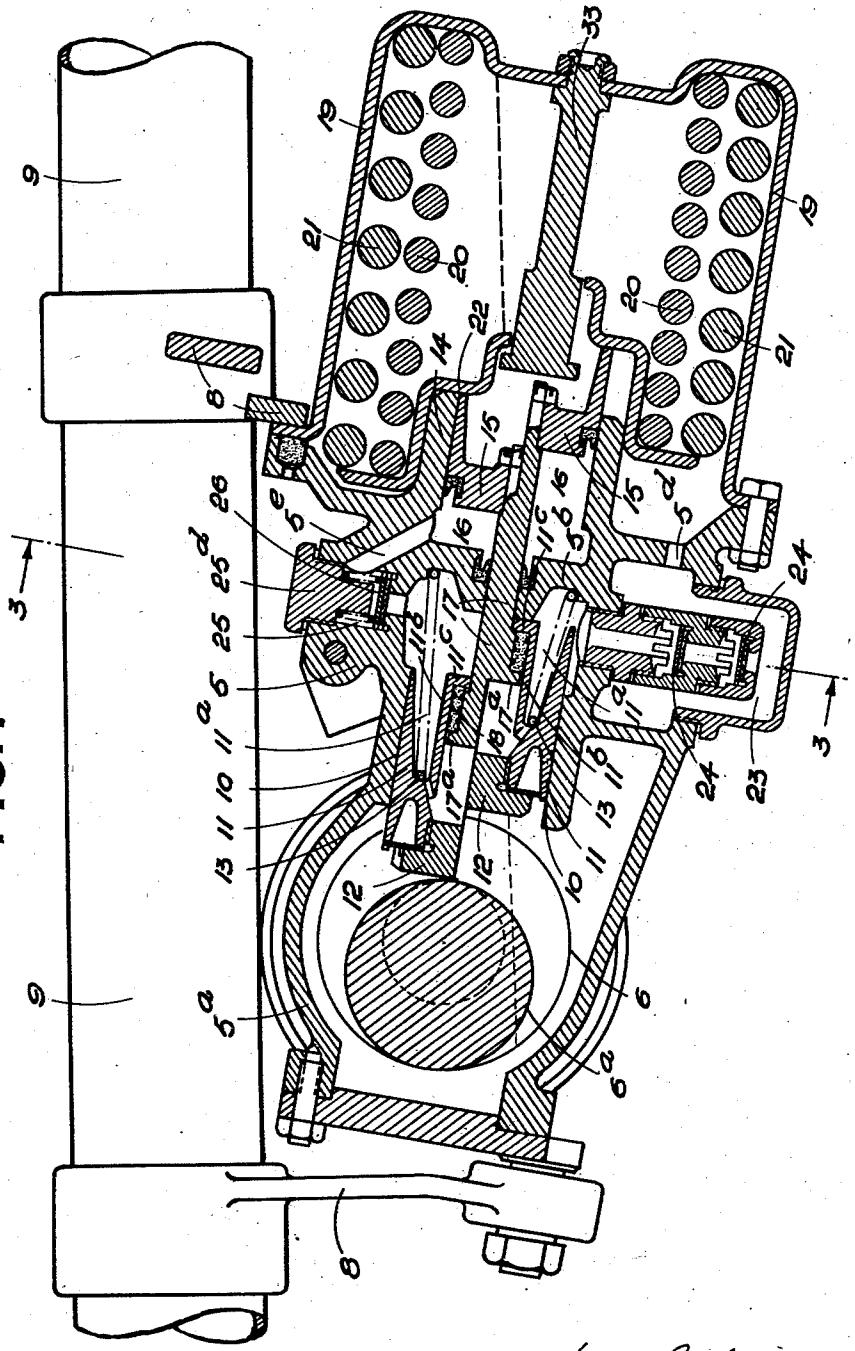
Dec. 16, 1947. J. H. PRATT ET AL 2,432,798

