R. H. RICE.

GOVERNING MECHANISM FOR AIR COMPRESSORS.

APPLICATION FILED AUG. 17, 1908.

919,953.

Patented Apr. 27, 1909.

Fig. 1.

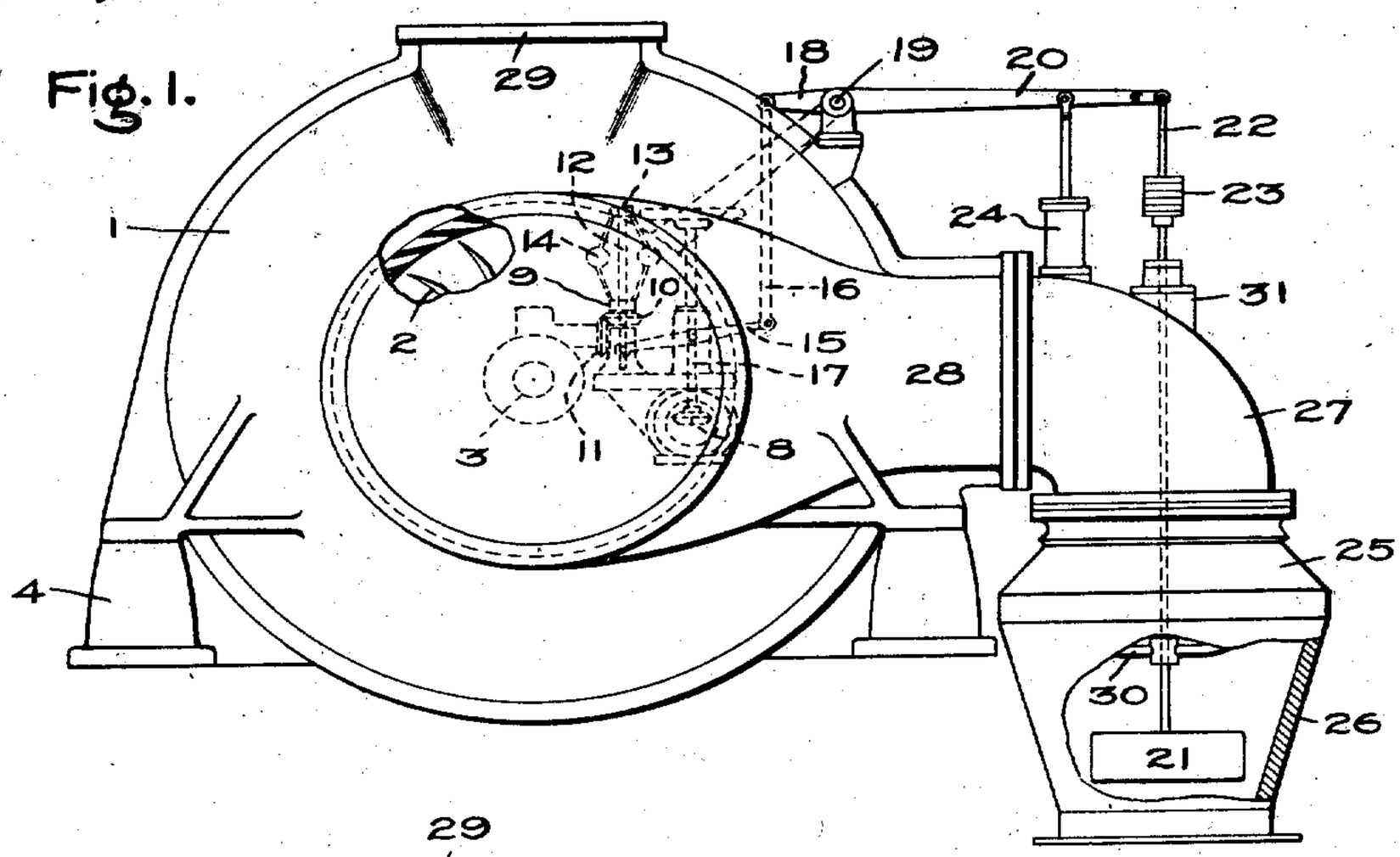
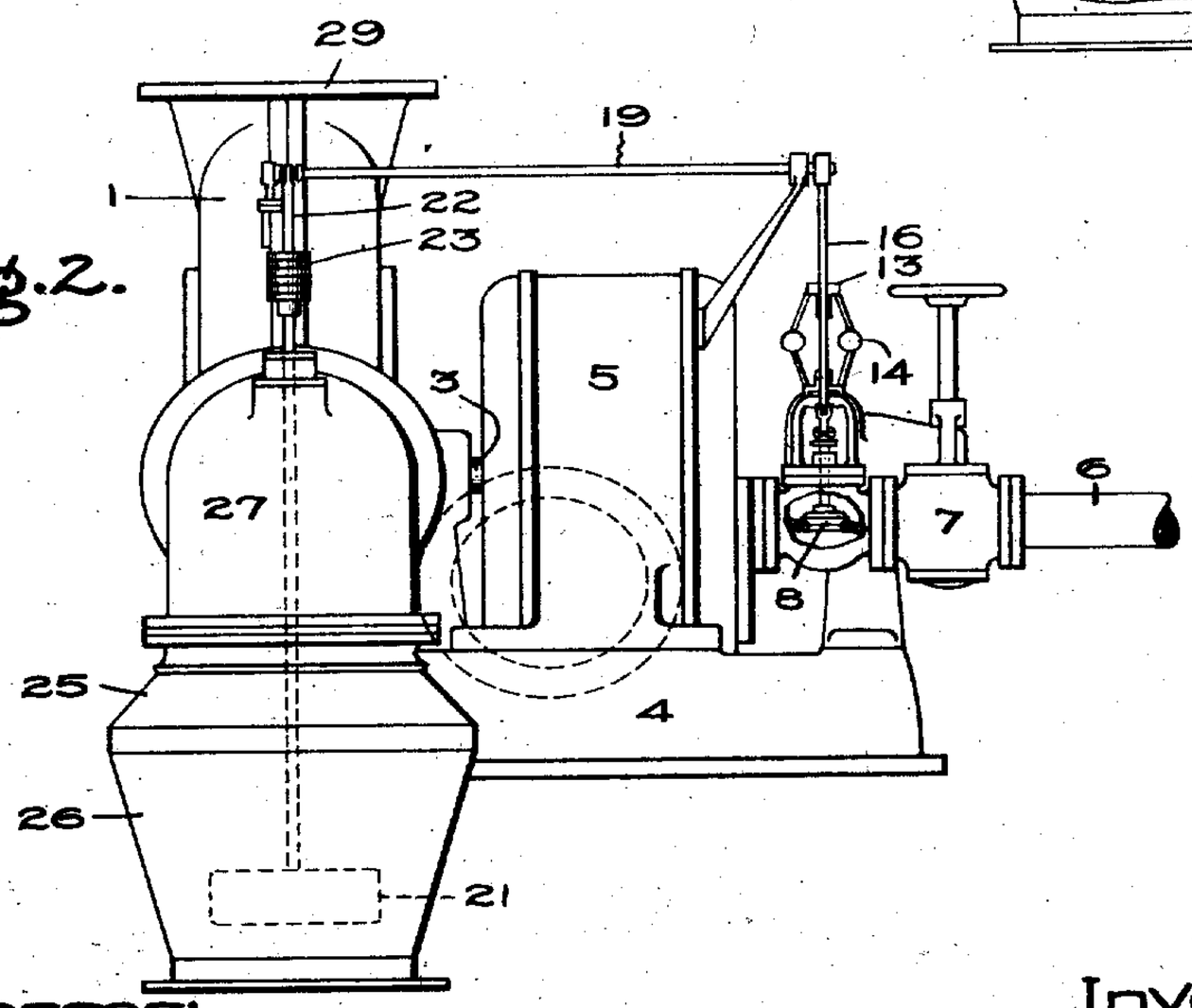


Fig. 2.



