No. 814,400. PATENTED MAR. 6, 1906.

C. SCHMITTHENNER.

GOVERNOR MECHANISM FOR MOTORS.

APPLICATION FILED OCT. 5, 1904.

4 SHEETS—SHEET 1.

Fig. 1.

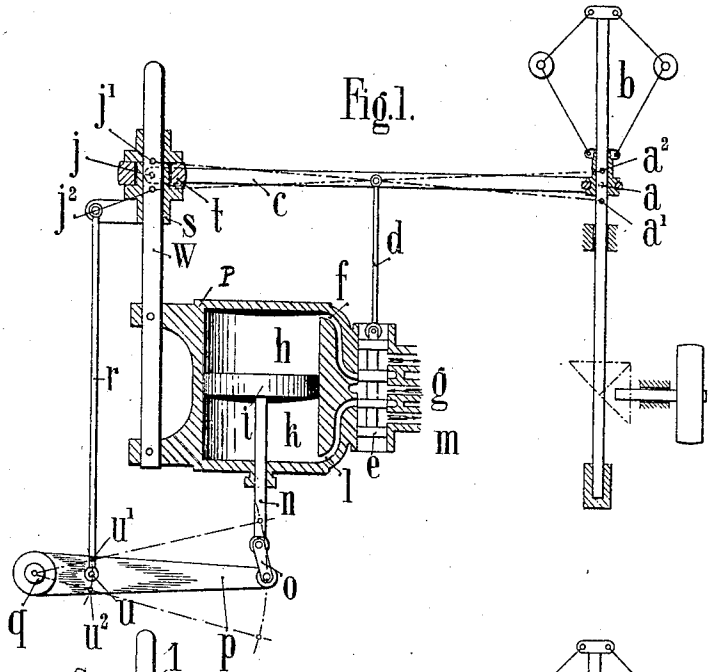
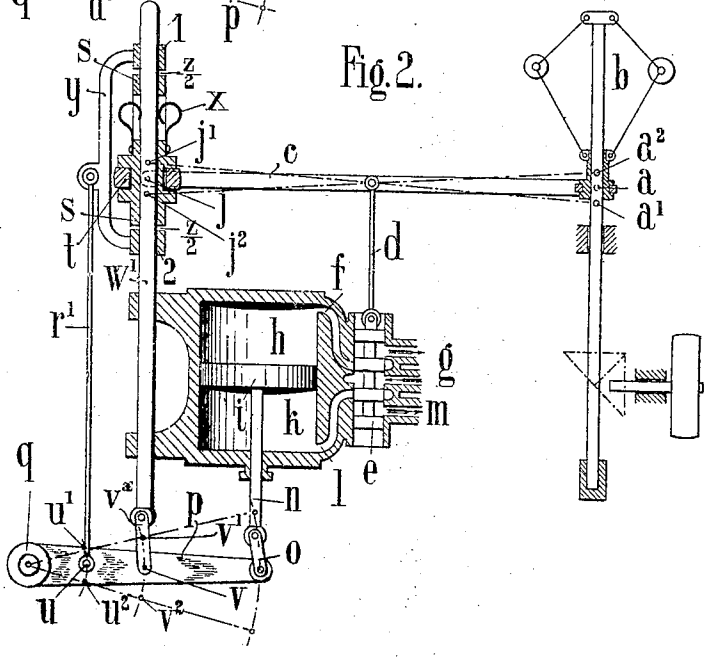


Fig. 2.



