July 8, 1952 R. W. SCHROEDER ET AL 2,602,517

PROPELLER FEATHERING CONTROL SWITCH

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Fig. 1.

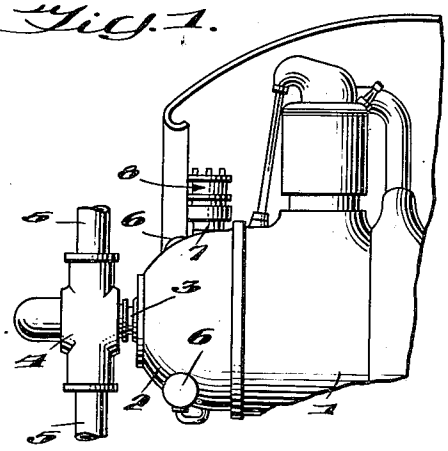


Fig. 8.

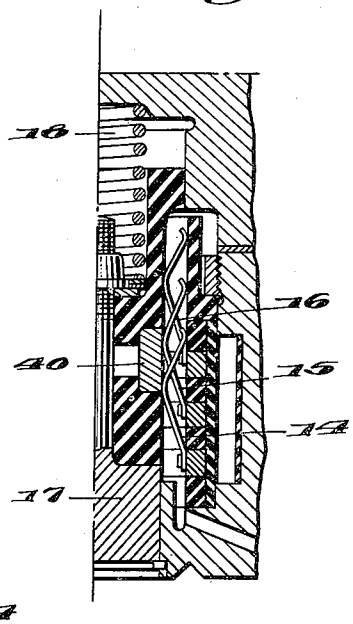


Fig. 6.

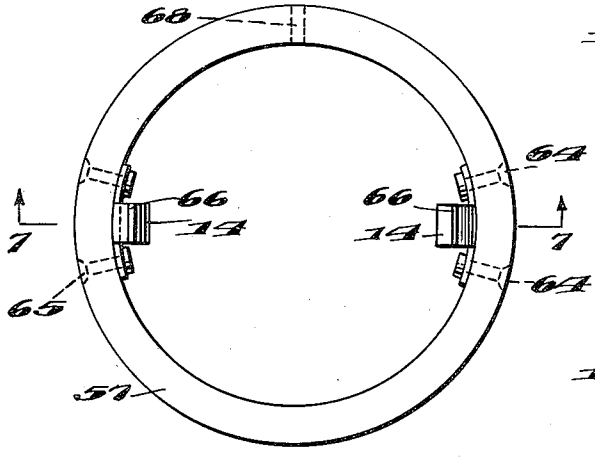


Fig. 9.

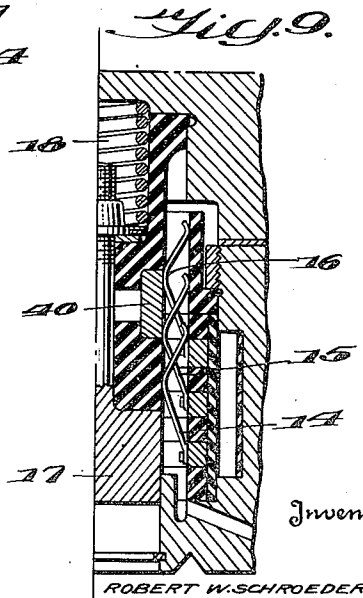
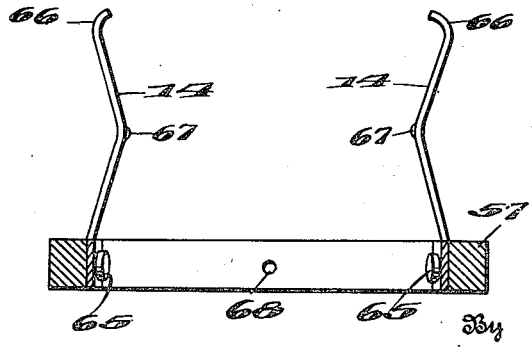


Fig. 7.



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Fig. 3.

