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MECHANICAL-PNEUMATIC TURBINE CONTROL

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Fig. 1

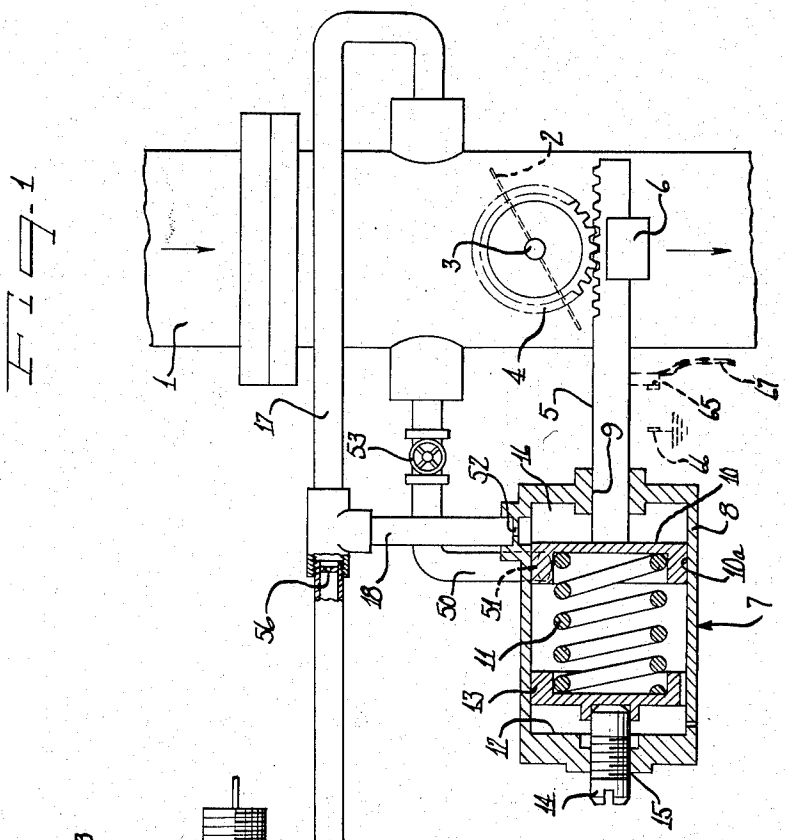
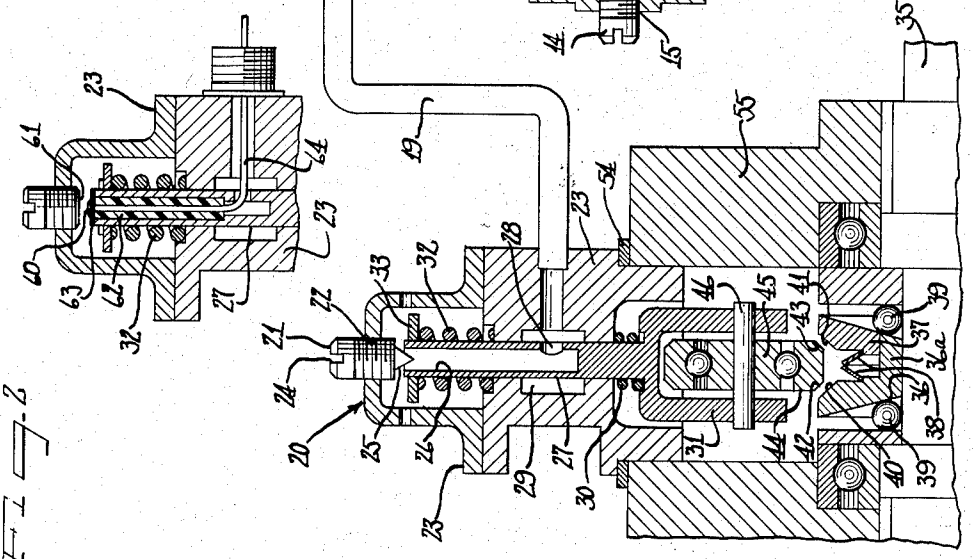


Fig. 2



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MECHANICAL-PNEUMATIC TURBINE CONTROL

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5 Claims. (Cl. 137—58)

This invention relates to speed controls and, more particularly, is concerned with the control of the speed of such machines as turbines, air motors and other similar motors deriving their power from a fluid medium under positive pressure.

