Nov. 4, 1958 | J. H. HICKEY | 2,858,698

PITOT DEICER

Filed Nov. 20, 1953

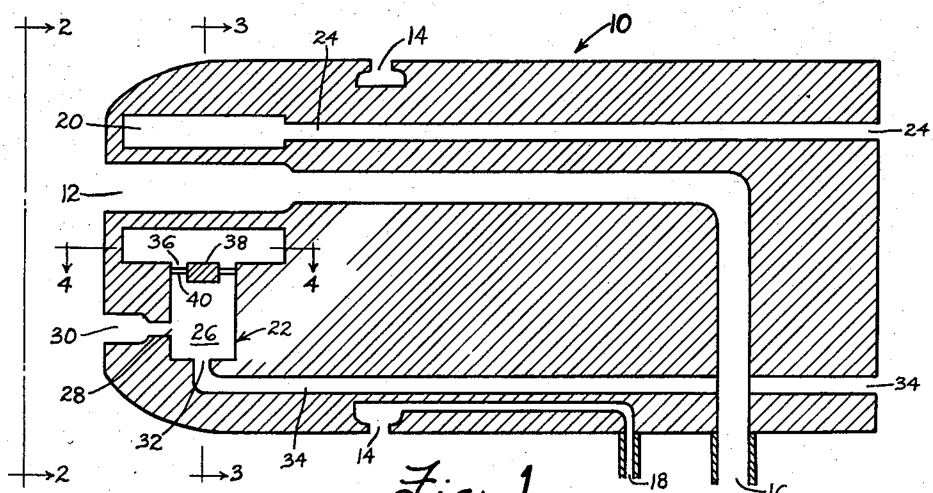

Fig. 1

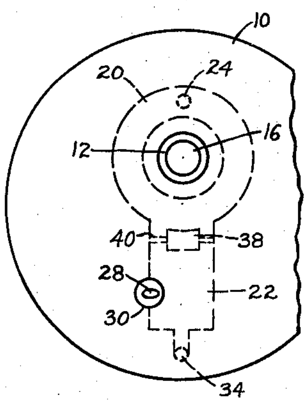

Fig. 2

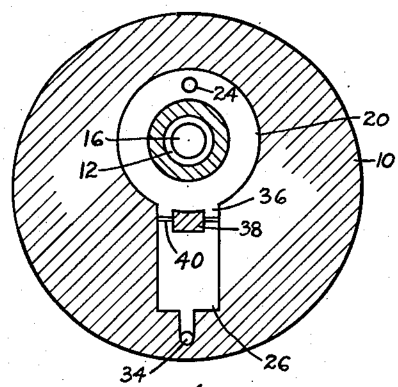

Fig. 3

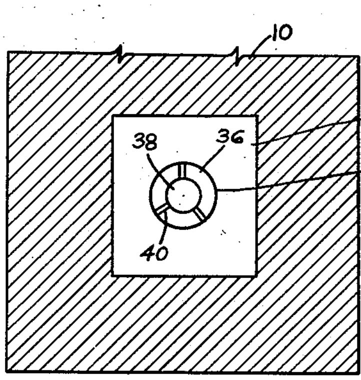

Fig. 4

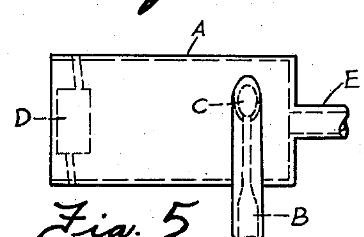

Fig. 5

INVENTOR

JOHN H. HICKEY

BY D. B. Snyder

R. I. Tompkins

ATTORNEYS

United States Patent Office

2,858,698

Patented Nov. 4, 1958

2,858,698

PITOT DEICER

John H. Hickey, Port Washington, N. Y.

Application November 20, 1953, Serial No. 393,525

4 Claims. (Cl. 73—212)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a device for preventing ice from forming around Pitot tubes.

The Pitot static tube is used in aeronautics to give the air speed of the airplane by combining a Pitot tube and a static tube or piezometer to form a pressure nozzle, and when used with a manometer, will determine the relative speed of a fluid. At low altitudes the Pitot tube operates efficiently to indicate the speed of the airplane. However, when high altitudes are used, the temperature drop is great and ice will form around the Pitot tube mouth, causing inaccurate determinations of air speed. Many attempts have been made to reduce the formation of ice, but with limited success. For example, it has been proposed to heat the Pitot tube, electrically, or in other ways, but the excess drain on the battery makes it inadvisable to use the deicing means continuously.

The instant invention overcomes the prior failures in the application of the principles of the vortex or Hilsch tube. In this manner, the inlet of the Pitot tube is maintained in ice free condition at all times and at a minimum of cost and maintenance.

A primary object of the invention is to provide a device that will prevent ice formation on the air speed indicating means of an airplane.

Another object of the invention is to provide a device that employs the principle of the vortex tube to use the heat obtained by the whirling motion of the air in the chamber to prevent ice formation on an air speed indicator.

More specifically it is an object of the invention to introduce a vortex tube in proximity to the Pitot tube used in aircraft to provide the heat necessary to prevent formation of ice when the aircraft attains high altitudes.

Another object of the invention is to provide a heat producing means that requires no moving parts and therefore, no maintenance.

Still another object of the invention is to provide a device that is simple and economical in construction, is readily installed and is strong and desirable for its intended use.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical section of the invention,

Fig. 2 is an end view of the device,

Fig. 3 is a section taken on line 3—3 of Fig. 1,

Fig. 4 is an enlarged detail of the heat producing means of the invention, and

Fig. 5 illustrates a vortex tube per se and the tangential air entry nozzle.