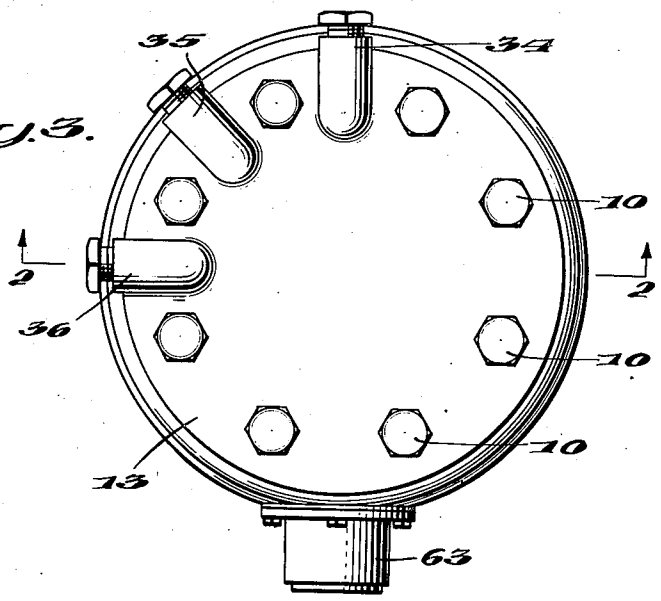
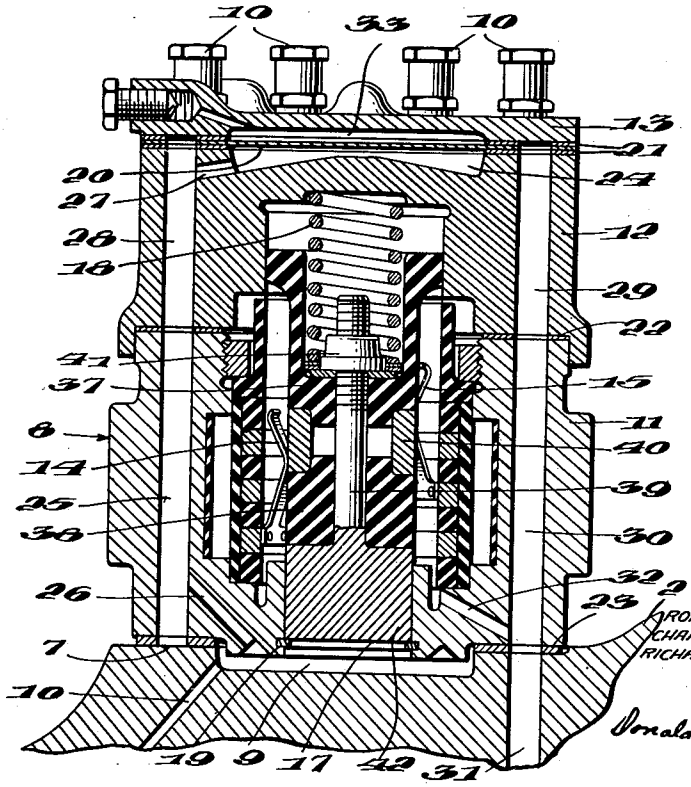


Fig. 2.



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Fig. 5.

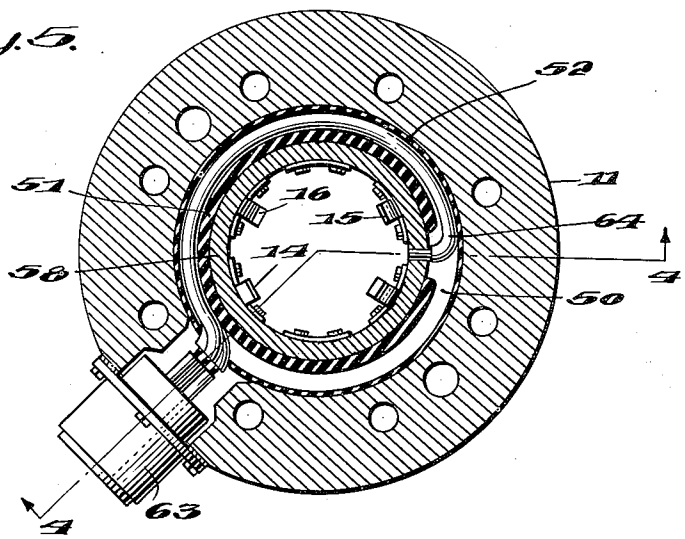
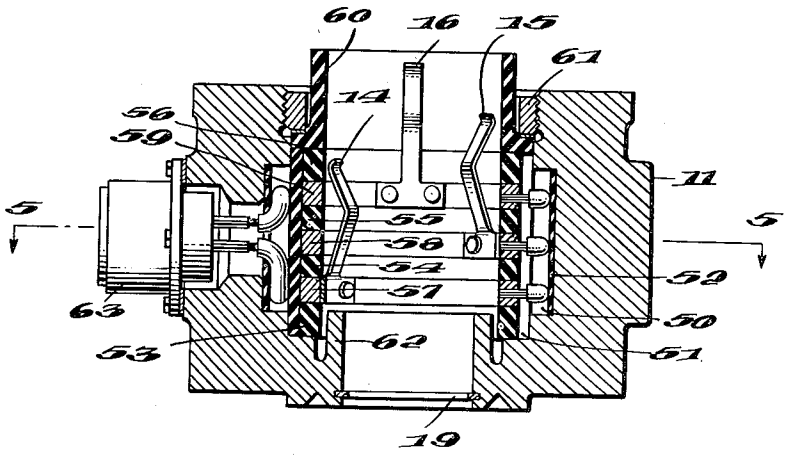


