United States Patent [19]

Erickson et al.

[11] **3,795,457**

[45] **Mar. 5, 1974**

[54] **MULTISTAGE PITOT PUMP WITH MEANS FOR FEEDING CLEAN FLUID TO SEALS**

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[73] Assignee: **Kobe, Inc.,** Huntington Park, Calif.

[22] Filed: **Feb. 26, 1973**

[21] Appl. No.: **335,483**

[52] **U.S. Cl.** **415/89,** 415/112

[51] **Int. Cl.** **F04d 1/14,** F01d 11/00

[58] **Field of Search** 415/89, 111, 112, 88

[56] **References Cited**

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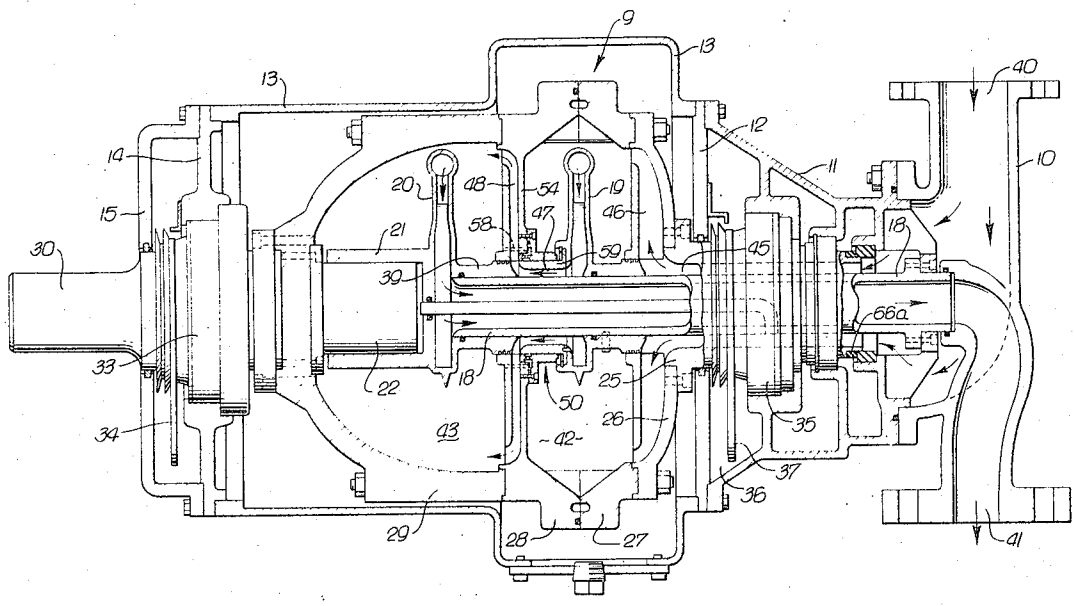
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Primary Examiner—Carlton R. Croyle
Assistant Examiner—Louis T. Casaregola
Attorney, Agent, or Firm—Harris, Kern, Wallen & Tinsley

[57] **ABSTRACT**

A multistage pitot pump, i.e., a centrifugal pump comprising a rotatable casing within a stationary housing, means for delivering the fluid to be pumped to the interior of the casing, a pitot tube assembly fixed within and having a pitot tube extending radially in the casing, and a discharge duct for the pitot tube in the pitot tube assembly and coaxial with the casing, in which an annular fluid seal is provided between the casing and the pitot tube assembly, with means for feeding clean fluid to the annular seal.