The vortex tube employed in the invention is illustrated in Fig. 5 and is of the counterflow type where the two

streams of gas travel in opposite directions. The vortex tube consists of a cylindrical tube A with a conduit nozzle B entering the cross-section tangentially at C at the outer periphery of tube A. While any point of entry on the periphery may be used, it is generally desirable to do so closer to one end of the tube. The end furthest away is the hot end and contains a restrictive member D acting as a throttle valve, while the end nearest the nozzle has an axial outlet tube E and is the cold orifice. In operation, the working fluid, generally air, enters conduit B and is discharged into cylinder A tangentially, creating a vortex. A portion of the fluid, depending on design and control, discharges through the hot side and the remainder through the cold outlet. Several theories have been advanced to explain the principle of operation. The most accepted one concerning the vortex tube effect considers the temperature differences obtained as due to a migration of kinetic energy due to viscous shear stresses within the rotating mass of gas produced by the vortex formed when fluid under ram pressure (or under pressure), enters the chamber. This vortex adheres to the law of constant angular momentum, where the velocity times the radius of any particle is a constant. Thus the inner radius of the tube near the axial center is small, and the radius increases towards the inner periphery of the tube with the tangential velocity highest at the axis of the tube and least at the periphery. This is an example of irrotational flow. Velocity distribution is changed by the tendency of any viscous flow to equalize its velocity distribution as the vortex expands axially and the irrotational flow changes to rotational flow. This changing velocity distribution causes transfer of kinetic energy outward from the tube axis. The kinetic energy transfer raises the temperature of the outer gas layer and lowers the temperature of the inner layers. However, since a temperature difference exists in the gas, a heat transfer results, where the heat energy flows from the hot outer layers to the cold inner layers. A rotational flow near the axis builds up and the pressure of the gas increases, as well as a pressure gradient towards the cold orifice. While this rotational flow builds up, the innermost layers separate and proceed out of the cold orifice, this action continuing until the irrotational flow is changed to a rotational one. The remaining gas, under rotational flow, travels axially and out of the hot end of tube A. The difference in temperature of the two streams is due to the overall kinetic energy flow outward being greater than the heat flow inward.

Referring to the invention in detail, the application of the vortex tube as a means to prevent formation of ice around a Pitot tube is illustrated in Figures 1–4. Housing **10** includes the usual Pitot tube **12** and annular static tube **14**. These tubes are connected by conduits **16** and **18** respectively to a manometer (not shown), by means of which the relative air speed is determined. Such expedient is well known and need not be further explained.

Surrounding Pitot tube **12** is an annular chamber **20** adapted to receive heated air from vortex tube **22**. Spent hot air is exhausted by means of conduit **24** through the rear of housing **10**.

Vortex tube **22** comprises a cylindrical pressure chamber **26** having tangential inlet **28** admitting built up ram, or air pressure by means of inlet conduit **30**. At one end of chamber **26** is an axial outlet **32** for removal of the cold air to the atmosphere through passage **34**. A coaxial annular outlet **36** is provided at the other end of vortex chamber **22** for removal of the hot air. Baffle **38** is held in spaced relation from the inner walls of chamber **22** by any suitable means, such as spiders **40**, at the outlet end **36** to provide the annular outlet means for removal of the hot air stream.

In operation, the modified Pitot tube is placed under the wings of an aircraft, or in any desired position to obtain air speeds. Ordinarily, at high altitudes, there would be a danger of ice formation around the mouth of the tube, rendering it useless. However, due to the movement of the aircraft, air intake means **30** supplies air under pressure in vortex tube chamber **26**. Due to the tangential construction of aperture **28**, a rotation of the air stream takes place in the chamber in a path of circular cross-section. The tangential velocity is highest at the axial center of chamber **26** and decreases as the periphery of the chamber is approached. The energy produced raises the temperature of the outer gas layer and lowers the temperature of the inner gas layer. The innermost cold layer passes out to the atmosphere through axial outlet **32** and passage **34**. Baffle **38** prevents any chance passage of cold air through the opposite side of chamber **26**. Annular outlet **36** enables the hot air produced in the vortex chamber to pass into annular chamber **20**. Chamber **20** closely surrounds Pitot tube **12** and serves to maintain the temperature sufficiently high to prevent ice formation around the mouth of the tube. Heated air is constantly supplied to chamber **20** by means of the continuous action of vortex tube **22** while the aircraft is in motion. Spent air is exhausted to the atmosphere by means of conduit **24**.

The device is very effective, for there are no moving parts to be maintained. Performance is therefore reliable and the cost of installation is at a minimum.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A Pitot structure comprising an elongated body, said body being provided with a Pitot passageway having an inlet portion, a first chamber surrounding and substantially coextensive with the length of the inlet portion of said Pitot passageway, a circular vortex chamber mounted in said body and communicating at one end thereof with said first named chamber, a discharge outlet in said vortex chamber and means providing an air inlet passage in said body and tangentially connected to said vortex chamber opposite the end communicating with said first chamber, whereby cold and heated layers of air are obtained and the heated layer enters said first chamber and the cold layer is discharged through said discharge outlet.

2. The combination of claim 1, wherein said vortex chamber includes a baffle adjacent the end communicating with said first chamber and means securing said baffle in spaced relation from the walls of the vortex chamber to discharge the heated layer in an annular stream.

3. The combination of claim 2, wherein said first chamber includes an exhaust conduit extending through said body to exhaust spent heated air to the atmosphere.

4. The combination of claim 3 wherein said vortex chamber is positioned normal to the longitudinal axis of the first chamber and said cold air discharge outlet is axially connected to said vortex chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,952,281	Ranque	Mar. 27, 1934
2,179,500	Diehl	Nov. 14, 1939
2,706,408	Holbrook	Apr. 19, 1955

FOREIGN PATENTS

871,408	France	Jan. 15, 1942