May 5, 1964 A. Y. DODGE 3,131,645

VORTEX JET PUMP

Filed Nov. 28, 1961

Fig. 1

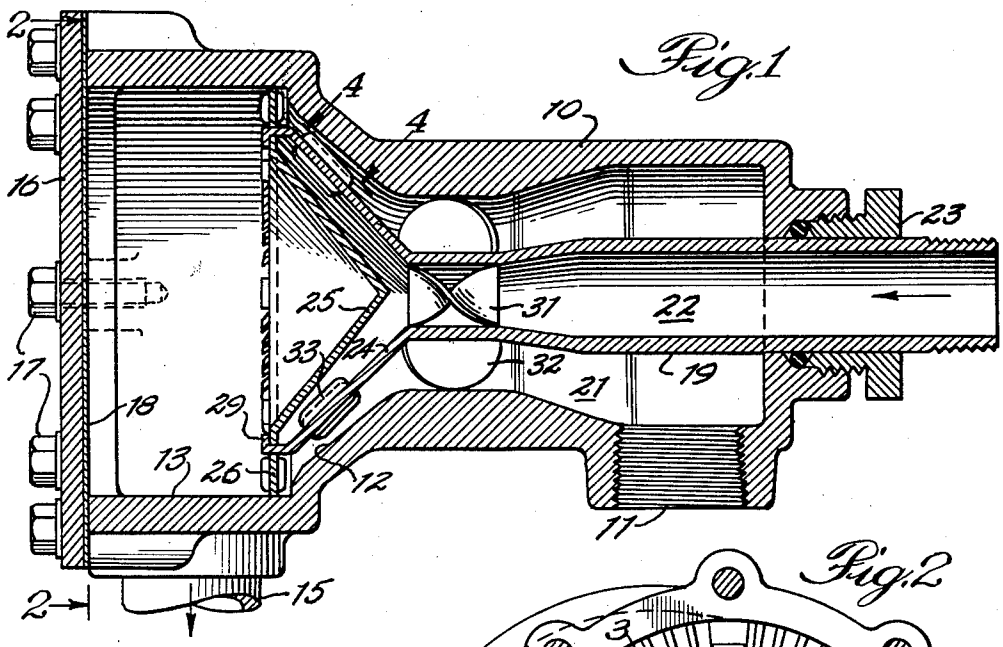


Fig. 2

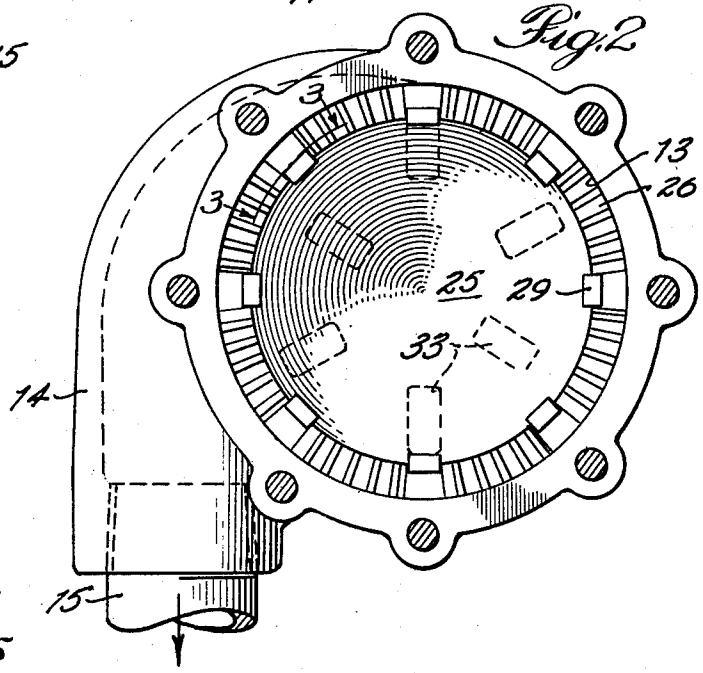


Fig. 3

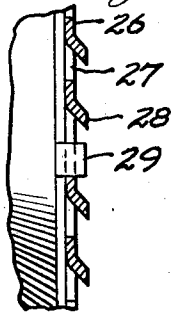


Fig. 4

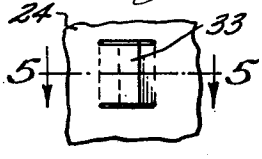
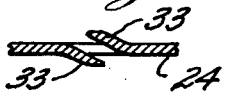


Fig. 5



INVENTOR:
Adiel Y. Dodge,
BY
Bair Freeman & Molinare
ATTORNEYS.

