H. F. SCHMIDT.

FLUID TRANSLATING DEVICE.

APPLICATION FILED SEPT. 14, 1914.

1,237,219. Patented Aug. 14, 1917.

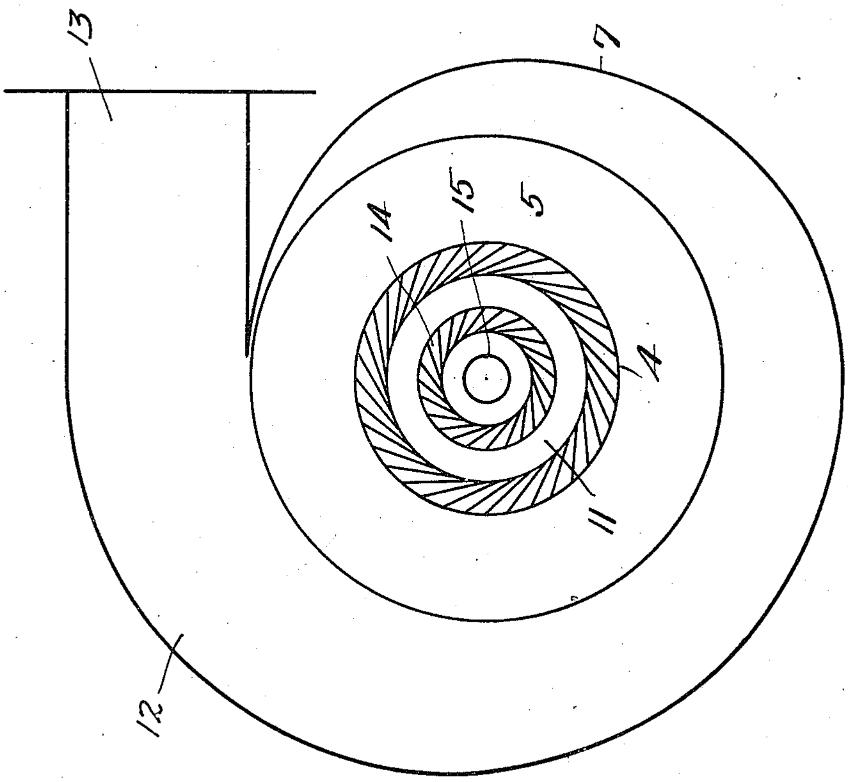


Fig. 1.

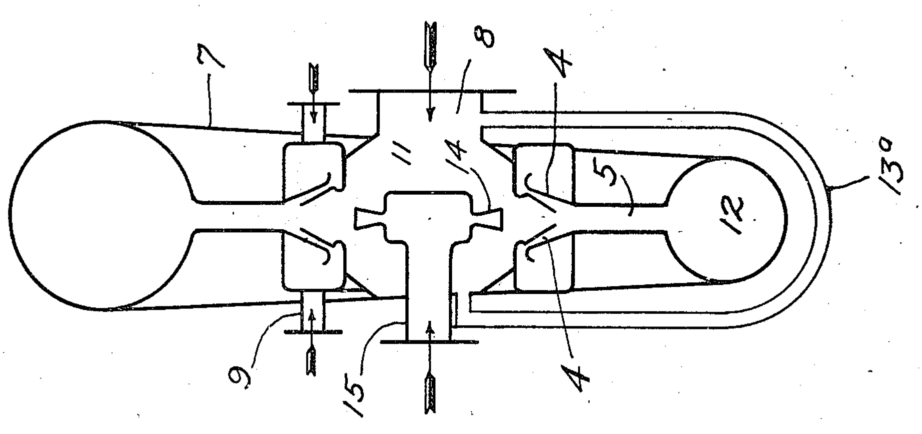
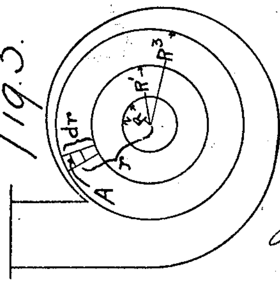


Fig. 2

Fig. 3.