3 Claims, 3 Drawing Figures



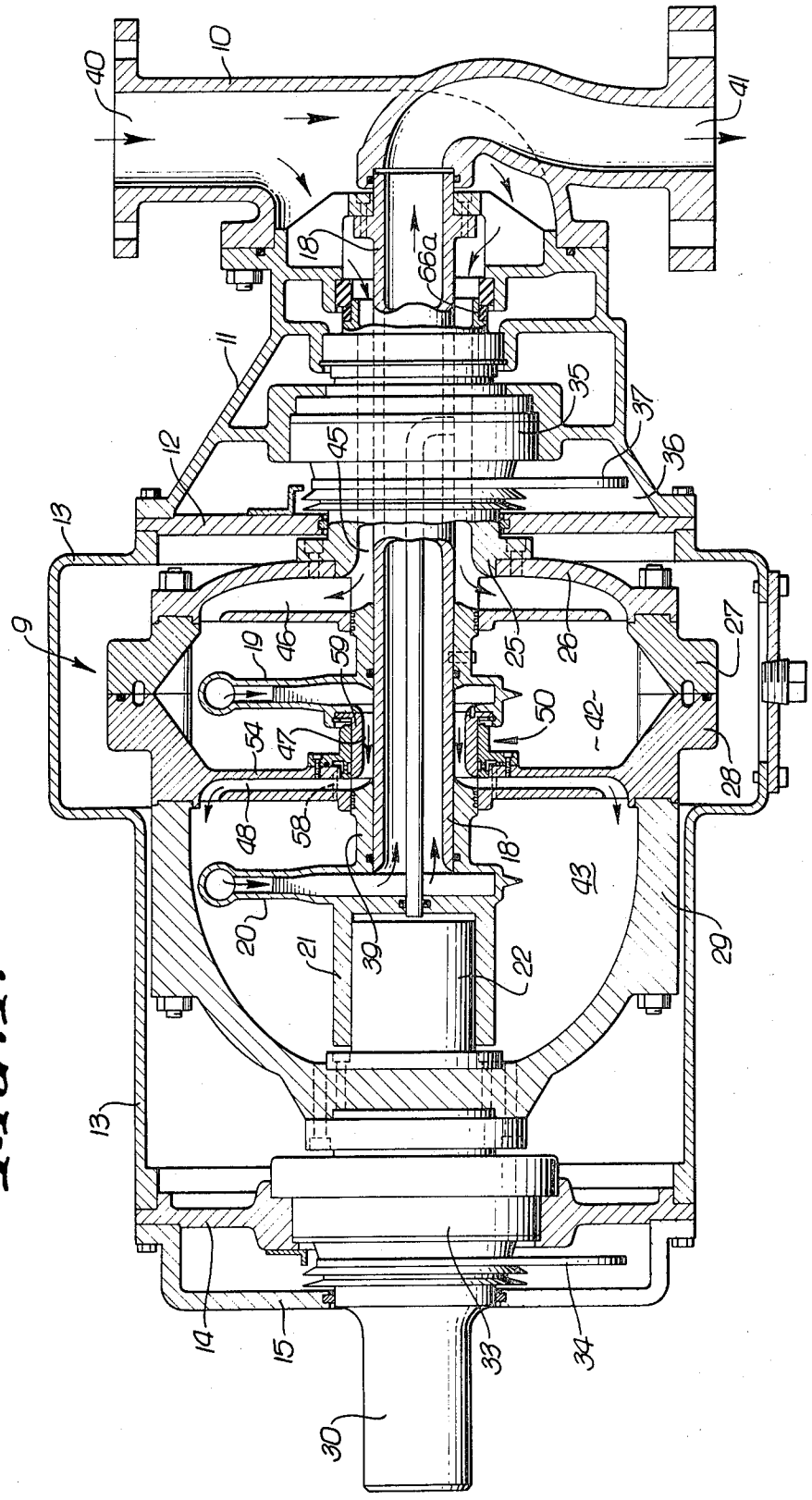

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FIG. 1.

FIG. 2.

