

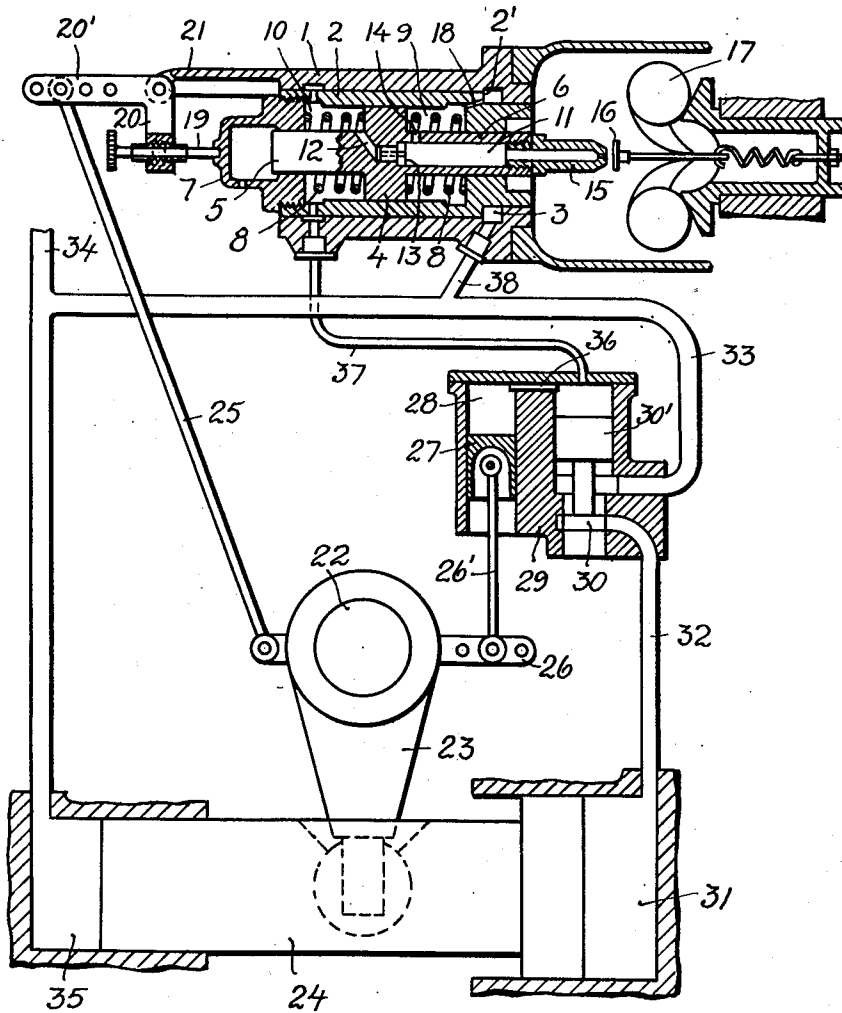
Nov. 4, 1952

O. S. RUUD ET AL

2,616,397

HYDRAULIC PRECONTROL OF PRESSURE FLUID OPERATED GOVERNORS

Filed Dec. 29, 1947



Inventors:

Otto S. Ruud and

Frygja Wilhelmsen

*[Signature]*  
— 84

## UNITED STATES PATENT OFFICE

2,616,397

HYDRAULIC PRECONTROL OF PRESSURE  
FLUID OPERATED GOVERNORSOtto Severin Ruud and Trygve Johan  
Wilhelmsen, Oslo, NorwayApplication December 29, 1947, Serial No. 794,220  
In Norway March 8, 1946Section 1, Public Law 690, August 8, 1946  
Patent expires March 8, 1966

5 Claims. (Cl. 121—42)

1

The present invention relates to a hydraulic pre-control for pressure fluid operated governors for prime movers, turbines, motors and the like of the type in which the movements of a centrifugal pendulum by throttling of a fluid outlet acts upon a piston (the pendulum piston) which is in hydraulic communication with the source of pressure fluid at one side and with the distribution slide of the servomotor at the other side, the movements of said pendulum acting upon a distribution slide that governs a servomotor in accordance with the movements of the centrifugal pendulum.

In pre-controls or relays of this type difficulties have been met as regards obtention of a desired return or compensation curve, because different pressures were acting at opposite sides of the pendulum piston and because the communication between said opposite sides took place through openings or slots the cross sectional areas of which were increasing or decreasing during the movements of the piston. The dimensions of such openings or slots had to be corrected during the operation of the apparatus since they could not be quite accurately determined beforehand.