WITNESSES:

INVENTOR.

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BY

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UNITED STATES PATENT OFFICE.

HENRY F. SCHMIDT, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

FLUID-TRANSLATING DEVICE.

1,237,219. Specification of Letters Patent. Patented Aug. 14, 1917.

Application filed September 14, 1914. Serial No. 861,637.

To all whom it may concern:

Be it known that I, HENRY F. SCHMIDT, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Fluid-Translating Devices, of which the following is a specification.

This invention relates to fluid translating devices, and particularly to devices employing the kinetic or velocity energy of the motive fluid in exhausting fluid from a receptacle to be evacuated, or in compressing fluid from a region of lower to a region of higher pressure.

An object of the invention is to produce a fluid translating device, of the kinetic type, in which means are employed for maintaining the operation of the device substantially constant for practically all varying conditions.

A further object of the invention is to produce a fluid translating device, of the kinetic type, in which a more stable and more efficient means than a diffuser tube is employed for converting the kinetic energy of the impelling fluid into potential energy.

A further object is to produce a fluid translating or ejecting device of greater capacity for a given size and weight than ejectors or similar devices now in use or known to me.

These and other objects are attained by apparatus embodying the features herein described and illustrated in the drawing accompanying and forming a part of this application.

In the drawing:

Figure 1 is a diagrammatic vertical sectional view of a device embodying my invention:

Fig. 2 is a diagrammatic transverse sectional view of the apparatus shown in Fig. 1: and

Fig. 3 is a diagrammatic view employed in connection with a mathematical demonstration, which is included in the application.

The apparatus illustrated as an embodiment of my invention includes means for discharging impelling fluid at a high velocity and in the form of a whirling disk-shaped jet into and through a velocity conversion chamber, in which the velocity or kinetic energy of the fluid is converted into potential energy as represented by an increase in pressure. This velocity conversion is accomplished, in the specific form of apparatus illustrated, by means of the centrifugal force occasioned by the rotary motion of the fluid.

In the illustrated embodiment of the invention an annular series of nozzles 4 is provided, which discharge fluid in substantially tangential streams into a velocity conversion or vortex chamber 5, in which the pressure of the fluid is gradually built up and from which the fluid is discharged at a pressure above that at which it enters the chamber. The annular nozzles 4 discharge fluid, employed as the impelling medium in ejecting or compressing a fluid from a region of lower to a region of higher pressure, and this fluid consequently entrains and imparts velocity to the fluid to be ejected or compressed. The mixture of impelling and impelled fluid or medium in traversing the chamber 5 moves, by reason of the rotary motion imparted to it by the coöperating nozzles 4, in a spiral path and is gradually compressed by the centrifugal force occasioned by the rotary motion and finally, overcoming the external pressure, leaves the chamber 5 practically devoid of kinetic energy.

With an apparatus operating in this manner there is no tendency toward upsetting, by which I mean a breaking down of the pressure at the discharge or outlet of the vortex to that at the inlet, or fluctuations of pressure within the vortex, due to causes other than changes in the rate of fluid or medium delivered. In addition to this, all the parts employed are stationary parts; they do not require adjustment for varying rates of flow or for varying conditions of discharge or inlet pressure, and the apparatus is capable of maintaining constant work of compression so long as the velocity of entrance into the vortex remains constant.

The following mathematical demonstration sets forth the action which takes place in the vortex chamber and describes more fully the principle on which the apparatus operates.