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VORTEX JET PUMP

Adiel Y. Dodge, % A. Y. Dodge Co., 206 S. Main St., Rockford, Ill.

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This invention relates to jet pumps and more particularly to a jet pump for pumping fluid by jet action plus centirfugal force.

Jet pumps have been known and used for many years, but their use has been limited because of their low efficiency. Improvement to increase their efficiency and capacity are disclosed and claimed in my patent No. 3,007,322 and my copending application Serial No. 129,689 filed August 7, 1961, and the present invention constitutes a further step in this direction.

It is a primary object of this invention to make use of centrifugal force in the form of an induced vortex thereby to produce rarified pressure at the core of said vortex and increased pressure at the periphery thereof.

One of the principal objects of this invention is to provide a jet pump which makes use of centrifugal force to increase the difference in pressure between the intake and discharge thereof.

It is another object of the present invention to provide a jet pump in which fluid is caused to flow smoothly through the pump with a minimum of turbulence.

Another object is to provide a jet pump in which turbulence of the fluid is reduced.

According to a feature of the invention, angular vanes are provided in the pump which cause the fluid to swirl as it flows through the pump. Swirling of the fluid in the coaxial passages carrying the propellant fluid and the fluid to be aspirated enables contact to be made between the different fluids with a minimum of shock between said fluids. Swirling of the fluid in the chambers creates a smooth flow condition and tends to eliminate turbulence. In addition, the swirling creates a centrifugal force which increases the vacuum in the passage carrying the fluid to be aspirated and to increase the pressure head across the pump and to increase its efficiency.

A further object is to provide a jet pump in which the propelling and propellent fluids are fed into a vortex chamber after being mixed and are discharged from it tangentially in a smooth efficient flow.

Preferably angular vanes are provided at the entrance to the vortex chamber to supplement the swirling action and to insure continued swirling in the vortex chamber and to convert velocity into pressure.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a sectional view with parts in elevation through a jet pump embodying the invention;

FIGURE 2 is a section on the line 2—2 of FIGURE 1;

FIGURE 3 is a section on the line 3—3 of FIGURE 2;

FIGURE 4 is a detail of one of the nozzle apertures; and

FIGURE 5 is a section on the line 5—5 of FIGURE 4.

The jet pump, as best seen in FIGURE 1, comprises a casing 10 which forms a tubular conduit having a lateral inlet 11 at one end thereof. Near its opposite end the

casing is formed with a conically flared portion 12 which connects to an enlarged casing portion having an axially extending wall 13. The wall 13 is approximately cylindrical throughout a major portion of its circumference as seen in FIGURE 2, and spirals outwardly to a generally tangentially extending discharge opening 14 to which a discharge conduit 15 may be connected. If desired, the wall portion 13 could be in the form of a spiral from one side of the discharge opening therefrom to the other, or could be shaped as shown with the major portion of its circumference cylindrical and communicating at one side at the discharge opening. The outer open end of the casing is closed by a flat cover 16 secured to the casing by screws 17 or similar fastenings, and preferably with a sealing gasket 18 so that it will seal the casing tightly.

A second conduit 19 is mounted within the conduit portion of the casing 10 and is of smaller diameter than the casing to define therewith coaxial passages 21 and 22. The conduit 19 preferably extends through the end of the casing and is sealed therein by a gland 23 or similar sealing means. At its inner end the conduit 22 is formed with a conically flaring portion 24 which lies opposite the conically flaring portion 12 of the casing.

The inner end of the conduit 22 is closed by a conical plate 25 whose conical surface is spaced from the flaring portion 24 of the inner conduit to define therewith an outwardly flaring passage. Preferably, the plate 25 is at a somewhat flatter conical angle than the conduit portion 24 so that the passage therebetween converges outwardly.

