

Sept. 20, 1971

M. PIET ET AL

3,606,586

AIR INJECTION PUMP

Filed July 14, 1969

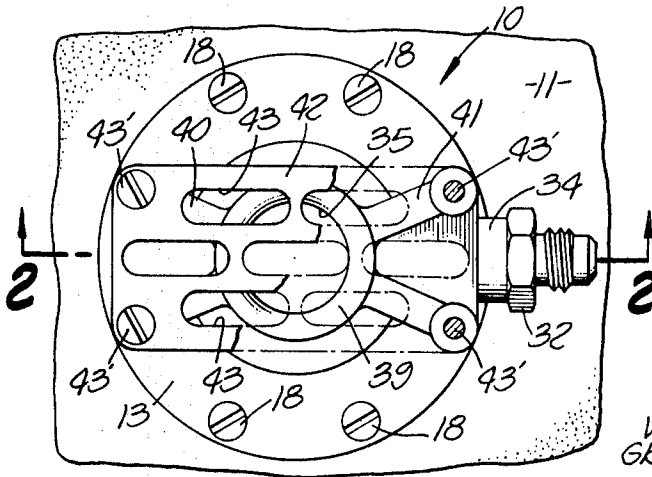


FIG. 1.

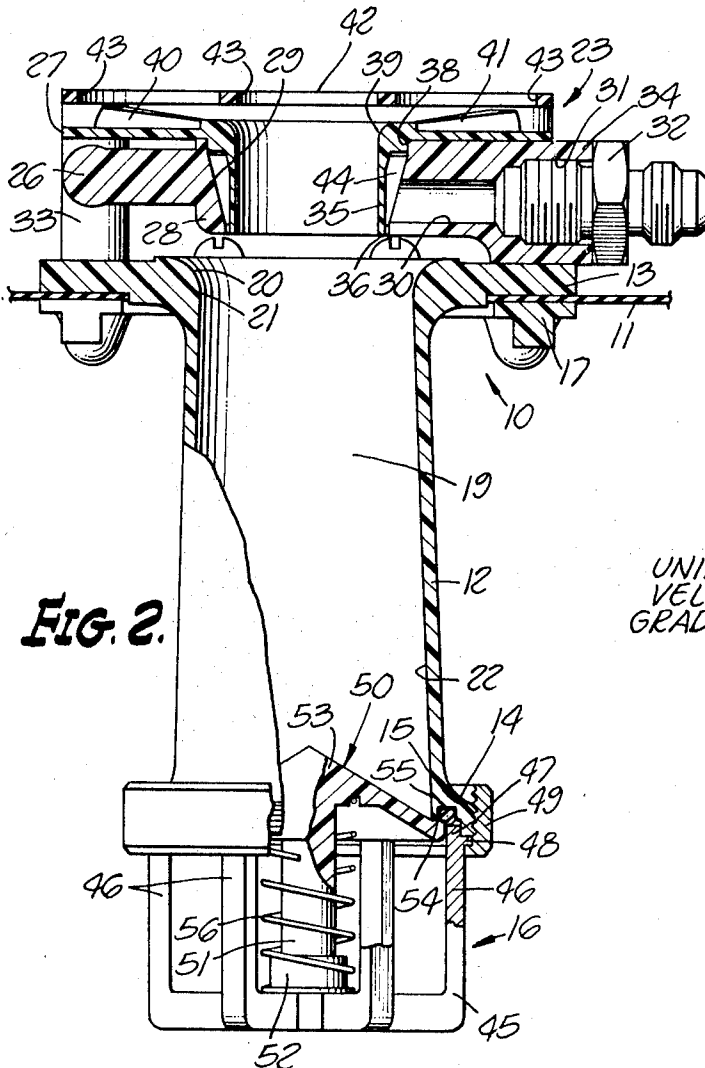


FIG. 2.

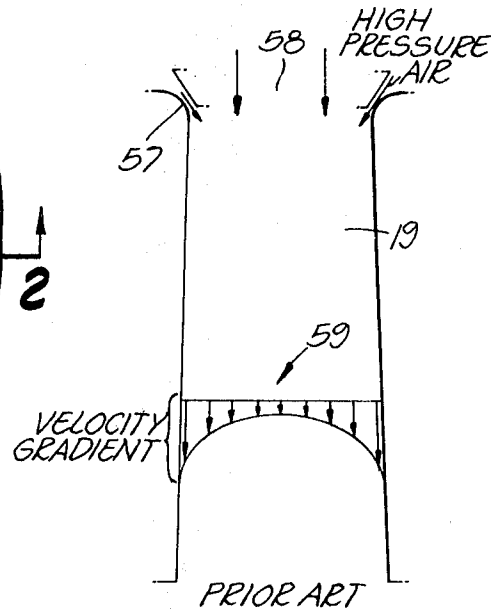


FIG. 3.

