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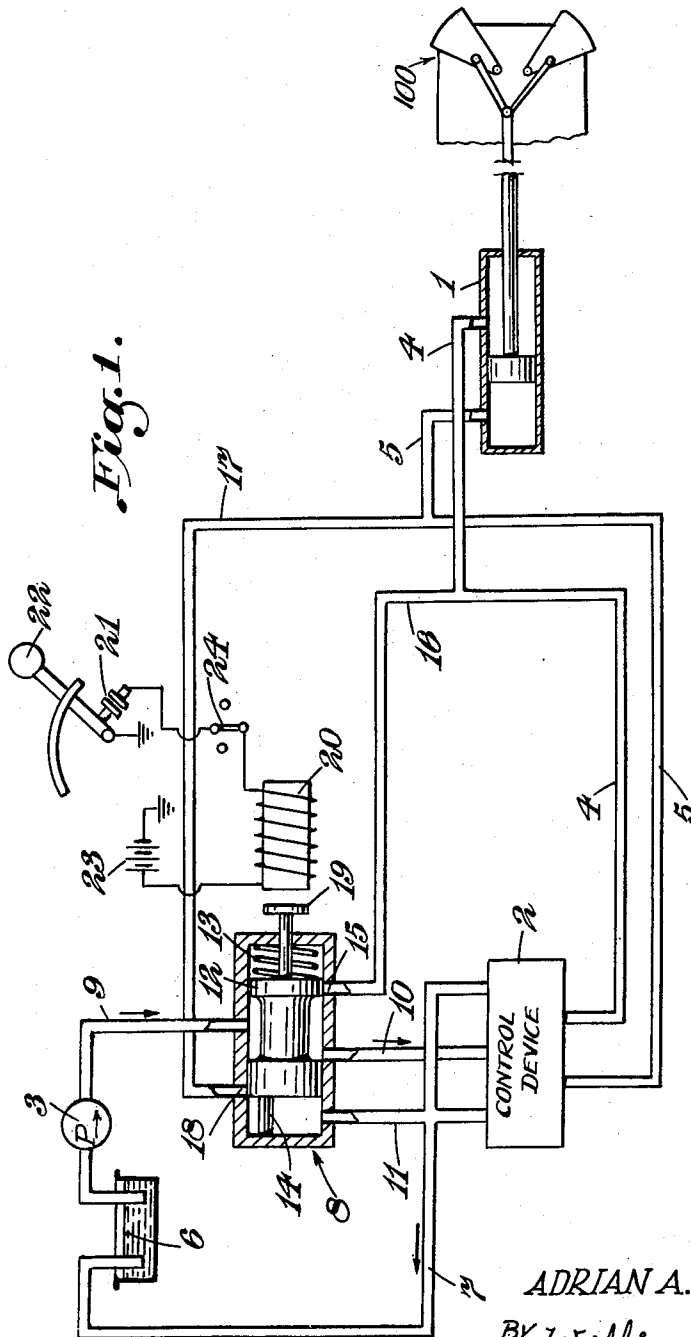
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CONTROL MEANS FOR VARIABLE JET NOZZLES OF JET PROPULSION UNITS

