

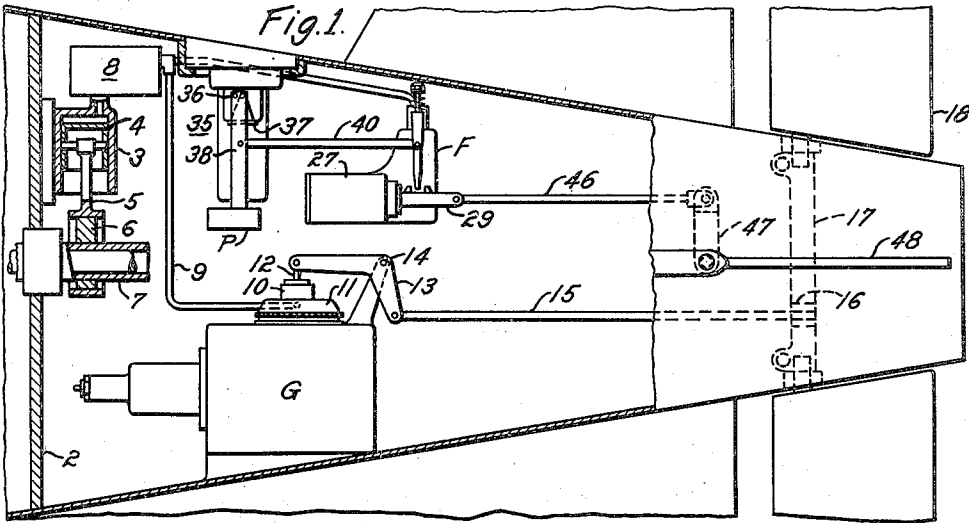
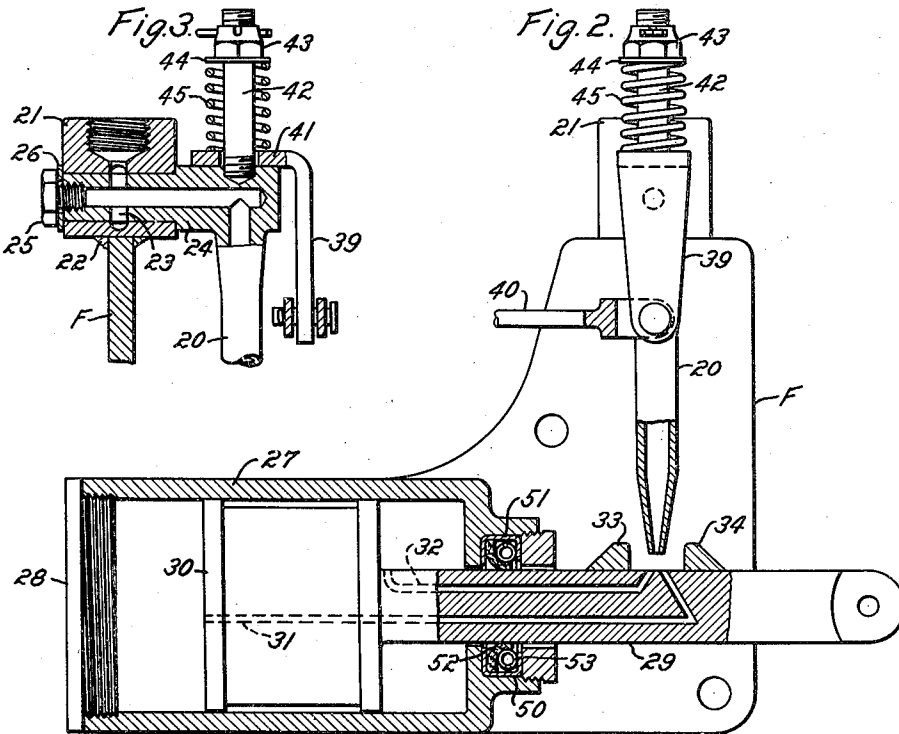
Feb. 21, 1950

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2,498,284

STEERING CONTROL WITH PNEUMATIC PICKUP

Filed April 22, 1946



WITNESSES:

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2,498,284

STEERING CONTROL WITH PNEUMATIC PICKUP

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Application April 22, 1946, Serial No. 663,805

4 Claims. (Cl. 114—25)

1

My invention relates to pneumatically controlled devices, and more particularly to apparatus for controlling the path of operation of a torpedo by the use of pneumatic equipment.

