July 11, 1961 T. E. QUICK 2,991,927

APPARATUS FOR MOVING FLUIDS

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Fig. 1.

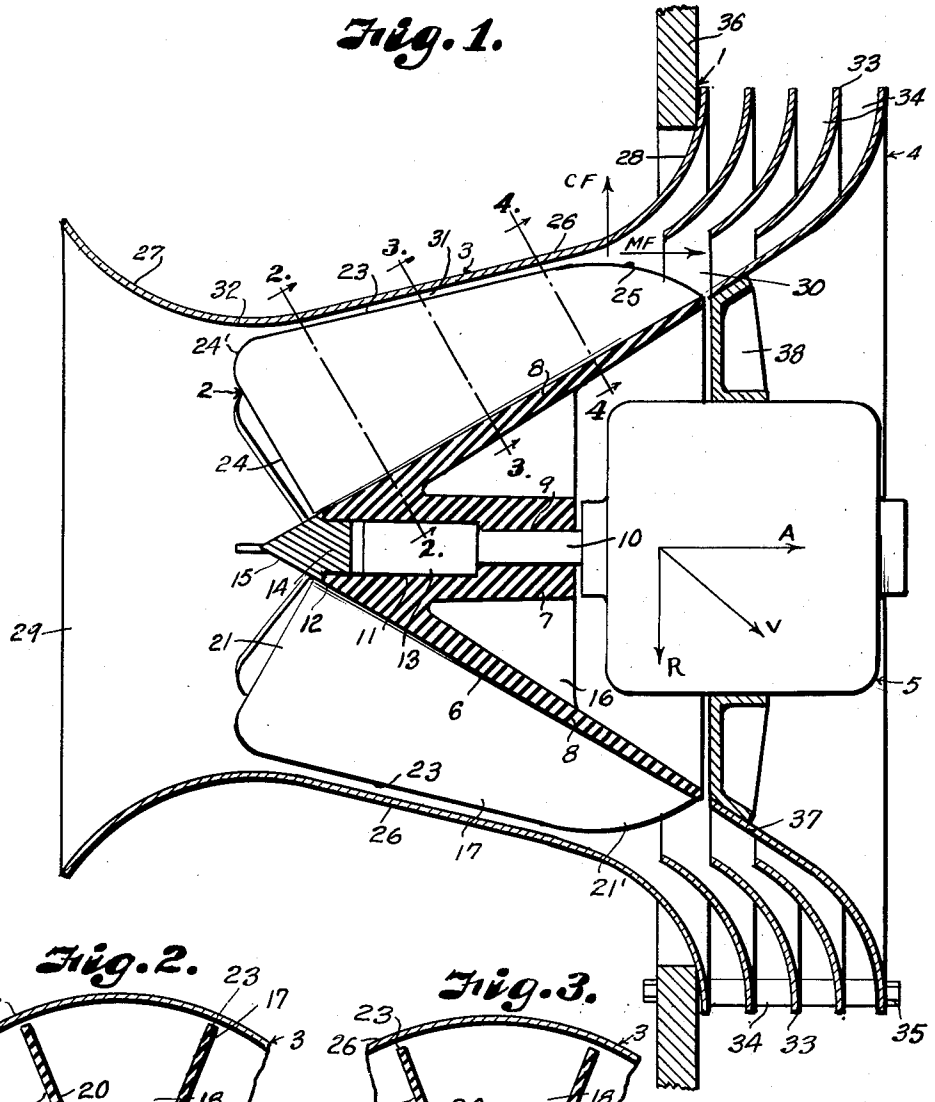


Fig. 2.

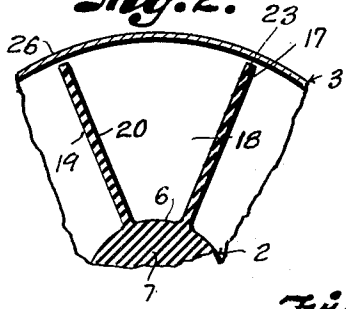


Fig. 3.

