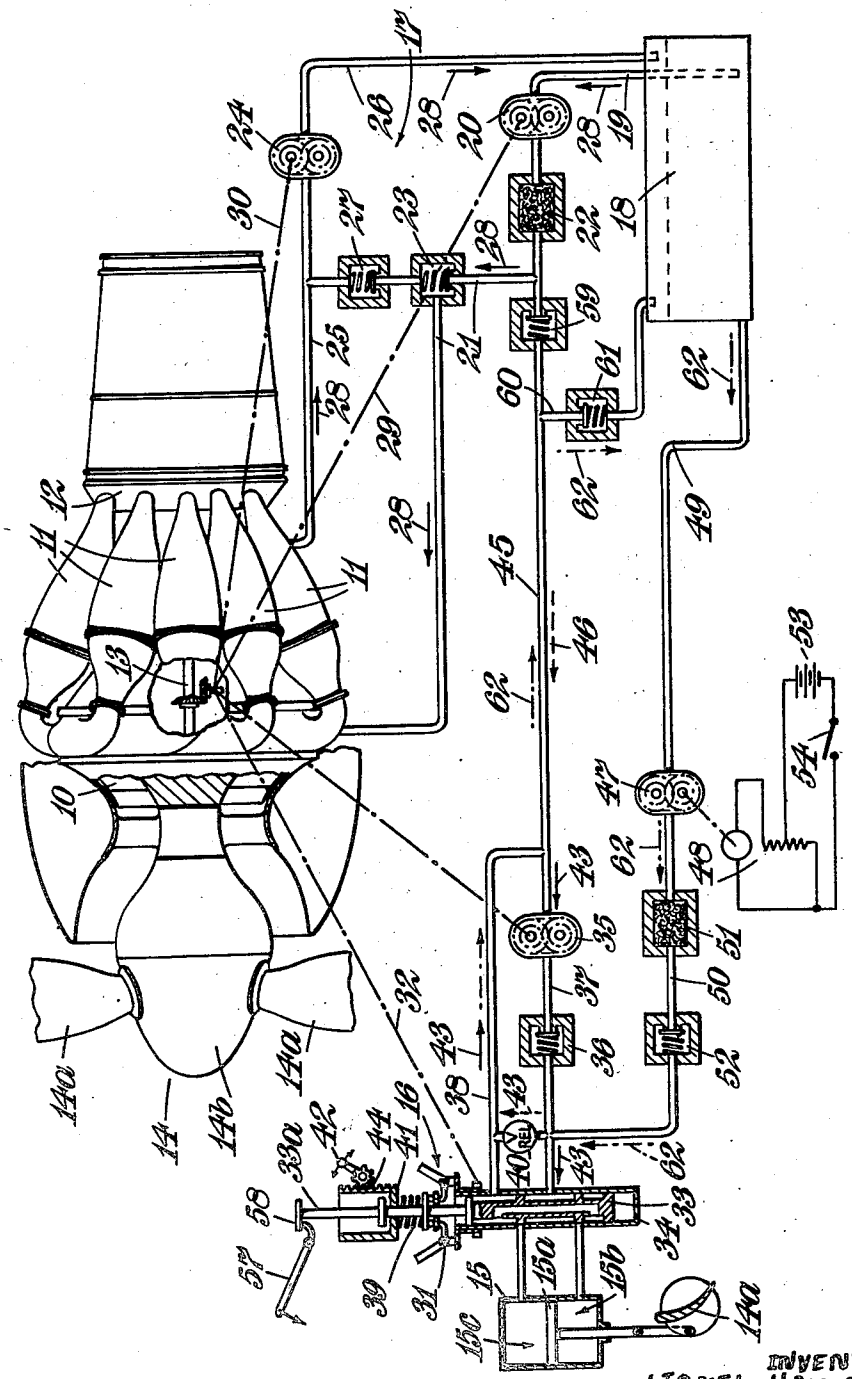
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PITCH CONTROL AND FEATHERING MECHANISM FOR VARIABLE PITCH PROPELLERS

