A. WILSTAM.

MOTIVE POWER SYSTEM.

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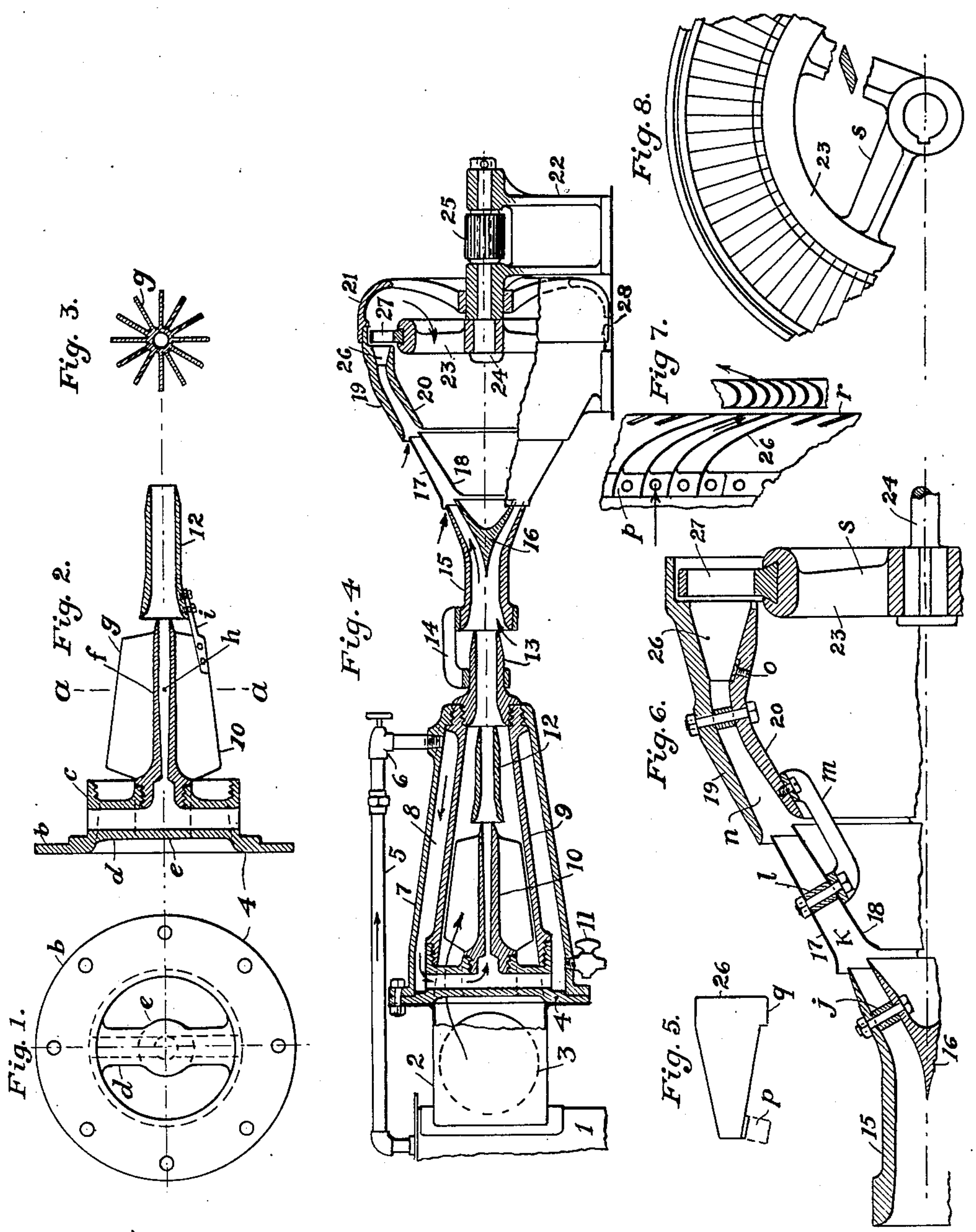
968,724. Patented Aug. 30, 1910.



WITNESSES:

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MOTIVE-POWER SYSTEM.

968,724. Specification of Letters Patent. **Patented Aug. 30, 1910.**

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To all whom it may concern:

Be it known that I, ALFRED WILSTAM, a citizen of the United States, residing in the city and county of Los Angeles, State of California, have invented a new and Improved Motive-Power System, of which the following is a specification.

My invention relates to a motive power system using steam as the primary motive medium, into which through injective action, hot gases of combustion and atmospheric air are combined, to give added heat, expansion qualities and volume to the working medium.

