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RUDDER MACHINES FOR AUTOMATIC PILOTS

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Fig-1

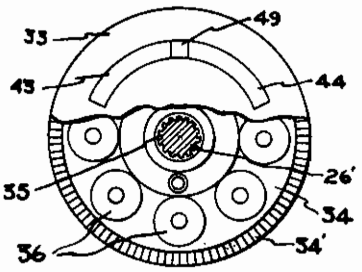


Fig-2

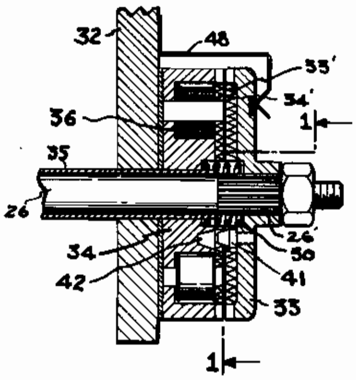
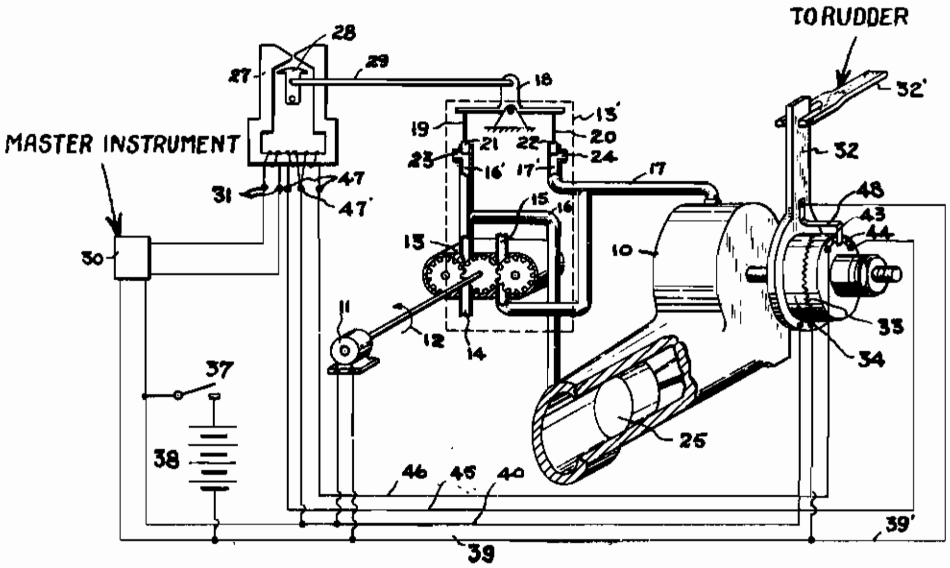


Fig-3



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ALIEN PROPERTY CUSTODIAN

RUDDER MACHINES FOR AUTOMATIC PILOTS

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This invention relates to an automatic steering device, the servo motor of which is connected to the controlled member by means of a disengaging clutch. Especially with aircraft, it is advisable for safety reasons to incorporate within the automatic steering devices means for disengaging the rudder motor from the steering linkages. Such a coupling has the advantage that the servo motor is not dragged along when steering is done by hand and that, therefore, its friction and resistance does not have to be overcome. Until recently, steering by hand generally was accomplished by short-circuiting the double-acting pressure fluid driven steering mechanism by means of a passage leading from one side to the other side. The disengaging of a cut-off clutch, which was provided for emergencies in aircraft steering devices, was generally not used because the re-engaging of the clutch was difficult. Great care had to be exercised to couple the rudder motor so as to keep the rudder in the correct relative position. If the two parts of the coupling were connected in any accidental position, it might be possible that the rudder motor, with its transmission system, would impose a wrong position upon the rudder, or the rudder motor might reach its stop, which in most present systems with limited stroke would happen long before the rudder is fully deflected.

The present invention solves the problem of causing correct relative positioning of the two parts of the clutch at the moment of engagement and furthermore, of causing engagement automatically. According to the present invention, the correct position between the coupling parts is obtained by means of a follow-up system which creates an impulse if the parts of the coupling have a relative deviation from their neutral position, which impulse controls the servo motor in such a way that it moves its own coupling part in a direction to follow the other part of the coupling, whereby engagement automatically occurs as soon as both parts reach their neutral position.

If an electromagnetic clutch is used, a switch is preferably provided which furnishes the follow-up impulse for an electromagnetic device controlling the servo motor. This switch is connected in the manner of a voltage divider. The wrong engagement of the two clutch parts is prevented in the simplest way by a spacer which is connected to one part of the coupling and which allows engaging of the two halves only if they are in their relative neutral position.

The follow-up motion of the servo motor may be arranged in such a way that the follow-up impulses act upon the same device which now serves the purpose of transmitting the steering impulses to the rudder motor, provided the follow-up impulses are more powerful than the impulses of the steering device.

When starting the steering device, the engaging of the clutch may be accomplished automatically in a simple manner by coupling the switch for the clutch magnet with the switch device controlling the rudder motor. This may be done by a single switch.

The invention is further explained by means of the modification shown in the drawings.

Fig. 1 shows a top view of the electromagnetic clutch, partly in section, along the line **1—1** of Fig. 2.

