

April 30, 1946.

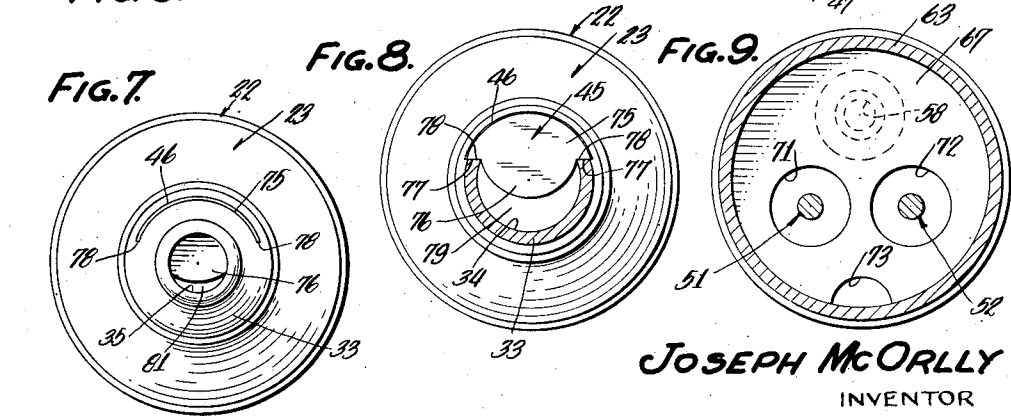
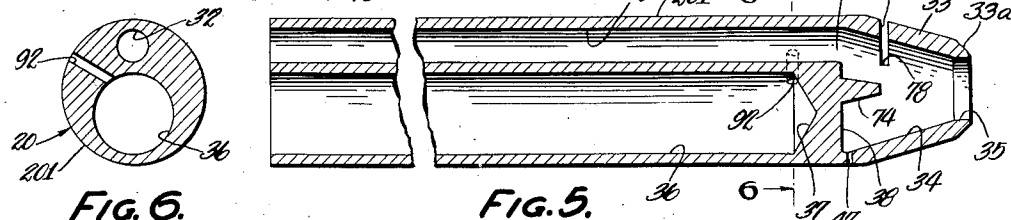
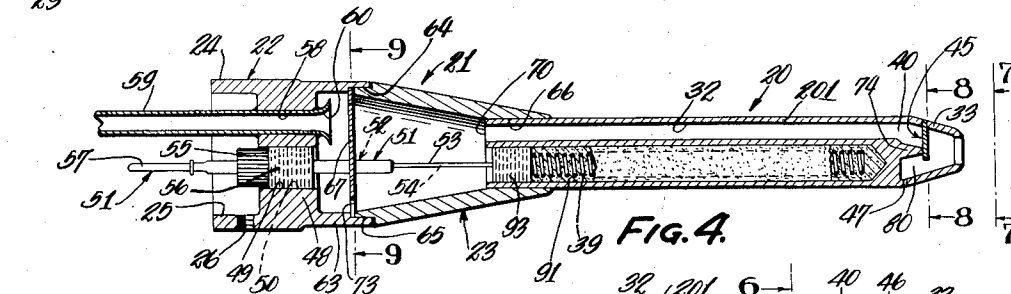
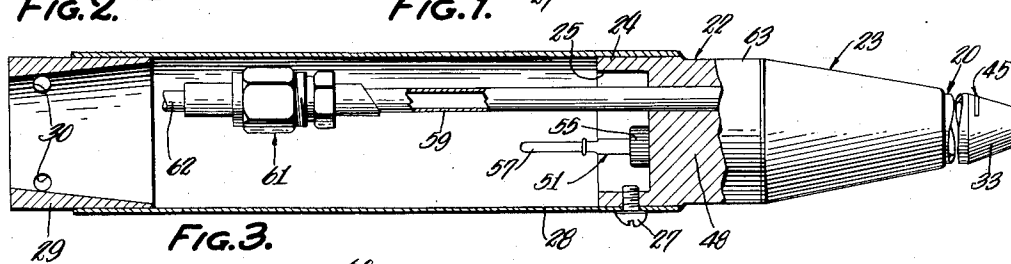
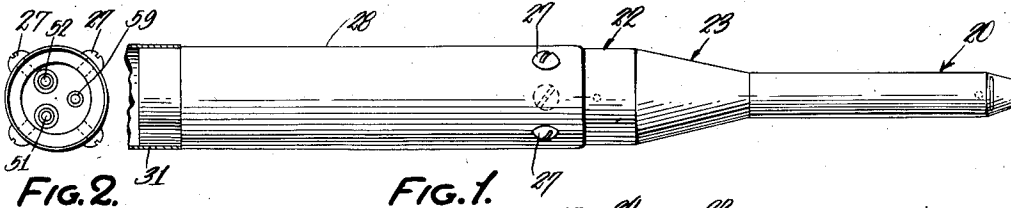
J. McORLLY