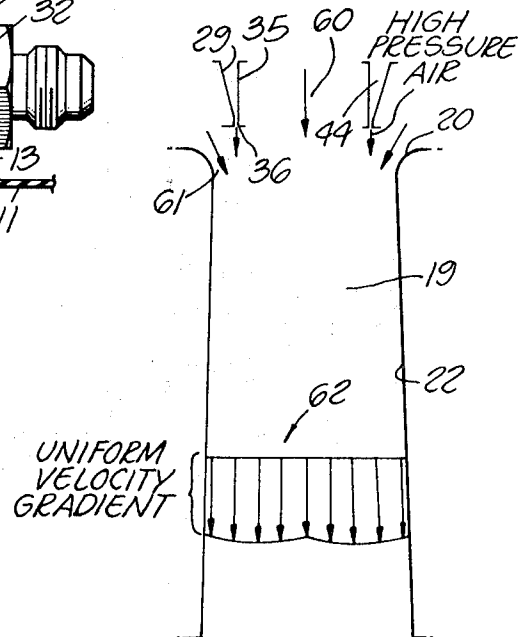


FIG. 4.

MEYER PIET
MURRAY A. CHILCOAT
INVENTORS
WHANN & McMANIGAL
Attorneys for Applicants
BY

Shepherd

1

3,606,586

AIR INJECTION PUMP

Meyer Piet, Arcadia, and Murray A. Chilcoat, Monterey Park, Calif., assignors to Futurecraft Corporation, City of Industry, Calif.

Filed July 14, 1969, Ser. No. 841,412

Int. Cl. F04f 5/48, 5/18

U.S. Cl. 417—177

2 Claims

ABSTRACT OF THE DISCLOSURE

An air injection pump in which a nozzle has parts in fixed coaxing relation to form an outlet opening for discharging an annular stream of pressurized fluid at a relatively high velocity into the throat end of a venturi passageway for inducing a large quantity of ambient outside fluid such as air to enter the passageway through flow paths interiorly and exteriorly of the annular nozzle discharge stream, so as to provide a combined flow of the streams through the passageway which will have a substantially uniform velocity gradient across the passageway, and thereby produce greater efficiency of the pumping operation.

BACKGROUND OF THE INVENTION

The invention relates to the field of air and gas pumping apparatus.

Air injection pumps have heretofore been known and used for the inflation of non-rigid articles such as life rafts, aircraft escape slides and the like. Such pumps have varied as to their general construction, but in the main have operated on the principle of employing a relatively small bottle or container as a supply source for a pressurized fluid, such as air or other appropriate gas, which could be connected to a nozzle and discharged at a relatively high velocity into the throat of a venturi passageway in a manner to induce a large flow of ambient air along with it into the article being inflated.

The prior available pumps of the type described above, inherently embodied structural designs which did not lend themselves readily to the necessary accuracies of construction required to obtain a high order of operating efficiency. In addition the prior art devices utilized high pressure jet arrangements which did not take full advantage of the aspirating capabilities of the jet or jets. For example, in one known arrangement a circular manifold has been used which is provided along one side with a series of circumferentially spaced outlet openings so as to provide a series of jets which were directed into the inlet end of the venturi passageway and utilized to induce flow of ambient air both inside and outside of the jet circle. While this arrangement has some operating advantages, it is inefficient for the reason that the separate jet streams interact with each other to set up eddy currents and flow disturbances which prevent a smooth flow through the venturi passageway.

In another known arrangement, the high pressure air has been introduced through a nozzle having an annular outlet opening positioned at the inner periphery of the inlet end of the venturi passage, the aspirated ambient air being admitted axially within the jet. This arrangement is also objectionable in that the jet configuration is disturbed by its engagement with and flow along the inner wall surface of the venturi passageway. This results in reduced efficiency of operation.

Still another example of prior art arrangements is that shown in the Thomas J. Zilka et al. Patent No. 3,338,266, which discloses an axially positioned nozzle having a

2

variable area annular jet arranged to aspirate ambient air at the outer periphery only of the jet stream, while the inner periphery of the jet stream engages and flows along a guiding wall structure which in this case also has the effect of disturbing the jet configuration to the end that uniform flow is interfered with and efficiency decreased.