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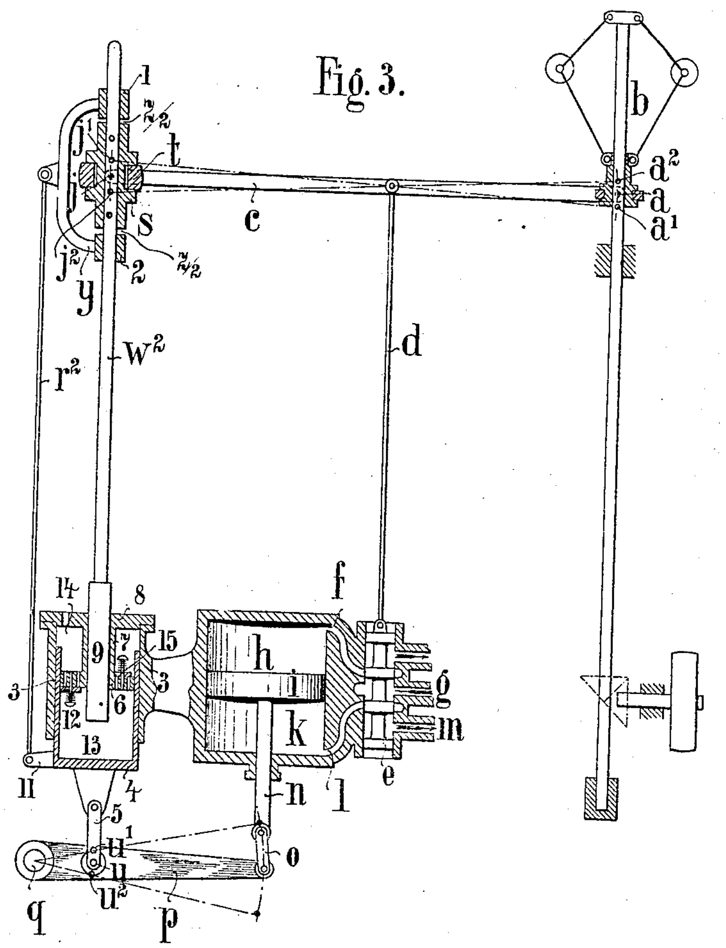
4 SHEETS—SHEET 2.

Fig. 3.



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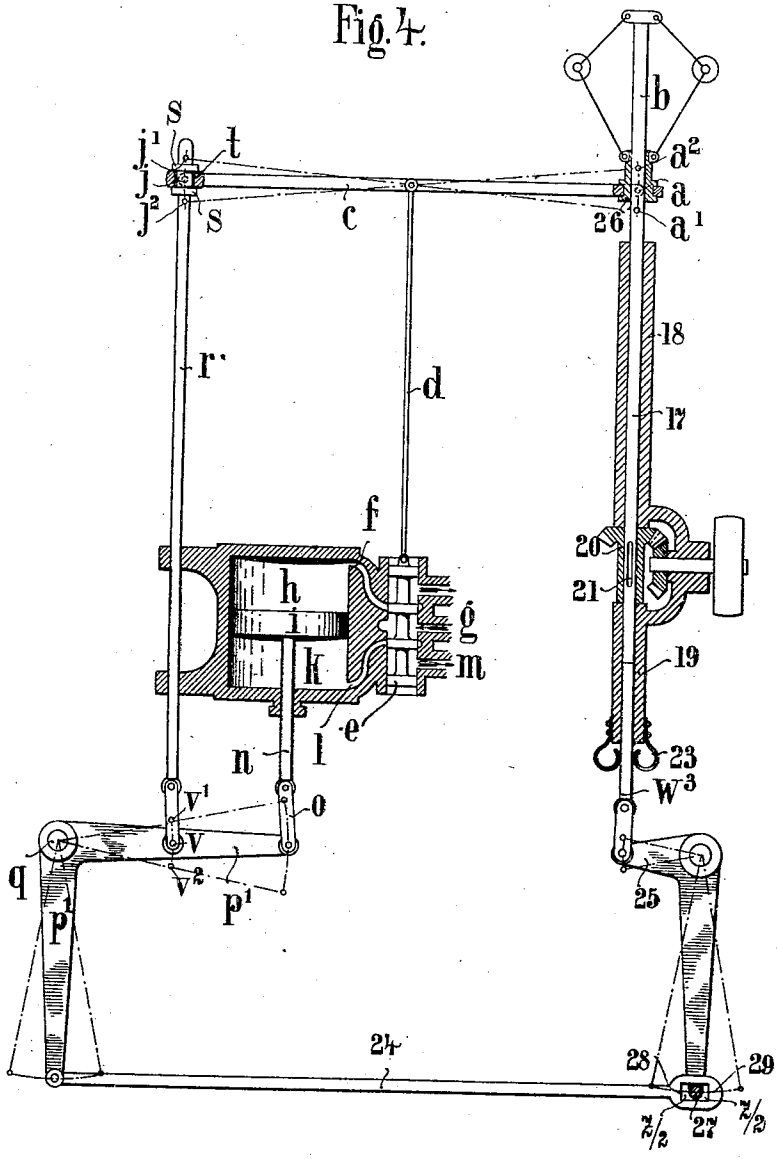
4 SHEETS—SHEET 3

