Feb. 2, 1960 G. STREET, JR 2,923,526

TURBINE

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Fig. 1.

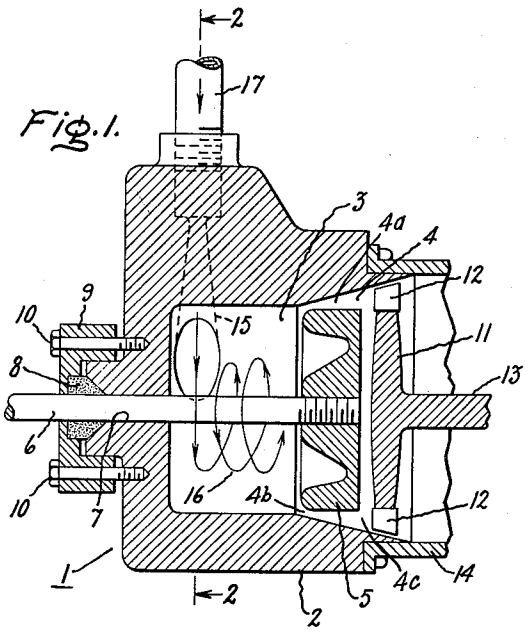


Fig. 2.

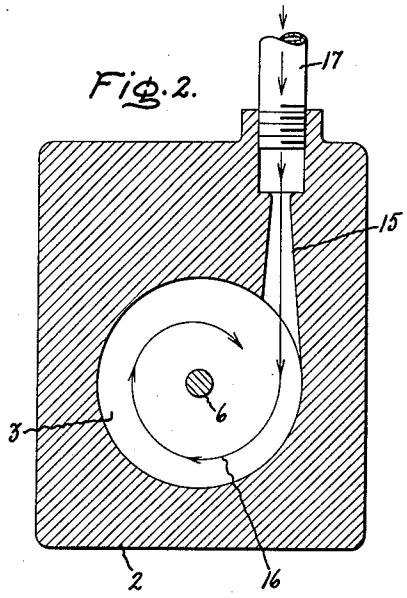
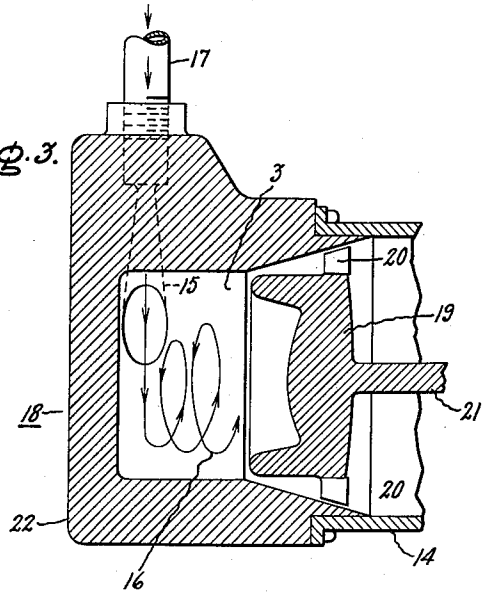


Fig. 3.



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TURBINE

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10 Claims. (Cl. 253—78)

My invention relates to an improved turbine. More particularly it relates to a fluid driven turbine having unique and useful means for directing the flow of fluid therein.

In the usual fluid driven turbine the pressurized fluid is directed at the turbine or impeller blades through a plurality of nozzles, each of which is carefully made to close tolerances to control the expansion and losses in fluid flow. Such nozzles are normally oriented in a fixed direction and the impeller blades in turn oriented so that the highest possible efficiency is realized at the rated load. Such nozzles have also been made adjustable so that the fluid is directed through them at different relative angles to the blades in order to realize the highest possible efficiency at different loads. It is also possible to vary the pitch of the blades themselves so that the fluid impinges thereon at different angles even though the nozzles be fixed. Considering the relative care and exactitude which must be exercised in providing even simple fixed nozzles and blades, it will at once be realized that the problems met in designing and building suitable adjustable nozzles or impeller blades are substantially increased.

