

Jan. 17, 1961

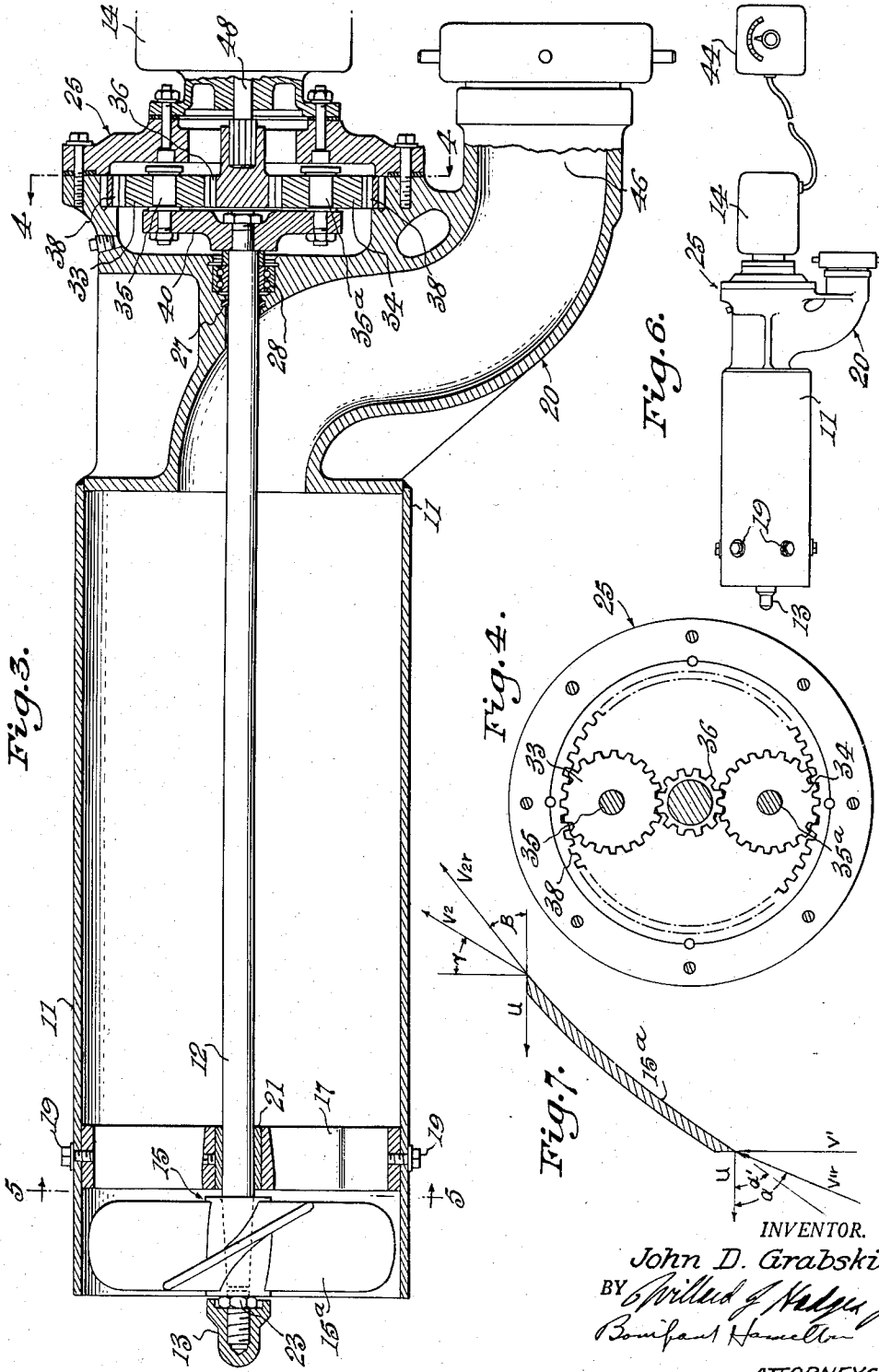
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2,968,442

TURBINE TYPE FOAM OR WATER NOZZLE FOR FIRE FIGHTING

Filed Feb. 4, 1959

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2,968,442

TURBINE TYPE FOAM OR WATER NOZZLE FOR FIRE FIGHTING

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Filed Feb. 4, 1959, Ser. No. 791,239

1 Claim. (Cl. 239—381)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment of any royalty thereon.

This invention relates generally to improvements in controlling the fluid flow through nozzles and the character and pattern of the fluid flow therefrom.

The instant invention further relates to improvements in automatic distributing nozzles designed principally for use in extinguishing fires.

The instant device overcomes the problem of the burdensome handling of a three-inch or larger fire hose and conventional screw type nozzle by several men, due to the burdensome size, weight and unwieldy maneuvering and manipulation of conventional types of fire hose nozzles during use.

The primary object of this invention is to provide means whereby the issuing fluid from the nozzle may be varied from a laminar flow stream of fluid to a clouded mist of comminuted particles of fluid and air in the form of a wide angle fog pattern.

A further object of this invention is to provide a turbine type of foam or water nozzle for fire fighting.