With the electrically propelled torpedo so generally used of late, electromagnetic devices are used to control the depth as well as the direction of operation of the torpedo, but some of the recently developed torpedoes do not include any electric equipment and with some electrically propelled torpedoes it is not feasible or desirable to electrically control the depth or the steering of the torpedo.

One broad object of my invention is the provision of torpedo rudder controlling devices of the non-electrical type.

Another broad object of my invention is the provision of pneumatically controlled rudder actuating devices for a conveyance moving through a fluid medium.

A more specific object of my invention is the provision of pneumatic devices for controlling the angular movement of the elevator rudders of a conveyance moving through a fluid medium.

A still more specific object of my invention is the provision of a piston disposed in a cylinder for actuating the elevator rudders of a torpedo by means of pneumatic elements, coupled to the depth responsive devices of a torpedo, for controlling the operation of the piston.

The objects hereinbefore stated are merely illustrative of many other objects and advantages that will become more apparent from a study of the following specification and the accompanying drawing, in which:

Figure 1 is a schematic showing of my invention as disposed in the tailcone of a torpedo;

Fig. 2 is a longitudinal sectional view of the piston and cylinder elements and the jet pipe for controlling the position of the piston in the cylinder; and

Fig. 3 is a sectional view of a detail of the elements for actuating the jet pipe from the depth responsive devices.

In Figure 1, the tailcone 1 of a torpedo is shown somewhat schematic. On the bulkhead 2, or any other suitable element fixed to the torpedo, I mount the pump cylinder 3. A piston 4 is disposed in the cylinder and this piston by means of a connecting rod 5 and an eccentric, or cam 6, coupled to the outer shaft 7 of the two propulsion shafts for the torpedo propellers. The pump supplies the pressure chamber 8 with air, or water, if the pump is connected to the outside of the torpedo, under pressure.

2

The fluid pressure in chamber 8 is used to actuate both the steering rudders and the elevator rudders. To this end, one conduit 9 transmits fluid under pressure to the gyro G. The arrangement is such that the gyro controls the flow of fluid either to the top or bottom of a piston in the cylinder 10 depending on the position of the control element in the housing 11 coupled to the gyro. The piston in cylinder 10 actuates the rod 12 either up or down depending on the control effect produced by the gyro.

The rod 12 is coupled to the bell-crank lever 13 pivoted at 14. Movement of the bell-crank lever 13 moves the link 15 longitudinally of itself to thus actuate the steering rudders 18 through the yoke 17 and the crank arm 16 fixed to the yoke and operatively coupled to the link 15.

A second conduit 19 transmits fluid under pressure from the chamber 8 to the jet pipe 20, the transmission being through the connection 21, the annular groove 22 in the bearing portion of the frame F, the radial openings 23 in the shaft portion 24 of the jet pipe 20 and the axial channel in this shaft portion of the jet pipe. A suitable nut 25 and spring washer 26 firmly but movably holds the jet pipe 20 in position in the bearing portion of the frame F.

The frame F is rigidly secured to the tailcone and a cylinder 27 is rigidly secured to the frame. The cylinder is of the simplest construction containing no valves of any kind. A threaded cap 28 closes the left or forward end of the piston whereas the right or aft end is provided with an axial bearing opening for receiving the piston rod 29 of the piston 30.