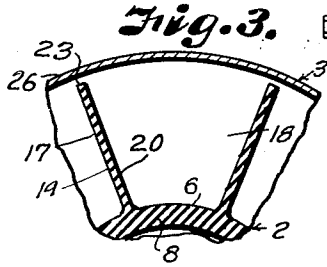
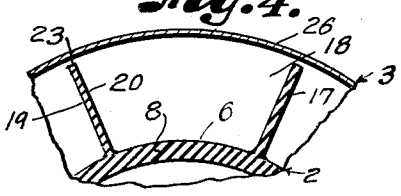


Fig. 4.



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Fig. 5.

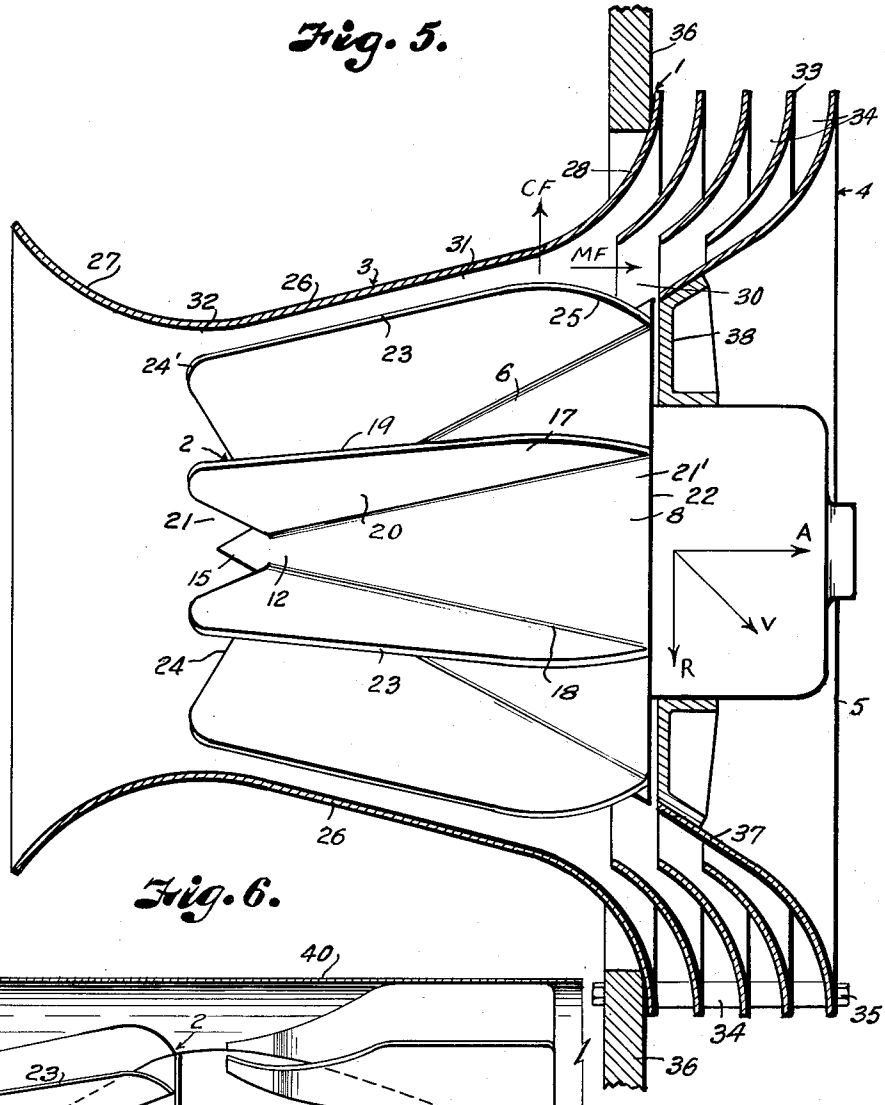
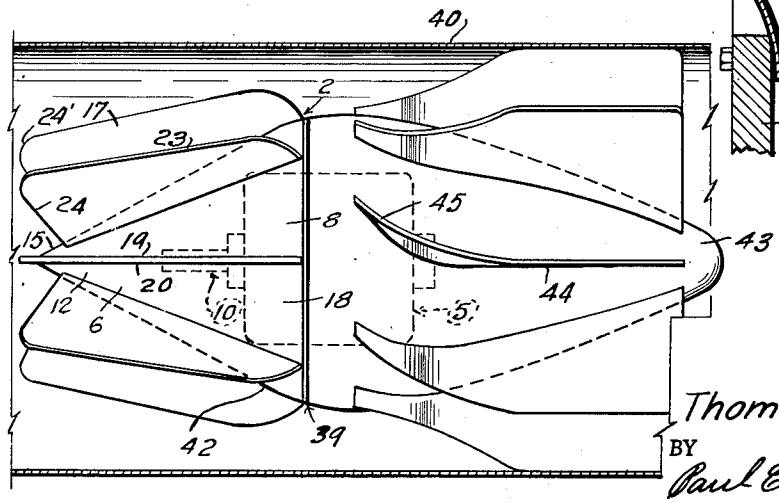