Filed Aug. 15, 1946

2 SHEETS—SHEET 1



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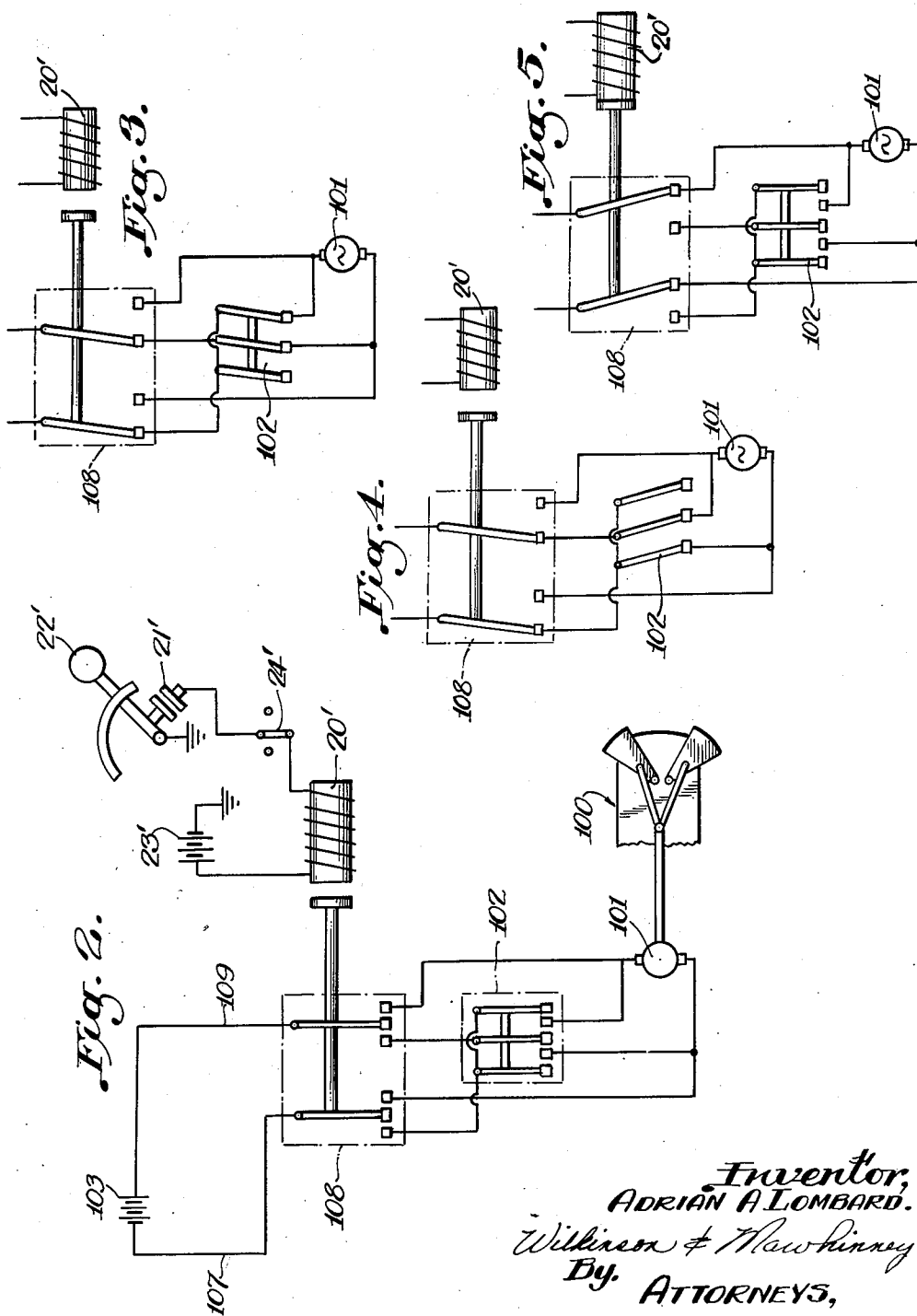
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2 SHEETS—SHEET 2



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CONTROL MEANS FOR VARIABLE JET
NOZZLES OF JET PROPULSION UNITS

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4 Claims. (Cl. 60—35.5)

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This invention relates to improvements in variable jet-nozzles for jet propulsion units and has for its object to provide improved means for effecting control of the area of a variable jet, to ensure that the thrust is reduced to a minimum when the throttle-valve of the unit is closed to the idling position. The invention may be applied to control systems in which the area of the nozzle is adjusted by means of a hydraulic ram controlled by a relay or servo-motor arrangement, or to a system in which the area of the nozzle is adjusted by an electric motor.

According to this invention, there is provided a control member which, when operated, overrides any other control and causes the movable parts of a variable jet nozzle to be set to the position of maximum nozzle-area. Preferably the said control member is constituted by or interconnected with the throttle-lever of the power unit and is arranged to be operative when the throttle-lever is moved to a predetermined low-power setting.

The invention may be applied to a power-operated variable jet-nozzle, and according to another feature, the said control member is arranged to operate by cutting off the power-supply to the normally controlling means and to supply directly or indirectly power to adjust the jet-nozzle to its maximum area.

When the invention is applied to a hydraulically operated nozzle of the kind above-mentioned, there is provided in combination therewith a two-position valve which in one position supplies fluid under pressure to the hydraulic system, and in the other position shuts off such supply and delivers fluid under pressure to the hydraulic ram to move it in the direction to open the nozzle.

According to another feature of the invention, the two-position valve is operated by an electric solenoid controlled by a switch which is constituted by, or operated by, the throttle-lever of the power unit and is arranged to be closed to energise the solenoid when the throttle-lever is moved to a predetermined closed position.

Two embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings of which Figure 1 shows in diagrammatic form one control means in accordance with the present invention for varying the area of a jet nozzle, and Figure 2 shows another control means according to the invention. Figures 3-5 show the control means of Figure 2 operative to decrease the area of the jet, increase the area of the jet, and in neutral position respectively.