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PITCH CONTROL AND FEATHERING MECHANISM FOR VARIABLE PITCH PROPELLERS

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1

This invention relates to variable pitch propellers and control mechanism therefor and is more particularly concerned with control mechanisms of the type comprising a constant-speed governor unit for hydraulically varying the airscrew pitch to maintain a constant engine rotational speed and a hydraulic feathering and unfeathering mechanism for moving the airscrew blades to the fully feathered position when the engine ceases to develop power and to move the blades from the fully feathered position on restarting of the engine. The constant speed governor unit and feathering and unfeathering mechanism have separate hydraulic pumps, that associated with the constant speed governor unit being engine driven and that for the feathering mechanism being driven by an electric motor. The constant speed governor unit operates in a closed hydraulic circuit, the return fluid from the pitch change gear of the airscrew being led to the inlet of the engine-driven pump of the constant speed governor unit; the closed circuit is "topped" up from the normal engine oil supply. This arrangement of the constant speed governor unit is desirable to avoid contamination of the oil in the unit and to prevent starving the engine of oil when large pitch changes are taking place.

The pump of the feathering and unfeathering mechanism draws fluid directly from the engine oil tank and delivers it past a non-return valve into the delivery line of the pump of the constant-speed unit so that the oil flows in the constant speed unit closed circuit, the return oil flowing to the inlet side of the constant speeed governor unit pump. The oil supply is taken from the engine oil tank as much more rapid pitch changes are required than with the constant speed unit.

In known arrangements of control mechanism of the type above described, during operation of the feathering and unfeathering mechanism the return oil flows to the engine since the inlet side of the pump of the constant speed governor unit is connected to the delivery side of the engine oil system pump for "topping up" purposes.

This known arrangement however suffers from the disadvantage, especially when it is associated with an airscrew driven by a gas-turbine engine, that due to the rapid operation of the feathering and unfeathering mechanism the engine oil tank may be emptied and the return oil in effect pumped into the engine which may have a sump capacity which is insufficient to receive it.

The present invention has for an object to provide a control mechanism of the type referred to

2

in which this difficulty is avoided and comprises means for ensuring that the return oil from feathering and unfeathering operations under control of the feathering and unfeathering mechanism is prevented from being pumped into the engine, and is returned to the engine oil tank.

The accompanying drawing illustrates diagrammatically a gas-turbine engine driving a variable-pitch propeller and the constant speed and feathering control mechanisms for the airscrew blades.

In the drawing, there is shown a gas-turbine engine comprising a compressor 10, a plurality of combustion chambers 11 connected to receive air compressed in the compressor 10, and turbine 12 connected to receive the heated gases from the combustion chambers and arranged to drive the compressor 10 through a shaft 13. The turbine 12 also drives an airscrew 14 of the variable-pitch type, whereof the mechanism for effecting the changes of pitch angle of the airscrew blades 14a is contained within the airscrew spinner 14b.

The mechanism for effecting changes of airscrew blade pitch comprises a hydraulic motor 15, shown for simplicity separate from the engine and airscrew, whereof one element such as the piston 15a is linked to each blade 14a to rotate it about its lengthwise axis.

The present invention is concerned with the control means for adjusting the pitch of the airscrew blades and comprises a constant speed governor unit 16 and a feathering and unfeathering unit which is normally operative when the engine has failed or is not running. These units are hydraulically operated and are connected with the engine lubricating system 17.

The lubricating system, in the form illustrated, comprises a reservoir 18 from which oil is drawn through pipe line 19 by an engine pressure pump 20 which delivers the oil to the engine through a pipe line 21 having connected in it a filter 22 and a non-return valve 23 which may be set to open at a pressure of, for example 70 lbs./sq. in. Oil which has passed through the engine collects in a sump (not shown) and the oil is drawn out from the sump by pump 24 through pipe line 25 and returned through pipe line 26 to the reservoir 18. A relief valve 27 set to open for example at 30 lbs./sq. in. is connected between pipe line 21 downstream of the non-return valve 23 and the pipe line 25. The oil flow in the lubricating system is indicated by arrows 28.