In order to find the pressure created in a free vortex, assume a tube extending from R_1 to R_3, Fig. 3, of area A and take a lamina of this tube of thickness dr at any radius r. Then the centrifugal force acting on this small mass of medium will be

$$dF=Adp=\frac{PAdr\mu^2}{gr}\text{ or }\frac{dr\mu^2}{gr}=vdp.$$

But μ is inversely proportional to the radius, hence the velocity μ at any point will be

$$\frac{\mu_1R_1}{r}$$

where μ_1 is the velocity of entrance to the vortex. Substituting the value of μ

$$vdp=\left(\mu_1R_1\right)^2\frac{dr}{gr^3}$$

and integrating between the limits p_2 and p_3 and $r=R_1$, and $r=\infty$.

$$\frac{r}{r-1}2gp_2v_2\left[\left(\frac{p_3}{p_2}\right)^{\frac{r-1}{r}}-1\right]=-\frac{\mu_1^2R_1^2}{\infty^2}+\frac{\mu_1^2R_1^2}{R_1^2}=\mu_1^2$$

which shows that for a 100 per cent conversion efficiency the vortex must be of infinite diameter. For any given radius of vortex R_3 the work done by the velocity conversion in foot-pounds will be

$$W=\frac{\mu_1^2}{2g}\left[1-\left(\frac{R_1}{R_3}\right)^2\right]$$

or the velocity conversion efficiency is

$$E=1-\left(\frac{R_1}{R_3}\right)^2$$

Now the reason for the statement that the pressure remains constant in an ejector having a free vortex will be evident from the preceding mathematical demonstration, since it follows that as the pressure created in the vortex is due to the centrifugal force acting on the fluid in the vortex, neglecting friction and eddies, the pressure created must be independent of the volume delivered. This must be true for the further reason that the volume delivered does not enter into the mathematical analysis as a function of the work done, whereas, in the mathematical deduction of the equation of flow (or work done) in a diffusion tube, the volume enters the equation in the expression $(V_1^2-V_2^2)$.

As previously stated, neglecting friction, the energy transformation taking place in a free vortex remains constant regardless of the volume delivered, even though the delivery is reduced to zero, and likewise the efficiency is for the same reasons constant, independent of the volume delivered. This explains the much higher efficiency, which may be obtained in the free vortex ejector at partial rating than is obtained in an ejector fitted with a diffusion tube. Further, when the element of friction is considered, the free vortex ejector has a considerable advantage over the diffusion tube ejector because the surface exposed to friction is very much smaller in proportion to the capacity.

Referring now to the drawing:

The apparatus illustrated includes a casing 7, provided with a port 8 adapted to communicate with a chamber to be exhausted or evacuated, and a port 9 through which impelling or motive fluid under pressure is delivered to the tangentially arranged nozzles 4. The nozzles 4, as shown, are arranged in two groups and are located on opposite sides of the inlet to the vortex chamber 5, which is included within the casing 7 and which communicates at its inlet end with a space 11 in open communication with the port 8. Each group of nozzles 4 is inclined inwardly so that one group coöperates with the other in discharging an annular or disk-shape stream of motive fluid through the inlet of, and into the vortex chamber 5. The nozzles 4 are divergent and are preferably so proportioned as to expand the motive fluid delivered to them to substantially the pressure existing at the port 8. The vortex is preferably, although not necessarily concentric; that is, the inner peripheries of its walls are concentric with the outer peripheries of its walls. A pressure chamber 12, which is shown in the drawing as a volute chamber, communicates with the outlet of the vortex and is provided with a delivery or discharge port 13. In the drawing I have shown a bypass 13[a] which places both sides of the chamber 11 in direct communication with the port 8. While this is not essential, it improves the operation of the apparatus by rendering the two groups of nozzles 4 equally effective. The apparatus also includes a group of accelerating nozzles 14 which, like the nozzles 4, are tangentially disposed with relation to each other and are adapted to receive fluid under pressure through a port 15 and to expand the fluid to substantially the pressure normally existing in the chamber 11. These nozzles are located in alinement with the chamber 5 and are adapted to discharge the motive fluid issuing from them into the chamber 5 after it has passed through a combining chamber located between the two groups of nozzles 4.