The present invention aims at providing a pre-control of the type specified the action of which, and especially the compensating operation of which may be exactly predetermined.

According to the invention the pressures at opposite sides of the pendulum piston are of equal value in middle position of said piston. Preferably such pressure is maintained at a value between  $\frac{1}{3}$  and  $\frac{2}{3}$  of the value of the pressure of the pressure fluid source.

In this connection there is, in a hydraulic communication between the front and rear sides of the pendulum piston, inserted a throttle member the bore of which is chosen in accordance with the period of compensation desired. This arrangement allows for an exact predetermination of the period of compensation only by making use of a throttle bore having a corresponding cross sectional area.

The invention will be more fully described with reference to the accompanying drawing that by way of example shows a somewhat diagrammatical illustration of an embodiment thereof.

The pre-control, which simultaneously forms a resilient link in the return movement, comprises a cylinder or piston housing 1 in which is displaceably mounted a sleeve 2, that near its front end is provided with a shoulder 2' that acts as a piston surface and closes off an annular space 3.

2

Within the sleeve 2 is slidably a piston 4 having guide projections 5 and 6, slidable respectively in an opening in the closed front end of sleeve 2 and in an end member 7 screwed into the rear end of the sleeve. On opposite sides of the piston 4 are provided springs 8, these springs may have like characteristics and maintain the piston 4 in a predetermined normal position within the sleeve 2, a space 9 being formed in front of and a space 10 in rear of the piston.

The front guide projection 6 of the piston has a longitudinal bore 11 that through a channel 12 communicates with the space 10 behind the piston. In front of channel 12 is inserted a throttle 13 having a narrow opening which establishes communication between spaces 9 and 10, the bore 11 communicating with space 9 through an opening 14.

Into the end of bore 11 is screwed a nozzle 15, the exit opening of which is controlled by a throttle-disc 16 receiving its movement from a pendulum governor 17 of usual construction driven by the machine to be governed.

Through a channel 18 the annular space 3 communicates with space 9 in front of the piston 4.

Pressing against the end member 7 of sleeve 2 is a screw 19 threaded into a nut that is rotatably journaled in one lever 20 of a bell-crank pivotable on a projection 21 extending rearwardly from the housing 1.

The controlling shaft of the machine to be controlled is designated by numeral 22 and carries fixed thereon a control arm 23 connected to the piston 24 of the servomotor, whereby said piston 24 may cause shaft 22 to swing in either direction, according to the control action operated. To said control arm is attached one end of a rod 25 the other end of which is connected to the other lever 20' of the bell-crank above mentioned, that is pivoted on the housing 1. The rod 25 may be attached at different distances from the pivot of said bell-crank whereby the effective length of the lever 20' may be adjusted.

The control arm 23 also carries an arm 26 to which is secured—at a desirable, shiftable point—the lower end of a piston rod 26', the top end of which carries a piston 27 reciprocating in a bore 28 in a housing 29 of the distribution slide. The latter has two diameters of which the smallest one 30 is provided with two guide edges serving to control the supply of fluid to and from the piston space 31 at the large end of the servomotor. To the distribution slide pressure fluid is admitted through a supply conduit 33 extending to the piston space 35 at the small end of the servomotor.

## 3

The large area 30' of the distribution slide serves to balance the slide between full pressure at the under side thereof and about half pressure at the top side. The space above 30' communicates through a channel 36 with the space 28 above piston 27 which latter serves as return piston. The space above the distribution slide 30' also communicates with the space 10 behind the pendulum piston 4, by means of a tube 37. The annular space 3 in the house 1 communicates with the conduit 33 through a tube 38.

The arrangement described operates as follows:

In the position shown in the drawing, which may be called a normal position, the annular space 3 is subjected to full pressure, which corresponds to the pressure of the oil coming from the source of pressure, and which pressure is pressing the sleeve 2 towards left, the latter abutting against the screw 19. From the annular space 3 oil flows through channel 18 and fills chamber 9, from which oil flows through the opening 14, the throttle 13 and the channel 12 to the space 10 and at the same time a jet of oil issues through the nozzle 15 against the throttling plate 16.

Thus both sides of piston 4 are in hydraulic communication with each other through the throttle 13, and the cross section of the bore in the latter determines the period of the resilient return movement of the piston, that is, the compensation period.