Fig. 4.



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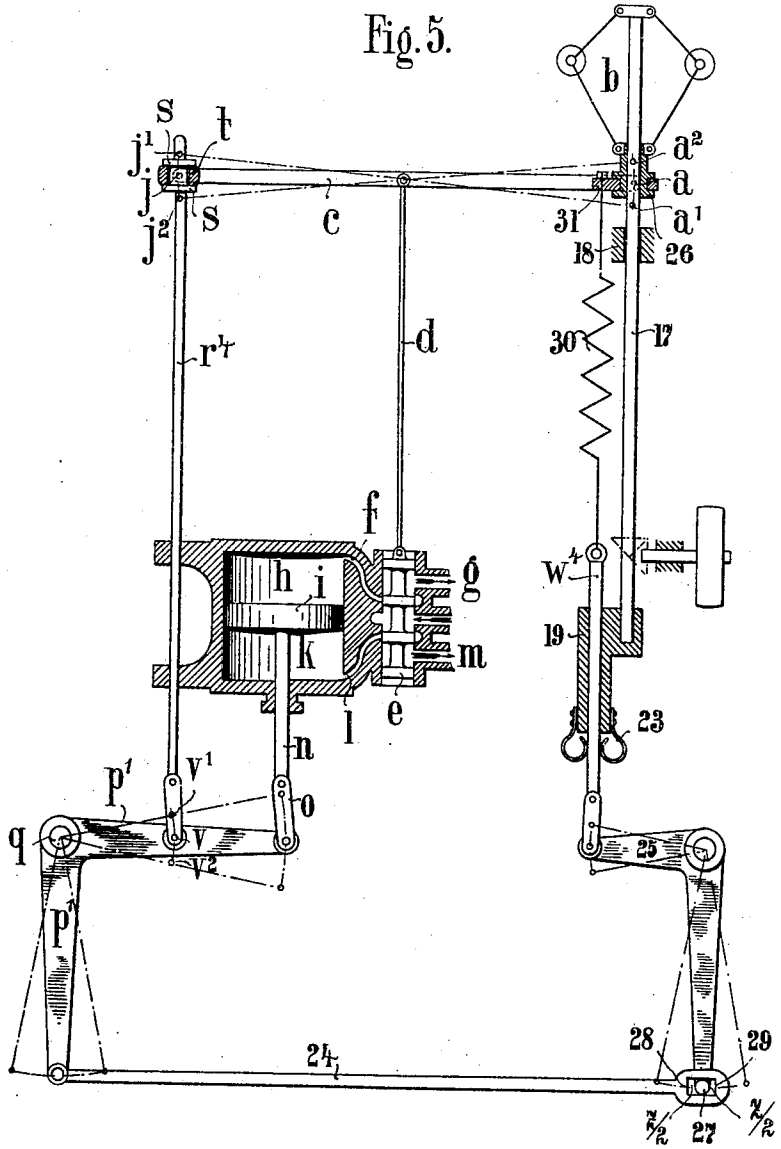
4 SHEETS—SHEET 4.

