Nov. 12, 1940. P. KOLLSMAN 2,221,547

HEAT PROTECTED PITOT STATIC TUBE

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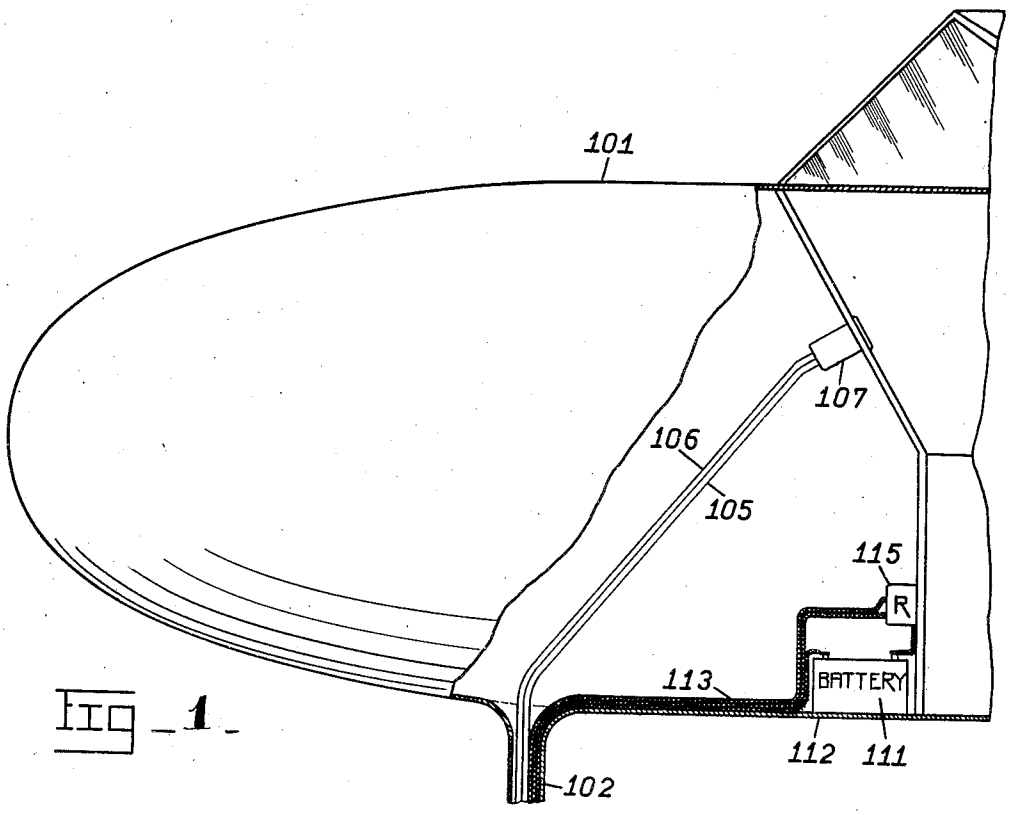


Fig. 1.

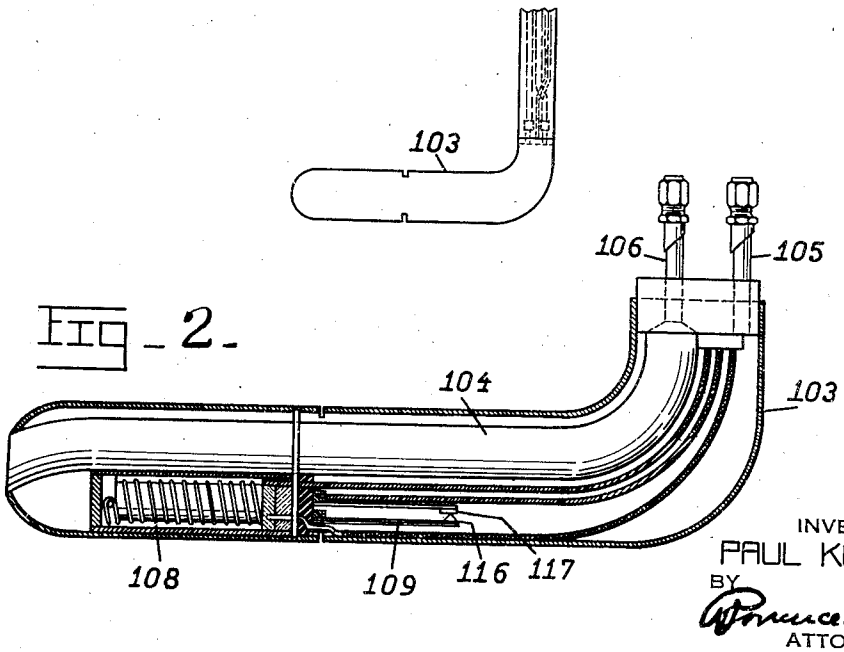


Fig. 2.