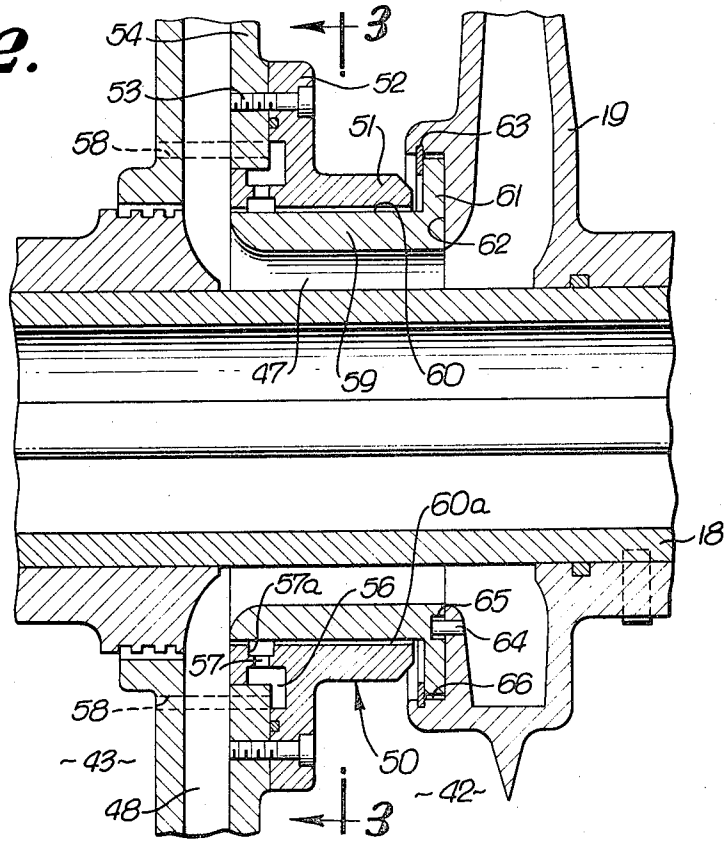
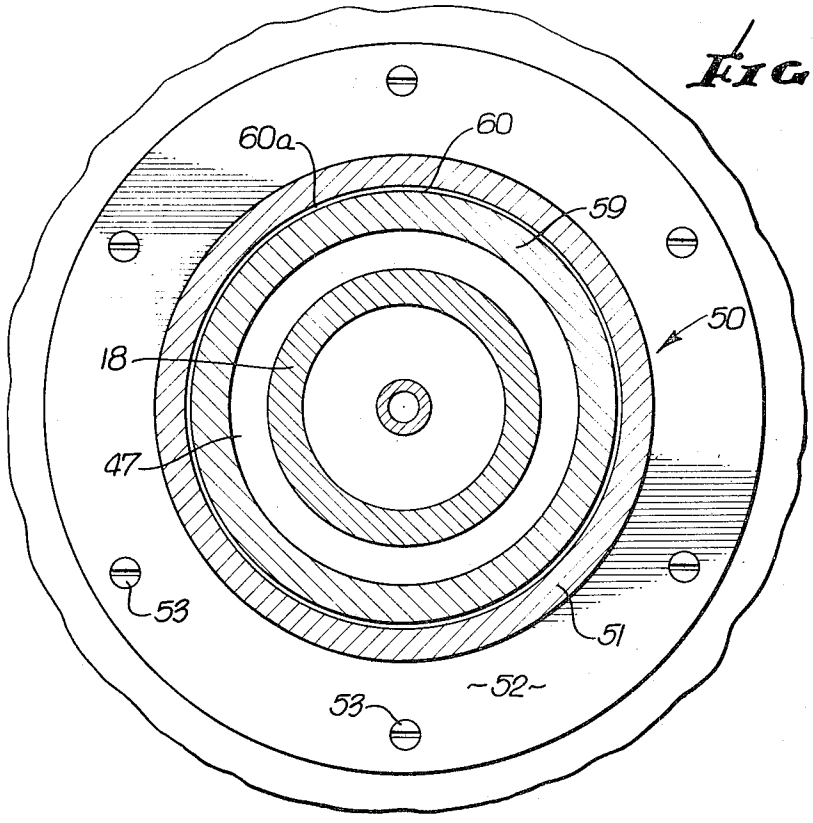

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FIG. 3.