The diameter of the channel 18 extending from the annular space 3 and the flow through the nozzle 15 are so adjusted that in middle position of the slide the pressure in spaces 9 and 10 amounts to about half of the pressure within the annular space 3. This pressure acts from space 10 through conduit 37 on the top side of the distribution slide 30' and is balancing the distribution slide in middle position thereof.

If the load on the controlled machine decreases the pendulum 17 causes the throttle plate 16 to move towards the nozzle 15 and to close the outlet thereof. Thereby the pressure within space 9 increases, and the piston 4 is moved rearwardly within the sleeve 2. Oil is then driven from space 10 through conduit 37 to the space above the distribution slide 30' and the latter is moved downwards from middle position, whereby oil under pressure is supplied to the servomotor chamber 31, and piston 24 and thus also arm 23 are moved towards left, which is the closed position. During the swinging movement of arm 23 the piston 27 is moved downwards and draws the excess of oil above slide 30' into the space 28, so that the distribution slide returns to middle position and the movement of the servomotor piston stops.

When the governor shaft 22 has had imparted thereto the closing movement necessary, the distribution slide is moving back to its middle position, the number of revolutions of the pendulum 17 is decreased, whereby the throttle plate 16 is moved away from the nozzle 15, so that a jet may again issue from the latter. Thereby the pressure within space 9 sinks and the spring 8 in space 10 presses the piston 4 forwards, that is, to the right, and simultaneously oil successively flows through throttle 13 into space 10.

When the number of revolutions of the pendulum 17 has again become normal, equilibrium has been reestablished between the forces acting upon the piston 4 and the latter stops.

## 4

If the load on the machine increases the number of revolutions of pendulum 17 decreases and moves the throttle plate 16 away from the nozzle 15. The pressure within the space 9 then sinks and piston 4 moves towards right. Hereby a decrease of pressure takes place within space 10 and is transmitted to the space above the distribution slide, whereby the latter is raised and allows oil to flow out of chamber 31 of the servomotor, so that piston 24 is moved towards right and rotates the shaft 22 accordingly, whereby move driving force is supplied to the machine. Simultaneously piston 27 is moved upwards and presses oil through channel 36 to the space above the distribution slide 30', which latter is thereby driven to its middle position.

When the governor has caused that sufficient force is supplied to the machine the number of revolutions of pendulum 17 increases and moves the throttle plate 16 towards the nozzle 15 whereby the pressure within space 9 again rises to normal value. During this period the spring 8 within space 9 slowly moves piston 4 left into normal position thereof, oil being driven from space 10 through the throttle 13 and entering space 9 until equilibrium is again obtained and the movement stops.

When sleeve 2 is displaced towards the throttle plate 16 the revolutions decrease, and when it is displaced in the opposite direction the revolutions increase. Since sleeve 2 has a smaller diameter outside the space 3 than at the inside thereof, the constant oil pressure in space 3 urges sleeve 2 away from the pendulum. This pressure is taken up by the screw 19 in the lever 20. Increasing revolutions cause the piston 4 to move towards the left, and oil is pressed through pipe 37 to the upper side of the slide 30' by which the same is moved downwards away from its normal position and allows oil from the conduit 33 to flow through conduit 32 to a cylinder 31 so as to move the piston 24 towards the left in closing direction. This movement is transmitted through the control arm 23 and shaft 22 to the apparatus controlling the supply of water to the turbine in order to decrease such supply. At the same time the rod 25 is pushed upwards and moves the screw 19 to the left allowing the oil pressure within the space 3 to move the sleeve 2 to the left and away from the pendulum whereby the revolutions are automatically increased. The position of piston 4 in relation to the sleeve 2 is not changed during this movement. The extent of the movement of sleeve 2 may be varied by adjusting the effective length of lever 20', whereby the governor is given the necessary degree of lag for parallel operation of a number of machines.

The object of this movement is to obtain a greater number of revolutions of a controlled machine at decreasing load and a smaller number of revolutions at increasing load. The difference in the number of revolutions of the machine when idling and when at maximum load is necessary for obtaining a correct distribution of the load between a number of simultaneously running alternating current machines.

The length of the stroke of piston 27, that serves to return the distribution slide, may be varied by adjusting the point where the piston rod 26' is attached to the arm 26, thus the intensity of the return operation may be varied according to desire.