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Fig. 6.

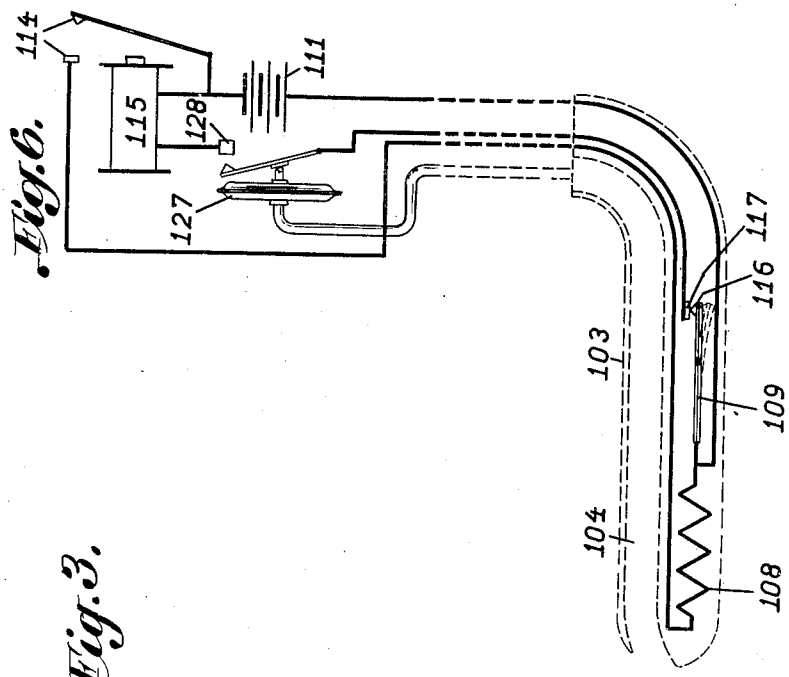


Fig. 3.

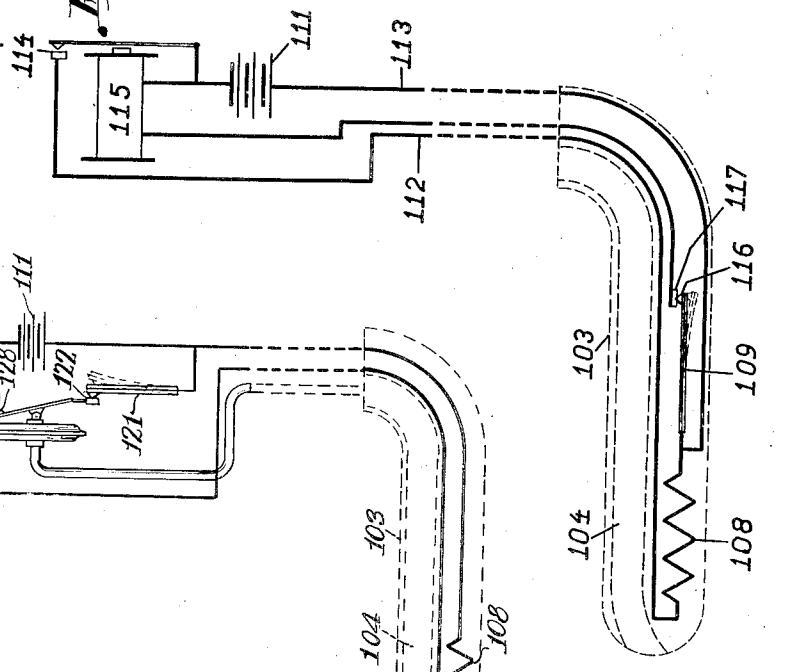


Fig. 7.

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Fig. 4.