Witnesses:

Marcus L. Byng.

J. Ellis Glen.

Inventor,

Richard H. Rice,

by Albert G. Davis

Att'y.

UNITED STATES PATENT OFFICE.

RICHARD H. RICE, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR AIR-COMPRESSORS.

No. 919,953. Specification of Letters Patent. Patented April 27, 1909.

Application filed August 17, 1908. Serial No. 448,769.

To all whom it may concern:

Be it known that I, RICHARD H. RICE, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Governing Mechanism for Air-Compressors, of which the following is a specification.

The present invention relates to mechanism for governing the volume as distinguished from the pressure of fluid discharged by a centrifugal air compressor, and is intended more especially for use where the compressor is employed in blast furnace work.

As is well known, the area through which air can pass in a blast furnace is constantly varying, due chiefly to differences in size and shape of the twyers and to differences in the size and amounts of ore and fuel contained in the furnace. Under some conditions air will freely pass through the furnace, while at other times its passage is greatly restricted or choked. For certain reasons, which need not be specified herein, it is desirable to pass a constant, or substantially constant, volume of air through the furnace, while it is in operation. A centrifugal compressor is well adapted to furnish air for such purposes owing to its relatively high speed of operation and to its extreme simplicity and its economy of operation. It has however this great drawback, that the pressure of the air discharged by the impeller does not increase when the output decreases.

I have discovered or invented a governing mechanism whereby the disadvantage above referred to can be overcome and the compressor caused to discharge a constant volume of air or other gas, while the pressure is caused to automatically vary up or down depending upon the freedom with which the air or gas is permitted to flow through the furnace or other receiving apparatus.

In carrying out my invention a suitable air compressor is provided comprising in its simplest form an impeller having suitable vanes which receive air or other gas usually at or about atmospheric pressure and gradually increase its pressure to the point of discharge. The fluid discharged by the impeller is collected in a conduit formed in or attached to the impeller casing.

The impeller is driven by a motor of suitable character, which is capable of operating at different speeds to suit the demand for power. The motor may be of any suitable type such, for example, as a relatively high speed turbine. The bucket wheel of the turbine may be directly or indirectly connected to the impeller as desired. The motor is provided with a regulator of any suitable construction which will vary the amount of energy supplied to the motor as the demand for fluid from the compressor changes. The character of the regulator will naturally vary with the type of motor used, as will readily be understood. For example, if the compressor be driven by an electric motor, it will be of a nature to increase or decrease the amount of electricity delivered to the motor. If a gas engine is employed, the regulator will vary the amount of fuel supplied to the cylinder, change the timing of the spark or control both the fuel supply and timing of the spark. In the case of an elastic-fluid turbine, which I consider the preferred arrangement, the regulator will increase the amount of steam when it is desired to increase the volume of the fluid delivered by the compressor, and decrease it when it is desired to reduce the volume. The type of regulator used for each of the types of motor referred to can be widely varied, as will readily be understood and appreciated by those skilled in the design and use of prime movers and other motors. As typical of a motor, I have shown a steam turbine, and as typical of a regulator I have shown a throttle valve acting to vary the admission of steam to the turbine.

In order that the volume of fluid passing through the compressor may be maintained constant, a means is provided which is sensitive to changes in said volume, which means is movable and is connected to the regulator of the motor and controls or actuates it. The control of this means over the regulator may be direct or indirect as best suits the requirements. The means in the embodiment of my invention which I have chosen to illustrate comprises a movable member or float. This member or float may be made in a variety of ways and be of any desired shape or form. It can be a double cone, a flat disk, a short cylinder, a ball or other suitable shape or structure. It is located at

a point where it will be sensitive to the volume of air or other gas passing through the compressor, as for example in an enlargement in the inlet, which enlargement may be formed in a variety of ways but which with advantage takes the form of two conical members whose large ends are united, the small end of one member being connected to the inlet side of the impeller of the compressor and the small end of the other member to the main inlet pipe or be open directly to the atmosphere.

