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THROTTLE VALVE OPERATING MECHANISM

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This invention relates to an operating mechanism for a throttle valve and has for a principal object the provision of new and improved apparatus of this type.

A more specific object of the invention is to provide new and improved means for operating the throttle valve of an elastic fluid turbine.

Another object of the invention is to provide an operating mechanism for a throttle valve which will permit the closing of the throttle valve in response to an operating condition of the turbine regardless of the setting of the member controlling the operating mechanism.

Still another object of the invention is to provide an operating mechanism for a throttle valve which will not open the throttle valve after the valve has been tripped and the tripping device reset until the control member has been brought to a position corresponding to the closed position of the throttle valve. This is to assure gradual restoration of pressure of the motive fluid under full manual control.

Other objects will appear hereinafter as the description of the invention proceeds.

The novel features of the invention and how the objects are attained will appear more fully from this specification and the accompanying drawing showing one embodiment of the invention and forming a part of this application, and all these novel features are intended to be pointed out in the claims.

In the drawing:

The figure is a diagrammatic view of a turbine equipped with a throttle valve operating mechanism embodying this invention, the throttle valve and operating mechanism therefor being shown in section.

Referring to the drawing more in detail, a throttle valve, here shown as a turbine throttle valve 1, is disposed in a conduit 2 through which elastic fluid under pressure, which may be steam, is supplied to a turbine 3. The throttle valve 1 is operated in opening and closing direction by motor means 4 which is actuated by fluid under pressure. The value of the fluid pressure applied to the motor means 4 is controlled by pilot valve means 5 which, being connected to a floating lever 6, is movable in response to movements of both the throttle valve 1 and a control member 7 which may be manually operated.

The throttle valve 1 may be tripped closed when an undesirable operating condition exists in the turbine 3, for example, when the turbine overspeeds or the condenser vacuum drops. The throttle valve 1 is here shown as adapted to be

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closed, when the turbine 3 overspeeds, through the action of an overspeed trip mechanism 8. The overspeed trip mechanism 8 controls the opening of a fluid pressure operable control valve 9 which controls the release of fluid pressure from the motor means 4. The closing of the control valve 9 is controlled by the control member 7 as will more fully appear.

The motor means 4 illustrated herein for actuating the throttle valve 1 is a known arrangement and other embodiments will be apparent to those skilled in the art. The motor means 4 comprises a piston 11 connected to the throttle valve 1 by a rod 12. The piston 11 is slidably enclosed in a cylinder 13 and is biased in valve-closing direction by any suitable means, here shown as a spring 14 disposed in the cylinder 13 and acting on the piston 11. A drain conduit 15 communicates with the cylinder 13 above the upper limit of travel of the piston 11. The cylinder 13 is here shown as formed in one end of a casing 16. The portion of the casing 16 which is not occupied by the cylinder 13 is divided into two chambers 17 and 18 by a bulkhead 19.

The walls of the top chamber 17, which will be referred to as the low pressure chamber 17, are provided with two ports. A first port 21 provides communication with the cylinder 13 above the upper limit of travel of the piston 11. A second port 22 cooperates with the pilot valve means 5.

The walls of the bottom chamber 18, which will be referred to as the high pressure chamber 18, are provided with five ports. A first port 23 communicates with the cylinder 13 below the lower limit of travel of the piston 11. A second port 24 communicates with a source of fluid pressure, here shown as a pump 25, through a conduit 26. An orifice valve 27 is interposed in the conduit 26 between the pump 25 and the port 24. A third port 28 communicates with the pump 25 through a conduit, 29, 29a. The overspeed tripping mechanism 8 is interposed between the port 28 and the pump 25 and will, when tripped, cut off the supply of fluid pressure to the conduit 29 and cause the conduit 29 to communicate with a drain 31. A fourth port 32 communicates with the conduit 29 through a branch conduit 33. Valve means 34 for controlling the flow of fluid through conduit 33 is disposed between the port 32 and the connection of conduit 33 with the conduit 29. A fifth port 35 connects chamber 17 with chamber 18 when pilot valve means 5 uncovers port 22.