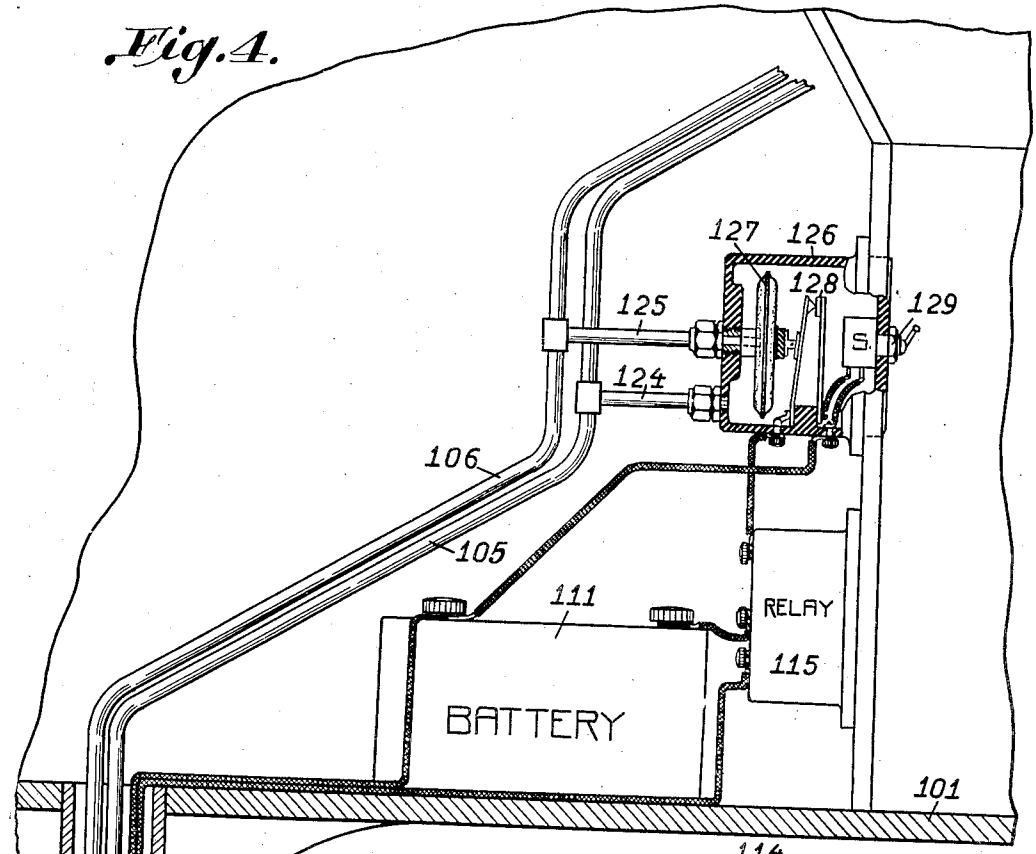
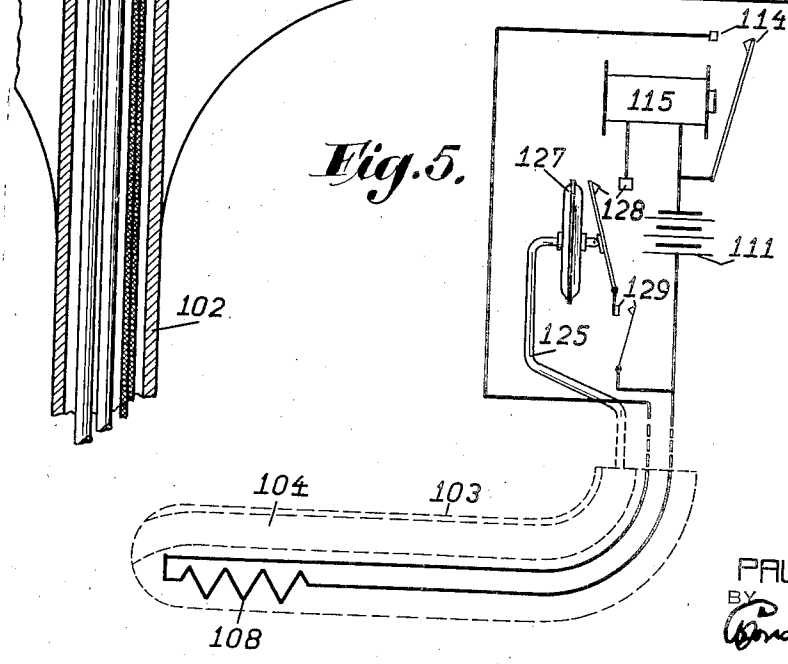


Fig. 5.