In steam turbine systems, the thermodynamic energy is converted into mechanical work by setting free, through combustion, the heat energy contained in certain fuel by burning same under a boiler, and conducting that part of the heat which is not lost in the combustion gases, to the water in the boiler, thus giving to the water molecules or particles, a swifter motion, thereby causing a strong repelling action, which changes the mass from its liquid to a gaseous state, in which changed condition it enters the steam turbine, whose function it is to convert as much as possible of the heat energy contained in the gaseous fluid, into useful mechanical work, while that which is not turned into work is carried off in the exhaust, keeping the latter in a gaseous state.

The loss of heat energy due to the wasting of hot combustion gases through the chimney, and the loss through the carrying away of heat in the exhaust steam, are the two principal causes for inefficiency in a steam turbine system.

The principal object of my invention is to perfect a motive power system in which the two main losses referred to are eliminated, and also to provide means whereby a single stage turbine, in my motive power system, may be efficiently run at a moderate speed.

The principal working action of this system may be briefly stated as follows: In a suitable furnace (not shown) connected to a steam generator or boiler, a certain fuel is burned so as to produce nearly smokeless combustion gases, during the process of which a part of the heat energy set free, is conducted from the combustion gases to the water in the steam generator for generating steam at a high pressure, which is conducted through a superheater surrounding a conical flue nozzle communicating with the chimney flue and carrying the hot combustion gases, so that when the hot combustion gases through injective action, as will be explained later, are drawn through said flue nozzle, heat will be conducted from the combustion gases through the wall of the nozzle into the superheater, so as to highly superheat the steam, which then is conducted to an expansion reheating nozzle, located in the center of the flue nozzle so as to injectively act on the combustion gases, causing them to accumulate and form a hot, movable mass passing through the central cone-shaped flue nozzle or inner casing of the superheater, and as these gases have a higher temperature than the steam, a part of the surplus heat from them conducts through the inner wall of the superheater into the steam, as has already been referred to, and another part of the heat will be caught by the expansion-reheating nozzle, above referred to, and conducted to the steam during the act of expansion within the nozzle, thereby not only preventing condensation in the nozzle and consequent friction loss, but actually superheating the expanded steam several degrees, causing thereby an increase in the volume which under the condition stated, gives an added velocity to the outflowing steam jet, which is then caused to injectively act on the combustion gases, forcing the latter through a second nozzle where the steam and combustion gases form a jet of high velocity and temperature which in its passage to a third nozzle injects into the path of action the remaining part of combustion gases, after which the heat-charged gaseous jet under high velocity, passes through a succession of nozzles or an injector battery, which is exposed to the open air so that a certain amount of air may be injected into the path of action, whereby the kinetic energy in the gaseous jet may be distributed over a larger body, thereby adding weight or momentum to the swift moving mass, with a consequent reduction in velocity, which velocity, if there were no frictional or other losses, would be equal to the velocity of the hot gaseous jet before injecting the air, divided by the square root of the number of times it is diluted by the injected air. For example; assuming the velocity of the gaseous jet before it injectively acts upon the air, to be 2400 feet per second, and designate that velocity with the letter V, and assume further that the gaseous jet had been increased through the injection of air 9 times in weight, and designate the increase by the letter N, and if the final velocity of the gaseous jet after the injection of the air be designated V_1, then

$$V_1=\frac{V}{\sqrt{N}}=\frac{2400}{\sqrt{9}}=800 \text{ feet per second,}$$

at which velocity it enters the turbine where its kinetic energy is converted into useful mechanical work.

Another feature of my invention is that the turbine in my motive power system may exhaust direct into the open air, on account of that the heat carrying gaseous jet is diluted with air, and also that upon delivering of the heat energy in the turbine to be converted into mechanical work, it has expanded down so completely, that its temperature is nearly that of the surrounding air.