From studies and tests made upon prior known devices of this character, as described above, it is clear that all of these devices are so constructed that non-uniform velocity gradients are obtained by the flow through the venturi passageway and are indicative of the lack of uniform flow which must be approached as nearly as possible in order to obtain high efficiency operation. In applicants' invention, as disclosed herein, the inherent problems and inefficiently operating structures of the prior art devices have been solved in a unique manner by providing a structure which is capable of being fabricated with a high degree of accuracy as necessary for efficient operation, and by orienting and placing a nozzle at the inlet end of the venturi passageway which is so arranged as to provide an annular jet having a continuous circumferential configuration, and wherein this jet is arranged to induce the flow of ambient air both within and exteriorly of the jet. With this arrangement the aspirating capabilities of the jet are utilized with greatly increased efficiency, and the jet and ambient air streams are conducted through the venturi passage with a substantially uniform and greatly improved velocity gradient than that possible in the prior art structures.

SUMMARY OF THE INVENTION

The present invention relates generally to pumps; and is particularly concerned with improvements in pumps of the air injection type such as utilized for the inflation of non-rigid articles such as life rafts, escape slides for aircraft, and the like, with ambient air.

Having in mind the inherent disadvantages of the prior art devices as heretofore described, it is one object of the herein described invention to provide an injection pump of improved simplified construction which can be more economically produced, which can be for the most part constructed of plastic materials, wherein the parts can be economically fabricated and worked to provide the necessary accuracy to assure high operating efficiencies.

A further object of the invention is to provide an improved pump of the character described, wherein the nozzle body comprises a unique two-part construction which permits the parts to be separately worked prior to assembly into a unitary structure, and which is of such construction as to permit variations of the nozzle discharge opening area in a facile manner to meet different installation requirements.

Another object of the invention is to provide a jet pump construction which utilizes an annular jet stream and in which means are provided for guiding aspirated ambient air into dual paths, one of these paths being within the jet stream and the other path outside the jet stream, whereby increased aspirating and flow inducing capabilities of the jet stream are obtained.

Still another object is to provide in a jet pump a jet stream and cooperatively associated paths of aspirated ambient air which will move through the venturi passageway of the pump with minimum of mutual interference, so as to provide a more uniform velocity gradient than in the heretofore obtainable prior art structures.

Further objects and advantages of the invention will be brought out in the following part of the specification, wherein detailed description is for the purpose of fully disclosing a preferred embodiment of the invention without placing limitations thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the accompanying drawings, which are for illustrative purposes only:

FIG. 1 is a top plan view of an air injection pump according to the present invention, as seen when mounted on a fragmentary portion of the envelope forming material of an inflatable object;

FIG. 2 is an axial longitudinal sectional view, taken substantially on line 2—2 of FIG. 1, certain portions being shown in elevation; and

FIGS. 3 and 4 are views diagrammatically illustrating and comparing the velocity gradient of the flow of the fluid in the venturi passageway of applicants' pump and certain known prior art structures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more specifically to the drawings, for illustrative purposes, the air injection pump according to the present invention is disclosed as comprising a pump unit 10 which is arranged to be mounted upon the envelope forming material 11 of an inflatable non-rigid article such as a life raft, escape slide for aircraft, and the like, with the delivery end of the pump positioned within the envelope and the fluid connection end of the pump positioned outside the envelope. While the invention will be described in particular with reference to articles of the foregoing character, it will be appreciated that this is only a typical installation and that the invention may be found generally useful for other applications.

As best shown in FIG. 2, the pump structure includes an elongate tubular barrel 12 which is provided at one end with a radially extending circumferential attaching flange 13, and at its opposite end with a circumferentially extending flange 14 having outer threads 15 for the attachment of a valve assembly 16 as will subsequently be described in detail. The flange 13 is arranged for cooperative association with a clamping ring 17 by means of which the pump may be clampingly secured to the envelope material positioned therebetween by means of a plurality of attaching screws 18 (FIG. 1).

The barrel 12 is fabricated to provide internally a venturi passageway 19 having at its inlet end a tapering wall portion 20 leading to a restricted throat portion 21 and thence through a truncated conical wall section 22 to the outlet end mounting the valve assembly 16.