Fig. 4.



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PROPELLER FEATHERING CONTROL SWITCH

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Application January 20, 1948, Serial No. 3,288

7 Claims. (Cl. 170—135.72)

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This invention relates to an automatic feathering control system for airplane engine propellers, and more particularly to the switch mechanism that is actuated in response to the power output of the engine, which actuates the feathering control upon engine failure.

This invention relates to the subject matter of co-pending application Serial No. 756,768, filed June 24, 1947, now U. S. Patent No. 2,595,345, issued on May 6, 1952.

As described in the co-pending application, in the conventional two-engine airplane, a pilot at take-off is fully occupied with manipulating several controls from the time he leaves the runway through the take-off period until altitude is reached. If, during the critical period of take-off, one engine should fail, the pilot must cut that engine and feather the propeller to reduce drag, so that the airplane can continue take-off on one engine and reach altitude where the pilot will have time to investigate the cause of the engine failure and determine the proper action to be taken under the circumstances. The pilot must remember to feather the propeller of the engine that has failed, cut off the fuel booster pump, and cut off the engine to prevent restarting with a feathered propeller. Because of the several additional controls that must be operated upon the engine failure, in addition to the several controls that must be manipulated for normal take-off, it is obvious that even where an airplane is designed for single engine take-off, it may be very hazardous when one engine fails. There is the additional hazard resulting from the human element, in that the best of pilots might erroneously feather the propeller of the engine that is still delivering power. When he realizes that one engine has failed and that the proper procedure is to feather the propeller and cut off the engine, it is very easy to inadvertently feather the wrong propeller. The use of the automatic feathering control, including the pressure-operated switch of the present invention, will minimize the hazard during take-off, and relieve the pilot of much of the confusion resulting from an engine failure.

The switch mechanism of this invention is a part of the circuit employed to detect a bona fide engine failure, and transmit a signal of such engine failure to the feathering control. As described in the co-pending application, it is important that the mechanism for detecting a bona fide engine failure must be such that the signal is transmitted to the feathering control only after the engine has been brought up to full torque output before the loss in pressure in the torque

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meter circuit, indicating engine failure, takes place.

It is an object of this invention to provide a switch mechanism in an automatic feathering control system that will respond to the pressure from the torque meter system to actuate the feathering control device.

It is another object of this invention to provide a switch mechanism that may be inserted in the conventional torque meter circuit to take off from the circuit a signal indicating the power output of the engine.

It is another object of this invention to provide a switch mechanism of simple, rugged construction that will withstand the vibration encountered from being mounted on the engine in the torque meter circuit.

It is a further object of this invention to provide a switch mechanism that may be inserted in the torque meter circuit to convert a drop in pressure in the system into an electrical signal for the feathering control device indicating an engine failure.

Further and other objects will become apparent from the description of the accompanying drawing which forms a part of this disclosure and in which like numerals refer to like parts.

In the drawings:

Figure 1 is a fragmentary sectional view showing the location and arrangement of the structure of the present invention.

Figure 2 is a fragmentary sectional view taken on the line 2—2 of Figure 3 through the engine and pressure switch.

Figure 3 is a plan view of the switch assembly.

Figure 4 is a sectional view of the housing of the switch taken on the line 4—4 of Figure 5.