The operation of the apparatus is as follows: Motive fluid delivered to the nozzles 14 is expanded in traversing these nozzles to substantially the pressure existing in the chamber 11, and is discharged at a high velocity into and through a portion of the chamber 11 or into an annular combining passage surrounding the nozzles 14 and located between the two groups of nozzles 4.

The motive fluid so discharged entrains fluid to be expelled from the chamber 11 and partly compressing this fluid delivers it to the vortex chamber 5. Depending upon the design of the nozzles 14 and of the annular combining passage surrounding them, fluid issuing from the nozzles 14 may occasion more or less preliminary compression of the entrained fluid, but the arrangement will preferably be such that the motive fluid discharged from the nozzles is highly effective as an entraining agent for the fluid to be expelled and delivers the fluid to be expelled partially compressed, but at a relatively high velocity, to the expelling nozzles 4. It will be understood by those skilled in the art that the nozzles 14 and the combining passage, shown in the drawings as surrounding the nozzles 14 and located between the two groups of nozzles 4, may be so designed that the combined motive fluid and the entrained fluid medium are practically brought to rest during the process of preliminary compression and are delivered to the nozzles 4 with practically no velocity. The nozzles 4 expand the motive fluid traversing them to substantially the pressure existing at the inlet to the vortex chamber 5, and deliver the fluid so expanded through the vortex chamber 5, entraining and compressing the motive fluid discharged by the nozzles 14 and the fluid entrained thereby. The inclination of the fluid discharge nozzles and their arrangement with relation to each other imparts a rotary motion to the fluid which, by reason of the centrifugal force resulting therefrom, builds up the pressure as it passes through the vortex chamber 5. After issuing from the vortex, the combined fluid is delivered through the discharge port 13. While the fluid discharged from the nozzles 14 effects a preliminary compression of the fluid medium contained within the chamber 11, as it passes through the annular combining passage located between the two groups of nozzles 4, the velocity energy of the fluid discharged from the nozzles 14 is preferably such as to assist the pressure conversion which takes place within the chamber 5.

While I have illustrated but one embodiment of my invention, it will be apparent to those skilled in the art, that the drawings are merely illustrative, and that various changes, substitutions, additions and omissions may be made in the apparatus illustrated without departing from the spirit and scope of the invention as set forth by the appended claims.

What I claim is:

1. In an apparatus of the character described, the combination of a chamber communicating with a source of medium to be compressed, a vortex communicating with the chamber, and stationary means for delivering a whirling jet of impelling fluid through said chamber and said vortex for entraining medium in passing through said chamber.

2. An apparatus of the character described, comprising a chamber communicating with a source of medium to be compressed, stationary means for delivering a jet of impelling medium through a portion of the chamber, and stationary means for effecting a centrifugal compression of the combined media issuing from said chamber.

3. An apparatus of the character described, comprising a chamber having a port for delivering medium to be compressed and communicating with an outlet through which compressed medium is discharged, stationary means for delivering a whirling jet of impelling medium through a portion of said chamber, and a stationary free expansion chamber between said first-mentioned chamber and said outlet, through which the combined media from the first chamber pass.

4. In an apparatus of the character described, a chamber from which medium is to be expelled, stationary means for delivering a stream of fluid having rotary motion, in combination with a substantially concentric stationary combining chamber, a vortex chamber, and a collecting chamber.

5. In an apparatus of the character described, a chamber from which fluid is to be expelled, stationary nozzles for discharging a substantially disk-shaped jet of whirling fluid through a portion of said chamber, in combination with a substantially concentric stationary combining chamber, a stationary concentric vortex chamber, and a concentric collecting chamber.