The control valve 9 which controls the release of fluid pressure from the motor means 4 comprises a cylindrical valve casing 36 extending

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through the bulkhead 19 and engaging, in surrounding pressure sealing relation, that portion of the wall of the high pressure chamber 18 in which are formed the ports 28 and 32. The valve casing 36 may be formed integral with the casing 16 and the bulkhead 19. An annular row of ports 37 is formed in that part of the valve casing 36 which is disposed in the high pressure chamber 18. The opposite end of the valve casing 36 is open to the low pressure chamber 17. Thus the high and low pressure chambers 17 and 18 communicate through ports 37 of valve casing 36.

A valve piston 38 is slidably fitted in the valve casing 36 and, when in position for normal operation of the turbine 3, is disposed to close the ports 37 thereby preventing communication between the high pressure chamber 18 and the low pressure chamber 17. The valve piston 38 is biased toward the closed end of the valve casing 36 by means of a spring 39 and is held against the bias of the spring 39, during normal operation, by fluid pressure admitted to the valve casing 36 through port 32. The piston 38 is carried by a rod 41 which is provided with a reduced end portion 42 forming a shoulder 43. The reduced end portion 42 is slidably carried in a bore in the wall of the low pressure chamber 17. The shoulder is adapted to abut the wall of the chamber 17 when the piston 38 is in position for normal operation. The spring 39 is held in axial alignment with the piston 38 by a circular boss 44 formed on the wall of the low pressure chamber 17.

Apparatus for controlling the supplying and exhausting of pressurized fluid to and from control valve 9 comprises valve means 34 which is connected by a rod 63 with pilot valve means 5 and is thereby operably connected to lever 6, the overspeed tripping mechanism 8 (see next paragraph) and pressure sealing means cooperating with the piston 38, here shown as a valve element 45 disposed on the lower side of the valve piston 38 in axial alignment with the port 28. The entrance of the port 28 is formed with a chamfer to provide a seating surface 46 for the valve element 45.

The overspeed tripping device 8 may be of any known design. It is here shown as comprising a valve 47 communicating with the lower end of the control valve casing 36 through the conduit 29 and branch conduit 33, with the pump 25 through conduit 29a, and with a drain 31. The valve 47 is normally held in a position permitting communication between the valve casing 36 and the pump 25 by a lever 50 pivoted at 48. A trip finger 49 pivoted at 51 engages the free end of the lever 50 during normal operation of the turbine 3. A spring loaded weight member 52 is mounted on the turbine shaft 53 with its center of mass spaced from the center of shaft 53 so that centrifugal force will move member 52 radially outward against the bias of the spring 54 when a predetermined overspeed of the turbine 3 is reached. When the weight member 52 so moves, it will strike the trip finger 49 and release the end of the lever 50 which in turn will permit a valve member 55 to move, under the bias of a spring 56, to a position which will close the conduit 29a leading from the pump 25 and permit communication between the valve casing 36 and the drain 31 through the port 28 and the conduit 29.

It will be apparent that the action of the valve 47 in cutting off fluid pressure from the passage 29a and the communication of the pas-

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sage 29 with the drain 31 will result in the downward movement of the control valve piston 38 in the control valve casing 36 under the influence of the spring 39. Such downward movement of the control valve piston 38 will permit communication between low pressure chamber 17 and high pressure chamber 18 through ports 37 of control valve casing 36. The fluid beneath the motor piston 11 will escape through the port 23, the ports 37, the valve casing 36 and the low pressure chamber 17 and enter the top of the motor cylinder through the port 21 and the spring 14 will move the motor piston 11 downward thus closing the throttle valve 1.

The pilot valve means 5 carries valve means 34 and both means are shown slidably disposed in a cylindrical pilot valve casing 57. Formed in casing 57 is a first annular groove 58 which communicates with the upper end of the motor cylinder 13 through the port 22, the low pressure chamber 17, and the port 21. A second annular groove 59 formed in the casing 57 communicates with the lower end of the motor cylinder 13 through the port 35, the high pressure chamber 18 and the port 23.

A third annular groove 61 formed in the casing 57 communicates with the space beneath the valve piston 38 through the conduit 33 and the port 32. A port 62 formed in the casing 57 communicates with the conduit 29 through the conduit 33.

Valve means 34 is disposed above the annular groove 61 in normal operation and is adapted to cover the groove 61 when rod 63 is brought to its lowest position, as will more fully appear. Valve means 5 closes the upper end of the casing 57 and functions to throttle the fluid passing through the annular groove 58 to the low pressure chamber 17. The annular groove 59 is disposed above valve means 34 and below valve means 5 and remains open and in communication with the high pressure chamber 18 through the port 35 at all times.