Fig. 6.



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United States Patent Office 2,991,927
Patented July 11, 1961

2,991,927

APPARATUS FOR MOVING FLUIDS

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Filed Feb. 3, 1958, Ser. No. 712,776
6 Claims. (Cl. 230—117)

This invention relates to an apparatus for moving fluids, and has for its principal object to provide a relatively small compact unit for moving a fluid medium efficiently and quietly in large volume and low pressure, the present application being a continuation in part of my copending application Serial No. 375,894.

Another object of the invention is to provide an efficient and quiet movement of fluids from a low pressure zone to a high pressure zone by creating separately moving streams of the fluid in streamline flow at high velocity for inducing flow of the fluid from the low pressure zone to maintain said moving streams of fluid, circumvolving the moving streams of fluid while maintaining said streamlined flow to increase the discharge velocity thereof, and diffusing the fluid streams into the zone of higher pressure with a minimum of turbulence.

Other objects of the invention are to provide a simple light weight inexpensive structure of inherently strong and enduring characteristics and which is adapted for high volume production of plastic material by injection molding process.

Further objects of the invention are to provide an impeller for creating flow of fluid which consists of a cone shaped or conoidal airfoil body having straight flat faced radial blades forming flow passages therebetween of substantially constant uniform capacities along the axial direction of the impeller; and to provide an impeller of this character in combination with a venturi shaped casing and a diffuser whereby a gaseous fluid such as air is accelerated before it enters the impeller responsive to induction effected by movement of the air through the passages as energy is being imparted tangentially incidental to rotation of the impeller and to diffuse the air at desired velocity.

A further object of the invention is to provide a diffuser which aids in inducing flow of a larger volume of air through the passages of the impeller while releasing the air at approximately the desired velocity and substantially without turbulence.

A further object of the invention is to provide an impeller which effects acceleration of the flow by retaining the fluid in circumvolved highly pitched flows incidental to the passages and to rotation of the impeller.

A further object of the invention is to provide an impeller wherein the passages between the blades maintain the airstream size substantially constant and under uniform velocity in an axial direction as the fluid is being accelerated circumferentially, thereby maintaining a uniform density and eliminating turbulence.

In accomplishing these and other objects of the invention as hereinafter pointed out, I have provided improved structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

FIG. 1 is a longitudinal section through a fluid moving apparatus constructed in accordance with the present invention, the motor being shown in elevation.

FIG. 2 is a fragmentary cross section near the inlet portion of one of the impeller passages, the section being taken on the line 2—2 of FIG. 1.

FIG. 3 is a similar section taken near the midpoint of the passage on the line 3—3 of FIG. 1.

FIG. 4 is a similar section taken through the discharge portion of the passage on the line 4—4 of FIG. 1.

FIG. 5 is a view similar to FIG. 1, but showing the impeller in elevation to better illustrate the shape of the passages that are provided between the impeller blades.

