May 27, 1958 G. BANERIAN 2,836,123

TURBO-PUMP

Filed Feb. 4, 1955

2 Sheets-Sheet 1

FIG. 1

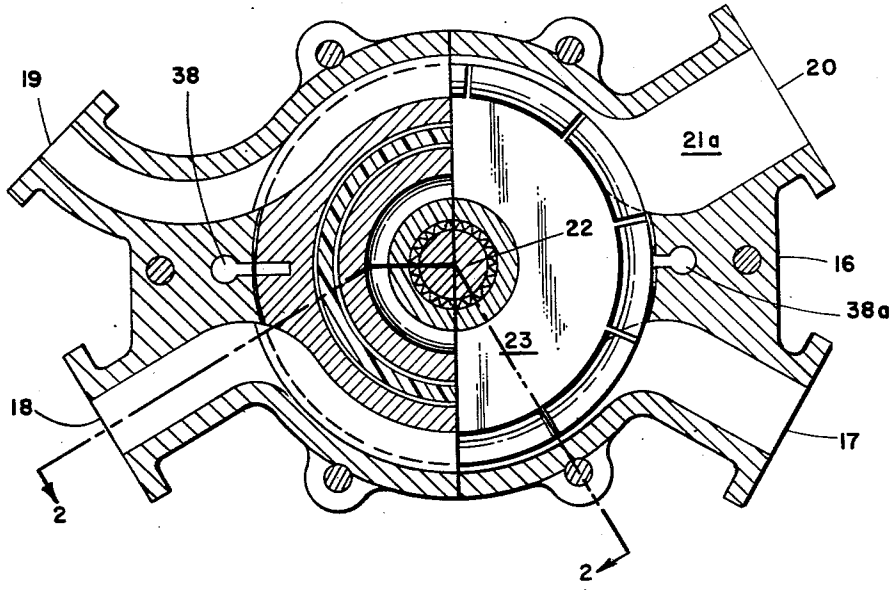
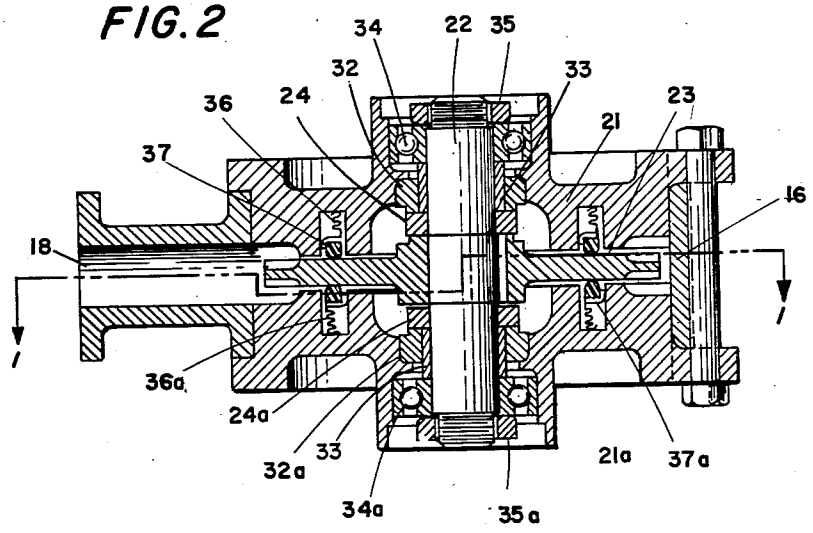


