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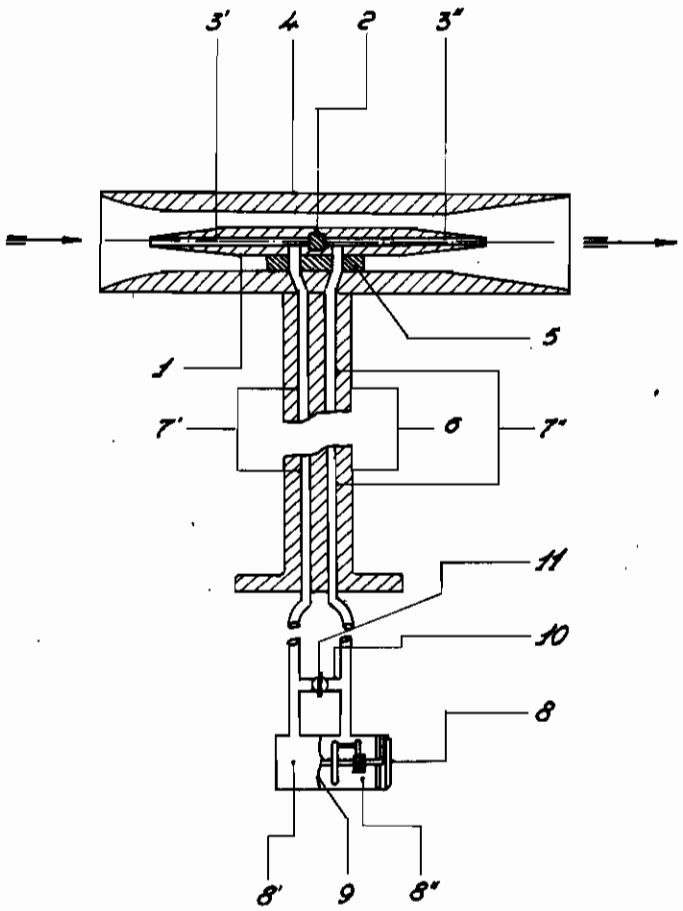

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ANEMOMETRIC ANTENNA FORMED WITH TWO PITOT TUBE INTAKES, OPPOSITELY DISPOSED, FOR MEASURING THE INDICATED VELOCITIES OF AIRCRAFTS

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It is known that the measure of the "indicated velocity" of an aircraft, which corresponds to the measure of its lift, is now normally effected with instruments of the type of the differential manometer, connected with an intake antenna, which comprises almost generally a Pitot tube associated with a static pressure intake. The antenna is usually secured in a suitable position at a certain distance away from the leading edge of the wings, taking care that the intake is placed at a point which is influenced as little as possible by the reactions due to the movement.

However, although it is possible to obtain correctly the total pressure, which is the sum of the static and of the dynamic pressures, even in the proximity of the lifting surfaces owing to particular devices for causing the Pitot to be non sensitive to substantial variations in the direction of the stream (which has been obtained by inserting it inside a larger tube suitably shaped) it is sufficient that the intake is effected in a zone in which the speed potential has a constant ratio between the total pressure and the velocity, according the Bernoulli's law.

However, it has not been possible up to the present, to eliminate in a permanent manner the disturbing action of the velocity on the static intake, so that in some cases, it has been proposed to provide an antenna suspended from a hollow cable so as to bring this intake to a zone in which the disturbances caused by the movement of the aircraft are partially or totally absent. However, apart from unfavorable local conditions, the difficulty for obtaining an efficient static intake in aviation, is particularly serious, because, as regard the troposphere, and the velocities to be considered at the present day, the static pressure is always substantially greater than the dynamic pressure, so that if the measure of the total pressure is taken to be accurate, an error of only 1% in the static pressure intake, produces a much greater error in the differential determination of the dynamic pressure, (and consequently of the indicated velocity), which error, varying in decreasing relation with the velocity, may assume values from 3% to 300%. Consequently, the inherent simplicity of the Pitot tube, used in hydraulics for over two centuries, is thus seriously compromised in areonautics relatively to the static pressure intake.

The present invention is intended to eliminate the static pressure and the serious inconveniences thereby caused when using it on aircrafts, and is based on the principle of the known double Pitot tube used in hydraulics, taking however into account the particular aerodynamical conditions which tend to complicate the problem to be solved. The problem is solved, according to the invention, generally by placing two Pitot heads oppositely disposed with respect to one another, inside a guide tube adapted to convey and to regulate the air stream so as to fulfill the following conditions;

(1) To insure the total pressure intake substantially independently from the actual direction of incidence;

(2) To form a field of velocity potential near the countercurrent intake of the first Pitot tube;

(3) To reproduce another field of velocity potential, in a section further down, near the exit, in the direction of the stream of the second Pitot tube placed in opposition, after the other Pitot tube;

(4) To provide a communication between the two Pitot heads, respectively with the two compartments in a tightly closed box, separated with an elastic membrane acting as sensitive element of a differential manometer.