In the bearing opening in the aft end of cylinder 27, I dispose suitable liquid seals 50 of one or more units. Each unit includes a retaining shell 51, a neoprene or rubber ring 52 shaped as shown and held in operative relation to the piston rod 29 by a garter spring 53. The liquid seal prevents the loss of pressure in the aft end of the cylinder 27 and prevents the entry of foreign materials as dust, dirt, oil, or other fluids from entering the cylinder.

The piston is provided with a channel 31 opening into the forward portion of the cylinder and a second channel opening into the aft end of the cylinder. The channels 31 and 32 traverse the piston rod longitudinally to a point aft of the aft end of the cylinder where they both turn off radially in the same plane and emerge on the side at close spacing as shown in Fig. 2. The jet pipe 20 has its nozzle directly in line with these openings, the arrangement being such that the

3

fluid issuing from the nozzle will enter the channels 31 and 32 and thus cause pressures to build up in the cylinder 27.

It will be obvious that if the jet is centered with respect to the two radial openings of the channels 31 and 32, the pressure in the two ends of the cylinder will be equal, and there will be no motion of the piston. If, however, the jet is displaced, say to the right, then the pressure will increase in the forward end of the cylinder and will be decreased in the aft end of the cylinder, thus forcing the piston 30 to the right until it again centers on the jet. Thus the piston follows the jet accurately.

The reaction force of the jet pipe 20 is transmitted directly to the bearing region so that no torque need be applied to control its position except to overcome the force of friction at the bearing. On the other hand, the force on the piston is large because the jet velocity-head is converted into substantially constant pressure-head with good efficiency, the efficiency being of the order of 70% or better. Thus, an amplification factor from one ounce to two hundred pounds, or 3200 times is easily obtained.

To prevent the jet pipe from getting out of alignment with the radial openings at times when the fluid pressure is not on a pair of stops 33 and 34 are provided on the piston rod 29. During normal operation, the nozzle end of the jet pipe does not, of course, touch either stop.

These stops 33 and 34 introduce the possibility of damage to the nozzle end of the jet pipe in case of violent movement of the jet pipe. Such violent movement of the jet pipe is prevented by the nature of the coupling between the depth responsive device 35 and the jet pipe. The nature of the coupling will become apparent presently.

The depth responsive device comprises a pendulum P pivoted at 36. The pendulum is also coupled through the diaphragm 37 and link 38 to be actuated by the hydrostatic pressure of the sea. The swing of the pendulum P with reference to the torpedo is thus a function of the angle the longitudinal axis of the torpedo makes with the horizon or the depth of the torpedo below the sea surface, or both. For the details of the depth responsive device reference may be had to my Patent No. 2,417,768, issued March 18, 1947, and entitled Control device.

The pendulum P is coupled to the lever 39 in shape of an L upside down. The lower surface 41 of the horizontal leg of this lever 39 is flat and engages with a like top surface on the hub of the jet pipe 20. A stud bolt 42 is fixed in the hub as shown passing through a relatively large opening in the horizontal leg of the lever 39. The upper end of the stud bolt 42 is threaded to receive a nut 43 and washer 44. A compression spring 45 under adjustable compression by the nut 43 is disposed between the washer 44 and the horizontal leg of the lever 39. The spring pressure thus assures that the jet pipe 20 moves with the movements of the pendulum for all normal movements of the pendulum, but does not move with the pendulum for the violent pendulum movements such as that which occurs when the torpedo is fired from the firing tube.

The piston rod 29 is by means of the link 46 connected to the crank arm 47 on the yoke for actuating the elevator rudders 48. From the foregoing, it is apparent that the elevator rudders follow the control effect produced by the depth responsive device 35 and that the steering rudders

4

follow the control effect produced by the gyro G.

While I have shown and described but one embodiment of my invention, I do not wish to be limited to the exact disclosure made but wish to be limited only by the scope of the claims hereto appended.