FIG. 2



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FIG. 4

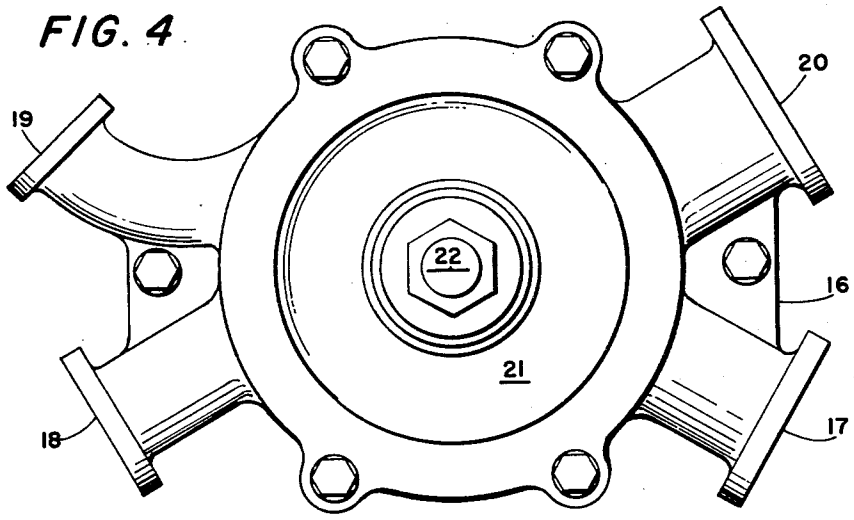


FIG. 5

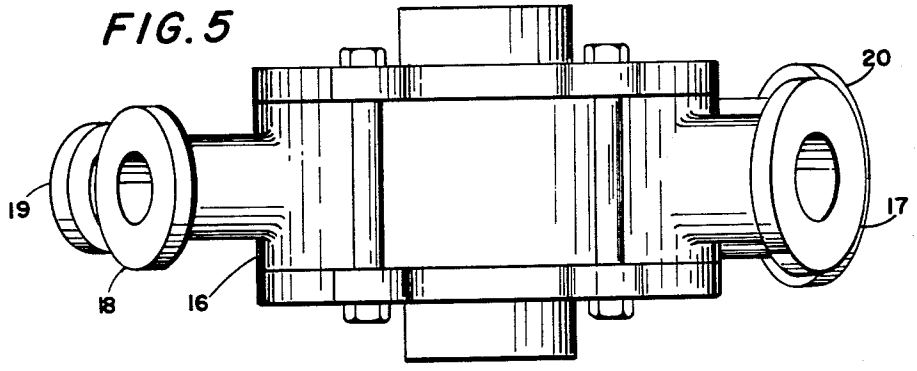
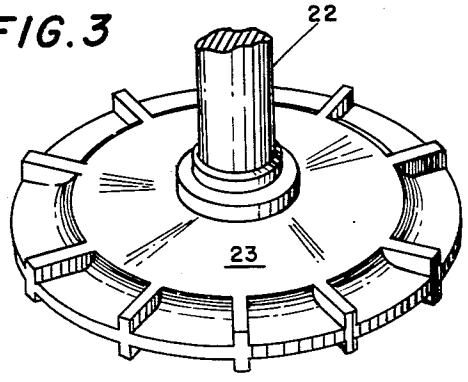


FIG. 3



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TURBO-PUMP

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Application February 4, 1955, Serial No. 486,119

4 Claims. (Cl. 103—87)

This invention relates to turbine pumps and has for its principal object to provide a unitary turbulence turbo-pump which is capable of being driven by high temperature gases or liquids.

A related object of this invention is to provide a turbine pump having a single rotor in which the buckets of the rotor function as both the power driven elements and the pumping elements.

It is also an object of this invention a provide a turbine pump in which the turbine rotor is cooled by the fluid being pumped.

Turbo-pumps operating off of gases to pump liquids have been known for many years, however, heretofore such pumps have been limited to the use of relatively low temperature fluids for their operation because of the tendency of rotors to rupture and warp at high temperatures. Several solutions to this problem have been suggested, such as external cooling and injecting coolants. These solutions have in general been found to be unsatisfactory in view of the complexity of the equipment required as well as an overall decrease in efficiency of operation.

A feature of this invention resides in the use of a single rotor as both the impelling and the pumping means. By this arrangement the rotor is cooled directly by the fluid being pumped, without the use of complicated cooling apparatus and with relatively small loss in efficiency. The turbine pump of this invention is capable of operating off of high temperature liquids ar gases such as those generated by rockets and jets. The foregoing and other features will be better understood from the following detailed description and the accompanying drawings, of which:

Figure 1 is a section of the pump on the line 1—1 of Figure 2;

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

Figure 3 is an isometric view of the turbine rotor and shaft;

Figure 4 is an external top view of the assembled turbulence turbine pump;

Figure 5 is an external side view of the assembled pump.

Referring to the drawings in detail: **16** is a peripheral housing member provided with an inlet port **17** and an outlet port **18** for the driving fluid, and an inlet port **19** and an outlet port **20** for the pumped fluid. Top and bottom housing sections **21** and **21***a* are bolted onto peripheral housing member **16** to form the turbine pump chamber. Alternatively, the housing and chamber members may be formed from two matching members.

Within the assembled housing on shaft **22** is mounted the turbine rotor **23** whose periphery is composed of a series of buckets of any desired form or configuration. The rotor is mounted rigidly on shaft **22** by splining or similar means. Mounted on the shaft on either side of the turbine rotor are, in order, thrust washers **24** and **24***a*, thrust collars **32** and **32***a* and sleeves **33** and **33***a*. Bearings such as ball bearings **34** and **34***a* are mounted at

the ends of shaft **22**, and the entire assembly held in place within the housing by nuts **35** and **35***a*.

The inner faces of housing members **21** and **21***a* may be provided with an annular groove, as illustrated, to receive tension providing means such as bellows **36** and **36***a* to maintain running face seals **37** and **37***a* in continuous contact with the turbine rotor. Running seals **37** and **37***a* may be composed of any relatively low friction material such as carbides, rubber, plastic, or the like.