Another object of this invention is to provide a nozzle whereby an adjustable whirling spray may be provided.

Another object of this invention is to provide a variable load actuated turbine fluid flow control in a nozzle under high fluid pressure which gives an infinite variation in the stream pattern between the limits of a wide angle fog pattern and a straight stream pattern.

Another object of this invention is to provide a nozzle having an electrical load actuated turbine control means within the nozzle housing to vary the quantity of flow and shape of fluid flow envelope issuing from the nozzle.

Another object of this invention is to provide a fluid flow atomizing nozzle which may be controlled remotely from the point of fluid discharge of the nozzle.

With these and other objects in view, the invention consists in certain novel features of construction and combinations and arrangements of parts, as will be more fully hereinafter described and claimed.

In the drawings:

Fig. 1 is a view, in elevation, of the nozzle and its turbine housing;

Fig. 2 is a front end view of Fig. 1;

Fig. 3 is a vertical longitudinal sectional view of the nozzle and turbine control mechanism;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3 showing the gearing mechanism connecting the propeller shaft to the electrical generator;

Fig. 5 is a view, partly in section, taken on line 5—5 of Fig. 3 showing turbine blade bearing or support means;

Fig. 6 shows a view, in elevation, of the preferred embodiment of the nozzle including an electrical load for the generator to control the turbine within the nozzle to vary the shape and character of fluid flow issuing from the nozzle; and

Fig. 7 is a section through impeller blade 15a of Fig. 3

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showing vectors representing the velocity of fluid entering and leaving blade 15a.

The instant turbine type nozzle consists essentially of a hydraulic turbine impeller mounted in the water discharge passage and connected to a loading device such as an electrical generator, electric brake, water brake, or other variable load means. The speed of the turbine may be varied by varying the load on the turbine impeller, thus varying the angle at which the foam or water leaves the turbine blading. This permits the operator, even at remote points from the nozzle, to obtain all types of discharge from a straight stream flow to a desired wide angle fog by simply varying the load on the turbine impeller within the open end nozzle.

Referring to the drawings, Figs. 1 to 7 illustrate the general form of the invention which consists of a turbine nozzle housing 11 containing therein turbine shaft 12, turbine shaft spider or support means 17 secured by bolt 19 which carries shaft 12 in bearing means 21, and turbine impeller means 15 rigidly attached to the end of shaft 12 by nuts 13 and 23. The other end of shaft 12 is connected by gear train means 25 to a loading device 14.

Loading device 14 in the embodiment illustrated employs as a variable load and turbine control device an electrical generator which, through shaft 12 and a gear train 25, imposes a load on the turbine impeller 15 to vary its speed. The pressurized fluid supply flowing through fluid conducting member 20, housing 11, and member 17 impinges upon the impeller blades 15a of member 15, such that the reaction of the fluid flow against the turbine impeller 15, as controlled by the loading device 14, results in a smooth, positive and reliable control of the fluid flow through the nozzle such that the fluid issuing from the nozzle may be varied from a laminar flow stream of fluid to a clouded mist of comminuted particles of fluid and air in the form of a wide angle fog pattern.

Referring to Fig. 3, propeller shaft 12 passes through housing 11, a portion of fluid passage 46, sealing means 27, and bearing means 28. Yoke 40 rotatively supports pinion gears 33 and 34. Gear 36 is operably connected to shaft 48 of loading device 14 by splining or other suitable means.

Fig. 4 shows a sectional view of gear train 25 comprising driver gear 36, pinion gears 33 and 34 and pinion support and bearing 35 and 35a, respectively, and stationary ring gear 38.

Fig. 6 shows the preferred embodiment of the invention in which the loading device 14 is an electric load for controlling the turbine impeller 15 (fluid impact) to vary the stream pattern issuing from the nozzle from a wide angle fog pattern to a straight stream pattern. Remote control of the discharge pattern from the nozzle may be accomplished by means of an electrical load 44 connected to the output of the generator used as a loading device. The electrical load 44 may be located remotely from the nozzle. However, it is to be well understood that means 14 is not restricted to an electrical load control means, but may be a fluid motor, mechanical brake means, an electrical load means which may be in various forms, as for example, an electrical generator, electrical braking motor, electrical selsyn motor or electromagnetic braking means, a fluid dynamometer or other suitable load means well known to those skilled in the art.

Fig. 7 shows a section through the impeller blade 15a with accompanying velocity vectors for the pressurized supply of water entering and leaving the impeller 15 in nozzle casing 11 of Fig. 3. The nozzle is capable of varying the angle of the stream of fire fighting foam or water from a straight stream to a wide angle fog or spray. If

the turbine is held fast so that it cannot rotate, the blades or vanes act simply as guide vanes and the stream is dispersed in a wide angle spray or fog pattern, the angle of the pattern with the axis of the nozzle being determined by the discharge angle β of Fig. 7. It is to be noted that with a constant absolute entrance velocity V_1 there will be only one condition or value of blade velocity U at which the fluid will enter the turbine tangent to the blade at entrance, that is, when $\alpha=\alpha'$ or when V_{1r} is coincident with the tangent to the blade as shown in Fig. 7 resulting in the relative discharge velocity V_{2r} being tangent to the blade. However, the relatively long fluid passage between the blades will straighten the stream and insure that the direction of the relative discharge velocity V_{2r} is essentially tangent to the discharge edge of the blade. Due to variation in the blade velocity U with the radius of the turbine wheel 15, the blades 15a should be made so that the blade angles of 15a vary with the radius of turbine wheel 15.