While the prior art has numerous patents describing speed controls of varying sorts, I am not aware of the provision in the prior art of very simple speed control means which may be utilized either as an overspeed control or as a speed regulator while at the same time utilizing simple controls. Whereas the prior art constructions have been dependent upon extremely complicated systems to correlate an overspeed condition to a reduction in throttle opening, the present invention is extremely simple in construction and provides a very sensitive control readily adaptable to any type of pressurized fluid motor whether the motor is to be utilized under heavy duty circumstances or only in small machines.

It is therefore an object of the present invention to provide a simplified speed control which may be utilized either as an overspeed safety control or as an automatic speed regulating means.

Another object of the present invention is to provide an overspeed control which has lockout means for closing the turbine throttle and maintaining it closed on an overspeed condition.

A further object of the present invention is to provide an automatic speed regulating device utilizing an extremely rugged governor combined with a very accurate speed control associated with the throttle of a pressurized fluid motor.

Yet another object of the present invention is to provide a simplified, yet automatic, speed control for pressurized fluid motors utilizing pressure of the inlet fluid, as automatically controlled in response to the speed of the motor, to modify the throttle opening of said motor.

A feature of the present invention is a centrifugal governor utilizing free floating, radially movable, ball weights cooperating with axially movable cams which contact in turn a radially movable control vent.

Still another feature of the present invention is the utilization of a throttle control means for locking the control in a throttle-closed position upon the sensing of a dangerous overspeed condition.

Still other and further objects will at once become apparent to those skilled in the art from a consideration of the following detailed description taken in connection with the drawings in which two modifications of the present invention are shown by way of illustration only.

On the drawings:

Figure 1 is a diagrammatic view in partial section of the control system of the present invention.

Figure 2 is a segmental view of a modification of the governor control means utilized in the control system of the present invention.

As shown on the drawings:

As may be seen from Figure 1, a pressurized fluid inlet line 1 is provided for supplying motive fluid to a motor of any type (not shown). The pressurized fluid which may be air or other similar medium, flows in the direction of the arrows past a throttle plate 2 pivotally secured in the conduit 1 by means of a shaft 3. The amount of pressurized fluid which leaves the throttle plate and enters the motor is determined by the position of the throttle plate and as may be seen from the drawings, rotation of the plate 2 in a clockwise direction will cause a closing action of the throttle.

Rotation of the throttle plate 2 in controlling the flow of motor fluid accomplished may be by various types of actuating linkages such as for example a rotary pneumatic motor or, as shown in the drawings, a rack and pinion actuator having a gear pinion 4 cooperating with a rack 5 which is supported thereagainst by means of a slide bearing 6 secured to the fluid inlet 1.

Control movements are imparted to the operating rack 5 by means of a piston type actuator generally indicated at 7. This actuator is firmly secured to a housing or other support fixed relative to the motor fluid inlet 1. The actuator 7 comprises a general housing 8 having an aperture 9 therein for the support of and passage of the rack 5. The rack 5 is fixedly secured to a piston 10 which is slidable within the housing 8 and has a sealing relation thereto. In order to provide a biasing force urging the rack 5 toward the right as viewed in Figure 1 to thereby open the throttle 2, a spring 11 is provided in the housing 8 and acts against the left hand face of the piston 10.

The spring 11 may of course be seated against the end wall 12 of the housing 8 if desired, but preferably it is seated against a backing plate 13, which is adjustably mounted relative to the wall 12. As may be seen in Figure 1, adjustment may be provided by means of a set screw 14 passing through a threaded aperture 15 in the wall 12. This threaded set screw 14 acts against the left hand face of the spring backing plate 13 to maintain the plate in an adjusted position to provide an accurate tensioning of the spring 11 for purposes which will be discussed below.