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MULTISTAGE PITOT PUMP WITH MEANS FOR FEEDING CLEAN FLUID TO SEALS

BACKGROUND OF THE INVENTION

The present invention relates in general to centrifugal pumps and, more particularly, to a centrifugal pump of the pitot type. A typical pitot pump comprises a rotatable casing having a pressure chamber, means for delivering the fluid to be pumped to the chamber of the casing, a pilot tube assembly fixed within the casing and having a pilot tube extending radially into the chamber for picking up fluid adjacent the periphery of the casing with a ram effect and a discharge duct for receiving fluid from the pitot tube, with the discharge duct in the assembly and coaxial with the casing. A typical pitot pump is shown in the copending application of John W. Erickson, one of the inventors herein, Ser. No. 280,677, filed Aug. 14, 1972, and assigned to the same assignee as the present application.

Such pitot pumps may be either single stage, as disclosed in John W. Erickson's above pending application, in which the rotatable casing has a single pressure chamber and a single pitot tube extending radially into such chamber, or they may be multistage, in which the rotatable casing has two or more such pressure chambers, each having a pitot tube, with the outlet from the pitot tube in the first chamber being connected to the inlet of the second chamber and the outlet from the pitot tube in the second chamber being connected to the discharge duct of the pump or to the inlet of the next similar stage of the pump. The fluid pressure in successive stages of such a pump increases and the outlet pressure of the pump increases with the addition of such stages to the first stage.

It is necessary to provide an annular seal between the rotatable casing and the pitot tube assembly between the stages of such a multistage pump, since the fluid pressure increases from stage to stage, to minimize fluid leakage therebetween, which reduces the efficiency of the pump substantially. Mechanical seals for high differential pressures have been used for such purpose, but have many disadvantages, such as high initial cost, difficult to assemble or install between stages, and poor performance in non-lubricating fluids such as water.

SUMMARY OF THE INVENTION

The present invention provides in such a multistage pump an annular fluid seal between two successive stages of the pump with means for supplying relatively clean fluid from the second stage to a point intermediate to the ends of the seal at a fluid pressure higher than the fluid pressure at each end of the seal, to provide a small flow of such clean fluid from such point to each end of the seal to lubricate the sealing surfaces of the seal and to prevent the entry of abrasive foreign material into the seal between such surfaces, and this is a primary object of the invention.

Other objects, advantages, features and results will more fully appear in the course of the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of a pitot pump incorporating the presently preferred embodiment of the invention;

FIG. 2 is an enlarged sectional view of the fluid seal of the invention; and

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The pitot pump has a rotatable casing 9 carried in a fixed support structure, with the support structure including an inlet-outlet casting 10 bolted to a housing 11 which in turn is bolted to a baffle plate 12 and a shell 13. Another baffle plate 14 and an end bell 15 are bolted to the shell 13. A central duct 18 is carried at the right end in the housing 11 and is bolted thereto. A first pitot tube 19 and a second pitot tube 20 are carried on and fixed to the duct 18, with the second pitot tube 20 having an end sleeve 21 riding on a shaft 22 of the casing 9.

The casing 9 includes a sleeve 25 disposed about the duct 18 and bolted to an end bell 26. A first casing section 27, a second casing section 28 and an end bell 29 are bolted to the end bell 26, with the shaft 22 bolted to the end bell 29. A drive shaft 30 is bolted to the outer side of the end bell 29.

The shaft 30 is carried in the plate 14 in a bearing 33. An oil supply for the bearing 33 is carried in the end bell 15, with an oil ring 34 aiding oil distribution. The bearing 33 includes a seal for blocking fluid flow between the end bell 15 and the interior of the shell 13. The sleeve 25 of the casing 9 is supported in another bearing 35 carried in the housing 11, with an oil supply for the bearing in the compartment 36 with an oil ring 37 positioned about the bearing. The plate 12 blocks fluid flow between the oil compartment 36 and the interior of the shell 13.

On the central duct 18 is fixed a tubular member 39 which carries the pitot tubes 19 and 20 and the end sleeve 21, all of which form a pitot tube assembly. The sleeve 25, the end bell 26, the casing sections 27 and 28, and the end bell 29 form the rotatable casing 9. The casting 10, housing 11, shell 13, and end bell 15 form a fixed housing for the rotatable casing 9.