The bore of the throttle 13 in the pendulum piston 4 determines the period of the resilient

5

return movement (the compensation period) and accordingly the length of said period is determined by giving said bore a desired cross sectional area. As the said bore is acting to compensate for both directions of movement of piston 4 springs 8 having different characteristics may be used if a different length of compensation period for opening and for closing is desired. It is possible to arrange the communication between front and rear side of the pendulum piston, with the throttle 13 therein, exterior of the piston.

We claim:

1. A stabilizing mechanism of the type wherein a centrifugal governor cooperates with a servomotor to regulate the speed of a machine comprising, in combination, a fluid pressure system for operating the servomotor; a first cylinder; a slide member moving in said first cylinder; valve means operated by said slide member and adapted to actuate the servomotor; a housing; a second cylinder disposed in said housing; a piston operating in said second cylinder having two action faces, said piston dividing said second cylinder into a first and a second chamber; two spring means in said second cylinder, one in each of said chambers, oppositely acting one on each face of said piston and tending to keep said piston in a middle position corresponding to a normal speed of the machine; a passage providing a permanent communication between said first and said second chamber; a pressure chamber adjacent to said first chamber of said second cylinder; a narrow passage providing a fluid communication between said pressure chamber and said first chamber of said second cylinder; duct means providing a fluid communication between said pressure system and said pressure chamber; a duct providing a fluid communication between said second chamber of said second cylinder and said first cylinder; a fluid outlet provided in said first chamber of said second cylinder; a centrifugal governor; a nozzle valve operated by said centrifugal governor to open and close said fluid outlet, thereby causing a movement of said piston changing the pressure in said second chamber of said second cylinder whereby said slide member in said first cylinder is set in motion so that said valve means actuate the servomotor; and adjustable means for returning said slide means and said valve means to a normal position after regulation of the machine has been effected.

2. A stabilizing mechanism of the type wherein a centrifugal governor cooperates with a servomotor to regulate the speed of a machine comprising, in combination, a fluid pressure system for operating the servomotor; a first cylinder; a slide member moving in said first cylinder; valve means operated by said slide member and adapted to actuate the servomotor; a housing; a second cylinder disposed in said housing; a piston operating in said second cylinder having two action faces, said piston dividing said second cylinder into a first and a second chamber; two spring means in said second cylinder, one in each of said chambers, oppositely acting one on each face of said piston and tending to keep said piston in a middle position corresponding to a normal speed of the machine; a passage providing a permanent communication between said first and said second chamber; a throttle member disposed in said passage and adapted to effect a predetermined length of the period of action of said piston; a pressure chamber adjacent to said first chamber of said second cylinder; a narrow pas-

6

sage providing a fluid communication between said pressure chamber and said first chamber of said second cylinder; duct means providing a fluid communication between said pressure system and said pressure chamber; a duct providing a fluid communication between said second chamber of said second cylinder and said first cylinder; a fluid outlet provided in said first chamber of said second cylinder; a centrifugal governor; a nozzle valve operated by said centrifugal governor to open and close said fluid outlet, thereby causing a movement of said piston changing the pressure in said second chamber of said second cylinder whereby said slide member in said first cylinder is set in motion so that said valve means actuate the servomotor; and adjustable means for returning said slide means and said valve means to a normal position after regulation of the machine has been effected.

3. A stabilizing mechanism of the type wherein a centrifugal governor cooperates with a servomotor to regulate the speed of a machine comprising, in combination, a fluid pressure system for operating the servomotor; a first cylinder; a slide member moving in said first cylinder; valve means operated by said slide member and adapted to actuate the servomotor; a housing; a second cylinder disposed in said housing; a piston operating in said second cylinder having two action faces, said piston dividing said second cylinder into a first and a second chamber; two spring means in said second cylinder, one in each of said chambers, oppositely acting one on each face of said piston and tending to keep said piston in a middle position corresponding to a normal speed of the machine, said spring means having different characteristics so as to render the time period for compensation different according to the direction of the movement of said piston; a passage providing a permanent communication between said first and said second chamber; a pressure chamber adjacent to said first chamber of said second cylinder; a narrow passage providing a fluid communication between said pressure chamber and said first chamber of said second cylinder; duct means providing a fluid communication between said pressure system and said pressure chamber; a duct providing a fluid communication between said second chamber of said second cylinder and said first cylinder; a fluid outlet provided in said first chamber of said second cylinder; a centrifugal governor; a nozzle valve operated by said centrifugal governor to open and close said fluid outlet, thereby causing a movement of said piston changing the pressure in said second chamber of said second cylinder whereby said slide member in said first cylinder is set in motion so that said valve means actuate the servomotor; and adjustable means for returning said slide means and said valve means to a normal position after regulation of the machine has been effected.