Valve means 5 and 34 are operably connected to floating lever 6 by a connecting rod 67. One end of floating lever 6 is pivotally connected to the piston rod 12 of the motor means 4 and the other end is pivotally connected to control means 69 which may comprise a rotatable threaded shaft 71 journaled in bearings 72. A nut 73 is threaded on the shaft 71 and is adapted to run along the shaft 71 when the shaft 71 is rotated. A pintle 74, carried by the nut 73, pivotally engages the floating lever 6. The nut 73 and pintle 74 may be considered to be the control member 7 as its position will normally control the position of the throttle valve 1. The shaft 71 may be rotated by a handwheel 75 mounted on the end of the shaft 71.

The operation of the above described apparatus is as follows:

Fluid under pressure, supplied by the pump 25, flows through the conduit 26, the orifice 27, the port 24, the high pressure chamber 18 and the port 23 into the space beneath the motor piston 11. Fluid under pressure also flows from the high pressure chamber 18 through the port 35, the pilot valve casing 57 and the port 22 into the low pressure chamber 17 thence to the space above the piston 11 and to the drain 15. The fluid flowing through the port 22 is throttled by pilot valve means 5. The fluid pressure in the high pressure chamber 18 and beneath the piston 11 will therefore be controlled by the position of pilot valve means 5.

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Assume that the apparatus is in the position shown in the drawing and that it is desired to open the throttle valve 1 further. The control member 7 is moved downward by rotation of the handwheel 75. This causes pilot valve means 5 to be moved downward restricting the flow of fluid through the port 22. The throttling of the fluid passing through the port 22 will increase the fluid pressure in the high pressure chamber 18 and in the space beneath the motor piston 11 since the orifice valve 27 permits a definite amount of fluid to enter the high pressure chamber 18. This increased pressure acting on the motor piston 11 will cause the motor piston 11 to move upward against the bias of the spring 14 thus moving the throttle valve 1 in valve opening direction.

As the motor piston 11 moves upward, the end of the floating lever 6 connected to the piston rod 12 also moves upward. This in turn causes pilot valve means 5 to move upwardly so as to progressively decrease the throttling of fluid through the port 22 until a state of equilibrium is reached and the fluid pressure acting on the motor piston 11 is balanced by the bias of the spring 14. The throttle valve 1 will then be in a position corresponding to a definite setting of the control member 7 and if the throttle valve 1 is to be opened further, the control member 7 must be advanced or, as shown here, moved downward.

Assume the apparatus to be in the position shown in the drawing and that it is desired to move the throttle valve 1 toward the closed position. The control member 7 is moved upward by rotation of the handwheel 75. This will cause pilot valve means 5 to be moved upward and the port 22 to be opened. The decreasing of throttling at the port 22 will cause a decrease in fluid pressure beneath the motor piston 11 and the spring 14 will move the motor piston 11 downward thus moving the throttle valve 1 in valve closing direction. The downward movement of the motor piston 11 will cause the downward movement of the end of the floating lever 6 which is connected to the piston rod 12 and this in turn will effect the downward movement of pilot valve means 5. The downward movement of pilot valve means 5 will increase the throttling at the port 22 until the pressure under the motor piston 11 is once again sufficient to hold the piston 11 against the bias of the spring 14.

Assume that the throttle valve 1 is in any open position and the turbine 3 exceeds the predetermined maximum speed. Centrifugal force will move the weight member 52 radially outward against the bias of the spring 54. The weight member 52 will strike the trip finger 49 which will move about its pivot 51 and be disengaged from the lever 50. Release of the end of the lever 50 will permit it to move angularly about its pivot 48 and remove restraint from the valve 47. The spring 56 will move the valve member 55 upward closing off the conduit 29a leading from the pump 25 and establishing communication between the space below the control valve piston 38 and the drain 31 through the conduit 29 and the port 23. This will release the fluid pressure beneath the control valve piston 38 and the spring 39 will move the control valve piston 38 downward until the valve element 45 seats in the entrance of the port 28.

When the control valve piston 38 moves downward, the ports 37 are uncovered and communication is established between the high pressure

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chamber 18 and the low pressure chamber 17 through the ports 37 of control valve casing 36. This provides a short path for the fluid which is released from beneath the motor piston 11 thereby permitting rapid flow of the fluid and insuring quick closing of the throttle valve 1. Release of fluid pressure from beneath the motor piston 11 causes the spring 14 to move the motor piston 11 downward and thus close the throttle valve 1.