The casting 10 is provided with an inlet 40 and an outlet 41. The rotatable casing 9 has a first pressure chamber 42 and a second pressure chamber 43, the first pressure chamber and the pitot tube 19 forming a first stage of the pump and the second pressure chamber and the pitot tube 20 forming a second stage of the pump.

The pump inlet 40 communicates through an annular passage 45 with a radial first stage inlet passage 46. The inner end of the first pitot tube 19 communicates with an annular passage 47 which in turn communicates with a radial second stage inlet passage 48. The inner end of the second pitot tube 20 communicates with the central duct 18, which in turn communicates with the pump outlet 41.

Located between the first and second pressure chambers 42 and 43 and between the rotatable casing 9 and the central duct 18 is a fluid seal, generally designated as 50, and shown in detail in FIGS. 2 and 3. The fluid seal 50 includes a tubular collar 51 having a radial flange 52 which is rigidly secured, as by circumferentially spaced bolts 53 to the inner radial wall 54 of the first pressure chamber 42. The collar and flange 51, 52 has an annular channel 56 provided with circumferentially spaced inwardly directed radial ports 57 commu-

nicating with an annular distribution groove 57a. Communicating between the radially inward portion of the second pressure chamber 43 and the annular channel 56 are a plurality of circumferentially spaced ports 58.

Within the collar 51 is a tubular sealing ring 59 having a main external sealing surface 60 and an annular radial end flange 61 which fits into an annular groove 62 in the base of the pitot tube 19 and is retained therein by an annular snap ring 63, the sealing ring 59 being retained against rotation relative to the pitot tube 19 by a pin 64 on the pitot tube which fits into a radial groove 65 in the ring. There is a slight clearance 60*a* between the external surface 60 of the ring 59 and the internal surface of the tubular collar 51 and a larger clearance between the external annular surface of the flange and an outer annular surface 66 of the groove 62, permitting the sealing ring 59 to float radially to obviate any concentricity problem as to the outer surface 60 of the ring and the internal surface of the tubular collar, and this is a feature of the invention.

The fluid to be pumped enters the casting 10 through the inlet 40 and flows through the connecting passage 45 and through radial passage 46 of the end bell 26 into chamber 42. A rotating seal 66a blocks fluid flow between the inlet passage 40 and the bearing 35.

The casing is driven in rotation clockwise as seen from the right-hand end of FIG. 1, via the drive shaft 30, with the pitot tube 19 picking up fluid adjacent the outer periphery of the chamber 42 with a ram effect and delivering fluid to the second chamber 43 via an annular passage 47 and radial distribution passage 48 in the casing section 28. The pitot tube 20 operates in the same way as the pitot tube 19, delivering fluid to the interior of the duct 18 and to the outlet passage 41.

In operation, fluid in the first chamber 42 is caused to rotate at relatively high speed by the rotation of the casing 9, heavier solid particles in the fluid is centrifuged by such rotation to the periphery of the chamber. The pitot tube 19 picks up a major portion of the rotating fluid in the first chamber 42, partially cleaned of such solid particles, and delivers such fluid, as described above, to the second chamber 43 where it is subjected to a second and similar centrifuging to remove additional heavy solid particles from the fluid, so that the fluid at the inner periphery of the chamber 43, adjacent to the ports 58 is relatively clean of solid foreign particles, which is another object of the invention.