FIG. 6 is a longitudinal section through a flow duct containing a fluid moving apparatus embodying the features of the present invention.

Referring more in detail to the drawings:

1 designates an apparatus constructed in accordance with the present invention, and which includes an impeller 2, an impeller casing 3, a diffuser 4, and a motor 5 for operating the impeller.

The impeller 2 includes a conoidal airfoil body 6 having an axial hub 7 carrying a rearwardly and outwardly flaring annular wall 8 which forms an angle with the axis of the hub of from substantially 15° to 40° or an included angle of between 30° and 80°, depending upon the number of blades to be employed. In the illustrated instance, ten blades are employed and the angle is substantially 30° with respect to the axis of the impeller.

The hub 7 is provided with an axial bore 9 for supporting the impeller on the armature shaft 10 of the motor 5, or, if desired, the impeller may be molded directly upon the armature shaft of the motor, since the construction is especially adapted to manufacture of the impeller of light weight plastic material by an injection molding process. To facilitate mounting of the impeller, the bore 9 has a counterbore 11 opening through the apical end 12 to pass an enlarged end 13 of the armature shaft 10, in which case the outer end of the counterbore is closed by a plug 14 having a conoidal end 15 conforming to the conical shape of the wall 8 of the impeller. If desired, the wall 8 may be stiffened with respect to the hub 7 by webs 16.

The blades 17 are elongated with respect to the radial depth thereof and extend longitudinally of the wall 8. The blades are positioned radially with respect to the rotational axis of the impeller. The blades are spaced apart in a circumferential direction to provide a plurality of longitudinal passages 18. The blades 17 are straight and preferably formed integrally with the wall 8 and the respective side faces 19 and 20 thereof are flat and located in planes equally disposed on opposite diametrical sides of the rotational axis and parallel therewith. The width of the passages 18 gradually increases from the inlet ends 21 thereof at the apical end of the conical body of the impeller toward the discharge ends 21′ at the base 22 of the conoidal body, however, to maintain substantially uniform flow capacity of the passages, the angle of the wall 8 of the conoidal body and the outer edges 23 of the blades are such that the blades gradually decrease in radial depth from the apex to the base of the conoidal body, thereby compensating for the rearwardly increasing space between the blades, as is best shown in FIGS. 1 to 4, inclusive. In other words, as the passages increase in width toward the rear of the impeller, the blades correspondingly decrease in radial depth to maintain substantially uniform cross sections along their entire length. By selection of the angles of the wall 8 relatively to the number of blades and the depth thereof, any variation in capacity should be kept within 20% variation between the inlet and outlet ends.

The forward end edges 24 of the blades project outwardly over the apical end of the impeller body and join with the outer longitudinal edges 23 in rounding curves 24′. The rear ends of the longitudinal edges 23 curve inwardly to join with the base portion 22 in rounding curves 25.

In the illustrated instance, the outer longitudinal edges of the respective blades are substantially 20° apart, as best shown in FIG. 3, while the forward end edges are substantially at 90° with respect to the surface of the wall 8. As above stated, flow capacities of the passages 18 are substantially constant and streamlined.

The casing 3 includes an annular rearwardly flaring linear wall portion 26 that closely conforms to the angle of the edges 23 of the blades, as shown in FIG. 1, and is substantially coextensive therewith and terminates at the respective ends of the blades in outwardly flaring bell portions 27 and 28 to respectively provide an inlet 29 and an outlet 30. The casing 3 is, therefore, of venturi shape and provides a venturi passageway 31 for the flow of air that is moved between the blades of the impeller. The constricted portion 32 of the passageway 31 is located substantially at the forward tips of the impeller blades and the outward bell 27 guides the air inwardly to the constriction 32 and through which the air is drawn at substantially high velocity responsive to induction produced by the airflow moving through the passages 18 between the blades of the impeller. The velocity pressure of the air discharged from the impeller is converted to static pressure through the diffuser 4. The diffuser 4 consists of a plurality of concentric outwardly and rearwardly curving rings or deflectors 33 of substantially equal diameters and conforming to the curvature of the bell portion 28. The rings 33 are spaced apart to provide a plurality of discharge passages 34 for radial discharge of the air. The rings 33 are spaced by spacing sleeves 34 on fastening devices such as bolts 35 by which the entire unit is mounted on a wall 36 that separates the low and high pressure sides of the apparatus. The inner of the rings 33 have a linear outwardly flaring portion 37 substantially registering with the base portion of the impeller which cooperates with the bell portion 28 of the casing to constitute the inner and outer sides of a common connection to the discharge passages 34 in which the air is divided into separate streams by the intermediate rings to better utilize the velocity pressure in overcoming the static pressure on the discharge side of the apparatus.