Fig. 5.



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GOVERNOR MECHANISM FOR MOTORS.

No. 814,400. Specification of Letters Patent. Patented March 6, 1906.

Application filed October 5, 1904. Serial No. 227,272.

To all whom it may concern:

Be it known that I, CARLOS SCHMITTHENNER, a citizen of the Empire of Germany, residing in Heidenheim-on-the-Brenz, in said Empire, have invented certain new and useful Improvements in Governor Mechanisms for Motor-Engines, of which the following is a specification.

In the use of indirectly-acting centrifugal governors for hydraulic and other motor engines the return guide motion has the object of arresting the motion of the servomotor which has been induced by the action of the governor as soon as the governor-sleeve arrives at the end of its motion, but inasmuch as the extent of the return guide motion is always connected with a certain after effect overregulation takes place.

The object of this invention is to so improve the indirectly-acting governor mechanisms for motor-engines that overregulation is prevented and a more effective action of the return guide motion is obtained; and for this purpose the invention consists in the governor mechanism for hydraulic and other motor engines hereinafter described, and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a vertical longitudinal section of an ordinary governor mechanism for motor-engines. Fig. 2 is a like section showing a governor mechanism according to my improved construction, and Figs. 3, 4, and 5 are different modified constructions of the improved governor mechanism.

Similar characters of reference indicate corresponding parts throughout the several views.

To properly describe my improved governor mechanism and its actuation, it is best to describe first the regulating effect of an ordinary hydraulic governor mechanism as heretofore employed and shown in Fig. 1. In said figure, b denotes a centrifugal governor of the usual type, the sleeve a of which is slidable on the governor-shaft of the engine to be regulated between the points a' a^2. P is the cylinder of a servomotor for said engine, said cylinder being provided with a sliding piston i, piston-rod n, ports f and l, and a slide-valve e for controlling the admission or discharge of the fluid-pressure through said ports, communicating with the cylinder at either side of the piston, as shown at h and k, from or into the inlet and outlet channels g m. q is the working shaft of the servomotor and controls the supply of fluid-pressure to the engine to be regulated. Said shaft is connected with the piston-rod n by means of a link o and crank or lever p, so that the reciprocatory movement of the piston i produces oscillation of said crank or lever, and thereby the rocking of said shaft. An upright fixed guide-rod w is mounted on the cylinder q, and slidable on said rod is a slide-piece or sleeve s, surrounded by and pivoted at j to a ring or collar t, connected by a lever c with the sleeve a of the governor b. A rod d extends downwardly from said lever c intermediately of the same and is connected in any suitable manner with the slide-valve e of the servomotor. The sleeve s is provided with a bracket to which is pivotally attached a guide-rod r. The opposite end of said guide-rod is pivoted upon the lever p, as shown at u, and is adapted to move between the points u' and u^2 upon the oscillation of said lever. The point of pivotal connection j between the lever c and sleeve s is movable between the points j' and j^2.

The operation of the mechanism is as follows: When the load on the motor-engine is diminished, the increase of speed raises the sleeve a of the centrifugal governor b and moves the lever c, connected with the sleeve a on the pivot j at its opposite end, in upward direction. Simultaneously with this motion the piston slide-valve e of the servomotor is moved by the connecting-rod d. The channel f is thereby opened and the pressure fluid conducted through the supply-tube g into the upper space h of the cylinder of the servomotor, so as to press the piston i of the same in downward direction. Simultaneously therewith the pressure fluid in the lower cylinder-space k is conducted through the channel l to the discharge-tube m. By means of the piston-rod n, link o, and lever p the working shaft q is turned in the direction of the hands of a clock and diminishes thereby the supply of the pressure fluid to the motor-engine to be regulated until by the diminished supply of power the increase of speed of the motor-engine is gradually arrested, and thereby the upward movement of the governor-sleeve a interrupted. Simultaneously there-