2,399,370

PITOT TUBE

Filed April 5, 1943

2 Sheets-Sheet 1



JOSEPH McORLLY
INVENTOR

BY *Treeman, Sweet, Albrecht, and Williams*
ATTORNEYS

April 30, 1946.

J. McORLLY

2,399,370

PITOT TUBE

Filed April 5, 1943

2 Sheets-Sheet 2

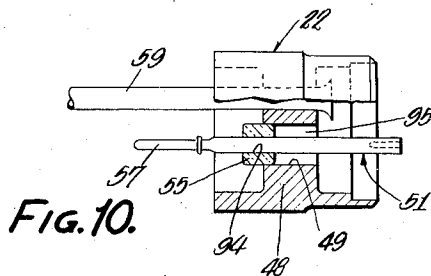


FIG. 10.

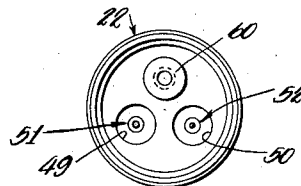


FIG. 11.

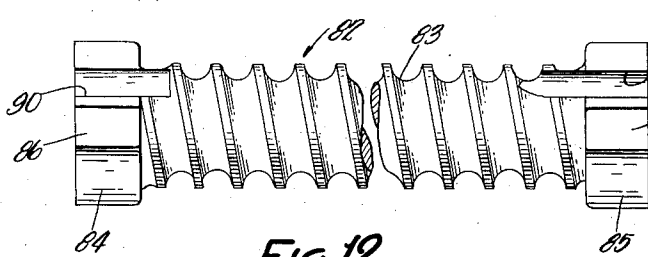


FIG. 12.

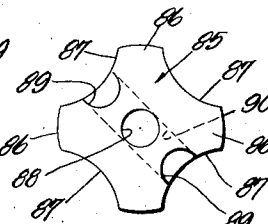


FIG. 13.

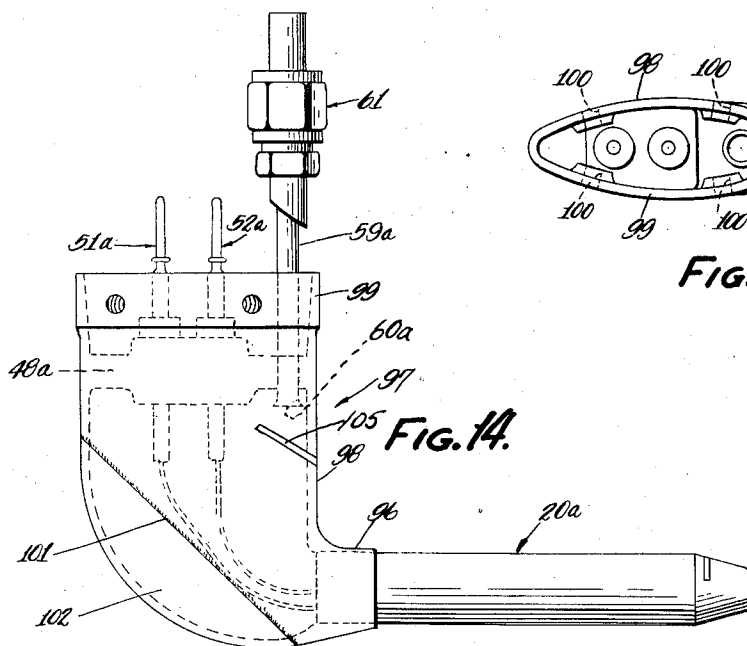


FIG. 14.