The motor 5 is preferably supported from the inner diffuser ring by brackets 38 that may extend radially from the motor casing and which are suitably connected with the inner ring. The respective parts of the apparatus are thus interconnected to provide a relatively small unit assembly.

In the form of the invention shown in FIG. 6, the fluid moving unit 39 is contained in a duct 40. The impeller 2 of the unit conforms to the structure of the previously described impeller, however, in this instance the base portion 42 of the impeller curves into registry with a streamlined casing 43 that is provided with vanes 44 having curved forward ends 45. The vanes 44 support the unit concentrically in the duct 40 and provide for straightening out the spiral streams discharged from the base of the impeller. In this construction, the cone shaped body of the impeller and the airfoil base of the casing 43 in cooperation with the duct produce the effect of a venturi.

Assuming that a unit is assembled and installed as illustrated in FIGS. 1 to 4, inclusive, and that the motor is in operation to rotate the impeller:

When the impeller reaches the intended r.p.m., centrifugal force develops as indicated by the arrow CF which is transmitted to a movement force indicated by the arrow MF. When the forces CF and MF come into effect, a low pressure area is established in the inlet portion of the venturi casing, so that exterior air rushes into the inlet of the venturi responsive to induction effected by the air streams passing in streamline flow through the passages 18 between the impeller blades as indicated by the arrow MF. Another low pressure area is created in the bottom of the passages along the conical surface of the impeller and along the retractive faces of the blades. As this low pressure develops, the air entering the venturi rushes into these areas and creates the movement of the air through the passages while the moving airstreams are being circumvolved by the impeller blades in the direction of rotation. As the forces CF and MF come into play, the resultant discharge forces, as indicated by the arrows A, R and V, are produced, the arrow A representing the axial force, the arrow R the circumferential force, and V the resultant force at which the streams of air are discharged into the diffuser.

It is thus obvious that the air is drawn from a low pressure zone at the inlet 29 of the venturi casing 3 by the separate streams of air that are caused to enter the low pressure areas at the bottom of the passages 18 and at the retractive sides of the impeller blades incidental to rotation of the impeller, and that these streams of air induce additional flow of air from the low pressure zone into the passages 18 for continuous movement in the axial directions thereof. While the air streams thus formed are under movement in an axial direction, the forward sides of the blades push or circumvolve the streams about the axis of rotation to discharge the air at increased velocity into the diffuser 4 wherein the air is diffused into the high pressure zone with a minimum of turbulence.

The venturi casing in combination with the impeller is an important feature, because the venturi action is established to supplement flow from the low pressure to the high pressure side. This is made possible because the impeller creates the energy that is necessary to establish and maintain the venturi action.

The form of the invention illustrated in FIG. 6 operates substantially in the same manner, with the exception that the air is discharged from the base of the impeller in an axial direction and the spiral movement of the air is straightened to parallel streams to continue through the duct.

From the foregoing, it is obvious that I have provided a simple light weight apparatus for moving fluids efficiently and quietly in large volume and low pressure. It is also obvious that the structure may be inexpensively produced because it is adapted for manufacture from plastic materials by injection molding process.