with the slide-piece s is moved by the return guide-rod r in downward direction, together with the slide-ring t and pivot j of the lever c, whereby the piston slide-valve e is moved, as the lever c has its temporary fulcrum on the sleeve a likewise in downward direction, and thereby returned to its median or non-acting position, as shown in Fig. 1; but inasmuch as at the moment when the governor-sleeve a arrives at the end of its upward motion the piston slide-valve e has not yet arrived in its median position the channels f and l are still open. The piston slide-valve of the servomotor will therefore continue in its downward motion, so that consequently a so-called "overregulation" takes place until the slide-valve e arrives at its median position and closes thereby completely the channels f and l.

The speed with which the piston slide-valve e closes the channels f and l depends on the speed of the pivot j—that is to say, on the speed of the return guide-rod r. The quicker the piston slide-valve e is returned the smaller will be the overregulation produced by the same. The geometrical combination between the full stroke a' a^2 of the governor-sleeve a and the distance j' j^2 described by the pivot j is equal to the distance between u' u^2 of the return guide-rod r and has to be so determined that in the lowermost position a' of the sleeve a the piston slide-valve of the servomotor is in its entirely open position, while in the highest position a^2 of the sleeve a the piston slide-valve e is in its entirely closed position.

By the improved governor mechanism the ratio between the working stroke of the servomotor and the distance through which the return guide-rod is moved is changed automatically by the governor during the regulating operation as required, so that the speed with which the piston slide-valve is returned into its median or non-acting position is likewise changed.

In Fig. 2 is illustrated a governor mechanism by which the condition set forth is practically carried out. In this case the stationary guide-rod w of the governor mechanism shown in Fig. 1 is made movable and employed as an auxiliary return guide-rod w'. The pivot v of the link $v^\times$, by which the auxiliary guide-rod w' is connected with the lever p, is so selected that it can be moved at a greater speed than the pivot u of the return guide-rod r'. On the auxiliary rod w' is arranged the slide-piece s, which carries the ring t and the pivot j of the lever c in such a manner as to be shiftable on the auxiliary return guide-rod w'. Bent friction-springs x are attached to the slide-piece s and arranged to press by their free ends on the rod w', so as to take along the lever c and the piston slide-valve e with the auxiliary return guide-rod w'.

On the auxiliary rod w' is arranged a shiftable yoke y, with which is pivotally connected the upper end of the return guide-rod r', so that the yoke follows the motion of the latter. The yoke y is guided by means of end sleeves 1 and 2 on the rod w', the sleeves being arranged, respectively, above and below the slide-piece s in such a manner that a small space z_2 is between each sleeve and the adjacent end of the slide-piece s.

The combined or twofold return guide mechanism operates in the following manner: In the position shown in Fig. 2 the slide-piece s and the auxiliary rod w' are coupled together by the friction of the springs x, so that consequently the auxiliary rod w' alone performs the return guide motion. As soon as the load on the motor-engine is decreased the piston slide-valve e is returned quicker into its median position as soon as the governor-sleeve a has arrived at its position of rest, for the reason that the auxiliary rod w' has a greater speed than the return guide-rod r has in the construction shown in Fig. 1. The stroke v' v^2 of the auxiliary return guide-rod w' is considerably greater than the stroke j' j^2 of the pivot j and would therefore not correspond with the stroke a' a^2 of the governor-sleeve a. Consequently in case of a considerable diminution in the load the greater stroke of the auxiliary rod w' would have a disturbing effect on the governor b. This disturbing effect cannot take place inasmuch as the slide-piece s, after moving through the small distance z_2, abuts against the lower sleeve 2 of the yoke y, and inasmuch as the auxiliary rod w' moves quicker than the rod r' and yoke y the slide-piece s remains long enough in contact with the sleeve 2 as the downward motion of the piston of the servomotor is continued. The auxiliary rod w' overcomes the friction of the springs x and is moved thereby in the bore of the slide-piece s. At the same time the slide-piece s and the pivot j of the lever c move with the diminished speed of the return guide-rod r' in downward direction. The piston slide-valve e is therefore placed under the influence of the normal return guide motion in the same manner as in the construction shown in Fig. 1, while the quick auxiliary return guide motion is entirely placed out of action. By the overregulation which is produced by the slow return motion by means of the return guide-rod r' the motion of the governor-sleeve a, as well as the motion of the servomotor and of the parts controlling the return guide motion, is reversed. At the moment when this reversion of motion takes place—that is to say, at the commencement of the movement of the auxiliary rod w' and return guide-rod r' in upward direction the slide-piece s is carried along, owing to the greater speed of the auxiliary rod w', and the piston slide-valve e is placed under the influence of the quicker auxiliary return guide motion, while the normal