6. In combination in an apparatus of the character described, a chamber communicating with a source of fluid medium to be expelled, stationary fluid delivery means for expanding motive fluid to substantially the pressure existing in said chamber and for delivering the fluid so expanded into and through said chamber in a disk shaped jet, stationary means communicating with said chamber receiving the disk-shaped jet of motive fluid and the fluid medium entrained thereby for effecting a conversion of the kinetic energy of the fluid media passing therethrough into potential energy as represented by an increase in pressure, a collecting chamber communicating with the outlet of said last mentioned means, and means for delivering expansive motive fluid to said fluid delivery means.

7. In combination in an apparatus of the character described, a chamber communicating with a source of fluid medium to be expelled, stationary means located within said chamber for expanding motive fluid to substantially the pressure existing within the

chamber and for discharging the fluid so expanded in a disk-shaped jet, stationary means surrounding said fluid discharging means and receiving said disk-shaped jet and fluid medium entrained thereby, for effecting a conversion of the kinetic energy of the fluid media passing therethrough into potential energy as represented by an increase in pressure, a collecting chamber surrounding said jet receiving means, and means for delivering expansive motive fluid to said fluid expanding and discharging means.

8. An apparatus of the character described, comprising a chamber, communicating with a source of medium to be compressed, stationary means for delivering a disk-shaped jet of expansive impelling fluid through a portion of the chamber, and stationary means for effecting a centrifugal compression of the combined media and fluid issuing from said chamber.

9. An apparatus of the character described, comprising a chamber having an inlet port for delivering medium to be compressed to the chamber, means for expanding motive fluid and for delivering it in a disk-shaped jet to and through a portion of said chamber, stationary means communicating with said chamber and receiving the fluid and the entrained medium discharged therefrom for effecting a centrifugal compression of the fluid and medium issuing from the chamber.

10. An air ejector, comprising a chamber having an air inlet port, a conduit for delivering steam to said ejector, stationary means within the chamber and communicating with said conduit for expanding steam issuing from the conduit and for delivering it at a high velocity and in the form of a disk-shaped jet into and through a portion of said chamber, and stationary means for effecting a centrifugal compression of the steam and entrained air issuing from the chamber.

11. An ejector comprising a receiving chamber communicating with a source of fluid medium to be ejected, motive fluid delivery means located within the receiving chamber and gradually increasing in area from the throat to the outlet thereof for expanding motive fluid to substantially the pressure of the fluid medium within said chamber and for discharging the fluid so expanded at a high velocity and in the form of an annular jet through a portion of said chamber, a stationary annular passage surrounding said fluid delivery means and receiving the annular jet of motive fluid and the fluid medium entrained thereby for effecting a conversion of the velocity energy of the combined fluid passing therethrough into potential energy as represented by an increase in pressure, a stationary collecting chamber receiving the fluid discharged from said last mentioned means, and means for delivering expansive motive fluid to said motive fluid delivery means.

12. An ejector comprising a receiving chamber adapted to communicate with a source of fluid to be ejected, in combination with stationary means located within the chamber for expanding motive fluid and for delivering the fluid so expanded in the form of a whirling disk shaped jet through a free space within said chamber, stationary means communicating with the free space of said chamber for receiving the whirling jet and the fluid entrained thereby and for effecting a centrifugal compression of the motive and entrained fluid passing therethrough, and a stationary volute chamber surrounding and communicating with said last mentioned means.

13. An ejector comprising a receiving chamber, having an inlet port for fluid to be ejected, an annular free expansion chamber communicating with said receiving chamber, stationary means for delivering a substantially disk-shaped jet of expansive motive fluid into and through said free expansion chamber, and means for delivering an auxiliary jet of motive fluid through said receiving chamber and into said free expansion chamber.

14. An ejector comprising a receiving chamber, having an inlet port for fluid to be ejected, an annular free expansion chamber communicating therewith, a volute chamber communicating with said free expansion chamber, means for delivering a disk-shaped jet of expansive motive fluid into and through said free expansion chamber, and means for delivering an auxiliary disk-shaped jet of expansive motive fluid through said receiving chamber and into and through said free expansion chamber.