Power for moving the piston 10 toward the left to close the throttle 2 is provided by introducing the pressurized fluid within the area 16 at the right hand side of the piston 10. In the present instance this pressurized fluid is supplied by means of conduits 17 and 18 which direct fluid from a point on the upstream side of the throttle plate 2 to the chamber 16.

The fluid pressure in the lines 17 and 18 is affected by several factors. The most important of these is a control vent regulator, generally indicated at 20, which is responsive to the speed of the fluid motor. Under normal speed conditions this vent is at least partially open and is connected by means of a conduit 19 to the conduit 17 and 18. In view of the normally open condition of this vent only a very low static pressure is found anywhere within the three tubes 17, 18 or 19. Hence the pressure within the chamber 16 is normally overcome by the spring 11 causing the rack 5 to move the throttle plate 2 into an open position.

The pressure is also of course variable according to the pressure of the inlet fluid at 1 and this pressure is also somewhat variable according to the position of the throttle, with a slight drop in pressure being realized when the throttle plate is opened. In using this control with the usual pressurized fluid motor however, the fluctuations in line pressure are relatively minor and the main control factor is the pressure level of the fluid in lines 17, 18 and 19 as controlled by the turbine speed reflected in a modification of the vent 20.

The vent 20 comprises a variable, needle valve, orifice. This orifice includes an adjustable needle screw 21 which is threaded into an aperture 22 in the outer vent housing 23. The screw is provided with a slot 24 for cooperation

with the conventional screw-driver by which the screw 21 may be adjusted axially relative to the housing 23. The needle screw 21 is provided with a needle head 25 which extends into the open end of the hollow bore 26 extending longitudinally of a vent rod 27. The bore 26 connects by means of a lateral bore 28 to the chamber 29 which in turn is connected to the conduit 19.

A consideration of the drawing will thus show that a movement of the vent rod 27 vertically toward the needle screw 21 will restrict the outlet of fluid from the conduit 19, through the bores 28 and 26 past the needle 25. When the rod 27 is positioned so as to contact the screw 21 the vent will be in its maximum closed position. The rod 27 is biased into its fully opened position, or position of maximum venting, by means of a spring 30 positioned between the housing 23 and a clevis fork 31 positioned at the end of the rod 27. This spring 30 is slightly less powerful than the spring 32 which is positioned between the housing 23 and a projection 33 secured to the opposite end of the rod 27. However, the spring 32 is manufactured to a length which will cause it to contact the projection 33 only after the spring 30 has caused the rod 27 to move downwardly to the point of maximum opening. Thus, in the normal operating range the spring 32 acts basically as a stop, rather than as a resilient force on the rod.

In order to control the vent 25, 26 in accordance with the speed of the fluid motor, a centrifugal governor is associated with the revolving shaft 35. The shaft 35 is preferably rotated by the turbine shaft directly but may of course be any rotating part associated with the turbine as long as the speed of the shaft 35 bears a direct relationship to the speed of the turbine itself which speed it is desired to control.

The governor comprises a wedge ring 36 having a sleeve section 36*a* upon which a second, axially slidable wedge section 37 is positioned. The wedge sections 36 and 37 are maintained in a separated relationship by means of two frusto-conical springs 38 and are urged toward each other by means of balls 39 which are moved radially outwardly by centrifugal force upon rotation of the shaft 35. During rotation of the shaft 35 at a speed sufficient to cause the wedges 36 and 37 to move axially toward each other, the wedge surfaces 40 and 41 of the wedges 36 and 37 contact respectively the surfaces 42 and 43 of the outer race 44 of a roller bearing follower. The follower comprises an anti-friction bearing having an inner race 45 rotatably mounted on a pivot pin 46 secured in the fork 31 of the vent rod 27.