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UNITED STATES PATENT OFFICE

2,221,547

HEAT PROTECTED PITOT-STATIC TUBE

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Application March 12, 1938, Serial No. 195,465

8 Claims. (Cl. 73—212)

This invention relates to Pitot-static tubes of the type adapted for use with airplanes for the determination of the air speed of the craft and relates particularly to heating systems for keeping the Pitot-static tubes free from ice, snow and sleet.

The prevention of the accumulation of ice upon and in the ports of such a tube is vital for its proper functioning. In an electrical heating system for Pitot-static tubes injuries may occur to the heating element, thus requiring frequent replacement of the heater. Accordingly provision for opening and closing the tube is necessary for replacing the heating element which may lead to weaknesses in the tube structure. Under my invention I prefer an integral, streamlined metallic tube or shell for the Pitot-static tube proper, within which I provide part of a heating system having automatic provisions capable of supplying heat, conductively transferred throughout the Pitot-static tube to prevent the formation of ice and, in addition so controlled as to prevent over-heating and the burning out of the heater even if the air exposure temperature to which the tube is subjected be relatively high.

In aerial navigation, particularly under conditions of fog, ice and snow, an air speed indicator is an essential instrument from which to compute distance traveled by a dead reckoning procedure. But under conditions of fog, snow and ice, particularly at temperatures close to the freezing point, the Pitot-static tube portion of the indicator tends to fill with ice and snow and to fail of functioning. In order to avoid this failure, it is customary to provide an electric heater adjacent the entrance end of the dynamic pressure duct, which serves to raise the temperature of the Pitot-static tube above the melting point of ice, thereby preventing adherence of congealed water to the exterior tube surfaces and melting out any congealed moisture which may enter the dynamic pressure duct. Difficulty is, however, experienced with such heaters in maintaining them in operative condition because of the low amount of heat which can be dissipated from the tube structure during non-flying periods and the relatively much larger amount of energy required to function for adequate heating during flight intervals. That is, with a plane on the ground in summer weather, a heat energy conversion in the heater of more than a very few watts will overheat the heater and burn it out, whereas in flight under icing conditions, a minimum of about 50 watts is required to keep the tube free of ice. This requires that the heater be switched on when icing conditions occur and switched off before landing, else the heater will be burned out and inoperative for the next ascent and the air speed meter may fail for this reason. Furthermore, a heater control for the tube under the pilot's hands is highly objectionable item, since it is another thing to burden the memory of a pilot already overloaded and the necessity of protecting the tube heater may result in neglect of some other more important instrument or control, with consequent accident or death.

In attaining the object of safeguarding the heater, I propose two provisions, either one of which is useful. A local temperature controlled switch in the circuit of the heater may be employed to cut off the current supply when the temperature of the tube and of the heater approaches an unsafe maximum and to turn it on when the temperature of the tube approaches an undesirable minimum. (I prefer to turn on current at a drop of temperature below 10° C. and to cut off the current at 20° C.)

The present invention provides means for the automatic protection of the Pitot tube and heater by the supply to the tube of sufficient heat energy during intervals of flying at low temperatures and cuts off the energy supplied to the heater during non-flying intervals and during flying at safe temperatures through the operation, individually or simultaneously of a pressure actuated switch responsive to dynamic air pressures and of a temperature responsive mechanism which is actuated by the ambient air temperature surrounding the Pitot-static tube, the dynamic duct therein or the airplane itself.

Objectively my invention effects a saving in expended heater energy, lower maximum temperature at a standstill of a plane when the heater circuit is left on and the elimination of replaceable heater units.

The invention further provides a special type of relay operating in conjunction with a temperature responsive or pressure-responsive member, simultaneously or one at a time, in conjunction with a heater member adjacent the dynamic duct of a Pitot-static tube.

An object of the invention thus is to turn on a Pitot-static tube heater automatically during intervals of flying at low temperatures and to turn it off during intervals of flying at safe temperatures.

Another object of the invention is to turn on a

Pitot-static tube heater during flying intervals and to turn it off during non-flying intervals.

Still another object of the invention is to turn on a Pitot-static tube during flying intervals at low temperatures and to turn it off during non-flying intervals and during flying intervals at safe temperatures.

Still another object of the invention is to relay-control the heater current to a Pitot-static tube heater.