15. An ejector comprising a receiving chamber, having an inlet port for fluid to be ejected, an annular vortex chamber communicating with the receiving chamber, a volute chamber communicating with the vortex chamber, expansion nozzles for delivering a main and an auxiliary disk-shaped jet of motive fluid into and through said vortex chamber.

16. An ejector comprising a receiving chamber communicating with a source of fluid to be exhausted, an annular series of stationary nozzles for expanding motive fluid to substantially the pressure existing in said chamber and for delivering the fluid so expanded in the form of a whirling disk-shaped jet into and through a portion of said chamber, stationary means communicating with said chamber for receiving the disk-shaped jet and the fluid entrained thereby and for effecting a velocity conversion of the fluid passing therethrough, a

stationary volute chamber communicating with said means and having a discharge port formed therein and means for delivering expansive motive fluid to said nozzles.

17. An ejector comprising a chamber from which expansive fluid is to be ejected, an annular passage communicating with said chamber, a volute communicating with said passage, a series of expansion nozzles for discharging a disk-shaped jet of expansive motive fluid into and through said passage, and an annular series of nozzles located centrally within said chamber for discharging a disk-shaped jet of impelling fluid through said chamber and into and through said passage.

18. An ejector comprising a chamber from which fluid is to be ejected, an annular passage communicating with said chamber, a collecting chamber surrounding and communicating with the annular outlet port of said passage, nozzles for expanding impelling fluid and for delivering it in the form of a disk-shaped jet into and through said passage, and means located substantially centrally within said chamber for delivering an auxiliary disk-shaped jet of motive fluid into and through said passage.

19. An ejector comprising a chamber from which fluid to be ejected is expelled, an annular passage communicating throughout its length with said chamber, a collecting chamber in open and free communication with said passage, expansion nozzles for delivering a whirling disk-shaped jet of motive fluid into and through said passage, and means located substantially centrally within said first mentioned chamber for discharging a whirling disk-shaped jet of expansive motive fluid into and through said passage.

20. An ejector, comprising a chamber from which fluid is to be expelled, an annular passage in open and free communication with said chamber, a collecting chamber surrounding said passage and in open and free communication with said passage, expansion nozzles located on opposite sides of said passage at the chamber side thereof for delivering a whirling disk-shaped jet of expansive motive fluid into and through said passage, and an annular series of nozzles located within said chamber for delivering a whirling jet of expansive motive fluid through said chamber and into and through said passage.

21. An ejector comprising a receiving chamber adapted to communicate with a source of fluid to be ejected, in combination with stationary means located within the chamber for expanding motive fluid to substantially the normal pressure existing within the chamber and for delivering the fluid so expanded in the form of a disk shaped jet through a free space within said chamber, stationary means communicating with said free space for receiving the jet and the fluid entrained thereby and for effecting a conversion of the kinetic energy of the fluid mixture passing therethrough into potential energy as represented by an increase in pressure, and a stationary collecting chamber communicating with said last mentioned means.

22. An ejector comprising a chamber having an inlet port through which fluid to be ejected is delivered to the chamber, stationary means located within the chamber for expanding motive fluid and for delivering it in a whirling disk shaped jet, stationary means communicating with said chamber for receiving said jet and for effecting a conversion of the kinetic energy of the fluid into potential energy as represented by an increase in pressure, and a stationary collecting chamber communicating with said receiving means.

23. In an apparatus of the character described, means for effecting a preliminary compression of fluid medium to be expelled, comprising a combining passage in open communication with a source of fluid medium to be expelled, and at least one motive fluid delivery nozzle for expanding motive fluid and for delivering the fluid so expended into and through said passage, in combination with means for subjecting the fluid medium issuing from said combining passage to further compression, comprising stationary motive fluid delivery means for expanding motive fluid and for delivering the fluid so expanded at a high velocity and in the form of a disk-shaped jet, stationary means surrounding said fluid-delivery means and in open communication with said passage for receiving the disk-shaped jet of motive fluid and the fluid entrained thereby and for effecting a conversion of the velocity energy of the combined fluid passing therethrough into potential energy as represented by an increase in pressure, a stationary collecting chamber surrounding the last mentioned stationary means and receiving the fluid discharged therefrom, and means for delivering expansive motive fluid to said nozzle and to said motive fluid delivery means.