The float is of constant weight and will, by virtue of said weight, ride or float on the incoming current of air or other gas. There will be a certain pressure difference between the upper and lower side of the float. This pressure difference, multiplied by the number of square inches in the float, will be just sufficient to overcome the effect of the weight. When a change in volume occurs, the float rises or falls in accordance therewith. In order to make this action effective on the speed of the motor, it is only necessary to provide a suitable connection between it and the regulator. This action may directly or indirectly move the regulator as desired. Whether the action is direct or indirect will depend largely upon the amount of power developed by the float and upon that required to move the regulator. In operation, as the volume of fluid entering the compressor momentarily increases, the float rises or moves away from the inlet, and by means of the connection to the regulator, the latter decreases the admission of energy to the motor and the speed of the latter falls sufficiently to reëstablish the proper conditions. Conversely, when the volume of fluid entering the compressor momentarily decreases, the float is lowered or moves toward the inlet which action causes the regulator to admit more energy to the motor and its speed is increased until the normal condition is reëstablished.

There is one more feature of my invention to be considered, namely, the means for preventing the speed of the compressor from reaching too high a value, which might happen if the choke in the furnace persisted or the outlet was accidentally closed. To prevent this a speed-responsive device or governor of any suitable construction is provided which is connected to the regulator in such manner that it is normally inactive in so far as the regulation of the motor is concerned, but becomes active when the speed reaches a certain value, for example 2700 or 3000 revolutions per minute. The figures given are illustrative and are not to be considered as limitations of my invention, for the speed governor may become active at a higher or lower speed. When the governor becomes active it modifies the action of the regulator in a manner to cause the latter to restrict the admission of energy, whatever its character, to the motor, to such an amount as will prevent the motor from overspeeding. In order to prevent too sudden movements of the means sensitive to changes in volume of the fluid passing through the compressor and of the regulator, a damping means such as a dash-pot can with advantage be used.

In the accompanying drawing, which illustrates one of the embodiments of my invention, Figure 1 is an end view of a turbine-driven air compressor, and Fig. 2 is a side elevation of the same.

1 indicates the casing of the centrifugal compressor, and 2 the impeller thereof, the latter being mounted on the main shaft 3 supported by suitable bearings carried by the bed-plate 4. The casing of the compressor is also supported by the bed-plate. Mounted on the bed-plate is a turbine 5, of any suitable construction; as here shown it is of the well-known Curtis type. The bucket-wheel is mounted on the main shaft 3. Steam is admitted to the turbine by the pipe 6 containing the shut-off valve 7. Between the shut-off valve and the turbine is a regulator or throttle-valve 8 which controls the passage of steam to the turbine. Driven by the main shaft of the turbine is a speed-responsive device comprising a collar 9 that is fast to the bevel-gear 10 and the latter meshes with a bevel gear 11 carried by a low speed shaft that is driven by the main shaft.

12 indicates a vertical spindle that slides in the collar 9 and to which is attached a collar 13, the latter in turn being connected to the centrifugally acting weights 14, so that as the speed of the turbine increases and the weights move outwardly the spindle 12 will be depressed. To the lower end of the spindle 12 is attached one end of the lever 15. The opposite end of the lever is connected to the rod 16. To the lever 15 at a point between its ends is connected the stem 17 of the regulator or throttle valve 8. The upper end of the rod 16 is connected to a lever 18 mounted on the horizontal rock-shaft 19. The opposite end of the rock-shaft is provided with a lever 20 which is connected at its free end with the float 21 by means of the rod 22.

23 indicates one or more weights carried by the rod 22 for the purpose of increasing or decreasing the effective action of the float 21 on the incoming body of fluid.