As will be seen, upon the application of sufficient centrifugal force to cause the balls 39 to move outwardly, the wedges 36 and 37 will contact the outer race of the follower 44 thereby forcing it radially of the shaft 35. This radial movement of the race 44 will be transmitted through the inner race 45 and the pin 46 to the vent rod 27 which will be actuated toward the needle 25 against the bias of the spring 30. In this movement, the vent rod 27 is prevented from rotation in any conventional manner. As shown this is accomplished by constructing the vent rod of a polygonal cross section.

As may be seen from a consideration of Figure 1 the control apparatus as shown is utilized as an over speed control. In such a control system the apparatus is utilized as a safety feature for preventing dangerous overspeed, rather than as an automatic control operable throughout a wide range of speeds. Thus in normal operation the vent rod 27 is maintained in position by the springs 30 and 32 such that the vent 25 is open and the race 44 is not in contact with either of the wedges 36 and 37. This condition will prevail throughout the normal operating range of the fluid pressure motor and no operation of the rod 27 to close the vent will normally occur.

Upon a rotation of the shaft 35 to a speed considered dangerous, the fly balls 39 will cause the wedges 36 and 37 to move axially along the shaft 35 toward each other and into contact with the race 44 thereby causing the vent rod 27 to move upwardly against the needle 25 closing the vent. Upon closure of the vent, pressure will build up in the lines 17 and 19 causing an increase in pressure in line 18 which will be transmitted to the chamber 16 behind the piston 10 of the actuator 7. This increase in pressure will cause the piston 10 to move to the left against the bias of the spring 11 thereby closing the throttle 2.

Since an overspeed condition of a magnitude sufficient to be dangerous is generally caused by some abnormal condition in the system it is generally desirable that the throttle remain closed and the motor shut down until the abnormality has been discovered and remedied. In order to accomplish this, simple, yet positive lockout means is herein provided for maintaining the piston 10 in its extreme left hand position after the vent 25, 26 has been closed and the throttle plate moved to its closed position as a result of an overspeed.

The lockout means for maintaining the throttle plate in the closed position comprises a conduit 50 which is connected to the fluid conduit 1 at a point upstream of the throttle 2. The conduit 50 is vented to the actuator housing 8 at a point 51 which is normally covered by the side wall 10*a* of the piston 10. However, upon movement of the piston 10 toward the left, the vent 51 will be opened thereby applying the pressure of the fluid in the conduit 1 to the chamber 16 whether or not the vent 25, 26 is subsequently opened.

In order to prevent leakage of the fluid under pressure from the chamber 16 through the pipes 18 and 19, in the event that the vent 25, 26 becomes opened after a shut down resulting from overspeed, an orifice 52 is provided in the conduit 18. This orifice provides a restriction in the line 18 which prevents the pressure in the chamber 16, resulting from connection with the conduit 50, from freely being dissipated through the vent 25, 26. The vent is also useful in ordinary control conditions as will be explained later since it provides a dampening effect and provides means for prevening wild fluctuations in pressure in the chamber 16 as a result of fluctuations due to changes in the vent 25, 26 or in inlet pressures in the conduit 1.

While as above explained, the unit may be very successfully utilized as an overspeed mechanism, it may also be utilized as an automatic throttle control over a wide range of motor speeds to provide a simple governor. In this event, the valve 53 in the lockout line 50 is closed, thereby preventing the venting of pressure from the conduit 1 to the vent 51. In such an installation a reduction in the speed resulting from an overspeed will cause the vent 25, 26 to open thereby relieving pressure in the chamber 16 to the orifice 52, conduits 18 and conduit 19 permitting the spring 11 to move the piston 10 toward the right thereby reopening the throttle 2.

When the device is to be utilized as a wide range automatic control, the vent rod 27 is adjusted by means of changing the tension in springs 30 and 32, or by removing the shims 54 between the housing 32 and the housing 55 to position the vent rod 27 so that the race 44 is in constant contact with the wedges 36 and 37. The needle screw 21 is then adjusted to the desired speed position and the screw 14 may likewise be adjusted to provide the desired response characteristic to the throttle actuator.