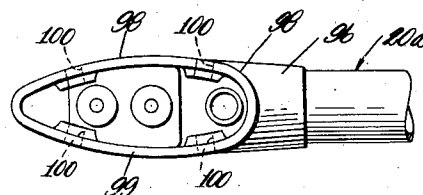


FIG. 15.

JOSEPH McORLLY

INVENTOR

BY *Freeman, Sweet, Abbott & Williams*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,399,370

PITOT TUBE

Joseph McOrlly, Pittsburgh, Pa., assignor, by
mesne assignments, to Edwin L. Wiegand Com-
pany, Pittsburgh, Pa., a corporation of Pennsyl-
vania

Application April 5, 1943, Serial No. 481,797

3 Claims. (Cl. 73—212)

This invention relates to Pitot tubes and more particularly such tubes as are used in connection with air speed indicators for indicating the speed of an airplane in flight. More specifically the invention relates to electrically heated Pitot tubes. The principal object of the invention is the provision of new and improved Pitot tubes of these types.

In the drawings accompanying this specification, and forming a part of this application, there are shown, for purposes of illustration, several forms which the invention may assume, and in these drawings:

Figure 1 is a plan view of a Pitot tube embodying the invention, along with a mounting means therefor partly broken away.

Figure 2 is an end view of the construction shown in Figure 1.

Figure 3 is a broken view on an enlarged scale, partly in longitudinal vertical section, of the construction shown in Figure 1, the section being taken on a plane at right angles to Figure 1.

Figure 4 is a longitudinal vertical sectional view of a Pitot tube embodying the invention on the same scale as Figure 3.

Figure 5 is a longitudinal sectional view of a part of the construction shown in Figure 4, on an enlarged scale.

Figure 6 is a section taken on the line 6—6 of Figure 5.

Figure 7 is an end view, on an enlarged scale, taken on the line 7—7 of Figure 4, looking in the direction of the arrows.

Figure 8 is a sectional view, on an enlarged scale, taken on the line 8—8 of Figure 4.

Figure 9 is a sectional view, on an enlarged scale, taken on the line 9—9 of Figure 4.

Figure 10 is a side elevation partly in vertical longitudinal section of a detail.

Figure 11 is an end view looking at the right end of the detail shown in Figure 10.

Figure 12 is a broken side elevational view of a detail.

Figure 13 is an end view looking at the right hand end of the detail of Figure 12.

Figure 14 is a side elevation of another Pitot tube embodying the invention and.

Figure 15 is a fragmentary plan view of the Pitot tube shown in Figure 14.

The Pitot tube shown in Figures 1 through 4 comprises a nose 20 and sealed chamber means 21 connected to the rear end of the nose. The chamber means 21 here shown comprises a generally cylindrical portion 22, of larger diameter than that of the nose 20, connected to the large

end of a frusto-conical portion 23 the small end of which is connected to the rear end of the nose. The cylindrical portion 22 of the chamber means includes a cylindrical flange 24 formed by an axially extending recess 25, and the flange 24 is here shown as provided with screw threaded holes 26 adapted to receive screws 27 which serve to fasten a cylindrical tube 28 to the flange 24. The other end of the tube 28 is here shown as having silver soldered or otherwise suitably fastened thereto a bushing 29 provided with screw threaded holes 30. The free end of the bushing 29 is adapted to be inserted in a tube 31 having holes (not shown) registering with the holes 30 of the bushing 29 and is adapted to be fastened to the bushing by screws (not shown) cooperating with the threaded holes. The tube 31 may be mounted in the leading edge of the wing of an airplane or other suitable portion of the airplane, so that when the bushing 29 is inserted in and fastened to the tube 31, the Pitot tube will extend in the direction of flight of the airplane.