What I claim and desire to secure by Letters Patent is:

1. In an apparatus for moving fluid from a low pressure zone to a high pressure zone, a venturi casing having a low pressure inlet and a high pressure outlet and providing a restriction intermediate the inlet and outlet, said casing having a substantially linear flaring portion extending continuously from said restriction to said high pressure outlet, an impeller having a conoidal body with the conical surface thereof extending from the restriction to the outlet in a continuous substantially linear direction and at an angle with respect to the axis of the conical body greater than the flaring portion of the venturi casing, said impeller also having straight flat faced blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially elongated relatively to radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi so that the blades cooperate with said linear flaring portion and the linear directed conical surface of said body to provide confined passages between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the flow passages are of substantially uniform capacity along the length thereof, and means for rotating and supporting the impeller within said venturi casing at the axis of said conoidal body for circumvolving fluid in said passages to develop a centrifugal force that translates to a movement force of streams of fluid in the direction of said outlet for effecting rush of fluid into the passages from the inlet of the venturi responsive to induction effected by the fluid streams and to create low pressure areas in the passages immediately adjacent said conical surface of the conoidal body of the impeller for movement of fluid thereinto from the inlet of the venturi.

2. In an apparatus for moving fluid from a low pressure zone to a high pressure zone, a venturi shaped casing having a low pressure inlet and a high pressure outlet and providing a restriction intermediate the inlet and outlet, said casing having a susbtantially linear flaring portion

extending continuously from said restriction to said high pressure outlet, an impeller having a conoidal body with the conical surface thereof extending from the restriction to the outlet in a continuous substantially linear direction and at an angle with respect to the xais of the conoidal body greater than the flaring portion of the venturi casing, said impeller also having straight flat faced blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially longer than the radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi so that the blades cooperate with said linear flaring portion and the linear directed conical surface of said body to provide confined flow passages between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the flow passages are of substantially uniform capacity along the length thereof, means for rotating and supporting the impeller within said venturi casing at the axis of said conoidal body for circumvolving fluid in said passages to develop a centrifugal force that translates to a movement force of streams of fluid in the direction of said outlet for effecting rush of fluid into the passages from the inlet of the venturi responsive to induction effected by the fluid streams and to create low pressure areas in the passages immediately adjacent said conical surfaces of the conoidal body of the impeller for movement of fluid thereinto from the inlet of the venturi, and a diffuser at the outlet of the venturi shaped casing for diffusing the fluid streams into the high pressure zone.

3. In an apparatus for moving fluid from a low pressure zone to a high pressure zone, a wall separating said zones and having an opening therethrough, a venturi casing having a low pressure inlet and a high presure outlet and providing a restriction intermediate the inlet and outlet, said inlet of the casing being curved inwardly to said restriction and having a substantially linear flaring portion extending continuously from said restriction into an outwardly belled portion at said outlet end, fastening means for securing the belled portion to the wall coaxially of the opening therethrough, an impeller having a conoidal body with the conical surface thereof extending from the restriction to the outlet in a continuous substantially linear direction and at an angle with respect to the axis of the conical body greater than said flaring portion of the venturi casing, said impeller also having straight flat faced blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially elongated relatively to the radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi casing so that the blades cooperate with said linear flaring portion of said venturi casing and the linear directed conical surface of said conoidal body to provide confined flow passages between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the flow passages are of substantially uniform capacity along the length thereof, a motor having a power shaft carrying the impeller within said venturi casing for circumvolving fluid in said passages to develop a centrifugal force that transposes to a movement force of streams of fluid in the direction of said outlet for effecting rush of fluid into the passages from the inlet of the venturi casing responsive to induction effected by said fluid streams and to create low pressure areas in the passages immediately adjacent said conical surface of the conoidal body of the impeller for movement of fluid thereinto from the inlet of the venturi casing, and a diffuser comprising a plurality of concentric bell shaped rings supported by said fastening means in spaced apart relation and concentric relation with the belled portion of the venturi casing to provide a plurality of circumferential outlets in connection with the outlet of the venturi casing to diffuse said fluid streams into the high pressure zone, the endmost ring having a conical portion in registry with the base of the conoidal body of the impeller, and brackets fixed to said conical portion of the endmost ring for supporting the said motor.