Figure 5 is a sectional view through the housing taken on the line 5—5 of Figure 4.

Figure 6 is a plan view of the contact springs and mounting ring.

Figure 7 is a sectional view taken on the line 7—7 of Figure 6.

Figures 8 and 9 are fragmentary sectional views of the piston and contact assembly shown under different conditions of pressure.

The engine and propeller assembly, shown in Figure 1, is a conventional arrangement of the engine and the controllable pitch propeller. The pitch of the propeller may be varied manually or automatically from flat to full feathered position, depending upon the requirements of the airplane. The pitch control mechanism may either comprise electrical or hydraulic components, or some of each. The internal combus-

tion engine 1 has a forward housing 2 through which the shaft 3 extends. Propeller hub 4 contains either hydraulic or electrical mechanism for controlling the pitch of propeller blades 5. Housing 2 contains a conventional torque meter, including a gear train actuating pistons to generate hydraulic pressure in cylinders 6. Pad 7 on housing 2 affords a mounting for the switch mechanism of this invention, generally indicated as 8, as shown in Figure 2. Pad 7 is formed with a depression 9. Passage 10 conducts oil under pressure from the torque meter mechanism to the chamber formed by depression 9. The switch assembly is secured to pad 7 by through bolts 10, as shown in Figure 3. The switch, generally indicated as 8, consists of a housing 11, cap member 12 and cover 13.

The housing 11 has assembled therein electrical contacts 14, 15 and 16, which will be more fully described in connection with Figures 4 to 7. Piston assembly 17 is inserted in body assembly 11 before cap member 12 is put in place on body assembly 11. Spring 18 extends between piston assembly 17 and cap 12 to hold the piston assembly in its initial position against lock ring 19. A diaphragm 20 is inserted between cover 13 and cap member 12. Suitable gaskets 21 are placed on each side of diaphragm 20 in the assembly. Gaskets 22 and 23 are placed between parts 12 and 11 and pad 7 to afford a suitable seal. Cap member 12 is formed with a depression 24 in the top to form a chamber on one side of diaphragm 20. Passages 25 and 26 are formed in housing 11 to afford a passageway for fluid from chamber 9 to chamber 24. Passages 27 and 28 are in communication with passages 25 and 26 to complete the passageway. Similarly aligned passages 29 and 30 form a return for fluid to passage 31 which communicates with the engine housing. Passage 32, formed in housing 11, provides a drain for any fluid that may seep past piston assembly 17 into the interior of the switch assembly. Cover member 13 is formed with a recess 33 forming, with diaphragm 20, a chamber. Cover 13 is also formed with plugged outlets 34, 35 and 36 in communication with recess 33. Outlet 35 affords a connection for a pressure line, so that the fluid pressure may be transmitted to some indicating instrument. Plugged outlets 34 and 36 then afford bleeder outlets for the hydraulic system. Pressure is transmitted from the torque meter system through passage 10, chamber 9 and passages 25, 26, 27 and 28 to chamber 24. The pressure is transmitted then by diaphragm 20 to the fluid in recess 33 and thence to outlet 35 to an indicator.

Piston assembly 17 consists of a piston 42 having a stem 39 secured thereto. Plugs 37 and 38, of any suitable non-conductor, complete the piston assembly and are cut out to afford a support for metallic ring 40. Nut 41 completes the assembly of piston 42 and members 37, 38 and 40. The outside diameter of the assembly formed by members 37, 38 and 40 is smooth and continuous. The upper portion of member 37 is flanged to afford a support for the piston assembly on the inside wall of cap 12.