The nose 20 of the Pitot tube includes a single piece 201 of copper, bronze, or other suitable material, preferably corrosion-resistant and having good heat-conductivity. The piece 201 is here shown as of circular cross-sectional outline, having a longitudinal passage 32 extending from a port 70 at the rear, to the tip 33 of the nose and communicating through a port 40 into a chamber 34 in the tip of the nose and thence with a dynamic pressure orifice 35 in the tip. The nose piece 201 has a longitudinally extending recess 36, here shown as of circular cross-sectional outline, extending from the rear of the nose piece 201 forwardly and terminating in a closed end 37 adjacent the rear wall 38 of the chamber 34 in the tip of the nose. Contained in the recess 36 is electrical heating means comprising a resistor 39 and hereinafter more fully described. Disposed in the chamber 34, and interposed between the port 40 and the orifice 35 is baffle means 45, of brass or other suitable material, fitting in a slot 46 through the upper wall portion of the tip 33 of the nose. The baffle means 45, hereinafter more fully described, is silver soldered or otherwise suitably fastened in the slot so as to be in effect integral with the tip of the nose. The outside principal surface of the tip 33 and the inside peripheral surface of the chamber 34 are frusto-conical, of equal taper, and the tip is here shown as having a bevel surface portion 33a of larger taper than the principal surface of the tip. The bottom of the chamber 34 is pro-

vided with a drain opening 47 preferably at its lowest point.

The cylindrical portion 22 of the chamber means 21 has a transverse wall 48 provided with two apertures 43, 50 through which extend terminals 51, 52 connected respectively to lead conductors 53, 54 to the resistor 39 of the heating means, the terminal means 51, 52 being each insulated from the walls of the respective apertures 49, 50 by suitable insulating means 55, 56 hereinafter described. The terminals 51, 52 have reduced end portions 57 adapted to cooperate with socket contacts in a receptacle connected to conductors (not shown), whereby these terminals may be connected to a source of electricity. The wall 48 has an aperture 58 into which extends an air tube 59 having a port 60 communicating with the inside of the chamber means 21. The air tube 59 is silver soldered or otherwise suitably fastened and sealed in the aperture 58. As shown in Figure 3 the air tube 59 may be connected by any suitable union 61 to an air tube 62 extending to an air speed indicating instrument.

As here shown the generally cylindrical portion 22 of the chamber means 21 has a cylindrical flange 63, and this flange has a counter bore 64 to receive a cylindrical end surface 65 formed on the rear end of the frusto-conical portion 23. The counter bore 64 and surface 65 are silver soldered or otherwise suitably fastened and sealed to each other, and the opening 66 in the smaller end of the portion 23 is silver soldered or otherwise suitably fastened and sealed to the nose piece 201, so that the chamber means 21 is air-tight except, of course, for the port 60 into the air tube and the entrance thereto from the passage 32. If desired a baffle 67 may be interposed between the port 60 of the air tube 59 and the port 70 of the longitudinal passage 32, this baffle having apertures 71, 72 (see Figure 9) substantially larger than the terminals 51, 52 and so located as to be respectively concentric with the terminals. The baffle 67 may have an aperture 73, here shown as arcuate, in its lower margin, but the aperture is not essential as will further appear. The baffle 67 may be disposed and held between the shoulder formed by the counter bore 64 in the flange 63 and the cooperating end of the conical portion 23.

The nose piece 201 of the Pitot tube is shown separately in Figure 5, the heating means 39 and the baffle 45 being removed. The chamber 34 in the tip of the nose piece 201 is desirably formed by applying a suitable drill to the end surface of the tip of the nose piece, the drill being disposed so that its axis is eccentric with respect to the surface of the tip of the nose piece and so that the axis of the drill is at an angle with respect to the axis of the nose piece. The drill is rotated about its own axis and at the same time the nose piece is rotated about its axis, with the result that the inside peripheral wall of the chamber 34 formed by this operation is frusto-conical. This operation results in leaving a nubbin 74 of conical form extending forwardly from the wall 33 of the chamber. The nubbin 74 has its end cut off so that the end defines a plane which just clears the baffle 45 when the latter is inserted in the slot 46.