With the parts adjusted as above described, any increase in the speed above the desired governed speed will cause the vent 25, 26 to close thereby moving the piston 10 to the left to reduce the throttle opening. In order to minimize hunting of the system and also to minimize wild speed fluctuations, chokes are provided in the conduit system. These chokes constitute the restricted orifice 52 above described and a further restricted orifice 56 in the conduit 19.

As above mentioned, the orifice 52 prevents fluctuations in the line 17 and 19 from being immediately felt in the

chamber 16 thereby providing a gradual modification of throttle setting. The orifice 56 likewise provides a dampening control by controlling the speed at which the pressure drop may occur in the conduits 17 and 18 as a result of opening of the vent 25, 26. Further, this restriction controls the amount of the flow of fluid from the conduit 1 to the vent 26, 27. For the latter purpose it may be desirable that the orifice 56 be a manually adjustable orifice and such an arrangement is considered within the scope of this invention.

While the above described system is hydraulic, in some installations it may be desirable to utilize an electrical system as an overspeed, safety, control. Such a control system may be constructed in accordance with the apparatus as shown in Figure 2 in which the speed responsive rod 27 is provided with an electrical contact 60 which cooperates with a second electrical contact 61 associated with the housing 32. Insulating material is provided between the electrical contact 60 and the rod 27 as shown at 62 and 63 thereby preventing the grounding of electrical current from the contact to the housing 32. The contact 60 is connected by an electrical conductor 64 to a solenoid, of any conventional sort which is not shown, the core of which is secured to the rack 5. As in the case of the hydraulic actuator, the solenoid core is biased into throttle opening position.

In operation, the electrical system operates to close the throttle in manner substantially identical to the hydraulic system. As soon as the rod 27 is moved against the contact 61 in response to a dangerous overspeed the solenoid will be energized closing the throttle. If desired, in the electrical system as in the hydraulic system a holding circuit may be employed to prevent the rack 5 from reopening the throttle upon reduction in speed. Such a holding circuit is conventional and requires only that a contact movable in response to movement of the rack 5 be provided for completing, in parallel, the electrical circuit closed by contacts 60 and 61. For example, as shown in dotted lines in Figure 1, electrical contacts 65, 66 may be provided. The contact 65 is connected by the conductor 67 to the contact conductor 64 and contact 66 is grounded to connect it to the contact 61.

When using the above described hydraulic or electrical apparatus as an overspeed control it has been found advantageous to utilize a snap action type spring at 38. In such an arrangement the spring 38 initially deflects substantially linearly in response to load, but upon reaching a predetermined load, the deflection increases greatly with little increase in load. This action provides a sharp cut-off of speed in a positive manner and provides greater sensitivity at speeds near the desired speed of cut-off.

As will thus be seen I have provided a novel and simple, yet extremely effective control for motors of the type utilizing a fluid under pressure as a power medium. This system has provided a very stable, and yet relatively inexpensive installation far superior to the complex structures of the prior art.

It will be understood that various modifications and variations may be made to the above described system without departing from the scope of the novel concept of the present invention.

I claim as my invention:

1. Automatic speed control for a fluid motor comprising in combination, an inlet conduit supplying a source of fluid under pressure, a throttle positioned in said conduit, throttle actuating means including a piston secured to said throttle and normally biased in to the throttle open position, fluid conduit means connected to the inlet upstream of said throttle and leading to said actuating means at the side of said piston opposite from said biasing means for urging said actuating piston into throttle closing position in opposition to said biasing means, a vent in said conduit means, governor means controlling said vent and normally positioning said vent in open condition to permit the pressure in said conduit means to be dissipated to atmosphere, and responsive to an overspeed of said motor for closing said vent, said governor means comprising a pair of wedge rings mounted concentrically on a shaft rotating with said motor, fly ball means associated with said wedges, inwardly facing cam surfaces on said wedges in contact with said fly balls whereby outward movement of said fly balls in response to centrifugal force will cause said wedges to move axially toward each other into contact with a radially movable vent rod, means on said vent rod associated with said conduit means for closing said vent when said wedges are moved toward each other on a predetermined centrifugal force on said balls and selectively operable holding means associated with said actuating means for maintaining said actuating means in throttle closing position subsequent to an overspeed condition sufficient to cause said actuating means to close said throttle.