The velocity vectors and vectorial angles of Fig. 7, showing a section of one form of impeller which may be used, are defined by reference symbols as follows:

- V_1 =absolute velocity of fluid entering turbine impeller blade 15a.
- V_2 =absolute velocity of fluid leaving turbine impeller blade 15a.
- V_{1r} =velocity of fluid entering turbine impeller blade 15a relative to a point on the turbine blade.
- V_{2r} =velocity of fluid leaving turbine impeller blade 15a relative to a point on the impeller blade.
- U =absolute linear velocity of a point on impeller blade 15a in the direction of rotation of impeller 15.
- β =blade 15a discharge angle.
- α' =blade 15a entrance angle.
- α =angle at which fluid actually enters blade 15a.
- γ =angle at which fluid leaves blade 15a.

$$K=\text{loss factor}=\frac{V_{2r}}{V_{1r}}$$

While a particular configuration of impeller has been shown, it is to be understood that other forms of impellers may be used. The novelty of the present invention resides in the manner of controlling the speed of rotation of the impeller by imposing a load thereon which may be varied uniformly over a considerable range varying from maximum speed (U) to standstill or zero rotation corresponding to a discharge pattern varying respectively, from a wide angle fog-like spray pattern to a straight stream. It is within the ability of those skilled in the impeller art to design a particular impeller to yield a desired spray pattern or a variety of patterns resulting from control of the impeller rotational speed by means of the load control herein described, and therefore this description will not attempt to describe the steps or theory involved in the design of any particular type of impeller. For the particular impeller design shown, however, the absolute velocity of fluid leaving turbine blade 15a, assuming $K=1$, is given by the formula:

$$(1) \quad V_2 = \sqrt{V_1^2 + 2U^2 - 2U\sqrt{V_1^2 + U^2} \cos \beta}$$

It is apparent from Equation 1 that with V_1 and β constant, the magnitude of V_2 is a function of the blade velocity U . It now remains to be shown that the discharge angle γ is a function of U assuming V_1 and β as constants.

Again assuming $K=1$

$$(2) \quad \gamma = \tan^{-1} \left[\cot \beta - \frac{U}{\sqrt{V_1^2 + U^2} \sin \beta} \right]$$

It is evident that γ is a function of U . If $U=0$, $\tan \gamma = \cot \beta$. As U increases, $\tan \gamma$ decreases and if β is properly selected so that at some realistic value $U=U_{\max}$,

$$(3) \quad \cot \beta = \frac{U_{\max}}{\sqrt{V_1^2 + U_{\max}^2} \sin \beta}$$

and γ will be zero and the fluid will leave the turbine in a direction parallel to the axis of rotation of impeller 15.

$$(4) \quad \cos \beta = \frac{U_{\max}}{\sqrt{V_1^2 + U_{\max}^2}}$$

Equation 4 will determine the blade discharge angle β . $U_{\max}$ should be the maximum speed of turbine impeller means 15.

Equation 2 above may be written:

$$(5) \quad \tan \gamma = \left[\frac{U_{\max}}{\sqrt{V_1^2 + U_{\max}^2}} - \frac{U}{\sqrt{V_1^2 + U^2}} \right] \frac{1}{\sin \beta}$$

Therefore, as U is varied from 0 to $U_{\max}$ the $\tan \gamma$ varies from $\cot \beta$ to 0, as a result of varying the load on the impeller. The variation in speed (revolutions per minute) of impeller 15 causing the stream pattern issuing from the nozzle to be varied, as desired, from a wide angle fog pattern to a substantially straight stream pattern.

The maximum braking which will be required when operating the nozzle with the impeller 15 stationary (locked), may be computed as follows:

W =weight of fluid flowing lbs./sec.

g =acceleration of gravity

V_1 =magnitude of fluid velocity, ft./sec.

R =mean flow radius of impeller blade 15a, in feet

F =force on the blade 15a, in pounds

T =torque, ft.-lbs.

$$F = \frac{W}{g} V_1 \cos \beta; \quad T = \frac{W}{g} R V_1 \cos \beta$$

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

I claim:

A nozzle comprising a chamber having an inlet and discharge opening, coupling means on said inlet for connecting a pressurized fluid supply to said chamber, impeller means rotatably mounted in said discharge opening, electrical generator means carried externally by said chamber, geared coupling means connected to the rotor of said generator means, shaft means connected between said geared coupling means and said impeller means and a variable resistive load connected to the output of said generator whereby adjustment of the load on said generator controls the rotational velocity of said impeller to vary the stream pattern discharged from said nozzle between the limits of a wide angle fog pattern to a substantially straight stream pattern.

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