24. In an apparatus of the character described, means for effecting a preliminary compression of fluid medium to be expelled, comprising a combining passage in open communication with a source of fluid medium to be expelled, and a divergent nozzle for expanding motive fluid and for delivering the fluid so expanded into and through said passage, in combination with means for compressing the mixture of fluid medium and motive fluid issuing from said passage, comprising stationary motive fluid delivery means gradually increasing in area from the

throat to the outlet thereof for expanding motive fluid and for delivering the fluid so expanded at a high velocity and in the form of a disk-shaped jet, an annular passage having stationary walls receiving the disk-shaped jet of motive fluid and the fluid entrained thereby for effecting a velocity conversion of the fluid passing therethrough, and an annular collecting chamber, having a discharge port, communicating with the outlet of said annular passage and receiving the fluid discharged therefrom, and means for delivering expansive motive fluid to said nozzle and to said motive fluid delivery means.

25. In an apparatus of the character described, means for effecting a preliminary compression of fluid medium to be expelled, comprising an annular combining passage, a series of nozzles for expanding motive fluid and for delivering it at a high velocity and in the form of a whirling jet into and through said passage, in combination with means for further compressing the fluid medium entrained by said jet and the fluid of said jet, said last mentioned means comprising a stationary means for expanding motive fluid and for delivering it in the form of a whirling jet, means in open communication with said combining passage for receiving the last mentioned whirling jet and the fluid entrained thereby and for effecting a centrifugal compression of the fluid passing therethrough, and a collecting chamber receiving the fluid mixture discharged from said last mentioned means.

26. In an apparatus of the character described, a chamber from which fluid is to be ejected, stationary means for expanding motive fluid to substantially the pressure existing in said chamber and for delivering the fluid so expanded in a disk shaped jet, stationary means in open and free communication with said chamber for receiving the disk shaped jet of fluid and fluid entrained thereby and for effecting a conversion of velocity energy of the fluid mixture into potential energy as represented by an increase in pressure, and a collecting chamber surrounding and communicating with said last mentioned means and having an exhaust port formed therein; in combination with a series of divergent motive fluid delivery nozzles for subjecting the fluid to be expelled to the entraining action of motive fluid before it is subjected to the entraining action of the motive fluid delivered from said first mentioned means.

27. In an apparatus of the character described, a chamber from which fluid is to be expelled, a series of motive fluid delivery nozzles for expanding motive fluid and for delivering it at a high velocity into said chamber, in combination with stationary means for expanding motive fluid to substantially the pressure of the mixture of entrained fluid and fluid issuing from said nozzles and for delivering the fluid so expanded in a substantially disk shaped whirling jet, stationary means for receiving the whirling jet and the fluid entrained thereby and for effecting a centrifugal conversion of the fluid passing therethrough and a stationary collecting chamber surrounding and communicating with said last mentioned means, and having an exhaust port.

28. In an apparatus of the character described, a chamber from which fluid is to be ejected, stationary means located within said chamber for expanding motive fluid to substantially the pressure existing within said chamber and for delivering it in a substantially disk shaped jet, stationary means in open and free communication with said chamber for receiving the disk shaped jet of fluid and fluid entrained thereby and for effecting a conversion of velocity energy of the fluid into potential energy as represented by an increase in pressure, and a collecting chamber surrounding and communicating with said last mentioned means and provided with an exhaust port; in combination with an annular series of accelerating nozzles located centrally within said chamber and in alinement with said stationary fluid receiving means, for subjecting the fluid to be expelled from said chamber to the entraining action of motive fluid before it is subjected to the entraining action of the fluid delivered from said first mentioned motive fluid delivery means, and means for delivering expansive motive fluid to said first mentioned means and to said nozzles.