When the throttle valve 1 is closed upon actuation of the tripping means 8 described above, the control member 7 will be in a position corresponding to some open position of the throttle valve 1. Therefore, the end of the floating lever 6 which is connected to the control member 7 will be lower than it is when the throttle valve 1 is closed by movement of the control member 7. This low position of the floating lever 6 will result in the valve means 34 being carried to a correspondingly lower position relative to the casing 57 such that it will cover the annular groove 61 which communicates with the space below the control valve piston 38.

Thus when the throttle valve 1 is closed through the operation of the tripping device 8, the space below the control valve piston 38 is isolated from fluid pressure by the valve element 45 seating in the entrance of the port 28 and by the closing of the groove 61 by valve means 34 which is carried by pilot valve means 5.

Resetting of the tripping device 8 is accomplished by pivoting lever 50 and finger 49 about their respective pivots 48, 51, until their adjacent ends engage each other as shown in the drawing. This will readmit fluid pressure to the conduits 29 and 33. However, the cross-sectional area of the valve element 45 is relatively small and therefore the force resulting from the fluid pressure acting on the valve element 45 will not be great enough to move the control valve piston 38 against the bias of the spring 39. It is apparent that the throttle valve 1 cannot be reopened as long as the control valve piston 38 is in a position which permits communication between the space above and the space below the motor piston 11. It is also apparent that the valve piston 38 cannot be moved to a position to prevent such communication until valve means 34, carried by pilot valve means 5, is moved to uncover the groove 61 and admit fluid pressure to the space below the control valve piston 38 for unseating the valve element 45. Since valve means 34 only moves in response to movement of lever 6, the control member 7 must be moved to a position corresponding to a closed position of the throttle valve 1 in order to raise valve means 34 to uncover the groove 61. When the control member 7 is so moved, the groove 61 is uncovered and communication is established between the space beneath the control valve piston 38 and the conduit 29 supplying fluid under pressure through the port 62, the annular groove 61, the conduit 33 and the port 32; fluid pressure is applied to the control valve piston 38 and the control valve piston 38 is moved against the bias of the spring 39 to its normal operating position where the shoulder 43 of the rod 41 abuts the casing 16 and where the control valve piston 38 closes the ports 37 and prevents communication between the high pressure chamber 18 and the low pressure chamber 17.

From the above description, it will be apparent to those skilled in the art that, with this invention, gradual restoration of pressure of motive fluid after tripping is assured with full manual

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control and that reopening of the throttle valve 1 while the control member 7 is in a position corresponding to an open position of the throttle valve is precluded.

From the foregoing it will also be apparent to those skilled in the art that the illustrated embodiment of the invention provides a new and improved operating mechanism for a throttle valve and accordingly accomplishes the objects of the invention. On the other hand, it will also be obvious to those skilled in the art that the illustrated embodiment of the invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combinations than those illustrated, without departing from the spirit of the invention or sacrificing all of the advantages thereof, and that accordingly the disclosure herein is illustrative only and the invention is not limited thereto.

It is claimed and desired to secure by Letters Patent:

1. A control mechanism comprising: fluid pressure supply means, a motor biased to move in a first direction, said motor means being hydraulically connected to said fluid pressure supply means and movable in a second direction in response to an application of fluid pressure to said motor; a pilot valve associated with said motor and movable to progressively open and closed positions controlling the rate of egress of pressure fluid from said motor; a controlling member selectively movable in different directions relative to an intermediate position; a lever associated with said motor, pilot valve and control member to progressively open said pilot valve to effect a movement of said motor in said first direction to effect a follow-up action of said pilot valve, and vice versa; a control valve operable separately from said pilot valve and movable from an open position to a closed position to control egress of fluid from said motor; biasing means associated with said control valve for urging said control valve to said open position; means including a dual fluid supply conduit and a fluid drain for controlling the flow of pressure fluid to and from said control valve, said fluid-controlling means including a movable first element effective in one position to connect said control valve with said fluid pressure supply means and effective in another position to connect said control valve with said fluid drain, and including a second element controllably positioned in one of said dual conduits and connected to said lever for movement therewith, said second element being progressively movable between limiting positions opening and closing said one dual conduit in response to movement of said lever in opposite directions.

