, and 123 is the spring which tends to hold the valve on its seat. The make-up valve 13′ has been shown in Fig. 1ª. It comprises a bush which is threaded into the wall of the pump cylinder and perforated at 131, and a valve body 132 on a seat 133.

The valves 12, 12′ are normal safety valves which are adjusted for a given pressure by varying the tension of their springs. When the predetermined pressure is exceeded, for instance, when the load on the motor unit becomes excessive or when an unusual resistance occurs in the gear on account of irregularities, the valves will open and permit liquid to escape into the oil chamber surrounding the pump cylinder until normal pressure has been reestablished. Loss of liquid due to the operation of the safety valves or to leakage is made up for by the valves 13, 13′ which open when the pressure in the liquid chamber exceeds the pressure on the suction side of the pump. As will appear from Figs. 2 and 3, the pump cylinder 1 may be so displaced with respect to its rotor 23 that the direction in which the rotor 24 in the motor cylinder 2 is rotating, is reversed. The distance D between the centres of the shafts 21 and 22 is constant but the eccentricities E and e of the pump and motor cylinders, respectively, are variable. In Fig. 2 the motor cylinder 2 is adjusted for any desired eccentricity e which may be varied as described, but the pump cylinder 1 has been adjusted to its limit of eccentricity so that its rotor 23 is in contact with the cylinder 1 at its upper side. The rotor 23 rotates clockwise, the liquid flows down in the pipe 3′ and up in the pipe 3 and rotation is imparted to the rotor 24 of the motor in clockwise direction. When, however, the position of the pump cylinder 1 is reversed with respect to its rotor, as shown in Fig. 3, so that the lower side of the rotor is in contact with the pump cylinder, the flow in the pipes 3 and 3′ will be short-circuited, that is, the liquid will flow from the pipe 3 to the pipe 3′ at the side of the pump cylinder which is facing the motor cylinder without flowing about the rotor 23 of the pump, as shown in Fig. 2. The consequence is that the liquid flows down in the pipe 3 and up in the pipe 3′ and so anticlockwise rotation is imparted to the rotor 24 while the rotor 23 still rotates clockwise.

It will be understood that the motor, notwithstanding the reversing of the direction in which its rotor 24 is rotating, may be adjusted within the range of its eccentricity, as described above.

Referring now to Fig. 4, 45 is an upright of a machine tool, for instance, a lathe or the like and 46 is a bracket on the upright in which the casing 14 is pivotally carried. A sprocket 47 is secured on the shaft 22 at the rear of the casing and a chain 48 imparts rotation to a sprocket 49 on a shaft of the machine. A pinion 50 is keyed on the latter shaft and meshes with a wheel 51 on a parallel shaft.

In this case the handle 9 for throwing out the pump unit is arranged on a shaft 52 which is carried in the base of the casing 14 and a cam on the shaft 52 corresponding to the cam 10 on the shaft 44 in Fig. 1 acts directly on the cylinder 1 instead of acting on the collar 11. This modification has not been illustrated as it will be understood by any expert.

Instead of being pivotally carried on the upright, the casing 14 may be secured to the upright by a suitable face plate, as is shown in Fig. 6.

Referring now to Fig. 5, this gear is designed on the same principle as that illustrated in Fig. 1, and corresponding parts have been indicated by the same reference numerals and will not again be described.

The pump of this gear is not reversible and therefore its pump cylinder 1 is provided only with a single safety valve 12. The rod 4 is replaced by a tube 53 in which a spring 54 corresponding to the spring 6 in Fig. 1 is inserted. It will be understood that the operation of the connecting element between the cylinders 1 and 2 is the same as that described with reference to Fig. 1 and that the means for varying the effective length of the rod which have been described with reference to Fig. 1, may be applied although they have not been illustrated. On the other hand, in this case it is not necessary to throw out the pump by means of the handle 9 when it is desired to arrest the motor as the pump rotates in one direction only, and therefore in this case it suffices to provide a by-pass or relief valve generally indicated at 17 by which the liquid under pressure from the delivery pipe 3 may be by-passed into the casing from the cylinder 1. This valve comprises a valve body 170 which is seated on a tapered face in the body of the cylinder 1, and is provided with a spindle 171 for operating it.