This invention relates more particularly to motive power systems of the kind described by Patent No. 940,769 and granted to me on the 23rd day of November, 1909, and comprises the following improvements: First, the first nozzle in the injector system through which the superheated steam from the superheater under high pressure issues and expands to nearly atmospheric pressure, converting thereby its potential energy into kinetic and the consequent drop in temperature of say from 400 deg. to 225 deg., is provided with reheating ribs or projections for catching the heat from the injected combustion gases and conducting same to the central expansion opening for supplying heat in the very act of expansion, thereby increasing the volume due to heat added and causing an increased acceleration in the velocity of the escaping steam in direct pro portion to the amount of heat units added. 2nd. The employment of more than one central nozzle for the injection of combustion gases. 3rd. The method of forming an injective nozzle through the employment of a pair of cone shaped concentric rings, one placed outside the other and connected together so as to form an annular nozzle of large capacity with a comparatively short length as a whole, but still maintaining such relation between width and length of the injection chamber, so as to produce an efficient nozzle with good injective and directive qualities. 4th. The method of maintaining a nearly equal cross section area through the guide vanes in the intake of the turbine motor, by increasing the height of the delivery side of the vanes in an inverse proportion as the channel or nozzles are diminished in width, due to the bending of the vanes to the exit angle, for the purpose of eliminating eddy currents or vibrations, so as to maintain an even and efficient flow of the aeriform fluid through same. 5th. The method of making the arms leading from the central hub in the turbine rotor of such fan-like section and shape, that when the rotor is put in motion, air will be let by or driven into the heart-like inclosure inside of the conical concentric nozzles to be available for injection into said nozzles. 6th. The method of employing a guard bell at the exhausting end of the turbine to protect the moving part of same and at the same time performing the function of a deflector to deflect a part of the exhausted aeriform fluid back into the heart-like inclosure to be again taken up into the injective path, while the steam in the aeriform fluid on account of its lowered temperature and the whirl in the deflector will become liquidized and by the centrifugal action thrown toward the walls of the deflector and drawn off by a drain and may again be fed to the boiler to complete the steam circuit, while the greater part of the exhausted aeriform fluid from the turbine will pass by the inner openings between the arms of the deflector bell direct out into the atmosphere.

The invention consists in the combination and details of construction described and claimed, and illustrated in the accompanying drawings forming a part of the specification, in which—

Figure 1 is an end view showing a flanged portion of the superheater and injector device, and Fig. 2, a longitudinal section through aforesaid flange with the reheating expansion nozzle and the second nozzle attached, and Fig. 3 is a cross section of the reheating expansion nozzle through the line *a—a* Fig. 2. Fig. 4 is mainly a longitudinal section showing the general assembling of the different parts constituting the system, and Fig. 5 is a side elevation showing approximately the shape of the guide vanes before bending, and Fig. 6 is a part section through the conical nozzles, vanes and turbine rotor, and Fig. 7 is a developed sectional plan through the vanes, illustrating by arrows, the passage of the fluid; and Fig. 8 is a part end view of the turbine rotor.

The characters of reference denote like and corresponding parts in each of the several figures of the drawing.

Referring to the drawing; 1 designates a steam generator or boiler having a flue 2 for carrying the hot gases of combustion, which flue is provided with an opening 3 for conveying out the products of combustion before starting up the injector system. To the end of the flue is attached, as shown in detail, Figs. 1 and 2, a flange 4, having a flanged portion *b*, bolted to the flue and to the outer concentric superheater casing 7, and also a cylindrical portion c, to which is connected the inner superheater casing 9, from which portion arm-like projections d, extend inward terminating in a hub e, to which is connected the reheating-expansion nozzle 10, having a central body f, from which are projected the heat conducting strips g, and having a central nozzle opening whose internal area gradually increases to its outlet, as shown in Fig. 4, or whose internal area gradually increases to a point h, then remains straight to the outlet as shown in detail, Fig. 2. To reheating expansion nozzle 10 is attached by one or more strips i, the second nozzle 12; the outer superheater casing 7, is joined to the inner casing 9, as shown, and forms the annular superheater chamber 8, which communicates with the steam generator 1 through pipe 5 and regulating valve 6 as shown, and also communicates with the reheating expansion nozzle 10, through the opening in arms d, in flange 4, and is provided with a drain 11. To the inner casing 9, is joined the nozzle 13, which by connecting piece 14, is connected to the diverging nozzle 15, having a central diverging cone-shaped part 16, connected to the outer part through a sufficient number of tubular separating pieces j, held in place by bolts as shown in Fig. 6. A cone-shaped nozzle K, is formed between the outer cone-shaped concentric ring 17, having its lower edges slightly flared outward and the inner concentric ring 18, having its lower edges flared inwardly and connected to the outer by a suitable number of tubular separating pieces held in place by bolts as shown, and connected to the inner casing of turbine intake 20, by a sufficient number of suitable connecting pieces m, as shown in Fig. 6. Said inner casing is connected to the outer casing 19, by a number of tubular connecting pieces held in place by bolts as shown in Fig. 6, and forms an annular space n, constituting the intake of the turbine. The exit or delivering side of said intake incloses the guide vanes 26, which are fastened to the inner casing 20, by a screw o, in a bend projection p, of the vane and by another projection q, locked into the slot r, in the edge part of the inner casing as shown in Fig. 5 and Fig. 7. The rotating vanes 27, are of the same kind and fastened to the rotor 23, in a similar manner as shown and described in Patent No. 925,065, granted to me on the 15th day of June 1909, but the spider part of the rotor is here different, as shown, having arms of such cross section, so as to act in a fan-like manner in permitting to pass, or driving the required amount of air or gaseous fluid into the heart-like inclosure inside of the conical nozzles, for the purpose of being injected into the injection path in said conical nozzles from the inner side.