The baffle 45 has a segmental upper portion 75 the upper arcuate margin of which conforms to and is flush with the adjacent outside surface of the tip 33 of the nose, and has a segmental lower portion 76 having an arcuate lower mar-

gin of smaller radius forming shoulders 77 which are adapted to abut the lower ends 78 of the slot 46. The construction and arrangement is such that the lower arcuate margin of the baffle 45 leaves below it a lune or crescent-shaped aperture 79 the tips of the crescent being directed generally upwardly, that is, generally toward the general axis of the longitudinal passage 32. The baffle 45 prevents direct stream line flow from the orifice 35 into the port 40 into the longitudinal passage 32. It will be evident that air entering through the orifice 35 cannot reach the port 40 without first passing through the crescent-shaped aperture 79 underneath the baffle 45, thence into the lower part of the annular chamber 80 at the rear of the plane of the baffle, and thence upwardly to the port 40 and thence into the passage 32. The cross-sectional area of the annular chamber 80, between the plane of the port 40 and the plane of the baffle 45, is obviously substantially larger than the cross-sectional area of the crescent-shaped aperture 79 as well as substantially larger than the cross-sectional area of the port 40. The cross-sectional area of the crescent-shaped aperture 79 is preferably made equal to the cross-sectional area of the orifice 35. Thus, in the embodiment disclosed the cross-sectional area of the orifice 35 is substantially less than the cross-sectional area of the annular chamber 80 between the plane of the port 40 and the plane of the baffle 45 but is substantially larger than the area of the port 40. As here embodied, and as can be seen in Figure 7, some air entering in a normal direction through the orifice 35 may enter the lower part of the annular chamber 80 directly since the lower margin of the portion 76 of the baffle 45 leaves a small crescent-shaped area 81, as viewed in normal aspect, when looking normally through the orifice 35.

The resistor 39 may be wound on a core 82 of porcelain or other suitable insulating material which in its central portion has a helical groove 83 for receiving the resistor, and which at its ends is provided with flanges 84, 85 providing circumferentially spaced projections 86, in this instance four, by reason of the omission of circumferentially spaced portions of the flanges here shown as arcuate recesses 87. The core 82 is provided with a central hole 90 through which one end of the resistor wire 39 may be threaded so that this end of the resistor wire may be brought out at the same end of the core at which the resistor wire starts in the helical groove. The resistor wire 39 may enter the groove 83 from a recess 89 and leave the groove and enter a slot 90 and thence into and through the hole 83.

The resistor 39 assembled with the core 82 is inserted into the open end of the elongated recess 36, the core being of course stopped by the bottom of the recess. The projections 86 are of such radial extent that they serve to center the core 82, and hence the resistor 39, in concentric relation with respect to the inside wall of the recess 36. Suitable refractory electrical insulating material 91 is then extruded into the spaces left between the resistor 39 and the core 82 and between the both of these and the inside of the recess 36, air being permitted to be displaced by the insulating material by reason of a vent aperture 92 extending through the nose piece 201 into the recess 36 near the end 37 thereof. In case the insulating material 91 is of a dry granular or comminuted nature it may be run into the open end of the recess and compacted

by vibration, for example. It will be evident that the physical nature of the insulating material 91 introduced into the spaces left between the resistor 39, the core 82, and resistor and core assembly and the inside of the recess 36 will determine in what manner it is to be introduced and further treated, if desired, as by baking or otherwise. The final result in any case is a resistor 39 which is embedded in compacted refractory insulating material 91 which is in direct heat conducting relation to the inside wall of the recess 36. Desirably, the insulating material 91 consists of or includes refractory material which while electrically insulating is at the same time a good heat conductor.

To complete the assembly of the heating means comprising the resistor 39 with and as part of the nose 20, the space between the end of the resistor and core assembly and the open end of the recess 36 is sealed with molten glass 93, solidified, or with any other suitable insulating seal which will also effectively seal the recess against the entrance of air and moisture; and the vent aperture 92 is sealed with silver solder or other suitable sealing means.