An object of this invention is to provide simple means in a fluid driven turbine for adjustably orienting and controlling the flow of fluid to the impeller blades.

Other objects will become apparent and my invention more clearly understood from a consideration of the following description and the drawing in which Fig. 1 shows a side elevational partial cross-sectional view of a turbine embodying my invention. Fig. 2 is a view of Fig. 1 taken in the direction 2—2, and Fig. 3 is a view similar to that of Fig. 1 showing a modification of my invention.

Briefly my invention comprises a turbine having a chamber for receiving fluid from a nozzle which is directed tangentially to the periphery of the chamber. The chamber has a downstream divergent outlet in which is mounted a plunger adjustable for upstream and downstream movement and defining in conjunction with the outlet a divergent annular nozzle. Located downstream of this annular nozzle are the turbine or impeller blades which, due to the impingement of fluid thereon, turn the wheel or rotor to which they are fixed, the rotor shaft and any work accomplishing device to which the turbine is connected.

Referring to Fig. 1, there is shown a turbine 1 having a stator or housing 2. Housing or stator 2 defines a chamber 3, normally circular in transverse cross-section, which has a downstream outlet 4. This outlet 4 is divergent in the downstream direction. Adjustably mounted in outlet 4 for upstream and downstream movement is plunger or plug 5. Preferably the outer periphery of plunger 5 is as shown in the drawing; that is, its periphery is parallel to the axis of the chamber 3 and outlet 4. In this manner there is provided between the plunger periphery and outlet 4 an adjustable annular nozzle 4*a* which is divergent in a downstream direction. As plunger 5 is moved upstream, the inlet 4*b* to this nozzle, as well as its outlet 4*c*, is restricted. Movement downstream of the plunger enlarges the inlet and outlet of the nozzle.

Movement of plunger 5 is accomplished in any desired manner. For example, a rod 6 can be fixed to the plunger extended axially through chamber 3 and the upstream wall of housing 2 through a hole 7 provided therein. Movement of shaft 6, and hence plunger 5, fixed thereto can be accomplished by any convenient well known means not shown. Escape of working fluid upstream along shaft 6 is prevented by suitable packing 8 around the shaft as shown and held in place by cap 9 adjustably held in place and pressurized by means such as bolts 10.

Located downstream of plunger 5 is a turbine rotor 11 having on its periphery a plurality of impeller blades 12. In the particular embodiment shown blades 12 are mounted in outlet 4 in line with the annular nozzle formed by the outlet and plunger 5. The outer edges of the blades 12 are sloped to conform to the divergent wall of the outlet in order to take full advantage of working fluid issuing from the nozzle. It will be realized, of course, that turbine rotor 11 can be located further downstream of the nozzle, if desired, although I prefer to position the rotor in the outlet itself. The energy transmitted to the turbine blades and rotor is delivered to any work device desired such as a generator, pump, and the like through shaft 13. A housing 14 surrounds the turbine downstream of the rotor, such housing being only partially shown and of any usual design.

Located in the upstream portion of the turbine is a nozzle 15 which is conveniently machined from housing 2, though a separately fabricated nozzle can be simply inserted in a mating hole in the housing. The lower portion of the nozzle is preferably divergent to allow for smooth expansion of the fluid flowing therethrough. As best shown in Fig. 2 of the drawing, nozzle 15 is so oriented that it is directed tangentially to the periphery of chamber 3, causing fluid fed through it into the chamber to form a vortex which is shown by arrowed line 16. Nozzle 15 is connected through conduit 17, suitably fitted to housing 2 and the nozzle, with a source of working fluid not shown. This working fluid may be any of those suitable for driving turbines, including steam or other vapors or fluids resulting from the combustion or decomposition of materials of which relatively slow burning explosive powders and alkyl nitrates are exemplary.