Figures 4 and 5 show in section housing 11 with the electrical contacts assembled therein. Housing 11 is formed with a bore therethrough, the wall of which is undercut to form a chamber 50. A sleeve of non-conducting material 51 is placed over recess 50 to form therewith an annular chamber. A thin sheet of non-conducting material 52 is placed around the outer wall of annular chamber 50. Insulating rings 53, 54, 55 and 56 serve as spacers between metallic conductor rings 57, 58 and 59. These rings are stacked inside of sleeve 51 with a snug fit to form a compact assembly. Flanged non-conducting sleeve 60 is assembled on top of sleeve 51 and ring 56. Annular lock nut 61 holds the rings and sleeves securely assembled in body 11. Flange 62 extends upwardly from the bottom wall of member 11 and affords an elongated bearing surface for piston 42. One part of the electrical connector plug is shown at 63. Wires 64 extend from plug part 63 through annular chamber 50 to a slot in member 51 through which the wires extend into and are secured to rings 57, 58 and 59. A typical contact ring assembly is shown in Figures 6 and 7. Contacts 14 are shown secured to ring 57 by rivets 65. Contacts 14 are so formed that the ends 66 bear upon and slide upon the inner wall of non-conducting ring 56 and sleeve 60, as the spring is deflected. Springs 14 are so formed that with one end secured to ring 57 and the other end free to slide on member 60, the center portion 67 is held against the outer periphery of piston assembly 17 with a predetermined constant contact pressure. Hole 68 is formed in ring 57 to facilitate securing the end of wire 64 by soldering.

Figures 8 and 9 are more or less diagrammatic, and are intended to show the operations of the fluid-pressure-actuated switch. Ring 40 is shown of such an axial dimension that when the piston assembly is in the initial position under a condition of no pressure, electrical contact is completed through the ring between contacts 14 and 15. These contacts close the circuit in which they are connected when there is no torque being delivered by the engine as indicated by the low pressure in the torque meter system. As the pressure in the torque meter system builds up, with an increase in torque, piston assembly 17 moves axially of the switch, compressing spring 18. In the extreme position, or high torque pressure position, the circuit will be completed between contacts 15 and 16 by ring 40. Contacts 15 and 16 correspond to the high-torque switch 18 shown in the above-mentioned copending application and, as fully set forth therein, when electrical connection is made therebetween, a circuit is completed to "arm" the automatic feathering system so that it will be in condition to operate should the engine fail during takeoff. Similarly, contacts 14 and 15 correspond to low-torque switch 19 of the prior application and, as also described therein, are adapted, in the event of such an engine failure, to complete a circuit to initiate the automatic feathering operation of the associated propeller. Thus contacts 15 and 16 serve to sense high-torque operation of the engine while contacts 14 and 15 serve to sense low-torque operation thereof. Under full power operating conditions of the engine, the circuit will be maintained through contacts 15 and 16. Should the fluid pressure in the torque meter system drop below a predetermined amount, as determined by the spring 18, piston assembly 17 will move downwardly and ring 40 will make contact between contacts 14 and 15. The loss in pressure will be a signal of failing torque output in the engine and the making of the electrical circuit through contacts 14 and 15, after full horse power output has been reached by completing the circuit through contacts 15 and 16, will actuate the propeller feathering control circuit to feather the propeller of the engine as described in the copending application.

It is to be understood that certain changes, alterations, modifications and substitutions may be made without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In an airplane power plant having an engine and a torque meter for generating a fluid pressure signal proportionate to the torque output of the engine; torque sensing apparatus for use in an automatic propeller feathering system, comprising an electric switch mechanism connected to said torque meter and actuated in response to the fluid pressure signal from said torque meter, said switch mechanism including a housing having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring in said cylinder urging said piston toward a predetermined position upon a decrease in pressure in said torque meter, switch contacts in said housing, a member in said housing mounted on said piston to move therewith in response to the fluid pressure in said torque meter, said member coacting with said switch contacts to complete electrical connection therebetween upon said piston being returned to said predetermined position by said return spring upon a loss of fluid pressure in said torque meter to indicate a decrease in torque output of said engine below a predetermined value.

2. In an airplane power plant having an engine, torque sensing apparatus for use in an automatic propeller feathering system comprising a torque meter for generating a fluid pressure signal proportionate to the torque output of the engine, and an electric switch mechanism connected to said torque meter and actuated by the fluid pressure generated by said torque meter, said switch mechanism including a housing mounted on said engine and having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder movable between high and low pressure positions in response to variations in pressure in said torque meter, a return spring in said cylinder to restore said piston to its low pressure position upon a decrease in pressure in said torque meter, spaced switch contacts in said housing, and a member in said housing mounted on said piston to move therewith in response to the fluid pressure in said torque meter, said member coacting with said switch contacts to complete electrical connection therebetween upon said piston being returned to the low pressure position by said return spring upon a loss of fluid pressure in said torque meter to indicate a decrease in torque output of said engine.