The flange 13 also serves as a support for a nozzle assembly as generally indicated at 23, this assembly extending from the opposite side of the flange 13 from that of the barrel 12. The nozzle assembly is shown as comprising a substantially rectangular nozzle body structure which bridges the inlet end of the venturi passageway. The nozzle body is fabricated of two parts or sections 26 and 27 which are preferably made of an appropriate material and for this purpose a glass-filled polycarbonate has been utilized since this material can be die cast and worked with the high order of accuracy to provide a high efficiency operating device.

The nozzle body section 26 is formed with an annular portion 28 between its ends, this portion having an inner truncated conical wall facing 29 which is tapered and has the small end positioned adjacent the inlet to the venturi passageway. Radially extending from this conical wall is a bore passage 30 which communicates with a threaded terminal port 31 adapted to receive a connection fitting 32 by means of which connection can be made with a high pressure fluid source of air or other suitable gas. The opposite ends of the section 26 are formed as brackets or foot portions 33 and 34 by means of which the annular portion 28 is positioned above the inlet to the venturi passageway.

The section 27 is formed with a tubular portion 35 which is adapted, when assembled with section 26, to extend into the annular portion 28. The outer diameter of the wall of the tubular portion 35 at the small outlet open-

ing end of the wall facing 29 is slightly less than the diameter of the opening so that there is formed an annular nozzle opening 36 which extends coaxially of the axis of the venturi passageway. At its opposite end, the tubular portion is thickened circumferentially and provided with a peripheral shoulder 38 which snugly fits within the large end of the tapered wall facing 29 and supports the tubular portion in anchored fixed relation to the tapered wall 29, and whereby the annular nozzle opening will be accurately formed. The inner surface of the tubular portion 35 at this end is rounded as indicated at 39 so as to facilitate the flow of entering fluid into the tubular portion. As shown in FIG. 1, diametrically opposed wing portions 40 and 41 extend from the adjacent end of the tubular portion 35 outwardly over the section 26 and form portions which may be bonded thereto in order to form a unitary assembly. As a protection against the entrance of foreign materials into the tubular portion 35, the outer end of the tubular portion is bridged by a guard or cover plate 42 having a plurality of flow openings 43 therein, which in this case have been shown as parallel arranged slots. The cover plate 42 is secured at its ends by appropriate screws 43' which at their inner ends are adapted to engage in threaded openings (not shown) formed in the attaching flange 13, and which serve to securely position and mount the nozzle assembly with the cover plate thereon in proper position on the flange 13.

The nozzle assembly construction just described provides an arrangement wherein the tubular portion 35 cooperates with the tapered wall facing 29 to form an internal cavity 44 which is in communication with the bore passage receiving high pressure fluid from the high pressure fluid source. The outlet from this cavity which decreases in cross section as it approaches the nozzle opening 36 effects a discharge of fluid in a circumferentially continuous annular stream at relatively high velocity. This stream enters the inlet end of the venturi passageway coaxially between the venturi passageway axis and the wall facing of the venturi passageway in such manner that an induced flow of ambient air is guided into a flow path within the jet stream, and a flow path outside the jet stream. Thus, the flow paths of the ambient air and the fluid in the jet stream are in concentric relation as they move into the venturi passageway. The aspirating capabilities of the jet stream are thus utilized with maximum effect to produce materially increased efficiency of operation of the pump.

As is usual with pumps of this character, and particularly where used for inflating non-rigid envelope structures, the discharge end of the barrel is provided with a normally closed valve structure which is arranged to open automatically during an inflating operation, and at the termination of the inflating process to close and thus prevent the escape of the fluid from the inflated envelope. Various types of valve structures have been utilized.

As shown in the embodiment of the present invention, the valve structure 16 comprises a cage or spider 45 in which circumferentially spaced arms 46 depend from a circumferentially extending rim portion 47 which contains a seating flange 48, the rim and flange being arranged to make a slip connection with the flange 14 of the barrel. The cage is removably attached to the barrel by means of a retaining nut 49.

The spider 45 serves as a support for a poppet valve 50, this valve having a stem 51 which extends through a tubular hub 52 of the spider structure and permits reciprocal movement of the stem. The other end of the stem 51 carries a conical valve head 53, this valve head at its periphery being adapted in valve closed position to seat upon a suitable O-ring 54, this O-ring being supported in a suitable groove 55 formed in the flange 14. The poppet valve is normally urged to a closed position by means of a coiled spring 56 which surrounds the stem, one end of this spring being engaged with the spider, and the other end being engaged with the valve head.