To illustrate the fluid pressures existing in our pump, assuming a given sized pump in which the rotatable casing is rotating at about 3,000 r.p.m., and assuming a fluid pressure in the inlet 40 of about 25 p.s.i.a., the fluid pressure in the outer periphery of the chamber 42 will be about 300 p.s.i.a. and the pressure in the inner periphery of such chamber, communicating with the seal clearance 60*a*, will be about 100 p.s.i.a. The fluid pressure in the annular passage 47 will be about 600 p.s.i.a., the pressure in the outer periphery of the second chamber 43 will be about 900 p.s.i.a. and in the inner periphery thereof communicating with the ports 58 will be about 700 p.s.i.a. Under such relatively high pressure of about 700 p.s.i.a., relatively clean fluid flows through the ports 58 into the annular channel 56 from which it flows through the radial ports 57 into the clearance 60a. In the illustration given, the fluid pressure in the radial ports 57 will be about 700 p.s.i.a., whereas the fluid pressure at the left-hand end of the clearance, as seen in FIG. 1, will be about 600 p.s.i.a. and the fluid pressure at the right-hand end of such clearance will be about 100 p.s.i.a. Such pressure differentials tend to cause a flow of clean fluid from the chamber 43 through the clearance 60*a* in both longitudinal directions from the radial ports 57 tending to prevent the entry of solid foreign material into the clearance and thus maintaining the adjacent surfaces of the clearance clean and lubricated, which is another object of the invention.

Since the clearance 60*a* is substantially uniform in cross-sectional area throughout its length, to substantially equalize the leakage therethrough from the distribution groove 57*a* the left-hand portion of the clearance 60*a*, as seen in FIG. 1, is made relatively short and the right-hand portion of the clearance is made relatively long, the relative lengths thereof being substantially proportional to the fluid pressure differentials across such portions of the clearance, which is a further object of the invention. For example, for the illustration given above, the total length of the clearance is about 2.62 inches, the width of the annular groove 57*a* is about 0.125 inches, the length of the left-hand portion of the clearance is about 0.375 inches, and the right-hand portion of the clearance is about 2.125 inches in length. This will provide a small, but substantially equal leakage from the annular groove 57*a* in both directions through the clearance.

Although we have shown and described an exemplary embodiment of the invention, we do not wish to be limited thereto, but desire to be afforded the full scope of the following claims:

We claim:

1. In a multistage pitot pump, the combination of:

a generally cylindrical rotary casing rotatable about its central axis, including first and second annular pump chambers longitudinally spaced along said casing;

an outer housing surrounding said rotary casing, said outer housing having an inlet port and a discharge port;

drive shaft means extending into one end of said housing and rigidly connected to said casing for rotating the same;

generally tubular means extending longitudinally in said housing and upon which said casing is mounted for rotation, such tubular means being fixedly mounted on said housing and having an inlet passage therein communicating between said inlet port and said first pump chamber for supplying a fluid to be pumped to said first chamber, said tubular means having a first pitot tube fixedly mounted thereon and extending radially in said first chamber, said first pitot tube having adjacent its outer end a first pitot inlet facing in a direction opposite to the direction of rotation of said casing, and a passage therein communicating between inlet and first pitot inletnd a longitudinal annular passage, said tubular means having a second pitot tube fixedly mounted thereon longitudinally spaced from said first pitot tube and extending radially in said second chamber, said second pitot tube having adjacent its outer end a second pitot inlet facing in a direction opposite to the direction of rotation of said casing, and a passage in said second pitot tube communicating between said second pitot inlet and a longitudinal discharge duct in said

tubular means and communicating with said outlet; and

fluid seal means in said longitudinal annular passage, including an annular collar fixed to an inner well of said first chamber for rotation with said casing, an annular sealing ring within said collar with a longitudinal clearance therebetween, said sealing ring being supported on said tubular means, said collar having port means communicating between the inner portion of said second chamber and said clearance intermediate its ends.

2. A device as defined in claim 1 in which said sealing ring is connected to said tubular means for slight radial movement of said ring relative thereto, but prevented from rotational movement relative thereto.

3. A device as defined in claim 1 in which said port means communicates with said clearance at a point at which the fluid pressure drop across the portion of said clearance on one side of said port means approximates the fluid pressure drop across the portion of said clearance on the other side of said port means.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,795,457 Dated March 5, 1974

Inventor(s) John W. Erickson and Vitolis Budrys

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 11, "pilot" should be --pitot-- (page 2, line 7);

Column 1, line 12, "pilot" should be --pitot-- (page 2, line 8);

Column 4, line 58, "inlet and first pitot inletnd" should be --said first pitot inlet and-- (page 11, line 23, claim 1)

Signed and sealed this 9th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patente