SERVO-MECHANISM

Filed Nov. 24, 1943 3 Sheets-Sheet 1

FIG. 1



James Henry Pratt
Albert Henry Godfrey Girling
Inventors

by Marshall & Marshall
Attorneys

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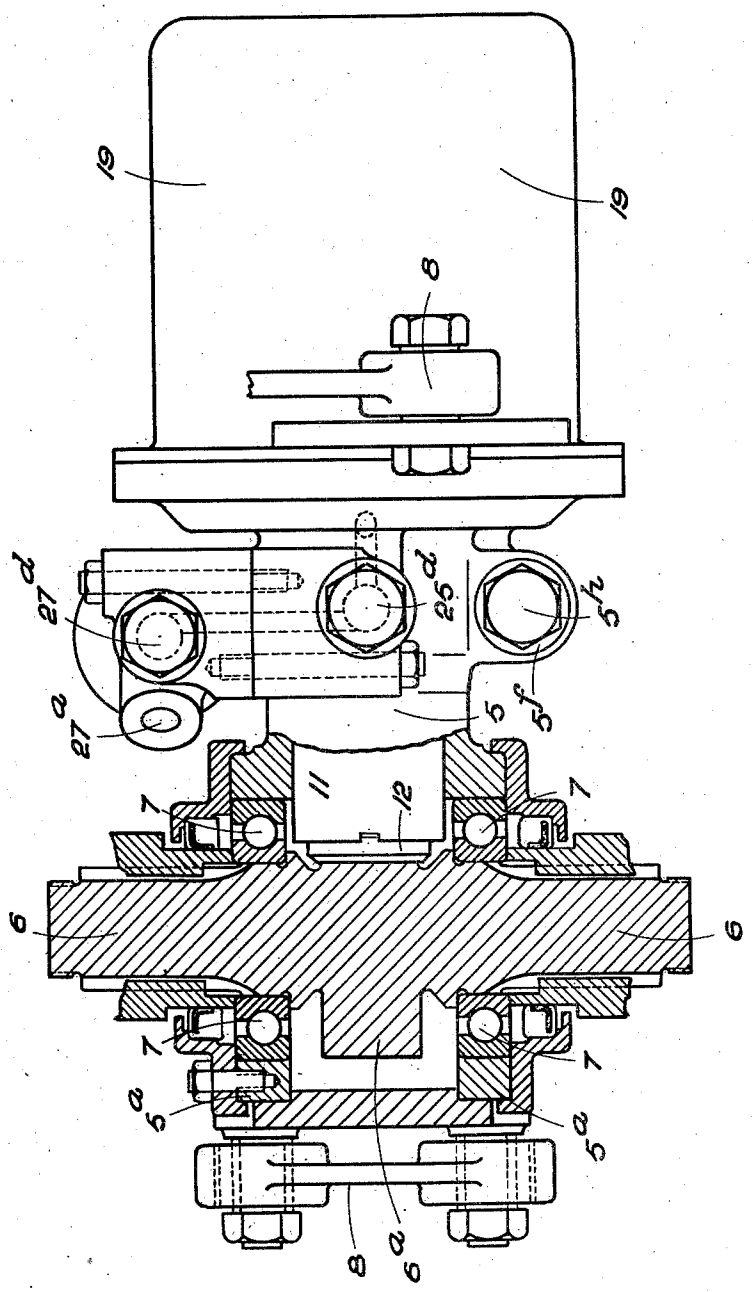
FIG.2



James Henry Pratt
Albert Henry Godfrey Girling
Inventors

Marshall & Marshall
Attorneys

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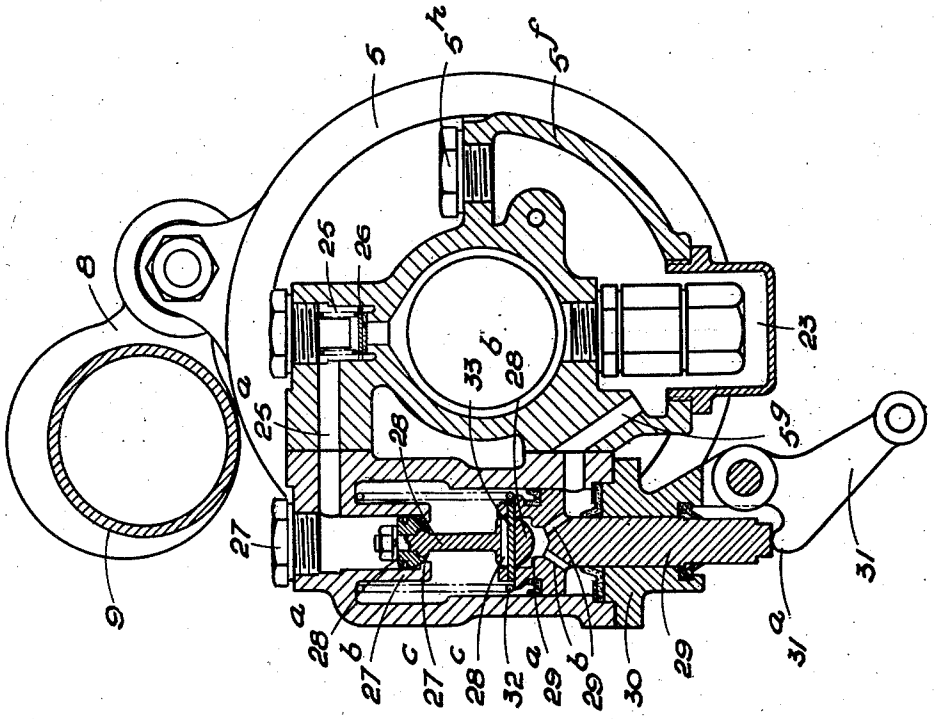