Shown in Fig. 3 is another embodiment of my invention. This turbine 18 is similar to that of Figs. 1 and 2 except for the plunger and turbine rotor arrangement and all similar parts are numbered alike. In the embodiment of Fig. 3 the plunger 5 and rotor 11 of the previous embodiment are combined into a plunger-rotor assembly 19. The upstream portion of assembly 19 serves the purpose of a plunger, and turbine or rotor blades 20 are fixed to the periphery of the assembly at its downstream portion. The assembly is adjusted for upstream and downstream movement through shaft or rod 21 by any convenient well known means. Shaft 21 also serves to transmit the rotation of the assembly 19 to any work device. Inasmuch as shaft 21 serves this dual purpose there is no need for carrying a shaft through the upstream wall of housing 22. The embodiment of Fig. 3 affords a turbine which is further simplified in manufacture over that of Figs. 1 and 2 in that the plunger and turbine rotor are combined and no provision need be made for separate plunger adjustment such as in Fig. 1. Fluid friction losses are also further reduced in the turbine of Fig. 3 because of the smooth path along the plunger portion to the impeller blades.

The operation of my new turbine will be explained particularly with reference to Figs. 1 and 2, it being understood that the turbine of Fig. 3 operates in a generally similar manner except for the plunger adjustment. The driving or working fluid enters chamber 3 expanding through tangentially directed nozzle 15. A typical path traced out by a part of the fluid is indicated by arrowed line 16. The entering fluid forms a vortex as shown having a relatively high rotational velocity and a relatively low translational velocity downstream. Hence, the energy of the fluid within the chamber is directed largely in a tangential or rotational direction and the velocity component in such rotational direction is also relatively large as compared to the downstream component. As the whirling working fluid reaches the annular nozzle formed by plunger 5 it undergoes a second expansion, this time in a downstream direction, whereby the downstream component of the fluid velocity as well as its force is increased and the rotational component proportionally decreased. Hence, the resultant of these components will, during the second expansion, be rotated a certain degree toward the downstream direction. The extent to which the resultant components are rotated in a downstream direction depends upon the throat area of the second nozzle. As the plunger is moved upstream, reducing the area of the nozzle throat, the downstream components are increased and the resultant force and velocity are directed more in the downstream direction. Conversely, as the plunger is moved downstream, increasing the throat area, the downstream velocity and force components are decreased. This is evident from a consideration of fluid flow principles.

In essence, my invention provides an effect in a turbine equivalent to using a plurality of ordinary adjustable nozzles without entailing the relatively high cost and care of fabricating such nozzles. The simplicity of my arrangement with its minimum of adjustable parts makes it less liable to failure and reduces maintenance. The adjustment of the direction of the fluid from the second nozzle permits efficient operation at varying loads. Thus, if the rotor blades are at a certain fixed angle for most efficient operation at a certain load and direction of fluid impingement against the blades, when a varying load is encountered, the plunger may be adjusted as indicated to obtain the best efficiency.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A fluid driven turbine comprising a housing defining a chamber therein having a divergent downstream outlet, a nozzle in the upstream end of said chamber directed tangentially to the periphery thereof, integral impeller blade and adjustable divergent outlet means mounted in said outlet, whereby said adjustable divergent outlet means predeterminedly control the fluid flow to said impeller blades.

2. A fluid driven turbine comprising a housing defining a chamber therein, said chamber having a divergent downstream outlet, a plunger coaxially mounted within said outlet to provide an adjustable divergent annular nozzle, impeller blade means in line with said annular nozzle and an inlet nozzle in the upstream portion of said chamber directed tangentially to the periphery thereof, said plunger operatively mounted between said inlet nozzle and said impeller blade to control the operational relation therebetween.

3. A fluid driven turbine comprising a housing defining a chamber having a nozzle in the upstream portion thereof directed tangentially to the periphery of said chamber and having a divergent downstream outlet, a plunger mounted in said outlet for rotative and translational movement to provide a variable divergent annular nozzle, impeller blade means rotatably mounted between said nozzle and said plunger to control the flow therebetween.