A bearing stand 22, carries the shaft 24, to which the rotor 23, is keyed, also the driving pinion 25, and centered around a bearing on the bearing stand 22, and connected as shown, to the outer turbine casing 19, is a bell-shaped guard bell or deflector 21, as shown, whose function is: 1st. As a guard to protect the turbine rotor. 2nd. As a receiver to receive the exhaust coming from the turbine. 3rd. As a deflector to deflect the exhaust in an inward direction so that it may come within the fanning action of the arms in the rotor, that a certain part of same may be used over again by being drawn into the heart-like inclosure within the conical nozzles, while the greater part of the exhaust escapes into the atmosphere around the inner edge of the guard bell or deflector. 4th. As a separator to separate the liquidized steam carried in the gaseous jet, which by the low temperature at this stage, and the whirling and inward turning action at this point will cause through centrifugal action the heavier water particles to be thrown outward to the walls of the bell, where water will be formed and subsequently drawn off by the drain, 28, placed at the bottom of same.

In the foregoing specification, only such parts have been shown and described as are thought to be important and necessary for the complete understanding of my motive power system, but as the requirements imposed on the system as a whole will naturally vary, so may the detailed construction and arrangement vary, particularly so with the different nozzles in the injector battery, and I desire it to be understood that various departures may be made from the forms of detailed construction herein shown and described, without departing from the spirit of my invention.

Having thus fully described my invention, what I claim as new in a motive power system of the class described, and desire to secure by Letters Patent, is:—

1. A motive power system of the class described, comprising in its combinations a reheating nozzle communicating with a source of steam and provided on its exterior with heat conducting projections, and so placed in a passage of hot combustion gases that heat from said gases will be caught by said projections and conducted to the interior of said nozzle to supply heat to the steam within said nozzle in the act of expansion, for the purpose of further accelerating the velocity of the passing steam through same, substantially as described and shown and for the purpose set forth.

2. A motive power system of the class described, comprising in its combinations a reheating-expansion nozzle placed in a source of hot combustion gases, said nozzle

having an internal nozzle opening or channel whose cross section areas gradually increase from its inlet end a certain distance toward, or to the outlet, substantially as described and shown and for the purpose set forth.

3. A motive power system of the class described comprising in its combinations of annular injective nozzles, each of said annular nozzles being made up from a pair of conical disks or rings of different size, one placed outside the other, and connected together so as to form a single annular nozzle from the space between said connected disks or rings substantially as described and shown in the drawing and for the purpose set forth.

4. A motive power system of the class described, comprising in its combinations a turbine having an intake and an injector-battery discharging into said intake, which intake has guide vanes whose heights are increased from the inlet end toward the exit end in an inverse proportion to the decreased width or space between the vanes from inlet end toward the exit end of same (which decrease is due to the bending of the vanes to the desired exit angle) for the purpose of maintaining an equal cross section-area through the space formed between said guide vanes, substantially as described and shown in the drawing and for the purpose set forth.

5. A motive power system of the class described, comprising in its combinations a turbine having a rotor with arms radiating from a central hub, said arms having a suitable cross-section whose longitudinal or longest axis is set at a certain angle in reference to the rotative direction of the rotor, so that the arms will have a fanning action when in motion, substantially as described and shown and for the purpose set forth.

6. A motive power system of the class described, comprising in its combinations a turbine having an outer casing and provided with a guard bell or deflector at its exhaust end, said guard bell or deflector having a bell shaped body connected to the outer casing of said turbine and so arranged that it confronts the exhaust coming from said turbine, and adapted for deflecting or conducting said exhaust gases toward the center of said turbine, and provided with a drain for the liquefied exhaust steam, substantially as described and shown and for the purpose set forth.

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Witnesses:
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