FIG. 3

James Henry Pratt
Albert Henry Godfrey Girling
Inventors

Marshall and Marshall
Attorneys

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2,432,798

SERVO MECHANISM

James Henry Pratt, Hall Green, Birmingham, and Albert Henry Godfrey Girling, Redgrave, Diss, Norfolk, England; said Gerling assignor to said Pratt

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2 Claims. (Cl. 103—23)

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This invention has reference to improvements relating to servo-mechanisms and has for its primary, but not exclusive, object the provision of a compact and substantially fool proof fluid operated servo-mechanism for actuating the brakes of relatively heavy vehicles.

According to the invention the improved fluid operated servo-mechanism is characterised by a pumping unit, an accumulator unit into which the output from the pumping unit is delivered and means for disengaging the pumping unit from a driving agency when the required volume has been delivered into the accumulator unit.

An embodiment of the invention will now be described with particular reference to the accompanying drawings which illustrate the invention in its application to a hydraulic servo-mechanism for operating the brakes of a heavy motor road vehicle.

In the drawings:

Figure 1 is a view of the improved hydraulic servo-mechanism drawn mainly in longitudinal vertical section together with such parts of a motor vehicle as are necessary to an understanding of the invention, the upper half of the section showing the positions occupied by the parts when the pumping unit is being driven and the lower half the positions occupied by the parts when the pumping unit has been disengaged from the driving agency.

Figure 2 is a sectional plan view of the servo-mechanism illustrated in Figure 1 and Figure 3 is a cross sectional view taken on the plane indicated by the line 3—3 of Fig. 1 looking in the direction of the arrows to said line.

According to the said illustrated embodiment of the invention the improved servo-mechanism incorporates a housing 5 a part 5*a* of which embraces the propeller shaft 6 which transmits the drive to the road wheels, not shown, said propeller shaft 6 being mounted in ball bearing races 7 carried at opposite ends of the part 5*a* of the housing 5. The housing 5 itself is supported by means of brackets 8 from a cross member 9 constituting part of the chassis of the vehicle.

The intermediate portion of the housing is divided into two sections by a transverse partition web 5*b*, said sections being termed henceforth the pumping section and the accumulator section.

The pumping section is provided with a longitudinally disposed cylinder 10 within which is reciprocably mounted an annular piston 11, hereinafter termed the pump piston 11. This pump piston 11 is provided in the head with a bearing

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plug 12 which co-operates with an eccentric 6*a* formed on the propeller shaft 6 said pump piston 11 co-operating with a spring 13 one end of which abuts the partition web 5*b* and the other end of which is seated in the bottom of a deep recess 11*a* in the pump piston 11 so that the pump piston 11 tends to be moved towards the eccentric 6*a* by the spring 13.

The accumulator section is provided with a cylinder 14 within which is reciprocably mounted a piston 15 which will be termed hereinafter the accumulator piston 15, the space between the said accumulator piston 15 and the adjacent face of the partition web 5*b* constituting the accumulator 16. This accumulator piston 15 is secured to one end of a piston rod 17 the other end of which is located within the aperture in the central portion 11*b* of the pump piston 11. The last mentioned end of the piston rod 17 is provided with a flange 17*a* between which and a complementary flange 11*c* on the central portion 11*b* of the pump piston 11 is an annular rubber buffer 18.

Bolted to the housing 5 on the accumulator section side is the open end of a cylindrical container 19 hereinafter termed the reservoir 19. Within this reservoir 19 is disposed a pair of pre-compressed coil springs 20, 21 which at one end abut the closed end of the reservoir 19 and which at the other end abut a cup 22 the central portion of which tends to remain in contact with the end of the skirt of the accumulator piston 15, the adjacent end of the accumulator cylinder 14 constituting a stop for limiting the inward movement of the cup 22 under the action of the pressure of the said springs 20, 21.