4. A stabilizing mechanism of the type wherein a centrifugal governor cooperates with a servomotor to regulate the speed of a machine comprising, in combination, a fluid pressure system for operating the servomotor; a first cylinder; a slide member moving in said first cylinder; valve means operated by said slide member and adapted to actuate the servomotor; a housing; a second cylinder disposed in said housing; a piston operating in said second cylinder having two action faces, said piston dividing said second cylinder into a first and a second chamber; two spring means in said second cylinder, one in each of said

7

chambers, oppositely acting one on each face of said piston and tending to keep said piston in a middle position corresponding to a normal speed of the machine; a passage providing a permanent communication between said first and said second chamber; a pressure chamber adjacent to said first chamber of said second cylinder; a narrow passage providing a fluid communication between said pressure chamber and said first chamber of said second cylinder; duct means providing a fluid communication between said pressure system and said pressure chamber; a duct providing a fluid communication between said second chamber of said second cylinder and said first cylinder; a fluid outlet provided in said first chamber of said second cylinder; a centrifugal governor; a nozzle valve operated by said centrifugal governor to open and close said fluid outlet, thereby causing a movement of said piston changing the pressure in said second chamber of said second cylinder whereby said slide member in said first cylinder is set in motion so that said valve means actuate the servomotor; adjustable means for returning said slide means and said valve means to a normal position after regulation of the machine has been effected; and adjustable means for automatically displacing said second cylinder in said housing causing a relative movement between said second cylinder and said piston whereby the controlling action of said piston is delayed.

5. A stabilizing mechanism of the type wherein a centrifugal governor cooperates with a servomotor to regulate the speed of a machine comprising, in combination, a fluid pressure system for operating the servomotor; a first cylinder; a slide member moving in said first cylinder; valve means operated by said slide member and adapted to actuate the servomotor; a housing; a second cylinder disposed in said housing; a piston operating in said second cylinder having two action faces, said piston dividing said second cylinder into a first and a second chamber; two spring means in said second cylinder, one in each of said chambers, oppositely acting one on each face of said piston and tending to keep said piston in a middle position corresponding to a normal speed of the machine, said spring means having different characteristics so as to render the time period for compensation different according to the direction of the movement of said piston; a passage providing a permanent communication

8

between said first and said second chamber; a throttle member disposed in said passage and adapted to effect a predetermined length of the period of action of said piston; a pressure chamber adjacent to said first chamber of said second cylinder; a narrow passage providing a fluid communication between said pressure chamber and said first chamber of said second cylinder; duct means providing a fluid communication between said pressure system and said pressure chamber; a duct providing a fluid communication between said second chamber of said second cylinder and said first cylinder; a fluid outlet provided in said first chamber of said second cylinder; a centrifugal governor; a nozzle valve operated by said centrifugal governor to open and close said fluid outlet, thereby causing a movement of said piston changing the pressure in said second chamber of said second cylinder whereby said slide member in said first cylinder is set in motion so that said valve means actuate the servomotor; adjustable means for returning said slide means and said valve means to normal position after regulation of the machine has been effected; and adjustable means for automatically displacing said second cylinder in said housing causing a relative movement between said second cylinder and said piston whereby the controlling action of said piston is delayed.

OTTO SEVERIN RUUD.

TRYGVE JOHAN WILHELMSEN.

## REFERENCES CITED

The following references are of record in the file of this patent:

## UNITED STATES PATENTS

| Number    | Name       | Date          |
|-----------|------------|---------------|
| 2,110,622 | Fischel    | Mar. 8, 1938  |
| 2,153,381 | Maas       | Apr. 4, 1939  |
| 2,353,692 | Cunningham | July 18, 1944 |
| 2,379,304 | Kalin      | June 26, 1945 |

## FOREIGN PATENTS

| Number  | Country     | Date          |
|---------|-------------|---------------|
| 87,631  | Switzerland | Dec. 16, 1920 |
| 96,933  | Switzerland | Nov. 16, 1922 |
| 99,383  | Switzerland | June 16, 1923 |
| 151,030 | Switzerland | Feb. 1, 1932  |
| 50,782  | Norway      | May 2, 1932   |