2. A centrifugally operated reciprocating element comprising a rotating shaft, a pair of wedge rings concentrically mounted on said shaft for axial movement relative thereto, spring means biasing said wedges apart, fly balls associated with each of said rings and coacting with inwardly facing cam surfaces thereof for moving said wedges toward each other against the force of said biasing means upon the speed of said rotating shaft reaching a point capable of causing said balls to overcome said spring, said reciprocating element lying substantially radially of said rotating shaft and having a follower thereon positioned between said wedge rings for cooperation therewith upon movement of said rings toward each other whereby said reciprocating element will move radially away from said rotating shaft upon the attainment of a predetermined speed of said rotating shaft.

3. An automatic speed control for a rotating fluid motor comprising in combination a motive fluid inlet, a throttle in said inlet, throttle actuating means normally biased into the throttle-open position, motor speed responsive means connected to said actuating means for biasing said actuating means into throttle closing position in opposition to said biasing means, said operating means being actuated in response to reciprocable movement of a control rod urged by a pair of wedges under the influence of centrifugally actuated means associated with said motor shaft whereby an increase in speed of said motor above a predetermined point will cause said wedges to actuate said reciprocating means to cause said actuating means to close said throttle, and selectively operable holding means associated with said actuating means for maintaining said actuating means in throttle closing position subsequent to an overspeed condition sufficient to cause said actuating means to close said throttle.

4. An overspeed control for a fluid motor having a motor fluid conduit supplying motive fluid thereto, a throttle in said conduit for controlling flow of said fluid to said motor, said overspeed control comprising fluid pressure responsive throttle actuating motor means connected to said throttle for closing the throttle to reduce the speed of said motor upon the introduction of fluid under pressure to said actuating motor means, control fluid conduit means connecting said actuating motor means to the motor fluid conduit at a point upstream of said throttle, vent means in said control fluid conduit, means automatically closing said vent means in response to a predetermined speed of said motor whereby pressure is permitted to build up in said control fluid conduit and in said actuating motor means to close said throttle, and holding means actuated by fluid pressure only in said control fluid conduit and operated by movement of said actuating motor means to throttle closed condition to retain said actuating means in throttle closing position

after an overspeed condition has resulted in closure of said throttle by said actuating motor means.

5. An overspeed control for a fluid motor having a motor fluid conduit supplying motive fluid thereto and a throttle in said conduit for controlling flow of said fluid, said overspeed control comprising a fluid pressure responsive throttle actuating motor means connected to the throttle for closing the throttle to reduce the speed of said motor, said actuating motor means comprising a cylinder having a piston therein for operation of said throttle upon the introduction of fluid under pressure to said actuating motor means, control fluid conduit means connecting said actuating motor means to the motor fluid conduit at a point upstream of said throttle, vent means in said control fluid conduit, means automatically closing said vent means in response to a predetermined speed of said motor whereby pressure is permitted to build up in said control fluid conduit and in said actuating motor means to bias said piston in a direction closing said throttle, and holding means for retaining said piston of said actuating motor means in throttle closing position after an overspeed condition has resulted in throttle closure, said holding means comprising a fluid conduit connected to the motor fluid conduit upstream of said throttle at a point of positive fluid pressure and connected to the end of said actuating motor means at a point in the cylinder thereof uncovered by said piston upon movement of said piston to a throttle closed position whereby movement of said piston to said throttle closed position will cause the application of a holding pressure against said piston to maintain it in its throttle closing position.

References Cited in the file of this patent

UNITED STATES PATENTS

662,144	Carroll et al.	Nov. 20, 1900
1,026,041	Kimball	May 14, 1912
2,201,629	McCullough	May 21, 1940
2,521,299	Mallory	Sept. 5, 1950
2,619,103	Davies et al.	Nov. 25, 1952

FOREIGN PATENTS

94,525	Germany	Oct. 26, 1897