4. In an apparatus for moving fluid from a low pressure zone to a high pressure zone, a venturi casing having a low pressure inlet and a high pressure outlet and providing a restriction intermediate the inlet and outlet, said casing having a substantially linear flaring portion extending continuously from said restriction to said high pressure outlet, an impeller having a conoidal body with the conical surface thereof extending from the restriction to the outlet in a continuous substantially linear direction and at an angle between 15° and 40° with respect to the axis of the conoidal body, said impeller also having straight flat faced blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially elongated relatively to the radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi casing so that the blades cooperate with said linear flaring portion and the linear directed conical surface of the said conoidal body to provide confined passages, between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the cross sectional areas of the inlet and discharge ends of the passages are within 20% capacity of each other, and means for rotating and supporting the impeller within said venturi casing at the axis of said conical shaped body for circumvolving fluid in said passages to develop a centrifugal force that translates to a movement force of streams of fluid in the direction of said outlet for effecting rush of fluid into the passages from the inlet of the venturi casing responsive to induction effected by the fluid streams and to create low pressure areas in the passages immediately adjacent said conical surface of the conoidal shaped body of the impeller for movement of fluid thereinto from the inlet of the venturi casing.

5. In an apparatus for moving fluid from a low pressure zone to a high pressure zone, a venturi casing having a low pressure inlet and a high pressure outlet and providing a restriction intermediate the inlet and outlet, said venturi casing having a substantially linear flaring portion extending continuously from said restriction to said high pressure outlet, an impeller having a conoidal body with the conical surface thereof extending from the restriction to the outlet in a continuous substantially linear direction and at an angle with respect to the axis of the conoidal body greater than the flaring portion of the venturi casing, said impeller also having straight flat faced blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially elongated relatively to the radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi casing so that the blades cooperate with said linear flaring portion and the linear directed conical surface of said conoidal body to provide confined passages between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the flow passages are of substantially uniform capacity along the length thereof, said impeller having a number of blades to maintain an angle therebetween of substantially 20°, and means for rotating and supporting the impeller within said venturi casing at the axis of said conoidal body for circumvolving fluid in said passages to develop a centrifugal force that translates to a movement force of streams of fluid in the direction of said outlet for effecting rush of fluid into the passages from the inlet of the venturi casing responsive to induction effected by the fluid streams and to create low pressure areas in the passages immediately adjacent said conical surface of the conoidal shaped body of the impeller for movement of fluid thereinto from the inlet of the venturi casing.

6. In an apparatus for moving fluid from a low pressure

zone to a high pressure zone, a venturi casing having a low pressure inlet and a high pressure outlet, said casing having a bell portion providing said inlet and joining with a substantially linear flaring portion joining with a larger bell portion providing said high pressure outlet, an impeller within said venturi casing having a conoidal body with the conical surface thereof extending from the apical portion of said body in continuous substantially linear direction to the base thereof and at an angle with respect to the axis of the conical body greater than the flaring portion of the venturi casing, said impeller also having straight flat blades extending radially and longitudinally from the conical surface of the conoidal body and in plane with said axis, said blades being substantially elongated relatively to radial depth of the blades and having outer edges in close relation with said linear flaring portion of the venturi so that the blades cooperate with said linear flaring portion and the linear directed conical surface of said body to provide confined passages between said blades of decreasing radial depth and correspondingly increasing width in the direction of said outlet whereby the flow passages are of substantially uniform capacity along the length thereof, means for rotating and supporting the impeller within said venturi casing at the axis of said conoidal body for circumvolving fluid in said passages to develop a centrifugal force that translates to linear movement of streams of fluid through said passages

in the direction of said outlet, a series of rings of substantially equal diameter and each having a curvature conforming to that of the larger bell portion, and means for supporting said rings in spaced apart concentric relation to provide discharge passages for diverting said streams of fluid radially when discharged from between said blades, said endmost ring having a linear flaring portion substantially registering with said base portion of the conoidal body of the impeller to cooperate with the larger bell portion to connect passages between said rings.

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