return guide motion is placed out of action. By the interposition of the auxiliary return guide motion the further overregulation is diminished and the governor *b* quickly returned to a condition of rest.

The modified constructon shown in Fig. 3 differs from that shown in Fig. 2 only by the fact that the double return guide motion is accomplished by hydraulic means. In a guide 3, which is permanently connected with the cylinder of the servomotor, is guided the casing 4 of an oil-cataract. The casing 4 is connected by a link 5 with the pivot *u* of a lever *p* and makes exactly the same motion as the return guide-rod r^2 of the normal return-guides shown in Figs. 1 and 2. The piston 6, owing to its connection with the hollow piston-rod 7, cover 8, and straight-line guide 3, is held in fixed position. In the hollow piston-rod 7 is guided a second piston 9 of considerably-smaller diameter than piston 6. On the piston-rod w^2 of the piston 9 is mounted a carrier *s* for the slide-ring, which carrier accomplishes the return motion by means of the slide-ring *t* and lever *c* in the same manner as the arrangement shown in Figs. 1 and 2. In the same manner as in Figs. 1 and 2 a yoke *y* incloses the slide-ring carrier *s*, so as to provide a small space at both sides equal to z_2 in axial direction. The yoke *y* is connected by a rod r^2 and arm 11 with the cylinder 4, so that it has to follow the movements of the same. The spaces 13 and 14 of the oil-cataract are filled with oil. The operation of this double return guide mechanism is as follows: When a small decrease in the load takes place, the return motion is started by the descending motion of the piston 7 and of the cylinder 4. In the cylindrical space 13 is created a vacuum, so that the piston 9 is forced by the atmospheric pressure in downward direction with considerably greater speed than that of the cylinder 4, inasmuch as its cross-section is smaller than that of the piston 6. The motion of the piston 9 causes the quick auxiliary return guide motion. When, however, a larger reduction in the load takes place, the slide-ring carrier *s* will abut against the eye 2 of the bail *y* after passing through the space z_2, inasmuch as the piston 9 is moved quicker than the yoke or bail *y*, connected with the cylinder 4. The piston 9 will assume a position of rest relatively to cylinder 4, so that a vacuum is formed in the space 13. In consequence thereof a spring-pressed valve 12, which is arranged in the piston 6, is opened, and thereby the passage of oil from the space 14 to the space 13 permitted. The quick auxiliary return motion by the piston 9 is thereby cut out and the slower normal return guide motion, having the same speed as pivot *u*, switched in. When after the return motion has arrived at a position of rest the reversing of the motion takes place, then the cylinder 4 moves in upward direction and closes valve 12 instantly, so that pressure is produced in the space 13. The piston 9 is now moved quicker in upward direction than the cylinder 4, and the slide-ring carrier *s* is moved away from the eye 2, so that the normal return motion is cut out and the quick auxiliary return guide motion switched in. In the piston 6 is arranged a second valve 15, which opens in a direction opposite to valve 12 and which permits the passage of the oil from the lower into the upper space of the cylinder 4 as soon as by the upward motion of the cylinder 4 the slide-ring carrier *s* abuts against the eye on the bail *y* and a vacuum is formed in the space 13.