Fig. 2 shows a longitudinal section through the two parts of the coupling.

Fig. 3 shows the assembly of the essential parts of an automatic steering device containing the coupling of this invention. This drawing is partly a perspective schematic.

In Fig. 3 the rudder motor **10** is designed as a crank-piston motor and is shown open in front. Oil serves as the pressure fluid and is provided by a three-wheel gear pump **13** driven by an electric motor **11** in the direction of the arrow **12**. The oil is sucked in through the pipes **14** and **15** and is pressed into the passages **16** and **17** leading to the servo motor. The control of the pressure oil is accomplished by a see-saw **18** to which two control pistons **21** and **22** are connected by means of spring wires **19** and **20**. If the see-saw **18** is inclined, one of the openings **23**, **24** is throttled, while the oil can freely escape through the other opening. In the throttle passage **16'** and **17'**, respectively, a pressure appears which acts upon the rudder motor through passages **16** or **17**, respectively, and thereby causes a corresponding motion of the power piston **25**. The motion of the piston is transmitted as rotation to the shaft **26** by means of a crank (not shown).

As described in the previous application A 90124 XI/62 *b*, the oil pump **13** and the drive motor **11** may be built into an integral assembly with the see-saw **18** and the rudder motor **10**.

The see-saw **18** is controlled by a rotary magnet **27**, the armature **28** of which is connected to the see-saw by means of a link **29**. The actual automatic steering impulses are transmitted to the rotary magnet from an electrical pick-off or transmitter, of known design, on the master instrument **30**, such as a directional gyroscope, through the winding **31**. As soon as the aircraft deviates from the desired attitude, the transmitter 30 sends current of correct direction through the coil 31, whereby turning of the armature 28 is caused, which in turn inclines the see-saw 18 and starts the rudder motor. The motion of the shaft 26 then is transferred to the rudder linkage 32′ by means of a lever 32.

The lever 32 is free to turn around the shaft 28 as long as it is not in engagement with the part 33 of the coupling. The part 33 may be shifted lengthwise on the splines 26′ of the shaft 26 and may be engaged with another clutch part 34. The part 34 is rigidly connected to the lever 32 and with the same is pressed onto a bushing 35 which in turn is pivoted on the shaft 28.

In Fig. 3 the two parts 33 and 34 of the clutch are engaged.

Fig. 2 shows the same parts disengaged.

Within the part 34 of the coupling, a number of electromagnets 36 are mounted, one of which is shown in section in Fig. 2. The two parts 33 and 34 of the coupling are made of soft iron and have teeth on their opposing engaging surfaces.

If a switch 37 in Fig. 3 is closed, a battery 38 is connected by means of leads 39 and 40 to the electromagnets 36. These magnets now attract part 33 of the coupling toward the part 34. The two parts of the clutch can only engage each other when a spacer 41 pressed into part 33 is directly opposite a hole 42 in the clutch body 34. In this position, the two clutch parts are in their relative neutral position.

In order to cause the two parts of the clutch to attain this position, the armature 33 of the clutch has two contact segments 43 and 44 which, by means of leads 45 and 46 are connected to a winding 47 on the rotary magnet 27. The winding 47 is center-tapped at 47′ and is connected to one terminal of the battery 38 if switch 37 is closed. The other terminal of the battery is connected by means of leads 39 and 39′ to a spring contact brush 48.

The operation is as follows:

If switch 37 is closed, motor 11 is excited, oil pump 13 is started and the transmitter 39 is ready for action. Furthermore, the electromagnets 36 are excited and the center tap 47′ of coil 47 is connected to the line. As long as there is relative positional disagreement between the two halves of the coupling, the spring brush 48 contacts one of the two segments 43 or 44. This causes a current to flow in one half of the winding 47 of the rotary magnet 27, which produces a motion of the armature 28 in such a direction that the shaft 26 of the rudder motor and, thereby, the part 33 of the coupling, follows the part 34 of the coupling. The position of part 34 is given by the lever 32 or by the position of the steering linkage 32′. The impulses causing follow-up motion of the rudder motor is of such a nature that in all cases it over-powers any impulse arriving at coil 31 from the transmitter 30. This assures the automatic follow-up action of the rudder motor no matter what the condition or action of the transmitter may be.

When relative positional agreement of the two halves of the coupling has been obtained, the spacer pin 41 is opposite hole 42, and the teeth 33′ and 34′ engage each other while part 33 of the clutch moves axially along the splines of the shaft 26′. As soon as positional agreement is obtained, coil 47 is disconnected because the spring brush 48 is now resting upon an insulated piece 49 located between the two segments 43 and 44. Even if the brush 48 should be somewhat wider than the insulated piece 49, the coil 47 is disconnected because the brush is not resilient enough to follow the part 33 of the coupling, whereby the connection between the brush 49 and the segments 43 and 44 is always interrupted.

Disengaging of the coupling after opening of switch 37, which disconnects the electromagnets 36, is assured by a helical spring 50 located between the two halves of the coupling, the pressure of which is somewhat smaller than that of the magnets when excited.

Although the above described arrangement has been developed especially for automatic steering devices for aircraft, it is understood that the same may be applied generally to stationary automatic regulators or servo motor controls.

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