It is one of the features of operation of the pump of the present invention, that the flow of jet fluid and the induced flow of ambient air takes place in concentric annular flow paths which produce a substantially uniform velocity gradient across the venturi passageway as compared to the prior art constructions, wherein the velocity gradient is of a manifestly non-uniform character. This feature is diagrammatically illustrated in FIGS. 3 and 4.

Referring to FIG. 3, there is shown a known structure of the prior art, wherein the high pressure air is supplied at the inlet end of the venturi passageway 19 through an annular nozzle as shown at 57, and which is disposed adjacent the wall of the venturi passageway. Induced ambient air flow is in this arrangement through a central path 58 which is positioned inside the annular jet stream discharged from the nozzle structure 57. In this concept, the high velocity jet stream is adjacent the venturi passageway wall, while the lower velocity of induced ambient air flow is along the axis of the venturi passageway within the jet stream. As thus arranged, the velocity gradient as diagrammatically illustrated at 59 is noticeably of non-uniform character with a greater velocity at the outer peripheral margins of the venturi passageway and the lesser velocities inwardly towards the axis of the passageway. As the result of this non-uniformity of velocity, the smooth flow through the venturi passageway is prevented, and the full aspirating characteristics of the jet are not taken advantage of to provide the induced flow of ambient air. As a consequence this type of prior art structure is noticeably inefficient in operation.

Referring now to FIG. 4, it will be observed that the jet stream issuing from the nozzle opening 36 is inwardly spaced from the wall of the venturi passageway so that ambient air is induced in two flow paths, one of these being through the central portion as indicated at 60 in which the ambient air flow path is within the jet stream and the other as indicated at 61 which is outside or surrounding the jet stream and between the jet stream and the inner wall of the venturi passageway. With this arrangement, maximum advantage is taken of the action of the jet stream to induce flow of ambient air, and since the flow paths are in concentric relation with the higher velocity flow path between the two lower velocity flow paths it is possible to obtain a substantially uniform velocity gradient as indicated at 62. The flow through the venturi passageway is thus more smooth than in the prior art structures and results in the obtainment of greater efficiency of operation.

From the foregoing description and drawings, it will be clearly evident that the foregoing objects and features of the invention will be accomplished.

Various modifications may suggest themselves to those skilled in the art without departing from the spirit of our invention, and, hence, we do not wish to be restricted to the specific form shown or uses mentioned, except to the extent indicated in the appended claims.

We claim:

1. Air injection pumping means, comprising:

- (a) an elongate tubular member having an inlet end communicating directly with ambient air, and an outlet end, and an internal wall providing a venturi passageway extending between said inlet end and outlet end, said passageway having a restricted throat portion adjacent said inlet end;
- (b) a body assembly connected with the inlet end of said tubular member, said body assembly being formed of two sections, one of said sections having a passage therethrough bounded by a truncated conical wall, the other of said sections having a tubular projection extending from one side adapted to extend into the larger end of said passage to coact with said conical wall and form a chamber with an annular outlet;
- (c) said tubular projection having an inlet end communicating directly with ambient air and forming an air flow passage positioned coaxially within said annular outlet, and said annular outlet forming a nozzle spaced from the inlet end of said tubular member for discharging an annular nozzle stream of fluid into the venturi passageway, said stream having an outer diameter substantially less than the diameter of said restricted throat, whereby ambient air can enter the inlet end of the tubular member for flow between its internal wall and said nozzle stream; and
- (d) a guard plate positioned over the inlet end of said tubular projection.

2. Air injection pumping means according to claim 1, including valve means normally closing said passageway at the outlet end of said tubular member, said valve means comprising a spider at the outlet end of said tubular member, a valve including a conical valve head at one end of a stem member supported by said spider for movement between opened and closed positions of said conical valve head with respect to a valve seat carried by said tubular member, and a spring normally urging the valve head toward its closed position.

References Cited

UNITED STATES PATENTS

1,506,908	9/1924	Kirgan	417—177
1,842,043	1/1932	Modra et al.	417—177
1,865,623	7/1932	Eidsmore	417—177
2,165,880	7/1939	Arkin et al.	230—95
2,236,551	4/1941	Striegel	239—424
3,338,266	8/1967	Zilka	137—604

CARLTON R. CROYLE, Primary Examiner

R. E. GLUCK, Assistant Examiner

U.S. Cl. X.R.

137—604; 417—185