3. In an airplane having an engine, torque sensing apparatus for use in an automatic propeller feathering system comprising a torque meter associated with said engine for generating a fluid pressure signal which varies with the torque output of the engine, an electric switch mechanism connected to said torque meter; said switch mechanism comprising a housing having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring in said cylinder to restore said piston to a predetermined position upon a decrease in pressure in said torque meter, switch contacts in said housing adjacent said cylinder, a member in said housing mounted on said piston to move therewith in response to the fluid pressure in said torque meter, said member coacting with said switch contacts to complete electrical connection therebetween upon said piston being moved to said predetermined position by said return spring upon a loss of fluid pressure in said torque meter to indicate a decrease in torque output of said engine.

4. In an airplane having an engine, torque sensing apparatus, for use in an automatic propeller feathering system comprising a torque meter for generating a fluid pressure signal proportionate to the torque output of the engine, an electric switch mechanism mounted on said engine and connected to said torque meter and actuated in response to the fluid pressure signal from said torque meter, said switch mechanism including a housing having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring to restore said piston to a predetermined position upon a drop of pressure in said torque meter, a switch contact support formed by a plurality of metal rings surrounding said cylinder extending inwardly of the housing therefrom, spacer rings of insulating material positioning said metal rings axially of the housing, said metal rings each having mounted thereon a plurality of resilient switch contacts, a member mounted on said piston to be moved therewith, said member being of such an axial extent that the contacts of the first two rings are electrically connected in said predetermined position to indicate that said torque is below a predetermined value, and upon an increase in pressure to a predetermined value, said member is moved by said piston to electrically disconnect the contacts of the first two rings and electrically connect the contacts of the next two rings to indicate high torque output from said engine.

5. In an airplane having an engine, torque sensing apparatus for use in an automatic propeller feathering system comprising a torque meter associated with said engine for generating a fluid pressure signal proportionate to the torque output of the engine, an electric switch mechanism connected to said torque meter and actuated by the fluid pressure generated by said torque meter, said switch mechanism including a housing having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring in said cylinder to restore said piston to a predetermined position upon a decrease in pressure in said torque meter, spaced switch contacts in said housing, a metal member mounted on said piston to move therewith in response to the fluid pressure in said torque meter, said member adapted to bridge said contacts to complete electrical connection between said switch contacts upon said piston being returned to said predetermined position by said return spring upon a loss of fluid pressure in said torque meter to indicate a decrease in torque output of said engine.

6. In an airplane having an engine, torque sensing apparatus for use in an automatic propeller feathering system comprising a torque meter associated with said engine for generating a fluid pressure signal in response to the torque output of the engine, an electric switch mechanism connected to said torque meter for operation thereby; said switch mechanism comprising a housing having a cylinder formed therein in fluid communication with said torque meter, a

piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring in said cylinder to restore said piston to a predetermined position upon a decrease in pressure in said torque meter, switch contacts in said housing, and an annular metallic member in said housing mounted on said piston to move therewith in response to the fluid pressure in said torque meter, said member interconnecting said switch contacts to complete electrical connection therebetween upon said piston being returned to said predetermined position by said return spring upon a loss of fluid pressure in said torque meter to indicate a decrease in torque output of said engine.

7. In an airplane power plant having an engine and a torque meter associated therewith for generating a fluid pressure signal proportionate to the torque output of the engine; torque sensing apparatus for use in an automatic propeller feathering system, comprising a switch mechanism connected to said torque meter and actuated in response to the fluid pressure signal from said torque meter, said switch mechanism including a housing having a cylinder formed therein in fluid communication with said torque meter, a piston in said cylinder moved in response to variations in pressure in said torque meter, a return spring to restore said piston to a predetermined position upon a drop of pressure in said torque meter, a switch contact support formed by a plurality of metal rings surrounding said cylinder extending inwardly of the housing therefrom, spacer rings of insulating material positioning said metal rings axially of the housing, said metal rings each having mounted thereon a plurality of resilient switch contacts, an annular member of conducting material mounted on said

piston to be moved therewith of such an axial extent that the contacts of the first two rings are electrically connected thereby in said predetermined position, and upon operation of the engine causing an increase in pressure in the torque meter, said member is moved by said piston to electrically disconnect the contacts of the first two rings, and upon a decrease in torque meter pressure, said member is moved by the return spring to again close said electrical contacts of said first two rings to indicate a decrease in torque output of the engine.

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