2. A control mechanism comprising: fluid pressure supply means, a motor biased to move in a first direction, said motor means being hydraulically connected to said fluid pressure supply means and movable in a second direction in response to an application of fluid pressure to said motor; a pilot valve associated with said motor and movable to progressively opened and closed positions controlling the rate of egress of pressure fluid from said motor; a controlling member selectively movable in different directions relative to an intermediate position; a lever associated with said motor, pilot valve and control member to progressively open said pilot valve to effect a movement of said motor in said first direction to effect a follow-up action of said pilot valve, and vice versa; a control valve operable

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separably from said pilot valve and movable from an open position to a closed position to control egress of fluid from said motor; biasing means associated with said control valve for urging said control valve to said open position; means including a dual fluid supply conduit and a fluid drain for controlling the flow of pressure fluid to and from said control valve, said fluid-controlling means including a movable first element effective in one position to connect through one of said dual supply conduits said control valve with said fluid pressure supply means and effective in another position to connect said control valve with said fluid drain, and including a second element controllably positioned in one of said dual conduits and connected to said lever for movement therewith, said second element being progressively movable between limiting positions opening and closing said one dual conduit in response to movement of said lever in opposite directions.

3. A control mechanism comprising: fluid pressure supply means, a motor biased to move in a first direction, said motor means being hydraulically connected to said fluid pressure supply means and movable in a second direction in response to an application of fluid pressure to said motor; a pilot valve associated with said motor and movable to progressively opened and closed positions controlling the rate of egress of pressure fluid from said motor; a controlling member selectively movable in different directions relative to an intermediate position; a lever associated with said motor, pilot valve and control member to progressively open said pilot valve to effect a movement of said motor in said first direction to effect a follow-up action of said pilot valve, and vice versa; a control valve having a predetermined area which is subjected to pressure fluid and effective upon application of pressure fluid thereto to move said valve separately from said pilot valve from an open position to a closed position to control egress of fluid from said motor; biasing means associated with said control valve for urging said control valve to said open position; means including a dual fluid supply conduit and a fluid drain for controlling the flow of pressure fluid to and from said control valve, a valve element carried by said control valve adapted to close one of said dual fluid supply conduits when said control valve moves into fully open position, said fluid-controlling means including a movable first element effective in one position to connect said control valve with said fluid pressure supply means and effective in another position to connect said control valve with said fluid drain, and including a second element controllably positioned in one of said dual conduits and connected to said lever for movement therewith, said second element being progressively movable between limiting positions opening and closing said one dual conduit in response to movement of said lever in opposite directions, said valve element presenting an effective area which is incapable of moving said control valve away from its said fully open position when said second element is in a position closing said one dual conduit.

4. A control mechanism comprising: fluid pressure supply means, a motor biased to move in a first direction, said motor means being hydraulically connected to said fluid pressure supply means and movable in a second direction in response to an application of fluid pressure to said motor; a pilot valve associated with said

motor and movable to progressively opened and closed positions controlling the rate of egress of pressure fluid from said motor; a controlling member selectively movable in different directions relative to an intermediate position; a lever 5 associated with said motor, pilot valve and control member to progressively open said pilot valve to effect a movement of said motor in said first direction to effect a follow-up action of said pilot valve, and vice versa; a control valve having a 10 predetermined area which is subjected to pressure fluid and effective upon application of pressure fluid thereto to move said valve separably from said pilot valve from an open position to a closed position to control egress of fluid from 15 said motor; biasing means associated with said control valve for urging said control valve to said open position; means for controlling the flow of pressure fluid to and from said control valve including a dual fluid supply conduit connected to 20 said fluid pressure supply means and including a fluid drain, a valve element carried by said control valve adapted to close one of said dual fluid supply conduits when said control valve moves into fully open position, said fluid-controlling 25 means including a movable first element effective in one position through one of said dual supply conduits to connect said control valve with said fluid pressure supply means and effective in an-

other position to connect said control valve with said fluid drain, and including a second element controllably positioned in one of said dual conduits and connected to said lever for movement therewith, said second element being progressively movable between limiting positions opening and closing said one dual conduit in response to movement of said lever in opposite directions, said valve element presenting an effective area which is incapable of moving said control valve away from its said fully open position when said second element is in a position closing said one dual conduit, the other of said dual fluid supply conduits bypassing said second element to hydraulically connect said control valve directly to said first element.

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