Yet another object of the invention is to relay-control the heater current to a Pitot-static tube heater by the combined action of a pressure-sensitive and temperature-responsive mechanism.

Still a further object of the invention is to shut off automatically the heater current during non-flying intervals, to shut off the heater current automatically during flying at safe temperatures and to permit a shutting off of the heater current manually during intervals when the heater is not needed, particularly when the plane is laid up out of service.

Other objects and structural details of the invention will be apparent from the following description when read in connection with the accompanying drawings, wherein:

Fig. 1 is a view in side elevation, partly in section, of an airplane fuselage equipped with the Pitot-static tube and protecting members of the device of the invention;

Fig. 2 is a view in vertical section of the Pitot-static tube and heater member of Fig. 7;

Fig. 3 is a diagrammatic view of the heater, heater circuits and protecting mechanism of the embodiment of Figs. 1 and 2;

Fig. 4 is a side view, partly in section, of an airplane fuselage equipped with an alternative form of the Pitot tube protecting mechanism;

Fig. 5 is a diagrammatic view of the tube and protecting mechanism of the embodiment of Fig. 11;

Fig. 6 is a diagrammatic view of circuits and apparatus of still another embodiment of the invention;

Fig. 7 is a diagrammatic view of circuits and apparatus of another embodiment of the invention.

In the embodiment of the invention shown in Figs. 1, 2 and 3 the heat sensitive member is placed within the Pitot-static shell to control a relay having heavy, rugged contacts mounted in a position where the contacts are readily reached for maintenance. As shown in Fig. 1, the airplane fuselage 101 has mounted thereon a strut member 102 carrying the shell 103, within which there is mounted the dynamic duct 104 of the Pitot tube structure. The shell 103 serves as the static pressure means, from which the static pressure at any given elevation is conveyed through a tube member 105 to instruments which require an accurate static pressure, such as the sensitive altimeter and the air speed indicator. Simultaneously, the dynamic pressure from the duct 104 is conveyed through a tube 106 to the air speed indicator 107 and such other instruments as utilize the dynamic pressure, mounted upon the instrument board. A heater member 108 is mounted within the streamlined Pitot-static shell 103 adjacent the dynamic duct 104 for the purpose of supplying heat thereto in sufficient quantities to prevent the formation and attachment of ice to the inner and outer surfaces of the tube and shell. Also within the shell 103 there is provided a temperature-responsive member 109, which may conveniently be a strip of the brass-invar steel material, well known as "bi-metal." A source of heating energy 111 such as a battery or a power driven generator is provided and connected, as shown in Fig. 3, to the heater 108 by appropriate leads 112 and 113, the circuit passing through the contacts 114 of a relay 115. The bi-metal 109 has an attached contact 116 which cooperates with a second contact 117. These contacts are connected in circuit with the winding of the relay 115.

As long as the temperature of the ambient air through which the plane is flying is above freezing or above a temperature of about 40 degrees Fahrenheit, the bi-metal member 109 holds the contacts 116 and 117 separated, open-circuiting the relay 115 and leaving the relay contacts 114 open, thereby preventing the flow of current through the heater 108. When, however, the temperature of the ambient atmosphere falls much below about 40 degrees, thereby approaching icing temperatures, the bi-metal 109 closes the contacts 116 and 117, energizes the relay 115 from the current source 111, thereby closing the contacts 114 and energizing the heater 108. Thus, it will be observed that while the temperature-responsive member is positioned within the shell of the Pitot tube, the duty required of the control contacts is so much reduced and so light that failures practically never occur and the heavier duty imposed upon the heater circuit contacts is readily carried since the relay contacts are convenient of access. Thus, the device of the invention provides a highly rugged automatic control for the heater member in a Pitot tube structure.

This type of automatic heater thus removes from the pilot's memory and consciousness all necessity for paying attention to any controls for the maintenance of his air speed indicator in operating condition. The power circuit control contacts are readily accessible for servicing by the ground crew, and the heater current is turned on automatically as soon as possible icing temperatures are reached and remains turned on until the temperature rises above the icing point. In addition, the pilot may land without the necessity of attention to the air speed indicator, and may land fully assured that the heater will not be injured by excess power or overheating and with the assurance that the heater will be ready for immediate service at the next flight.