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Referring to Figure 1 the variable jet nozzle 100 is preferably constructed as described in the specification to Patent No. 2,523,842 and is operated by motor means, which in this embodiment, is as described in said specification and is a hydraulic ram 1 which is controlled manually or automatically in any convenient manner as for example in the manner set forth in the specification to Patent No. 2,514,248 or Patent No. 2,575,879. The control means will not be described in detail but is generally indicated by the reference numeral 2 in the accompanying drawing. The control means 2 is provided to regulate the passage of pressure fluid from the pump 3 to the hydraulic ram by way of the pipes 4 or 5 and also to regulate the escape of fluid from the ram to a reservoir 6 by means of pipe 7.

The control provided by the present invention is effected by means of a two-position valve which is generally indicated by the reference numeral 8. This valve conveniently takes the form of a piston-valve arranged in the hydraulic system between the delivery pipe 9 from the pump 3 and the control means 2 to which the valve 8 is connected by means of pipes 10 and 11. The valve 8 comprises a piston member 12 which is engaged at one end by a spring 13 and carries at its other end a stop 14 to engage the cylinder barrel the arrangement being that the spring 13 urges the piston 12 so that the stop 14 engages the barrel in which position the piston valve is in its inoperative position. This position is shown in the accompanying drawing and it will be clear that there is then provided a connection from the hydraulic pump 3 to pipe 10 and thence to the control 2 so that all normal control movements of the nozzle can be effected by the control means 2.

The barrel of the valve 8 is provided with a port 15 which is normally closed by the piston 12 and communicates by pipes 16, 4 with the right hand end of the hydraulic ram 1, this being the end to which pressure is applied to move the ram to increase the area of the nozzle. The other end of the hydraulic ram is connected by pipe 5 to the control means 2 but an additional pipe connection 17 is made from this end of the valve 8; and the port-opening 18 for this pipe connection is closed in the inoperative position of the piston-valve.

The piston 12 is connected to the armature 19 of an electric solenoid 20 so as to be moved by it from its inoperative position to its operative position when the solenoid is energised and the solenoid is controlled by a switch 21 which is mounted on the throttle-lever 22 of the power unit and

is arranged so as to be closed when said lever is moved to a position in which the fuel supply to the unit is reduced to a minimum so that the unit is in its idling condition. Current for the operation of the solenoid 20 is obtained from a battery 23 although it is to be understood that some other convenient source may be provided. As is clear from the drawing, the switch 21 is constituted by a contact carried on the throttle lever 22 co-operating with a fixed contact.

In the operation of this device the valve means 8 is retained in its normal or inoperative position as shown in the manner described above for all positions of the throttle-lever 22 other than its closed position and the pressure fluid from the pump 3 is supplied to the control means 2 which automatically regulates the nozzle area. When, however, the throttle lever is moved to the idling position, switch 21 is closed and solenoid 20 energised so that the piston 12 of valve 8 is moved towards the right. As a consequence the piston 12 stops the supply of pressure fluid to pipe 10 and simultaneously ports 15 and 18 are opened. As a result the supply of hydraulic fluid to the control means 2 is cut off and a supply directed along pipes 16 and 4 to the right hand end of the hydraulic ram 1 so that the latter adjusts the variable nozzle to increase the area thereof. The consequent movement of the ram displaces pressure fluid from the other end of the cylinder which is delivered through pipes 5 and 17 to valve 8 and thence by pipe 11 to the reservoir 6 so that there is no possibility of the ram being located by the setting which the control means 2 may happen to occupy at the time the throttle 22 is moved to the idling position.

A master switch 24 is provided in the circuit of the solenoid 20 so that the valve 8 may be rendered inoperative in any particular circumstances.

In another embodiment of this invention, shown in Figure 2, the motor means for effecting variation in area of the jet-nozzle is a reversible electric motor 101. This motor 101 may be controlled by a control switch or switches 102 which may be controlled manually or automatically according to predetermined operating conditions of the power-unit. There may be provided in the supply lines 107, 109 from the battery 103 to the normal controlling switch or switches 102, a two-position switch 108 which in one position (to the left in the figure) gives a supply to the normal controlling switch or switches 102, and in its other position (to the right in the figure) gives a supply direct to the electric motor 101 to adjust the area of the jet nozzle towards its maximum value. Switch 108 is set manually or by common means well known in the art to the position of Fig. 3 for operation of the nozzle members by control switch 102. This switch 108 is operated in any convenient manner by the closure of the throttle controlled switch 21'. Figure 3 of the drawings shows the connection when the switch 21' is not closed but the normal control switch 102 is set to decrease the area of the jet. Figure 4 illustrates a similar arrangement when the control switch 102 is set to increase the area of the jet. Figure 5 illustrates the connections of Figure 2 when the switch 21' is closed so that the control switch 102 is disconnected by the battery 103, but so that the electric motor 101 operates to increase the jet area. As before a master switch 24' may be provided in the circuit of the throttle-controlled switch to render it inoperative if desired in any particular circumstances.