4. A fluid driven turbine comprising a housing defining a chamber therein having a divergent downstream outlet, a nozzle in the upstream portion of said chamber directed tangentially to the periphery thereof, a plunger adjustably mounted in said outlet for translational movement therein to provide a variable divergent annular nozzle, impeller blade means in line with said annular nozzle and responsive to the flow therethrough.

5. A fluid driven turbine having impeller blade means, a housing defining a chamber having a divergent outlet, a nozzle in the side of said chamber at the end opposite said outlet, said nozzle being directed tangentially to the periphery of said chamber, a plunger integral with said blade means and mounted in said outlet to provide an adjustable annular nozzle means to predeterminedly control the flow through said impeller blade means.

6. A fluid driven turbine comprising a stator defining a chamber having a divergent outlet at the downstream end thereof, a nozzle in said chamber at the upstream end thereof directed tangentially to the periphery of said chamber, a plunger mounted in said outlet for rotative and translational movement therein and coacting therewith to provide an adjustable annular nozzle, and impeller blades on the periphery of said plunger in line with said annular nozzle and operatively responsive thereto.

7. A fluid driven turbine comprising a stator defining a chamber having a divergent outlet, means for introducing fluid into said chamber tangential to the periphery of said chamber at the upstream end opposite said outlet whereby said fluid has a relatively high rotational velocity and a relatively low translational downstream velocity toward said outlet, a turbine rotor having impeller blades around the periphery thereof rotatably mounted in said outlet, a plunger arranged for movement in an upstream and downstream direction mounted in said outlet and coacting therewith to provide an adjustable annular divergent nozzle directed at said impeller blades.

8. A fluid driven turbine comprising a housing defining a chamber and a divergent outlet at the downstream end of said chamber, a nozzle in the upstream portion of said chamber, said nozzle being directed tangentially to the periphery of said chamber, a turbine rotor adjustably mounted in said outlet and having impeller blades around the periphery of said rotor, a plunger integral with said turbine rotor and mounted in said outlet upstream of said turbine rotor predeterminedly cooperating with said outlet to provide an adjustable annular nozzle directed at said impeller blade.

9. A fluid driven turbine comprising a stator defining a chamber having at its upstream portion means for introducing a fluid therein tangentially to the periphery thereof whereby said fluid has a relatively high rotational velocity and a relatively low translational downstream velocity, a divergent outlet at the downstream end of said chamber operatively coacting with an adjustable plunger mounted therein to predeterminedly form an adjustable divergent annular nozzle, downstream movement of said plunger decreasing the downstream axial velocity component of fluid issuing from said nozzle and upstream movement of said plunger increasing said axial velocity component, impeller blade means integral with said plunger and operatively responsive to the flow through said nozzle.

10. In a fluid driven turbine, means defining a chamber, nozzle means tangentially coupled to said chamber for expanding fluid into the chamber to generate a vortex having a relatively high rotational velocity and relatively low translational velocity, turbine blade means operatively associated with said nozzle means, and plunger means at one end of said chamber operatively mounted within said chamber between said nozzle means and said turbine means defining an adjustable divergent outlet leading axially from said chamber for variably expanding the fluid

in an axial direction to change the translational velocity of the vortex.

References Cited in the file of this patent

UNITED STATES PATENTS

882,127	Stevens	Mar. 17, 1908
2,357,527	Lundquist	Sept. 5, 1944
2,405,282	Birmann	Aug. 6, 1946
2,431,398	Hasbrouck	Nov. 25, 1947
2,635,849	Buchi	Apr. 21, 1953
2,640,678	Andresen	June 2, 1953
2,641,441	Nilsen	June 9, 1953
2,692,080	Schwaiger	Oct. 19, 1954
2,824,520	Bartels	Feb. 25, 1958