It is not necessary that the temperature-responsive elements be in the immediate neighborhood of the Pitot tube since it is the temperature of the atmospheric air which determines whether the heater current shall be on or off and not the actual temperature of the Pitot tube. Accordingly the structure of Fig. 7 may be utilized as an alternative embodiment which will be described later.

The presence of an air stream above some threshold velocity past the surface of the Pitot tube will insure the safety of the heater member against burn-out and accordingly, the heater member may be turned on as soon as flying speed is reached and may remain turned on until a landing is made.

For this purpose the embodiment shown in Figs. 4 and 5 may be utilized. In this embodiment the same strut member 102 attached to the fuselage 101 may be utilized with the Pitot shell 103 and dynamic duct 104 therein. Branch pipes 124 and 125 may be led from the dynamic duct

106 and the static duct 105 to the pressure-responsive member 126.

The pressure-responsive member 126 may contain a pressure actuated capsule 127 connected to the dynamic duct 106 and the casing of the member 126 may be connected to the static duct 105 and shell 103. Adjacent the capsule 127 there are provided contacts 128 which are connected in the coil circuit of the relay 115, as shown in Fig. 5. An auxiliary hand switch 129 may be connected in series with the contacts 128, to complete the relay coil circuit. The heater member 108 is connected to the power source 111 through leads, as shown, and through the relay contacts 114.

In the operation of this embodiment, the hand switch 129 may be closed at any convenient time, but the contacts 128 remain open until flying speed is obtained and the dynamic pressure built up in the duct 104 to such a value as to expand the capsule 127 and thereby close the contacts 128, thus closing the coil circuit of the relay 115, and attracting its armature to close the contacts 114. This permits current to flow in the heater 108, which will continue as long as flying speed is maintained, or until the switch 129 is opened by hand. If the switch 129 is not opened by hand but the plane lands, the loss of flying speed reduces the pressure in the capsule 127 and thereby opens the contacts 128 to de-energize the relay 115, open its contacts 114 and de-energize the heater 108, thereby preventing a burn-out.

Thus, since flying speed provides an air stream over the Pitot-static tube shell structure sufficiently great to remove from it any excess amount of heat which might injure the heater, the heater may be energized during all flying periods, under the control of the dynamic pressure in the capsule 127, thus likewise freeing the pilot from the necessity of remembering his Pitot tube heater to make sure that it functions when needed and does not burn out. That is, a fully satisfactory protection of the tube and of the heater is obtainable by the simple feature of dynamic pressure control of the heater power supply circuit.

In some instances it may be desired to conserve the electrical energy supply to the utmost, such as during flying in Arctic regions where the normal ground temperatures may on occasion be below freezing. The embodiment of Fig. 6 provides this function by a combination of temperature-sensitive control and pressure control.

As shown in Fig. 6, a similar Pitot-static tube structure is provided consisting of a similar shell 103 housing a dynamic duct 104, adjacent to which is a similar heater 108, the whole structure being mounted in any desired way, such as upon a strut of the same kind as the strut 102 shown in Fig. 1. A pressure responsive capsule 127 is provided and connected to respond to the dynamic pressure in a manner similar to the capsule shown in Fig. 4. In addition the capsule may also be acted upon by the static pressure, as hereinbefore described. The capsule 127 operates the contacts 128 for the control of current in the relay coil 115. A temperature-responsive member, which may be a bi-metal strip 109, actuates the contacts 116 and 117. These contacts are connected in series with the contacts 128 and the relay coil 115, the entire circuit being energized by the power supply 111. The relay contacts 114 are closed by the relay when both contacts 116—117 and contacts 128 are closed, thereby supplying heater power from the power supply 111 to the heater 108.

In the operation of this embodiment of the invention, the heat-sensitive member 109 will close the contacts 116—117 when the termperature approaches the freezing point, or goes below. But the relay circuit is not closed until flying speed is obtained which provides sufficient dynamic pressure to actuate the capsule 127 and close the contacts 128. Thus, if in flight a temperature safely above the icing point is reached, the contacts 116—117 open, which opens the relay circuit and thereby opens the relay contacts to disconnect the power supply to the heater 108, without regard to the presence or absence of flying speed. Similarly, if the plane lands, the lack of dynamic pressure opens the contacts 128, similarly disconnecting the heater power from the heater 108 without regard to the ambient temperature.

Thus, this embodiment of the invention provides a fully automatic control of the Pitot tube heater which not only protects the heater and the air speed indicator readings, but conserves the utmost possible heating power.