I claim as my invention:

1. In apparatus for controlling the direction of movement of a conveyance moving through a fluid medium, in combination, means for producing a control effect as a function of the deviation of the movement of the conveyance from a desired path of movement, a source of fluid pressure, a pivotally mounted jet pipe having a nozzle disposed to move as a function of the control effect, said jet pipe being connected to said source of fluid pressure, a cylinder, a piston in the cylinder having a piston rod projecting from one end of the cylinder, said rod being provided with a channel opening into the forward cylinder head and ending in a radial opening nearer the aft end of the rod and with a second channel opening into the aft cylinder head and ending in a radial opening directly adjacent the first radial opening but forward of the first radial opening, said radial openings being normally aligned with the nozzle of the jet pipe whereby the velocity head of the fluid issuing from the nozzle is transformed into equal static pressure-heads in each cylinder head when the openings and nozzle are in true alignment but becomes greater in the forward cylinder head and less in the aft cylinder head when the nozzle moves aft and becomes greater in the aft cylinder head and less in the forward cylinder head when the nozzle moves forward whereby the piston is caused to move with the movements of the nozzle, rudders for said conveyance, and means for connecting the piston rod to the rudders to thus cause rudder movements as a function of said control effect.

2. In apparatus for controlling the direction of movement of a conveyance moving through a fluid medium, in combination, means for producing a control effect as a function of the deviation of the movement of the conveyance from a desired path of movement, a source of fluid pressure, a pivotally mounted jet pipe having a nozzle disposed to move as a function of the control effect, said jet pipe being connected to said source of fluid pressure, a cylinder having a first cylinder head and a second cylinder head, a piston in said cylinder having a piston rod projecting from the second cylinder head, said rod being provided with a pair of channels, one opening into the first cylinder head and the other in the second cylinder head and said channels terminating in radial contiguous openings in the rod but in reverse order to the openings in the cylinder heads, said radial openings being aligned with the nozzle of the jet pipe whereby the fluid issuing from the nozzle will produce pressure effects in the cylinder heads causing said piston and thus the rod to follow the movements of the nozzle of the jet pipe, rudders for said conveyance and coupling means between the rod and the rudders to cause the rudders to move as a function of said control effect.

3. In the steering control for a torpedo, in combination, steering rudders for controlling the direction of movement of the torpedo, a pump operated by the torpedo propulsion equipment, a pivotally mounted jet pipe coupled to the depth control devices on the torpedo to thus swing as a function of the control effect of the depth con-

trol devices, said jet pipe being coupled to be supplied with gas under pressure from the pump and producing a jet of gas under relatively high velocity to the supply region of the pump to thus provide for recirculating use of the gas in the torpedo, a cylinder, a piston having a rod projecting through a gas seal from one cylinder head, said piston rod being provided with a pair of channels opening respectively in the two cylinder heads and in closely spaced relation adjacent the nozzle end of the jet pipe, whereby said piston is caused to follow the swings of the jet pipe, and operative coupling means between the piston rod and the rudders to thus actuate the torpedo rudders as a function of the piston movement.

4. In the steering control for a torpedo, in combination, steering rudders for controlling the direction of movement of the torpedo, a pump operated by the torpedo propulsion equipment, a gas pressure storage tank, a pivotally mounted jet pipe coupled to the depth control devices on the torpedo to thus swing as a function of the control effect of the depth control devices, said jet pipe being coupled to be supplied with gas under pressure from the pump and producing a

jet of gas under relatively high velocity to the supply region of the pump to thus provide for recirculating use of the gas in the torpedo, a cylinder, a piston having a rod projecting through a gas seal from one cylinder head, said piston rod being provided with a pair of channels opening respectively in the two cylinder heads and in closely spaced relation adjacent the nozzle end of the jet pipe, whereby said piston is caused to follow the swings of the jet pipe, and operative coupling means between the piston rod and the rudders to thus actuate the torpedo rudders as a function of the piston movements.

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