The sump as is usual with gas-turbine engines has a capacity substantially smaller than that of the reservoir 18.

The pumps **20**, **24** are engine-driven, the drives being indicated diagrammatically at **29**, **30** respectively.

The constant speed governor unit as illustrated is of known construction and comprises a centrifugal governor **31** driven from the engine through a drive indicated at **32** and arranged to adjust a piston valve **33** working in a cylinder **34** against spring **39**. The piston valve **33** controls the flow of pressure fluid from a pump **35** to the hydraulic motor **15**, the return fluid passing to the suction side of the pump **35** so that the governor hydraulic circuit is a circulatory circuit. This circuit comprises pump **35** which delivers fluid into pipe-line **37** past non-return valve **36** to the cylinder **34** and thus, according to whether the piston valve **33** is raised or lowered (as viewed in the drawing) from its central position, to the upper side **15***c* or lower side **15***b* of the hydraulic motor piston **15***a*. When pressure fluid is admitted to the space **15***c*, the piston **15***a* moves downwardly (as viewed in the drawing) and the pitch of the blades is coarsened. When pressure fluid is admitted to space **15***b*, the pitch of the blades **14***a* is fined-off. The return fluid flows from space **15***c* or **15***b* past valve **33** into pipe-line **38** back to the suction side of pump **35**. A relief valve **40** is provided between pipe-line **37** downstream of valve **36** and pipe-line **38**. The fluid flow in the governing operation is indicated by arrows **43**.

The spring **39** against which the governor **31** acts to lift the piston valve on increase of engine speed has an abutment **41** which is adjustable by means of lever **42** through rack and pinion **44** to select the rotational speed to which the airscrew is governed. As illustrated, on increase of speed from the selected speed, the piston valve **33** is raised admitting pressure fluid to the space **15***c* to coarsen the airscrew blade pitch, and on decrease of speed from the selected speed, the piston valve **33** is lowered admitting pressure fluid to the space **15***b* to fine off the airscrew blade pitch.

Any loss of pressure fluid from the governor circuit is made up from the engine oil circuit through a branch pipe line **45** connected at one end to pipe-line **21** between filter **22** and valve **23** and at its other end to pipe-line **38**. The topping-up oil flow is indicated by arrow **46**.

The feathering and unfeathering unit is normally employed to feather the airscrew blades **14***a*, that is to move them to maximum coarse pitch, when the engine fails or is intentionally stopped in flight of the aircraft and to move them from the feathered position on restarting the engine. The unit comprises in the form illustrated a pump **47** driven by a compound wound D. C. motor **48** so as to be independent of the engine for its operation. The pump draws oil from the reservoir **18** through pipe-line **49** and delivers through pipe-line **50** comprising filter **51** and non-return valve **52** to valve **33** and thus to the hydraulic motor **15**. The oil is taken from reservoir **18** as when feathering more rapid pitch changes occur, and thus more oil is required than when the constant speed governor is operating. The supply of current from a battery **53** to motor **48** is controlled by a switch **54**. A feathering trip lever **57** is operated by manual selection to engage a shoulder **58** on an extension **33***a* of piston valve **33** to lift the valve **33** against spring **39**, thereby to admit pressure fluid delivered by pump **47** to space **15***c* and to feather the airscrew blades **14***a*. Thus to "feather" the airscrew blades the lever **57** is moved to lift the valve and the switch **54** is closed. At the end of the feathering operation the switch **54** may be opened to avoid continuous running of the motor **48**. Whilst the airscrew blades remain feathered the valve **33** remains in the lifted position.