The insulating seals for the terminals 51, 52, one of which (51) may be seen in Figure 10, may include a bushing 55 of porcelain or any other suitable insulating material, this bushing having an outside diameter which is slightly less than the inside diameter of the aperture 49 in the wall 48. The diameter of the hole, 94, in the bushing 55 is slightly larger than the diameter of the shank of the terminal 51 disposed therein. The bushing 55 is here shown as partly inserted in the aperture 49 of the wall 48; and to complete the terminal seal ground glass cullet is tamped into the space 95 left between the terminal 51 and the inside wall of the aperture 49. The entire cylindrical portion 22 is then fired to a temperature sufficient to bring the ground glass cullet to a desired molten state whereupon by a suitable ram (not shown) the glass in the plastic state is rammed toward the bushing 55 (suitably held) so as to get rid of any air bubbles or voids. The glass adheres to the shank of the terminal 51 and to the inside wall of the aperture 49 and to the bushing 55 so as to give an air-tight glass seal 56 (Figure 4). The right hand end of the molten glass may be suitably held and the bushing 55 rammed against the glass, if desired. The use of a bushing 55 is desirable but not essential as it is possible to replace the bushing with glass by the use of a suitable removable mold (not shown) forming a continuation of the left hand end of the aperture 49 whereby the glass in the mold will project from the left hand face of the wall 48 in the same manner as does the bushing 55, this projecting portion of the glass being in this case a unitary part of the glass which is within the aperture 49. The projecting portion of the bushing serves to increase the electrical creepage resistance.

Satisfactory materials for the portion 22 and the terminals 51, 52 have been found to be brass for the portion 22 and stainless steel for the terminals 51, 52, these materials and the ground glass cullet being chosen so as to have coefficients of expansion such that the seal will remain tight and effectively mechanical-shock resistant. Stainless steel has the advantage that the glass, in the molten state, "wets" the steel; also, it possesses considerable strength as compared to other metals and will stand more vibration,

rough handling, etc., without flexing or damaging the seal. However, the invention is not limited to the use of the particular materials hereinbefore mentioned.

The Pitot tube may be dull nickel plated against corrosion even though corrosion-resistant materials are used throughout. In the disclosed construction it is possible to drill the drain hole 47 before nickel plating, if desired, so that the inside surface of the hole will also be nickel plated.

Referring now to Figures 14 and 15, there is here shown an embodiment of the invention in which the nose 20a of the Pitot tube is identical with the nose 20 of the Pitot tube in the embodiment hereinbefore described but in this instance the nose 20a is silver soldered or otherwise suitably fastened in an aperture in a portion 96 of an adaptor means 97 generally in the form of an elbow. The adaptor means 97 is here shown as having a body portion 98 provided with a wall 48a analogous to the wall 48 in the portion 22. The wall 48a has an aperture through which extends an air tube 59a which may be connected to an air tube leading to a speed indicating instrument, similarly to the air tube 59. Also extending through the wall 48a are a pair of terminals 51a, 52a connected to lead wires to the heating means in the nose 20a of the Pitot tube. The terminals 51a, 52a and the air tube 59a are sealed in the respective apertures in the wall 48a through which they pass in a manner already set forth in connection with the previously described embodiment. The upper portion of the adaptor means 97, as viewed in Figure 14, is provided with a flange 99 having screw threaded holes 100 adapted to receive screws (not shown) for fastening the adaptor means to a tube (not shown) having a section adapted to fit the cross-sectional outline of the flange, said tube being carried by some part of the airplane and extending in such direction that the axis of the nose 20a is directed in the line of flight of the airplane. The adaptor means 97 may be made in the form of a die casting and is divided along the plane 101 so that the adaptor means is completed by a portion 102, thereby providing access to the inside of the adaptor means, whereby the electrical connections between terminals 51a, 52a and the leads to the resistor in the nose 20a may be made, and thereafter the portion 102 is silver soldered or otherwise suitably fastened and sealed to the main part of the body portion 98 along the joint defined by the plane 101. The joint between the portion 102 and the portion 98 has a minimum perimeter to seal and therefore a minimum chance for leaks. The body portion 98 of the adaptor means is of oval stream line cross-sectional outline as may be seen in Figure 15, this outline being uniform from the top of the body portion 98 to the portion 96.