In the construction shown in Fig. 4 the slide-ring carrier *s* is also shown mounted on the return guide-rod r^3, so that the left end of the governor-lever *c* has an unchangeable stroke $j' j^2$ equal to $v' v^2$. The fly-ball governor *b* and its shaft 17 are axially shiftable in the guides 18 and 19, while the bevel-wheel 20, which is seated loosely on the shaft 17, is so arranged between the two guides 18 and 19 that it cannot be shifted in axial direction, but that it remains always in mesh with its adjacent bevel-wheel. The gear-wheel 20 is slidable on the shaft 17, but is prevented from rotation independently thereof by means of a groove and key 21, so that rotary motion is imparted to the governor *b* irrespective of the axial position of said shaft. The shaft 17 is supported by a shiftable slide-piece w^3, the upper end of which is formed in the nature of a step-bearing and which is also axially shiftable in the guide 19. Friction-springs 23, that are attached to the guide 19, press with such a force on the slide-piece w^3 that the friction alone is sufficient to sustain the fly-ball governor and hold it in its proper corresponding position. By two elbow-levers p' 25 and the connecting-rod 24 the servomotor-piston as well as the fly-ball governor are raised or lowered, but always in a direction opposite to that of the return guide-rod r^3. The simultaneous motion of the return guide-rod r^3 and the axial shifting of the shaft 17 of the fly-ball governor exert a motion in opposite direction on the governor-piston *e*, provided that the governor-sleeve 26 remains, with regard to the shaft 17, in a position of rest. When, therefore, the return guide motion carries the piston back into its median position, the shifting of the governor-shaft produces at the same time the motion of the governor-piston away from the median position. The lever proportions between the return guide-rod r^3 and the governor-shaft 17 are so selected that the return guide motion prevails somewhat, so that still a return guide motion of the governor-piston *e* is imparted, but with a diminished speed. The resulting movement represents the normal return motion of the piston *e*. The connect-

ing-rod 24 is not positively connected with the elbow-lever 25, inasmuch as the pin 27 of the elbow-lever 25 moves in an elongated opening of the rod 24, so that the latter can only turn the elbow-lever 25 when, after passing through the space z_2 at both sides, it abuts by one of its stops 28 or 29 against the pin 27.

The controlling operation takes place as follows: With uniform motion or with small changes in load the return guide-rod r^3 alone produces quick return, as the rod 24 can be freely moved in both directions for the distance z_2 without turning the elbow-lever 25 or shifting the governor-shaft 17. With a greater decrease of the load the governor-sleeve is moved in upward direction and the servomotor-piston and the return guide-rod r^3 are moved in downward direction. Simultaneously the connecting-rod 24 is moved toward the left. After passing through the space z_2 the stop 29 abuts against pin 27 and shifts the fly-ball governor after overcoming the frictional resistance of the springs 23 in upward direction As soon as by the decrease of power the speed of the governor is not increased and the governor-sleeve 26 arrives at a relative position of rest in regard to shaft 17 the governor-piston e is under the influence of the motion resulting from the downward motion of the return guide-rod w^3 and the upward motion of the governor-shaft 17. This resulting movement, however, is the before-described slower normal return motion. In reversing the motion the stop 29 is moved away from the pin 27, the shifting of the governor-shaft 17 ceases, and the governor-piston e is now only under the influence of the quick return guide motion of the rod r^3.

The modification shown in Fig. 5 differs from that shown in Fig. 4 only that the slide-piece w^4 shifts only the governor-sleeve, but not the entire fly-ball governor. For this purpose the slide-piece w is arranged sidewise of the governor-shaft. The connection of the governor-sleeve 26 by slide-piece w^4 is produced by a strong screw-spring 30, the upper end of which is attached to the slide-ring 31 of the governor-sleeve and the lower end of which is attached to the slide-piece w^4. In the position shown in Fig. 5 the spring is not set to tension. The friction of the springs 23 has to be always greater than the greatest tension or pressure strain that can be exerted by spring 30.