At its outer edge the plate 25 has an annular ring portion 26 which fits slidably within the wall portion 13 of the casing. The flange portion 26 is formed with a series of openings 27 therethrough defined by cutting and punching out tongues 28 from the flange portion. In this way the openings 27 tend to direct the fluid flowing therethrough in a spiral path substantially tangent to the wall 13 as the fluid enters the chamber defined by the wall 13. For connecting the inner conduit to the plate 25, tongues 29 may be formed at the ends of the conically flared portion of the inner conduit, which extend through openings in the plate and are bent over as shown.

Fluid entering the coaxial passages is given a swirling movement by means of a vane 31 positioned within the inner conduit 22, and an annular series of vanes 32 positioned around the inner conduit within the casing. The vanes 31 and 32 are angled in the same direction to cause the fluid flowing through the passages to swirl in the same direction.

The swirling fluid flowing outwardly through the inner passage passes therefrom to mix with the fluid flowing through the outer passage through openings in the conically flared portion of the inner conduit. As best seen in FIGURES 4 and 5, these openings are formed by cutting and punching out lips 33 which define generally tangentially extending nozzles. These nozzles tend to direct the fluid flowing therethrough in the same direction in which it is caused to swirl by the vane 31, so that the fluid will flow smoothly through the nozzles and will mix smoothly with the swirling fluid flowing through the outer passage 21 without shock. As best seen in FIGURE 2, the openings defined by the lips 33 are radially staggered so that the fluids flowing through the inner and outer passages will mix progressively.

In use the inner conduit 22 is connected to a source of

fluid under relatively high pressure, and the inlet opening 11 to the casing is connected to a low pressure source of fluid to be aspirated. As the high pressure fluid flows through the inner passage 22, it is caused to swirl by the vane 31 and further by the openings 33 to enter the outer passage at the outer portion of the conically flared part thereof. This fluid will then flow through the openings 27 into the large vortex chamber defined by the wall 13, where it continues to swirl around until it flows out the outlet. Flow of the high pressure fluid through the inner passage and the openings 33 will induce a flow of the low pressure fluid through the outer passage 21 to mix smoothly with the high pressure fluid in the area of the openings 33. The mixture will be carried through the openings 27 into the vortex chamber where the fluid will continue to swirl in the same direction until it passes smoothly through the discharge opening.

It will be noted that in the jet pump of the present invention there is no diffuser chamber, as has been required by all previous jet pumps in which velocity is converted to pressure by a draft tube or the like. In the jet pump of the present invention, the swirling fluid immediately upon being mixed passes into the vortex chamber where velocity is partially converted to pressure by centrifugal force. In this construction the vortex chamber takes the place of the conventional diffuser or draft tube, and converts the velocity to pressure smoothly with a minimum of shock or turbulence.

Furthermore, the swirling of the fluids at the point where they mix adjacent to the openings 33 causes mixing of the fluids with a minimum of shock and turbulence so that the jet pump functions at a high efficiency. Outward flow of the swirling fluids through the conical passages creates a centrifugal effect further tending to increase the aspiration of the low pressure fluid and to improve the efficiency. It will be understood, of course, that the cone angle can be varied as desired up to a flat 90° cone and can flare along either straight or curved lines. In addition, mixing at the peripherally outer portion of the conical passages tends to prevent any short circuiting or recirculation which can occur in a conventional draft tube pump. Due to these several features, the jet pump of the present invention functions at a high degree of efficiency and is capable of pumping large volumes of fluid at relatively low pressures.

Adjustment of the volume of fluid to be aspirated and the resulting pressure can easily be accomplished simply by sliding the inner conduit and closure plate 25 axially of the outer casing. Axial movement of the inner conduit will vary the cross-sectional area of the conical portion of the outer passage, thereby increasing or decreasing the area of the passage through which the aspirated fluid is flowing to control the volume of fluid which will be aspirated.