In order to prevent the return fluid from the hydraulic motor **15** passing into the engine as is the case during feathering with known arrangements, the following arrangement is provided. A non-return valve **59** is provided in branch pipe-line **45** to prevent the return oil flowing from the hydraulic motor **15** from flowing into pipe-line **21** and a return pipe **60** is connected to the branch pipe-line **45** between the non-return valve **59** and its point of connection to pipe-line **38** so that the return oil flows into return pipe **60** and is delivered to the reservoir **18**. A relief valve **61** is provided in return pipe **60** and the relief valve is loaded to open when the pressure in the pipe-line **45** is substantially higher than the normal delivery pressure in the lubricating system. If, for instance, valve **23** is loaded to open at 70 lbs./sq. in. the valve **61** may be loaded to open at 100 lbs./sq. in. This arrangement prevents topping up oil flowing in the direction of arrow **46** from being returned directly to the reservoir **18**.

The oil flows during feathering are indicated by chain line arrows **62**.

To move the blades from the feathered position the lever **57** is operated to allow the valve **33** to drop and the switch **54** is again closed to supply pressure fluid to the hydraulic motor **15**. Pressure fluid is thus delivered to space **15***b* and the blades **14***a* moved from the feathered position to a fine pitch setting suitable for starting.

The feathering operation of the system is as follows:

During normal operation of the constant speed governor unit, the valve **61** in the return pipe **60** to the tank is closed since the oil pressures developed in the return pipe line do not reach a value of 100 lbs. per square inch. Any losses of oil from the closed constant speed governor unit circuit are made up by oil flowing from the engine oil pump **20** past the non-return valve **59** in the branch pipe **45** and, since the delivery pressure of the engine oil pump is about 70 lbs. per square inch, no oil will flow back to the engine oil tank past the valve **61** set to open at 100 lbs. per square inch.

During feathering and unfeathering, the return oil is prevented by the non-return valve **59** in the branch pipe **45** from being delivered intto the engine and the pressure in the pipe line **45** builds up until it is sufficient to open the valve **61**. In this way, during feathering and unfeathering operations under control of the feathering and unfeathering unit, oil drawn from the engine oil tank by the pump **47** of the mechanism is made up by return oil, and over-oiling of the engine prevented.

The arrangement above described is especially useful when the airscrew is, as illustrated, driven from a gas-turbine engine as such engines have a low oil capacity and a small sump capacity.

We claim:

1. For use with an engine arranged to drive a variable pitch airscrew, the combination with an engine lubricating system comprising a reservoir and an engine pressure oil conduit to deliver pressure oil to the engine, of a hydraulic constant speed governor unit comprising a pump, a hydraulic motor, a governor pressure conduit from

said pump to the hydraulic motor and a return oil conduit from said hydraulic motor to the suction side of said pump; of a branch conduit connected to said engine pressure oil conduit and to said return oil conduit; of a feathering and unfeathering unit comprising a second pump connected to withdraw oil from said reservoir and to deliver oil to said hydraulic motor through said governor pressure conduit, and an electric motor to drive said second pump; of a non-return valve in said branch conduit arranged to prevent oil flow from the return oil conduit to said engine pressure oil conduit; of a further conduit connected with said branch conduit between the non-return valve and the return oil conduit and arranged to deliver to the reservoir; and of a loaded valve in said further conduit arranged to open only when the pressure in said branch conduit reaches a selected value in excess of the pressure in the engine pressure oil conduit.

2. For use with an engine having a variable pitch airscrew, the combination with a circulatory engine oil pressure system, a constant speed governor unit for controlling the airscrew pitch comprising a closed hydraulic circuit, a conduit connecting the closed hydraulic circuit with the circulatory engine oil pressure system to convey oil from the engine oil pressure system to the closed hydraulic circuit, and a feathering and unfeathering hydraulic circuit for the airscrew, comprising a fluid reservoir and said conduit to convey return fluid of the feathering and unfeathering hydraulic circuit; of valve means connected in said conduit to prevent the return fluid of said feathering and unfeathering hydraulic circuit flowing into said engine oil pressure system, and means connected to convey said return fluid from said conduit to said reservoir and arranged to operate when the pressure of said return fluid in said conduit attains a selected value in excess of the pressure in said engine oil pressure circuit.

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