The regulating operation is as follows: With uniform speed or small changes of load the slide-piece w^4 is not moved, owing to the play in the space z_2 between the pin 27 and the two stops 28 29 of the rod 24. The return guide motion is therefore accomplished solely by the return guide-rod r^4. The lower end of the spring 30 remains fixed, while the upper end follows the motion of the governor-sleeve. When a greater decrease in the load takes place, the stop 29 carries the pin 27 along and the slide-piece w^4 is moved up. The spring 30 is thereby compressed and the governor-sleeve 26 moved in upward direction, while the return guide-rod r^4 is moved in downward direction. By this motion the governor-piston e is returned with a slower speed in the same manner as in the construction shown in Fig. 4 into its median position, as when the return guide motion alone is employed.

It is immaterial in which manner the twofold return guide motion is accomplished. Any suitable mechanism may be selected, whether operated by mechanical or hydraulic means, provided that it permits the changing of the ratio of motion between the stroke of the servomotor and the stroke of the return guide motion. It is necessary, however, that the geometrical combination between the servomotor and the return guide motion is not, as in the governor mechanisms heretofore known, a constant and unchangeable one, but that the ratio between the motion of the servomotor and the motion of the return guide mechanism is capable of being automatically changed by the governor, according to requirements.

It is obvious that the ratio of motion between the parts referred to can be accomplished in an analogous manner by different successive steps. The underlying principle of construction can be applied to all kinds of indirectly-acting governors for hydraulic and other motor engines.

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

1. In a governor such as described, the combination, with a servomotor, of a centrifugal governor in operative connection with the valve thereof, means for returning said valve to its median or non-acting position at high speed after small variations of load, and means for returning said valve to non-acting position at high and low speed consecutively after greater variations of load.

2. In a governor such as described, the combination, with a servomotor, of a centrifugal governor in connection with the valve thereof, means controlled by said governor for returning said valve to non-acting position at high speed after small variations in load, and means controlled by said governor for actuating said valve at high speed at the beginning and at low speed at the end of the return motion after greater variations of load.

3. The combination, with a servomotor embodying a slide-valve, of a governor in connection with said valve, means for returning said slide-valve to non-acting position, a second means for returning the same at different speed, and means for operatively connecting said first or last named means con-

secutively with said governor and slide-valve upon greater variations of load.

4. The combination, with a servomotor embodying a slide-valve, of a governor in connection with said valve, a rod for returning said slide-valve to non-acting position, a second rod likewise controlled by said governor and operable to return said valve at different speed, a coupling in connection with one of said rods, and means for automatically releasing said coupling toward the end of a greater return motion.

5. The combination, with a servomotor and its slide-valve, a governor controlling said valve, a rod controlled by said governor for returning said slide-valve to its median or non-acting position at low speed, a second rod controlled by said governor for returning said valve at high speed, and a yielding coupling in connection with one of said rods.

6. The combination, with a servomotor, of a governor for controlling the valve thereof, a rod controlled by said governor for returning the valve of said servomotor to its median or non-acting position at low speed, a second rod controlled by said governor for returning said valve at high speed, a yielding coupling in connection with one of said rods, and stops connected with the other rod for automatically releasing said coupling.

7. In combination, a servomotor embodying a reciprocating piston, a slide-valve and a working shaft, a governor, a connection between said governor and said slide-valve, a lever connecting said piston with said working shaft, axially-movable high and low speed rods in operative connection with said slide-valve and said lever for returning the former to non-acting position, a yielding coupling in connection with said high-speed rod and stops guided on said high-speed rod and connected with said low-speed rod for automatically releasing said coupling.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CARLOS SCHMITTHENNER.

Witnesses:

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N. MAIER.