It is of course not necessary that the temperature-responsive member be positioned in the Pitot tube shell structure. It may be instead positioned at any convenient point which partakes of the temperature of the air through which the plane is flying, as is shown in Fig. 7.

The embodiment of Fig. 7 utilizes a similar static shell member 103 supported upon a convenient strut, of the type shown in Fig. 1. The shell 103 contains the dynamic duct 104 and heater 108. The capsule 127 is responsive to the dynamic pressure, as previously described, for the operation of the contacts 128 which are connected as previously described in connection with Figs. 4 to 6. The temperature-sensitive member 121 is placed in any convenient position where it will partake of the normal ambient air temperature, and the contacts 122 controlled by the temperature-responsive member 121 are connected in series with the contacts 128 in a manner analogous to that of the embodiment of Fig. 6, for the control of the relay 115 and its contacts 114, which turns the current on and off to the heater 108.

The operation of this embodiment is closely similar to the operation of the embodiment of Fig. 6.

Thus, the device of the invention provides a simple system for the continued protection of an air speed indicator system, in which a heater is provided for preventing the accumulation of ice, snow and sleet in and upon a Pitot-static tube structure and in which the heater member is fully protected against the danger of burn-out without burdening the pilot's memory or hands with controls and the necessity of operating them to turn the heater current on during icing conditions and to turn it off upon landing.

While there are above disclosed but a limited number of embodiments of the device of the invention, it is possible to provide still other embodiments without departing from the inventive concept herein disclosed and it is therefore desired that only such limitations be imposed upon the appended claims as are stated therein.

What I claim and desire to secure by United States Letters Patent is:

1. The combination with a Pitot-static tube for aircraft having metallic static and dynamic pressure ports; of an electric heating element arranged to heat said ports; and means responsive to the speed of the craft for controlling a

flow of electrical energy to said heating element.

2. The combination with a Pitot-static tube having metallic static and dynamic pressure ports; of an electric heating element arranged to heat said ports; and means responsive to a difference in pressure between said static and said dynamic pressure ports for controlling a flow of electrical energy to said heating element.

3. The combination with a Pitot-static tube having metallic static and dynamic pressure ports; of an electric heating element arranged to heat said ports; and pressure responsive means connected to said dynamic pressure port for controlling a flow of electrical energy to said heating element.

4. The combination with a Pitot-static tube having metallic static and dynamic pressure conduits; of an electric heating element arranged to heat said conduits; a switch connected to control a flow of electrical energy to said heating element; and a pressure responsive means responsive to the pressure in said dynamic pressure conduit, said pressure responsive means being connected to actuate said switch.

5. The combination with a Pitot-static tube having metallic static and dynamic pressure ports; of an electric heating element arranged to heat said ports; a switch connected to control a flow of electrical energy to said heating element; and a diaphragm responsive to a difference in pressure between said static and said dynamic pressure ports, said diaphragm being connected to operate said switch.

6. The combination with a Pitot-static tube including a metallic shell member having static and dynamic pressure conduits therein; of an electric heating element arranged to heat said shell; a relay including a winding and an armature, the armature being connected to control a flow of electrical energy to said heating element; a switch connected to control a flow of electrical energy to said winding; and a diaphragm responsive to a difference in pressure between said static and said dynaanic pressure conduits, said diaphragm being connected to opearte said switch.

7. The combination with a Pitot-static tube including a metallic shell member having static and dynamic pressure conduits therein; of an electric heating element arranged to heat said shell; a relay including a winding and an armature, the armature being connected to control a flow of electrical energy to said heating element; a temperature responsive first switch within said shell; a second switch, said first and said second switch being connected jointly to control a flow of electrical energy to said winding; and a diaphragm responsive to a difference in pressure between said static and said dynamic pressure conduits, said diaphragm being connected to operate said second switch.

8. The combination with a Pitot-static tube having metallic static and dynamic pressure conduits; of an electric heating element arranged to heat said conduits; a relay including a winding and an armature, said armature being connected to control a flow of electrical energy to said heating element; a temperature responsive first switch responsive to changes in temperature of the atmospheric air; a second switch, said first and said second switch being connected jointly to control a flow of electrical energy to said winding; and a diaphragm responsive to a difference in pressure between said static and said dynamic pressure conduits, said diaphragm being connected to operate said second switch.

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