The pump cylinder 10 is in communication with the reservoir 19 by way of an inlet valve chamber 23 and a passage 5*d* in the partition web 5*b*. Disposed within the inlet valve chamber 23 is a pair of superposed inlet valves 24 which control the flow of liquid from the reservoir 19 to the pump cylinder 10, the duplication of the valves 24 being made as a safeguard.

The pump cylinder 10 is in communication with the accumulator 16 by way of a valve chamber 25 and passage 5*e* and the said valve chamber 25 has located therein a spring controlled one-way disc outlet valve 26.

The accumulator 16 is also in communication by way of the valve chamber 25 and passage 25*a* with a second valve chamber 27 termed the balancing valve chamber 27 when a valve 28*a* is lifted from its seating 27*c*, said balancing valve chamber 27 in turn being in communication by

a passage 27a with the pipelines, not shown, leading to hydraulic brake actuating means of known kind.

The passage 25a from the valve chamber 25 to the balancing valve chamber 27 enters at the top of the said chamber 27 and disposed within a depending housing 27b in the upper portion of the said chamber is a part-spherical valve 28a which co-operates with a seating 27c at the lower end of the depending housing 27b. The part-spherical valve 28a is carried at the upper end of a stem 28 the lower end of which carries a part-spherical valve 28b which co-operates with a seating 29a formed in the centre of a piston 29 hereinafter termed the operating piston 29, which is carried at the end of a plunger 29b reciprocably mounted in a guide 30 screwed into the lower end of the balancing valve chamber 27. The lower end of the said plunger 29b abuts a horn 31a carried by a lever 31 which is fulcrumed at one end to the housing 5 end of the said lever 31 being connected to a brake pedal, not shown, under the driver's control.

A coil spring 32 disposed within the balancing valve chamber 27 tends to press the operating piston 29 downwardly and thus draw the upper part-spherical valve 28a on to its seating 27c.

The lower part-spherical valve 28b is connected to the operating piston 29 by means of a cross bar 33 the intermediate portion whereof passes through a slot 28c in the valve 28b which is of a greater depth than the cross bar 33 thus permitting of a degree of lost motion. The two part-spherical valves 28a, 28b have a balancing action as will be described hereinafter.

A filling neck 5f which enters the inlet valve chamber 23 is provided for filling the said chamber and the reservoir 19 with liquid preferably the liquid normally used in hydraulic braking mechanism said neck 5f being closed by a screw plug 5h.

The outlet valve chamber 25 and the upper end of the balancing valve chamber 27 are closed also by screw plugs 25d and 27d respectively.

The acting surface of the pump piston 11 is made with area greater than the area of the acting surface of the accumulator piston 15.

Hydraulic packings are provided throughout the unit where necessary.

The accumulator springs 20, 21 are associated with a bolt 33 which in conjunction with the cup 22 maintains the springs 20, 21 compressed when the reservoir casing 19 is removed.

When the accumulator is full the flange 11c at the end of the central portion of the pump piston 11 comes into contact with the boss in the center of the partition web 5b.

The operating piston 29 is provided in the head with straight through passages 29b which open into the lower end of the balancing valve chamber 27, said lower end of the balancing valve chamber 27 communicating with the reservoir 19 by way of a passage 5g and the inlet valve chamber 23.

The operation of the invention in the embodiment described is as follows:

The accumulator springs 20, 21 are arranged to develop a force of 3970 lbs. so that when the accumulator 16 is at its maximum capacity a pressure of 1000 lbs. to the square inch is developed, the pressure being 800 lbs. to the square inch when the accumulator 16 is nearly at its minimum capacity.

Initially the whole housing 5 is filled with liquid and on a subsequent outward stroke of the pump piston 11 liquid is drawn from the reservoir 19 into the pump cylinder 10 by way of the duplicated inlet valves 24. On the rotation of the propeller shaft 6 the eccentric 6a bears on the bearing plug 12 in the closed end of the pump piston 11 whereby the said pump piston 11 is moved inwardly and caused to force liquid from the pump cylinder 10 into the accumulator 16 by way of the disc outlet valve 26 valve chamber 25 and passage 5e pressure thus being built up in the accumulator 16 against the resistance offered by the accumulator piston 15 acting under the influence of the coil springs 20, 21.

When the accumulator 16 is fully charged the bearing plug 12 is removed out of contact with the eccentric 6a due to the release of pressure stored in the rubber buffer 18. This pressure is stored by reason of the fact that owing to the difference in areas the accumulator piston 15 travels further than the pump piston 11 and consequently the buffer is compressed, but when the accumulator 16 is full the buffer 18 maintains a pressure in the pump cylinder 10 and as this pressure leaks past the pump piston 11 the energy stored in the buffer 18 is released and thus draws the bearing plug 12 away from the eccentric thus disconnecting the unit from the driving agency.