In operation a driving gas or liquid under pressure is admitted from a suitable source (not shown) such as a gas generator, through inlet port **17** to expert force against the turbine rotor **23** which then rotates in a clockwise manner (with reference to Figure 1) thereby pumping the fluid to be pumped, which is admitted through port **19** and forced out through port **20**. The spent driving liquid or gas is then exhausted through port **18**.

Although centrifugal force will ordinarily expel all of the gas or liquid entrained in the rotor buckets through exhaust ports **18** and **20**, it may be desirable in some instances to provide some additional means to insure complete exhaustion of the spent fluid or gas. For this purpose, vents **38** and **38***a* may be provided to either the atmosphere or a low pressure source, as illustrated in Figure 1. With reference to Figure 1, the driven fluid is vented when a rotor bucket is open to vent **38***a* by virtue of the low external pressure. The driving fluid is vented in a similar manner when a rotor bucket passes vent **38**.

Running face seals **37** and **37***a* may be provided to compensate for poor tolerances in the rotor and the housing members so as to prevent commingling of fluids or fluid and gas as well as loss of pressure.

The turbo-pump of this invention will operate equally well from either gas in the driving side or liquid under pressure; however, some modification in porting dimensions may be necessary in order to obtain maximum efficiency. These dimensions are in general a function of the velocity and density of the liquid or gas involved.

If it is desired to use the turbine pump in connection with extremely high temperature gases such as those obtained from rockets, jets, and the like, it may be desirable to provide a ceramic lining for the housing chamber as well as the rotor itself.

Although the efficiency of the pump itself is somewhat lower than that of conventional pumps now in use, the overall efficiency of the unitary turbo-pump of this invention, used in connection with very high temperature gases, will about equal that of conventional pumping means, although using fewer parts. In addition, the use of a single rotor wheel of rugged design in a device of such simple construction provides a turbo-pump which is considerably less subject to operational malfunction.

The turbo-pump of this invention lends itself to convenient and economical manufacturing production inasmuch as the housing elements may be of cast materials and the turbine rotor either cast or milled.

An additional feature resides in the continuous cooling of the turbine rotor. The rotor is cooled continuously during the pumping phase by direct contact with the cooling liquid, and also during the impelling phase by a residual boundary layer of the cooling fluid. However, if additional cooling is desired, conventional cooling means such as external cooling may be used to supplement this effect.

The turbo-pump of this invention is also readily adaptable for use as a prime power source either alone or in conjunction with the pumping function of the device. When used in this manner, the shaft **22** is simply extended to the outside of the pump housing and rotary power taken directly from the shaft. When used only as a source of power all inlets can be used to admit driving fluids. The prime mover portion of a turbo-pump of this type has the

advantage over conventional turbines of providing high efficiencies at low blade tip velocity to fluid velocity ratios.

I claim:

1. A turbulence turbo-pump for operation by high temperature motive fluids which comprises in combination a pump housing, a turbine rotor within said housing whose periphery comprises a number of buckets, fixed with respect to said rotor and adapted to both impel and be impelled, at least two inlet and outlet ports in said housing and arcuate passages between said inlet and outlet ports in said housing forming a circular race for said rotor.

2. A turbulence turbo-pump for operation by high temperature motive fluids which comprises in combination a pump housing, a turbine rotor rotatably mounted upon a shaft journaled at both ends in said housing, said rotor having a periphery comprised of a plurality of buckets fixed with respect to said rotor and adapted to both impel and be impelled, inlet and outlet ports in said housing for driving fluid, inlet and outlet ports in said housing for fluid to be pumped and arcuate passages between said inlet and outlet ports in said housing forming a circular race for said rotor.

3. A turbulence turbo-pump comprising in combination a pump housing, a turbine rotor rotatably mounted upon a shaft journaled at both ends within said housing, said rotor having a number of buckets disposed about its periphery adapted to both impel and be impelled, an annular race for said turbine rotor within said housing communicating with an inlet and outlet port for a driving fluid and an inlet and outlet port for the fluid to be pumped, thereby forming separate passages for said driving fluid and the fluid being pumped, and venting means provided between said driving fluid inlet and pumped fluid outlet, and between said driving fluid outlet and said pumped fluid inlet to avoid commingling of the fluids.

4. A turbulence turbo-pump comprising in combination a pump housing, a turbine rotor rotatably mounted upon a shaft journaled at both ends within said housing, said rotor having a number of buckets disposed about its periphery adapted to both impel and be impelled, an annular race for said turbine rotor within said housing communicating with an inlet and outlet port for a driving fluid and an inlet and outlet port for the fluid to be pumped, thereby forming separate passages for said driving fluid and the fluid being pumped, and one or more annular running face seals disposed against the face of the rotor within the bucket periphery to prevent commingling of the driving fluid and the fluid being pumped.

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