In the present instance means are provided in connection with the cylinder 1 of the pump for equalizing transverse forces so as to facilitate its movement in the guide 35. Grooves 15 and 15′ are formed in the outer face of the cylinder 1 and connected with the space within the cylinder by bores 16 and 16′. Obviously, the grooves and bores might also be provided on the cylinder 2 of the motor, particularly if its diameter is equal to that of the pump cylinder. In the example illustrated, however, the motor cylinder 2 is without the equalizing system as its inside diameter is larger than that of the pump cylinder 1 and therefore the motor cylinder 2 has only a short spigot-like extension beyond the shoulder 33 which does not permit the arrangement of equalizing means as does the larger area available in the pump cylinder 1. The force exerted at the wheel 30 and the spindle 19 is so considerable that equalizing means are not indispensible in the motor cylinder. The size of the cylinder is only a secondary consideration with respect to the equalizing system, the primary consideration being the general type of supports for the cylinder. The equalizing system is provided whenever the area available for guiding the motor cylinder 2 is comparatively large.

The spigot at the end of the motor cylinder fits the guide 35 in which the pump cylinder 1 slides. At the opposite end of the motor cylinder is provided with the boss 31 and the parts connected therewith, including the hand wheel 30, are the same as described with reference to Fig. 1.

Referring now to Fig. 6, this illustrates the adaptation of my gear to the frame 55 of a machine which performs reciprocating movements, for instance, a planer. 63 is a flange at one side of the casing 14, by which it is secured to the frame 55, and 27 is a pulley which is secured on the pump shaft 21.

The pump is adjusted and reversed as described with reference to Figs. 2 and 3. Any suitable means may be provided for connecting the gear 14 with moving parts of the machine so as to control its operation in conformity with the operation of the machine. For instance, I may provide a pinion, not shown, on the shaft 22 of the motor which meshes with a rack on any reciprocating part of the machine, for instance, its table, not shown. Lugs 64, 64 are carried on, or operatively connected with, the reciprocating part and are fitted to slide on a bar 56. Fitted to slide on the bar between the lugs is a sleeve 65 with a pin 59. 57 is a double-armed lever which is fulcrumed on the frame 55 at 58 and engages the pin with a slotted eye at the end of its upper arm, and 60 is a link connected with an arm 61 on a shaft 18 for regulating the position of the pump cylinder 1. The shaft 18 corresponds to the spindle 19 in Figs. 1 and 5 but in the present instance the shaft 18 is equipped with a cam or the like, not shown, for engaging a recess in, or a projection on, the pump cylinder 1, in such manner that the cylinder is reciprocated upon rotation of the shaft. This mechanism controls the motion required for adjusting the gear by displacing the pump cylinder and the motor cylinder merely moves in conformity with the motion of the pump cylinder, being connected thereto by the connecting element described. The motion of the motor cylinder is limited by a threaded check 62. By means of this check the eccentricity of the motor corresponding to the normal speed of the machine is adjusted. The check 62 has been indicated in Fig. 3. The displacement of the pump causes a corresponding displacement of the motor, the means for effecting this being the same as when, conversely, the pump is displaced by the motor. Fig. 3 shows the motor cylinder in its upper final position and engaged with the check 62. In this position the motor is rotating at its normal speed corresponding to the operating or forward stroke of the bar 56. The eccentricity of the motor cylinder 2 and its rotor 24 is comparatively large as shown in Fig. 2 and for the sake of simplicity the pump is shown at maximum eccentricity. When the pump cylinder 1 is now moved downwardly from the position illustrated in Fig. 3 by the system 57, 60, 61 it will entrain the motor cylinder 2 through a certain small distance and move it out of contact with the check 62. By displacing the pump cylinder the motor is reversed but at the same time its eccentricity is reduced while the eccentricity of the pump cylinder is the same but opposite its original eccentricity, as shown in Fig. 2. The output of the pump therefore is not varied but the speed of the motor is increased and the return stroke of the bar 56 is performed at this increasing speed. When the pump is again reversed, the several operations will occur in opposite sequence. The motor cylinder is entrained by the pump cylinder until it is arrested by the check 62 while the pump cylinder moves into its position of maximum eccentricity in upward direction and independently of the motor cylinder as shown in Fig. 3 and the gear is now ready for another forward stroke of the bar 56.