When it is desired to apply the brakes, the brake pedal is depressed thereby turning the lever 31 associated therewith and causing the horn 31a to lift the plunger 29. The lifting of the plunger 29 in its first stages causes the seating 29a to engage the lower balancing valve 28b thus sealing the balancing valve chamber 27 from exhaust. Further movement of the plunger 29 raises the upper balancing valve 28a off its seating 27c. The raising of the upper balancing valve 28a permits liquid to pass from the accumulator 16 into the balancing valve chamber 27 and thence to the brake applying means by way of the passage 27a. As the balancing valve chamber 27 is then under pressure there is a reaction on the operating piston 29 so that if there is a tendency to an excess pressure in the said chamber 27 the piston 29 is moved downwards against the resistance of the effort being applied to the brake pedal. Such a downward movement of the piston 29 would allow the upper balancing valve 28a to close on to its seating 27c, thus cutting off the supply of pressure from the accumulator 16. Any further downward movement of the piston 29, even if slight, causes the seating 29a to become clear of the lower balancing valve 28b, thus allowing excess pressure in the balancing valve chamber to escape, until as soon as the pressure in the balancing valve chamber 27 has dropped to a pressure proportional to the brake pedal effort the piston 29 rises again and causes the seating 29a to engage the lower balancing valve 28b, so that the pressure in the balancing valve chamber tends to remain always at its lower value. Thus a balancing action is provided and the braking effort exerted made proportionate to the force applied by the driver so that a sense of "feel" is introduced.

In the event of more liquid being required for the performance of a braking operation due to wear of the brake shoe linings the loss of volume in the accumulator 16 enables the pump to come into operation and pass liquid to the pipe lines in addition to the liquid normally tending to pass thereinto from the accumulator 16.

Should an abnormal pressure be required to be applied due say to oily brake shoes this may be obtained by applying such pressure to the brake

pedal that the operating piston 29 is caused to act on the fluid column in the balancing valve chamber 27. This operation is rendered possible for the reason that when the accumulator 16 is full, a further travel of the piston rod 17 is stopped and the accumulator springs 20, 21 are consequently fully compressed so that extra pressure on the pedal cannot increase the compression of the said springs 20, 21 but must act through the operating piston 29 to increase the pressure in the pipe lines.

The propeller shaft 6 makes one revolution for every two feet of road travel so that if required the requisite pressure is rapidly forthcoming even in emergency and abnormal conditions.

The application of full braking pressure requires only a small pedal travel thus reducing time lag.

A servo-mechanism in accordance with the invention is compact, substantially fool proof and readily adaptable to existing motor road vehicles.

The invention is not limited in its application to motor road vehicles as it may be employed with other hydraulically operated mechanism in which similar conditions of working apply.

We claim:

1. A fluid-operated servo-mechanism comprising, in combination, a pump having a suction stroke and a pressure stroke, resilient means for causing the pump to execute its suction stroke, constantly operating mechanism for causing the pump to execute its pressure stroke after each suction stroke, and mechanism adapted to be actuated by fluid discharged from the pump to apply force greater than the force supplied by said resilient means to impel the pump in the direction of its pressure stroke so as to prevent the execution of a further suction stroke, the latter mechanism including a resilient connection through which such force is applied, and the pump being connected to a point at which the pressure is lower than the pressure in the pump at the end of its pressure stroke, by means of a slow leak to permit the discharge of fluid to cause

the pump to be impelled further in the direction of its pressure stroke by the energy stored in said resilient connection whereby the pump is brought completely out of engagement with said constantly operating mechanism.

2. A fluid-operated servo-mechanism comprising, in combination, a pump having a suction stroke and a pressure stroke, resilient means for causing the pump to execute its suction stroke, constantly operating mechanism for causing the pump to execute its pressure stroke after each suction stroke, and hydraulic motion-multiplying mechanism adapted to be actuated by fluid discharged from the pump to apply force to impel the pump in the direction of its pressure stroke so as to prevent the execution of a further suction stroke, the latter mechanism including a resilient connection through which such force is applied and in which energy is stored by the multiplication of motion, and the pump being connected to a point at which the pressure is lower than the pressure in the pump at the end of its pressure stroke, by means of a slow leak to permit the discharge of fluid to cause the pump to be impelled further in the direction of its pressure stroke by the energy stored in said resilient connection whereby the pump is brought completely out of engagement with said constantly operating mechanism.

JAMES HENRY PRATT.
ALBERT HENRY GODFREY GIRLING.

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