I claim:

1. Control means for a jet-propulsion unit having a variable jet comprising hydraulically-operating servo-motor means to vary the opening of the jet nozzle between a maximum opening position and a minimum opening position; hydraulically-operating normal control means arranged to control said servo-motor means; a manual power control lever operable between a maximum power position and a minimum power position; a two-position hydraulic control valve such that in a first position hydraulic fluid is passed to said normal control means, and in the second position hydraulic fluid by-passes said normal control means to operate said servo-motor means to move the jet nozzle to its maximum opening position; and solenoid circuit means, including a solenoid, interconnecting said manual power control lever and said two-position valve, whereby said valve is moved by the solenoid to the second position when the circuit is closed by the control lever in its fully closed position.

2. Control means for a jet propulsion unit having a variable jet nozzle comprising motor means actuating said nozzle between a maximum opening position and a minimum opening position, power supply means, a first connection between said power supply means and said motor means to supply power for actuating said nozzle, normal control means for said motor means in said first connection, first shut-off means in said first connection movable between an inoperative position and an operative position in which it shuts off said power supply means from said motor means, a second connection between said power supply means and said motor means to supply power for moving said nozzle to its maximum opening position, second shut-off means in said second connection movable between an operative position in which it shuts off said power supply means from said motor means and an inoperative position, a manual power-control lever movable between a minimum power position and a maximum power position, first operating means between said manual power-control lever and said first shut-off means and actuated on movement of said manual power-control lever to its minimum power position to move said first shut-off means to its operative position, and actuated on movement of said manual power-control lever from its minimum power position to move said first shut-off means to its inoperative position, and second operating means between said manual power-control lever and said second shut-off means and actuated on movement of said manual power-control lever to its minimum power position to move said second shut-off means to its operative position, and actuated on movement of said manual power-control lever from its minimum power position to move said second shut-off means to its operative position.

3. Control means for a jet propulsion unit having a variable jet nozzle comprising motor means actuating said nozzle between a maximum opening position and a minimum opening position, power supply means, a first connection between said power supply means and said motor means to supply power for actuating said nozzle, normal control means for said motor means in said first connection, first shut-off means in said first connection movable between an inoperative position and an operative position in which it shuts off said power supply means from said motor means, first biasing means biasing said first shut-off means to its inoperative position, a manual

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power-control lever movable between a minimum power position and maximum power position, first operating means between said manual power-control lever and said first shut-off means, and actuated on movement of said manual power-control lever to its minimum power position to move said first shut-off means against its biasing means to its operative position, and actuated on movement of said manual power-control lever from its minimum power position to allow said first shut-off means to move under the action of its biasing means to its inoperative position, a second connection between said power supply means and said motor means to supply power for moving said nozzle to its maximum opening position, second shut-off means in said second connection movable between an operative position in which it shuts off said power supply means from said motor means and an inoperative position, second biasing means biasing second shut-off means to its operative position, and second operating means between said manual power-control lever and said second shut-off means and actuated on movement of said manual power-control lever to its minimum power position to move said second shut-off means against its biasing means to its inoperative position, and actuated on movement of said manual power-control lever from its minimum power position to allow said second shut-off means to move under the action of its biasing means to its operative position.

4. Control means for a jet propulsion unit having a variable jet nozzle comprising motor means actuating said nozzle between a maximum opening position and a minimum opening position, power supply means, a first connection between said power supply means and said motor means to supply power for actuating said nozzle, normal control means for said motor means in said first connection, first shut-off means in said first connection movable between an inoperative position

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tion and an operative position in which it shuts off said power supply means from said motor means, a second connection between said power supply means and said motor means to supply power for moving said nozzle to its maximum opening position, second shut-off means in said second connection movable between an operative position in which it shuts off said power supply means from said motor means and an inoperative position, said two shut-off means being connected for movement together so that when said first shut-off means moves to its operative position said second shut-off means moves to its inoperative position and vice versa, biasing means biasing said two shut-off means the first to its inoperative position and the second to its operative position, a manual power-control lever movable between a minimum power position and a maximum power position, a solenoid operative when energized to move said two shut-off means against the biasing means the first to its operative position and the second to its inoperative position, an electric power supply for the solenoid, and a control switch in circuit with said electric power supply and said solenoid closing of which energizes said solenoid, said control switch being operatively associated with said manual power-control lever to be closed on movement of said lever to its minimum power position and to be opened on movement of said lever from its minimum power position.

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

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