24 indicates a dash-pot that is connected to the lever 20.

The float 21 is located within an enlargement in the inlet conduit of the compressor. The enlargement comprises two conical members 25 and 26. The former is connected to the elbow 27 that discharges into the conduit 28. The conduit 28 is made of two principal

parts, one of which goes to one side of the impeller 2 and the other to the opposite side.

29 indicates the outlet or discharge orifice of the compressor.

In order to guide the float 21 in its vertical movements guides 30 and 31 are provided.

Assuming, for example, that the volume of fluid discharged by the compressor decreases, the float 21 will be lowered slightly and in so doing raise the rod 16 and at the same time raise the valve stem 17 and attached valve, increasing the supply of steam to the turbine. This causes the speed of the turbine to increase and the pressure of the air discharged by the compressor will also increase until the volume of fluid discharged by the compressor is restored to normal. On the other hand, assuming that the volume of fluid passing through the compressor increases above normal, the float 21 will be raised, the rod 16, valve stem 17 and attached valve depressed, thus decreasing the admission of steam to the turbine and the speed of the latter will be decreased by the necessary amount.

When the speed of the turbine rises above the predetermined value the speed governor, by pushing the spindle 12 downward, decreases the valve opening and decreases the amount of steam admitted to the turbine. When normal speed conditions are restored the speed governor ceases to control or in any way modify the action of the regulator.

Instead of connecting a means which is sensitive to changes in the volume of fluid flowing through the compressor directly to the regulating valve, as shown, it may be connected to the pilot valve of a hydraulic governing mechanism for the turbine such as shown in the Emmet patent No. 859,286, dated July 9, 1907, or it may be connected to the shield plates where a governing mechanism is employed of the character shown in my Patent No. 815,742, dated March 20, 1906.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

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

1. In combination, a compressor, a motive power agent for driving it, and means responsive to changes in the volume of fluid entering the compressor for regulating the speed of the said agent.

2. In combination, a compressor, a motor connected to the compressor for driving it, a regulator controlling the motor, and a device sensitive to changes in the volume of fluid passing through the compressor and which is moved by the fluid for modifying the action of the regulator.

3. In combination, a compressor, a motor connected to and driving the compressor, a regulating means, and an element located in a passage through which fluid acted upon by the compressor flows for automatically causing the regulating means to increase the amount of energy supplied to the motor when the volume of fluid passing through the compressor decreases below normal and to decrease the amount of energy supplied when the said volume increases.

4. In combination, a compressor, a motive power agent for driving it, means responsive to the volume of fluid entering the compressor, a regulator for controlling the admission of energy to the motor, which is sensitive to the action of the means, and a device for modifying the action of the regulator to prevent the speed of the said agent from exceeding a predetermined value.

5. In combination, a compressor, a motor for driving it, means responsive to the volume of fluid passing through the compressor, a regulator for the motor, which is sensitive to the action of the said means, and a speed-responsive device for modifying the action of the regulator, which only comes into active service when the speed of the motor exceeds a certain value.

6. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to variations in the volume of fluid passing through the compressor, a valve mechanism for controlling the admission of fluid to the motor, which is sensitive to movements of the means, and a speed governor that assumes control of the valve mechanism to the exclusion of said means under predetermined conditions.

7. In combination, a compressor, an elastic-fluid motor for driving it, a float which rides on the body of fluid entering the compressor, and a regulator for the motor, which is sensitive to movements of the float.

8. In combination, a compressor, an elastic-fluid motor for driving it, a float which rides on the body of fluid entering the compressor, a regulator for the motor, which is sensitive to movements of the float, and a governor responsive to speed conditions, that modifies the action of the float on the regulator under certain conditions.

9. In combination, a compressor, a motive power agent for driving the compressor, a means that changes its position sensitive to variations in the volume of fluid entering the compressor, a regulator for the motor that is sensitive to changes in position of the said means, and a device for damping the movements of the said means.