The operation of the Pitot tube will now be described with reference to Figures 1 through 9. As the nose 20 moves in the direction of flight of the airplane, air enters through the dynamic pressure orifice 35 into the chamber 34 in the tip 33 of the nose. Thus the air in the chamber 34 is put under pressure. By reason of the baffle 45 air can enter the port 40 only by first passing through the crescent-shaped aperture 79 into the chamber 80 thence to the port 40. Thus the air in the passage 32, in the chamber means 21, and the tube 59 is put under pressure dependent upon the speed of the airplane, and thus pressure is transmitted through the tube 62 to the speed indicating instrument responsive to that pres-

sure. The baffle 45 stops and deflects downwardly water spray or moisture which is then promptly drained off through the drain hole 47. This of course prevents water and moisture from getting into the passage 32.

Under icing or frosting conditions the chamber 34 might become so clogged as to prevent true speed indication, or even to completely cut off air pressure into the passage 32 so that no speed indication at all will be given. The heating means comprising the resistor 39 is provided particularly to guard against such conditions but also serves to evaporate moisture when icing conditions do not obtain. It will be evident that the heating means is in effect integral with the nose 20, the resistor 39 being embedded in insulating material 91 which is in direct heat-conducting relation with the inside wall of the recess 36 forming a metallic sheath for the insulating material. The wall of the recess 36 is an integral part of the metallic nose piece 201 so that heat is transferred directly from the resistor 39 to all parts of the nose piece including the integral tip 33. Thus, the walls of the chamber 34 including its rear wall 38 are thoroughly heated. The baffle 45 is in effect integral with the nose piece 201 so that the baffle is efficiently heated. While the nubbin 74 is not indispensable, it aids in bringing heat from the wall 33 into the chamber 34 and to the baffle 45.

By reason of the excellent heat transfer from the resistor 39 to all parts of the nose 20 the latter is either freed of moisture or ice or kept free of moisture or ice even under icing conditions where the temperature is 40° below zero Fahrenheit or lower, with an expenditure of electrical energy in the resistor 39 as little as 80 watts. Furthermore, by reason of the excellent heat transfer to ample heat dissipating areas of the nose 20 the resistor 39 may, if desired, be supplied with current, continuously, even when the airplane is not in motion, and in normal summer ambient temperatures. Hence the circuit to the resistor may be completed even at the take-off, even in summer, it being unnecessary for the aviator to wait until cold altitudes are reached or to guess whether moisture conditions or icing conditions obtain. Naturally, automatic devices for cutting in the resistor are unnecessary.

For purposes of showing the proportions of the parts the principal dimensions of one embodiment of the invention may be mentioned. The cylindrical portion of the nose 20 has a length outwardly from the part 23 of approximately 3 inches and an outside diameter of approximately 0.55 of an inch. The axial length of the frusto-conical tip portion 33 is approximately $\frac{3}{4}$ of an inch. The taper of the principal surface of the tip 33 and the taper of the inside peripheral surface of the chamber 34 are both equal to approximately 16½°. The bevel surface portion 33a of the tip 33 has an axial length of approximately $\frac{1}{8}$ of an inch and a taper of approximately 45°. The area of the orifice 35 is approximately 0.049 of a square inch. The area of the crescent-shaped aperture 79 is approximately 0.049 of a square inch and the area of the passage 32 is approximately 0.0145 of a square inch. The baffle 45 is spaced approximately $\frac{1}{3}$ of an inch from the extremity of the tip 33. The diameter of the drain hole 47 is approximately $\frac{3}{16}$ of an inch. The diameter of the recess 36 is approximately $\frac{1}{3}$ of an inch. It will be understood that the dimensions herein given are by way of illustration only and that the invention is not limited thereto.

In addition to features hereinbefore mentioned, it will be evident that a Pitot tube in accordance with the invention requires but few simple parts, readily assembled. Threaded fittings are eliminated. The parts are corrosion-resisting, rugged, solid, and ruggedly assembled. There are no light gage shells. The heating means is sealed against moisture. The terminal pins 51, 52 are in effect mechanically integral with the tube, the joint between them and the tube being mechanically shock proof and maintaining the chamber means 21 sealed under air pressure tests. In general, all joints are in effect integral, rugged, and air-tight.