For a given position of the check 62 and with a given displacement of the pump cylinder from its upper position in Fig. 3 into its lower position in Fig. 2 the ratio of the forward and return speeds of the motor and consequently of the bar 56 will be constant, the return stroke being performed at a higher speed than the operating or forward stroke. Obviously the ratio may be varied by varying the displacement of the pump cylinder or the position of the check 62, or both factors. For a given adjustment, however, the operating conditions will be the same.

In the present instance, the casing 14, instead of being fulcrumed to the upright 55, is connected thereto by means of a face plate 63.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:—

1. A hydraulic change-speed gear comprising a motor unit and a pump unit, each unit having a casing and a rotor, means for varying the relative position of said casing and said rotor of each unit, and a connecting element between those parts of the units which are displaced for varying said relative position, said element being fixed to one of said parts and adapted to move within limits with respect to the other part.

2. A hydraulic change-speed gear comprising a motor unit and a pump unit, each unit having a casing and a rotor, means for varying the relative position of said casing and said rotor of each unit, and a connecting element between those parts of the units which are displaced for varying said relative position, said element being fixed to one of said parts and adapted to move within limits with respect to the other part, said motor unit having a larger range within which said relative position can be varied than said pump unit.

3. A hydraulic change-speed gear comprising a motor unit and a pump unit, each unit having a casing and a rotor, means for varying the relative position of said casing and said rotor of each unit, a connecting element between those parts of the units which are displaced for varying said relative position, said element being fixed to one of said parts and adapted to move within limits with respect to the other part, and means for varying the effective range of said connecting element.

4. A hydraulic change-speed gear comprising a motor unit and a pump unit, each unit having a casing and a rotor, means for varying the relative position of said casing and said rotor of each unit, a connecting element between those parts of the units which are displaced for varying said relative position, said element being fixed to one of said parts and adapted to move within limits with respect to the other part, and means connected with said element for displacing that part to which said element is fixed, independently of the other part.

5. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing and a rotor, each casing having a cylindrical part, guides for the parallel displacement of each casing in said frame, and a connecting element between said casings, said element being fixed to one of said casings and adapted to move within limits with respect to the other casing.

6. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing and a rotor, each casing having a cylindrical part, said cylindrical part having a passage extending from its inside to its outer face,

guides for the parallel displacement of each casing in said frame, and a connecting element between said casings, said element being fixed to one of said casings and adapted to move within limits with respect to the other casing.

7. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing and a rotor arranged eccentrically in its casing, a connecting element between said casings which is secured to one casing and adapted to move within limits with respect to the other casing, and means for varying the position of the last-mentioned casing with respect to its rotor independently of the other casing.

8. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing adapted to be displaced in said frame so as to vary its position with respect to its rotor, a connecting element between said casings which is secured to one casing and adapted to move within limits with respect to the other casing, and means attached to one of said casings for displacing it in said frame.

9. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing adapted to be displaced in said frame so as to vary its position with respect to its rotor, means attached to one of said casings for displacing it in said frame, a rod secured to one of said casings, a dog on said rod, and an abutment on the other casing adapted to engage said dog on said rod in a given relative position of said rod and said casing.

10. A hydraulic change-speed gear comprising a frame, a motor unit and a pump unit in said frame, each unit having a casing and a rotor arranged eccentrically in its casing, a connecting element between said casings which is secured to one casing and adapted to move within limits with respect to the other casing, means for varying the position of the last-mentioned casing with respect to its rotor independently of the other casing, and pipes connecting said casings and adapted to maintain their connection notwithstanding the relative displacement of said casings.

11. A hydraulic change-speed gear comprising a motor unit and a pump unit, each unit having a casing and a rotor, means for reversing the flow of liquid from said pump unit, means for varying the relative position of said casing and said rotor of each unit, and a connecting element between those parts of the units which are displaced for varying said relative position, said element being fixed to one of said parts and adapted to move within limits with respect to the other part.

In testimony whereof I affix my signature.

WILHELM KÜHN.