The general shape of the guide tube, is similar to that of a Venturi tube; said guide tube is cylindrical on its outer surface, and is provided inside with a cylindrical central middle portion, merging at both ends with conical profile, the two Pitot intakes being placed each inside said conical profile, so that the corresponding free sections of the guide tube may have equal areas. By means of tests in the wind tunnel, it is possible to determine the most suitable conical profiles and any other dimension of the device in relation with the diameter of the intake. Theoretical considerations, assisted by practical tests, are favorable to the positive results obtainable, as well as to the possibility of reproducing in series construction the antenna according to the invention, thus eliminating the necessity of individual calibration.

It is possible consequently to manufacture for aerial uses, a device similar to the double Pitot tube well known in hydraulics. Said device being adapted for measuring the indicated velocity in relation to the difference of pressure in the two Pitot tubes, without the use of static intakes. In fact, in the first of these tubes, placed in countercurrent, the total pressure P, is equal to the static pressure P_3 plus the dynamic pressure P_d, generally multiplied by a coefficient K; while the second tube disposed in the direction of the stream, gives a pressure P_2, which is equal to the static pressure P_3, minus the dynamic pressure P_d, mul-

tiplied by the same coefficient K. Consequently, the difference $P_1—P_2$, which may be measured with a differential manometer or other equivalent instrument, has the value of $2kp_d$, which may be immediately traduced for showing the indicated velocity, while the static pressure P_s is neutralized and has no influence on the measure. It must be observed that the differential manometer operates with pressures which are at least twice as much the pressures acting in the present instruments provided with a Pitot static antenna, which allows, in addition to a greater resistance to be assigned to the operating elements, a greater accuracy in the working of the indicator, even at slow speeds. It may also easily be proved that if the registration of the total pressures P_1 and P_2 was subjected to errors comparable to those to which is subjected the static pressure obtained from the velocities indicated with the antenna according to the present invention, would generally be of an order considerably smaller.

The form of construction of the present invention shown schematically in the accompanying drawing comprises an anemometric intake antenna with a double Pitot tube, connected to an indicating instrument.

The tapered body 1 is traversed longitudinally by a cylindrical bore, which in the middle is provided with a diaphragm 2 forming two closed end sections 3', 3'', acting as Pitot tube heads opposed to one another. A tubular casing 4 which in the inside has a smaller diameter central portion merging towards the end openings with conical profiles having different inclinations, serves to capture the air stream substantially independently with respect to the effective direction of the outside stream, and to convey said stream so that in the neighborhood of the free ends of the two Pitot heads, the same axial dynamic pressure is present, directed axially in the direction of the relative movement. The tapered body I is rigidly fixed to the tubular casing 4 by means of a support 5, in correspondence to which the casing is provided with a supporting arm 6 adapted for fixing the antenna to the aircraft. Both the support 5 and the arm 6 have streamlined profiles so as to oppose the minimum resistance to the air current. These parts, as well as the tubular casing 4, are traversed by the tubes 7'; 7'' providing communications between the Pitot heads 3', 3'', respectively with the two compartments 8', 8'' of the tightly closed chamber 8, provided with a separating elastic membrane 9, Chamber 9 thus provides an element of a differential manometer, in which the deformations of the membrane 8 are amplified by means of an amplifying mechanism, and caused to rotate an index finger moveable on a graduated dial. At any point along the tubes 7', 7'', for example, before the point of insertion of these tubes to the indicating instrument, said tubes are connected together by a tube 10 provided with a cock 11, for opening or closing at will the communications between said tubes 7' and 7''.

Supposing that the relative movement of the air with respect to the intake antenna, takes place in the direction indicated by the arrows and that the cock 11 is closed, in the tubes 3', 7' and in the compartment 8', the pressure P_1 will obtain, the compartment 8'', there will be the pressure $P_2=P_3—kPd$. The membrane 9 will consequently tend to bend itself towards the compartment 8' to an amount such as to balance the elastic forces developed by it with the pressure increase $P_1—P_2=2k.Pd$, existing in the compartment 8', while the static pressure, which is present on both sides of membrane 9 is neutralized. If now the cock 11 is opened, thereby causing tubes 7' and 7'' to comunicate with one another, through the tubes 3', 7', 10, 7'' and 3'', an air current will be created, and in both compartments 8', 8'' of the chamber 8, the pressure:

$$\frac{P_1+P_2}{2}=P_s$$

will obtain. By setting now the index finger of the differential manometer to zero, it will remain in this position whichever is the velocity of the stream. This is an essential condition to which the antenna according to the present invention must comply. On the other hand, the possibility of passing through the two Pitot heads a stream of air which produces a strong scavenging action therethrough, provides a very efficient means for preventing the formation therein of dangerous obstructions.

The two oppositely disposed Pitot heads, instead of being combined into a single tubular casing, may also be arranged as two separate antennaes, each of which comprises a Pitot head provided with a suitable tubular casing, having its own support and a suitable tubing; in such case said two antennaes must be mounted opposite one to the other, and at such distance from each other as to avoid mutual interference. The tubings leading from these antennaes, will be connected to the indicating instruments as above described, and the operation of the whole unit is identical with that of single antenna, which latter however, is to be preferred for practical considerations.

In the form of construction illustrated in the accompanying drawing, the operation of the cock 11 may be effected by the diaphragm 2, by making this latter moveable, or by controlling said cock from a distant point by means of an electromagnet.

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