While one embodiment of the invention has been shown and described in detail, it will be understood that this is illustrative only and is not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. A jet pump comprising coaxial conduits defining coaxial flaring passages, one of the passages receiving a propellent fluid under relatively high pressure and the other being connected to a source of fluid to be aspirated, the inner conduit having spaced openings therein adjacent to the larger end of the passages for flow of fluid from one passage to the other, means closing the end of the conduit receiving the propellent fluid whereby the propellent fluid flows through said openings, angular vanes over which the fluid flows positioned upstream of the openings to cause the fluid in both passages to swirl in the same direction as it flows through the conduits and the openings, a mixing chamber connected to the larger end of the conduit which is connected to the source of fluid to be aspirated, and means forming an outlet from the mixing chamber.

2. The jet pump of claim 1 in which said spaced openings open substantially tangentially of the passages in the same direction as the fluid is swirling.

3. A jet pump comprising coaxial conduits defining coaxial flaring passages, one of the passages receiving a propellent fluid under relatively high pressure and the other being connected to a source of fluid to be aspirated, a mixing chamber connected to and forming a continuation of the outer conduit to receive fluid flowing through both of the passages, a central cone at the inlet end of the mixing chamber spaced from the inner surface thereof to define therewith an annular inlet passage and closing the larger end of the inner passage, means defining an outlet for the mixing chamber spaced from the inlet passage, and a plurality of tangential discharge apertures located in the inner conduit adjacent to the larger ends of the passages.

4. A jet pump comprising coaxial conduits defining coaxial passages, one of the passages receiving a propellent fluid under relatively high pressure and the other being connected to a source of fluid to be aspirated, the inner conduit having spaced openings therein for flow of fluid from one passage to the other, means closing the inner conduit downstream from the openings whereby fluid therein will flow through the openings into the outer conduit, a centrifugal vortex chamber connected at its periphery to the periphery of the outer conduit and receiving fluid from the passages, a tangential outlet from the vortex chamber, and means upstream from the vortex chamber to cause fluid entering the vortex chamber to swirl in a direction to flow smoothly out the tangential outlet therefrom.

5. A jet pump comprising coaxial conduits defining coaxial passages, one of the passages receiving a propellent fluid under relatively high pressure and the other being connected to a source of fluid to be aspirated, the inner conduit having spaced openings therein for flow of fluid from one passage to the other, means closing the inner conduit downstream from the openings whereby fluid therein will flow through the openings into the outer conduit, a centrifugal vortex chamber connected at its periphery to the periphery of the outer conduit and receiving fluid from the conduits, a tangential outlet from the vortex chamber, first angular vanes upstream of the openings in the inner conduit to cause the fluid to swirl as it flows through the conduits, and second angular vanes between the openings and vortex chamber to cause the fluid to continue to swirl in the same direction, the tangential outlet facing toward the swirling fluid to conduct it smoothly from the vortex chamber.

6. In an injector pump, the combination of three spaced conical parts forming an outer outwardly flaring annular passage and an inner outwardly flaring annular passage, and a multiplicity of tangential nozzles located in the intermediate conical part discharging into the outer passage to induce flow of fluid to be pumped through the outer passage.

7. In an injector pump, the combination of three spaced conical parts forming an outer outwardly flaring annular passage and an inner outwardly flaring annular passage, a multiplicity of tangential nozzles located in the intermediate conical part discharging into the outer passage to induce flow of fluid to be pumped through the outer passage, and vanes upstream from the nozzles to induce a vortex swirl of the fluids flowing through the passages.

8. The construction of claim 6 in which said nozzles are located in radially staggered positions in the intermediate conical part.

9. A jet pump comprising an outer casing having a conically flared portion joined at its larger end to an axially extending annular wall portion, a closure for the wall portion defining with the wall portion a vortex

chamber, an inner conduit having a conically flared portion registering with the conically flared portion of the casing and defining therewith a conically flared outer passage, a conical closure closing the larger end of the inner conduit and defining therewith a conically flared inner passage, the inner conduit having openings therein through which fluid can flow from the inner to the outer passage, means defining a flange having flow openings therethrough at the larger end of the inner conduit and which fits slidably in the vortex chamber for axial adjustment of the inner conduit to vary the size of the outer passage, and means defining an outlet from the vortex chamber.

10. The jet pump of claim 9 in which the openings in the inner conduit and in the flange define tangentially extending nozzles to cause the fluid to swirl as it flows therethrough.

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