Tests show that a Pitot tube in accordance with the invention passes all requirements, including de-icing speed; wattage, voltage and current tolerances; dielectric test; pressure test; immersion test; magnetic interference test; endurance and power consumption test; heat conductivity; maximum weight; accuracy of speed indication, etc. The accuracy of speed indication is such that there is an error of less than one mile per hour with speeds of 50 to 400 miles per hour.

Tests have shown that no drain hole is necessary for the chamber means 21 because it has been found that in a Pitot tube made in accordance with the invention, if moisture reaches the inside of the chamber means 21 either in front of or behind the baffle 67, it will be evaporated by the heat in the chamber means. The single drain hole 47 in the tip of the nose has been found to be sufficient. The baffle 67 may be retained however, if desired, as it may be used to serve the purpose of minimizing the transmission of air pressure pulsations into the port 60. Also, if moisture should get past the baffle 45 into the passage 32 it would strike the baffle 67, and even if it eventually got past the baffle 67, through the apertures 71, 72, for example, it will not enter the air tube 59, even if the airplane is in vertical flight because the terminal margin of the port portion 60 is above the adjacent surface of the wall 48 so as to provide a slight reservoir; and to further safeguard this port against entrance of moisture the walls of the port portion are flared outwardly as clearly shown in Figure 4.

The operation of the embodiment shown in Figures 14 and 15 is obvious from that of the previously described embodiment. It will be evident that since the nose 20a is identical with the nose 20, such noses may be manufactured separately and readily combined with other parts to form either the straight type of Pitot tube shown in Figure 1 or the elbow type shown in Figure 14, for example.

If desired, a baffle 105 may be provided in the embodiment shown in Figure 14, this baffle being inserted and fastened in a slot in the body portion 98 in a manner similar to the way in which the baffle 45 is installed in the tip of the Pitot tube. The baffle 105 will serve to shed any moisture which might drop from the air passage of the tube 20a if the airplane should be flying horizontally upside down, thereby preventing such moisture from dropping into the end 60a of the air tube 59a.

From the foregoing it will be apparent to those skilled in the art that each of the illustrated embodiments of the invention provides a new and improved Pitot tube and accordingly, each accomplishes the principal object of the invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiments of the invention may be variously changed and

modified, or features thereof, singly or collectively, embodied in other combinations than those illustrated, without departing from the spirit of the invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and the invention is not limited thereto.

I claim:

1. A Pitot tube, comprising: a nose including a tip portion having a dynamic pressure orifice into a chamber in said tip portion, and including a main portion extending rearwardly from said tip portion and having a longitudinal passage having a port into said chamber; said chamber having a frusto-conical inside wall tapering forwardly to said orifice; and baffle means in said chamber, interposed between said orifice and said port, so constructed and arranged that it leaves an area of communication substantially equal to said orifice, said area of communication being generally transverse to and offset from the general axis of said port and being of generally crescent outline the points of which are directed generally toward the general axis of said port.

2. A Pitot tube, comprising: a nose including a tip portion having a dynamic pressure orifice into a chamber in said tip portion, and including a main portion extending rearwardly from said tip portion and having a longitudinal passage having a port into said chamber; said chamber having a frusto-conical inside wall tapering for-

wardly to said orifice; baffle means in said chamber, interposed between said orifice and said port, so constructed and arranged that it leaves an area of communication substantially equal to said orifice, said area of communication being generally transverse to and offset from the general axis of said port and being of generally crescent outline the points of which are directed generally toward the general axis of said port; and said chamber having a drain through the bottom wall thereof, between said port and said baffle means.

3. A Pitot tube, comprising: a nose having a dynamic pressure orifice and including a portion having a passage having an opening in the rear of said nose and communicating with said orifice; chamber means comprising tubular means having an opening at one end cooperable with the rear of said nose, and said chamber means comprising end wall means separate from said tubular means, said tubular means having an opening at its other end cooperable with said end wall means for forming a joint therewith; dynamic pressure tube means communicating with the inside of said chamber means, said pressure tube means being sealed in said end wall means; baffle means, in said chamber means, abutted at opposite sides by portions of said end wall means and said other end of said tubular means; and means for sealing said joint and holding said baffle means in place.

JOSEPH MCORILLY.