29. In combination in an apparatus of the character described, a chamber from which fluid is to be ejected, a stationary annular passage communicating with said chamber and radially disposed with relation to said chamber, stationary motive fluid delivery nozzles located on opposite sides of the inlet to said annular passage and adapted to expand motive fluid and to discharge the motive fluid so expanded in the form of a disk shaped jet into and through said annular passage, a set of auxiliary nozzles located within said chamber for expanding motive fluid and for delivering the expanded fluid in a disk shaped jet between the first mentioned nozzles and into said annular passage, and a collecting chamber surrounding and communicating with the outlet of said passage.

30. In combination in an apparatus of the character described, a chamber from which fluid is to be ejected, an annular passage communicating with said chamber, a volute chamber surrounding and communicating with said passage, a set of motive fluid delivery nozzles located on each side of the inlet to said passage and adapted to expand

motive fluid and to deliver the expanded fluid in the form of a whirling disk shaped jet into and through said passage, a set of auxiliary nozzles located substantially centrally within said chamber for expanding motive fluid and for delivering the expanded fluid in a whirling disk shaped jet between the first mentioned sets of nozzles and into said passage, and means for delivering expansive motive fluid to all of said nozzles.

31. In an apparatus of the character described, means for effecting a preliminary compression of fluid medium to be expelled, comprising a combining passage in open communication with a source of fluid medium to be expelled, motive fluid delivery means gradually increasing in area from the throat to the outlet thereof for expanding motive fluid to substantially the pressure of the fluid medium at the inlet to said passage and for discharging the fluid so expanded into and through said passage, in combination with means for finally compressing the fluid medium entrained by the motive fluid delivered from said first mentioned means, and comprising stationary motive fluid delivery means gradually increasing in area from the throat to the outlet thereof for expanding motive fluid to substantially the pressure existing at the outlet of said combining passage, and for discharging the fluid at a high velocity and in the form of a disk-shaped jet, stationary means surrounding said last mentioned fluid delivery means and in open and free communication with said combining passage, for receiving the disk-shaped jet of motive fluid and fluid medium entrained thereby and for effecting a conversion of the velocity energy of the combined fluid and fluid medium passing therethrough into potential energy as represented by an increase in pressure, a stationary collecting chamber surrounding the last mentioned stationary means and receiving the fluid discharged therefrom, and means for delivering expansive motive fluid to both of said motive fluid delivery means.

32. In an apparatus of the character described, means for effecting a preliminary compression of fluid to be expelled, comprising a combining passage having its inlet in open communication with a source of fluid medium to be expelled, at least one divergent nozzle expanding motive fluid to substantially the pressure normally existing at the inlet to said combining passage and for discharging the fluid so expanded into and through said passage, in combination with means for finally compressing the motive fluid discharged from said nozzle and the fluid medium entrained thereby, comprising stationary means for expanding motive fluid to substantially the pressure existing at the outlet of said combining passage, and for discharging the fluid so expanded at a high velocity and in the form of a disk-shaped jet, a stationary annular passage in open communication with the outlet of the combining passage for receiving the disk-shaped jet of motive fluid and the fluid medium entrained thereby and for effecting a pressure conversion of the velocity energy of the combined fluid and fluid medium passing therethrough into potential energy as represented by an increase in pressure, a stationary collecting chamber surrounding the stationary fluid receiving means and receiving the fluid discharged therefrom, and means for delivering expansive motive fluid to said nozzle and to said fluid discharging means.

In testimony whereof, I have hereunto subscribed my name this 21st day of August, 1914.

HENRY F. SCHMIDT.

Witnesses:
C. W. McGHEE,
E. W. McCALLISTER.