10. In combination, a compressor, a motive power agent for driving it, a means sensitive to variations in the volume of fluid entering the compressor, comprising a casing and a device therein which moves in accordance with changes in the volume of fluid passing therethrough, a regulator for controlling the speed of the said agency, and a connection which transmits the movements of the said device to the regulator.

11. In combination, a compressor, an elastic-fluid motor for driving it, a float which rides on the fluid entering the compressor and as its volume increases moves in one direction and as it decreases moves in the opposite direction, a guide for the float, a valve means controlling the admission of fluid to the motor, and a connection for transmitting motion from the float to the valve means.

12. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to changes in the volume of fluid entering the compressor, a regulator for controlling the motor, which is under the control of said means, and a shut-off valve in the supply conduit of the motor.

13. In combination, a compressor, a motive power agent for driving it, a regulator means for said agent, a weighted float connected to the regulator means which rides on the fluid passing through the compressor and is subjected to a difference in pressure on opposite sides, the weight of the float and attached parts being balanced under conditions by the said difference in pressure.

14. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a regulator for controlling the motor, a conduit, a float located in the conduit and acted upon by the column of fluid passing through said apparatus which changes its position as the velocity of the fluid column changes, and which coöperates with the regulator to control the motor.

15. In combination, a centrifugal apparatus for imparting pressure to a fluid, an elastic fluid motor for driving it, a valve mechanism for controlling the speed of the motor, a fluid conveying conduit, and a float located in the conduit which is movable in response to changes in the volume of fluid passing therethrough and which determines the effective action of the valve mechanism.

16. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a mechanism for controlling the speed of the motor, a fluid conveying conduit, a conical member forming a part of the conduit, a float located in said conical member and which moves in response to changes in the volume of fluid passing therethrough, and a means for transmitting the movements of the float to the controlling mechanism to control the effective action of the latter.

17. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a regulator for controlling the speed of the motor, a float located in and moved by the fluid passing through said apparatus which coöperates with the regulator to control the motor, and means for varying the effective action of the float.

In witness whereof, I have hereunto set my hand this fourteenth day of August, 1908.

RICHARD H. RICE.

Witnesses:
JOHN A. MCMANUS, Jr.,
CHARLES A. BARNARD.

DISCLAIMER.

919,953.—*Richard H. Rice*, Lynn, Mass. GOVERNING MECHANISM FOR AIR-COMPRESSORS. Patent dated April 27, 1909. Disclaimer filed December 5, 1912, by the assignee, *General Electric Company*.

Enters this disclaimer—

"To that part of the claims which is identified as follows, to wit:

"1. In combination, a compressor, a motive power agent for driving it, and means responsive to changes in the volume of fluid entering the compressor for regulating the speed of the said agent.

"2. In combination, a compressor, a motor connected to the compressor for driving it, a regulator controlling the motor, and a device sensitive to changes in the volume of fluid passing through the compressor and which is moved by the fluid for modifying the action of the regulator.

"3. In combination, a compressor, a motor connected to and driving the compressor, a regulating means, and an element located in a passage through which fluid acted upon by the compressor flows for automatically causing the regulating means to increase the amount of energy supplied to the motor when the volume of fluid passing through the compressor decreases below normal and to decrease the amount of energy supplied when the said volume increases.

"4. In combination, a compressor, a motive power agent for driving it, means responsive to the volume of fluid entering the compressor, a regulator for controlling the admission of energy to the motor, which is sensitive to the action of the means, and a device for modifying the action of the regulator to prevent the speed of the said agent from exceeding a predetermined value.

"6. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to variations to the volume of fluid passing through the compressor, a valve mechanism for controlling the admission of fluid to the motor, which is sensitive to movements of the means, and a speed governor that assumes control of the valve mechanism to the exclusion of said means under predetermined conditions."

[*Official Gazette, December 17, 1912.*]

Disclaimer in Letters Patent No. 919,953.

10. In combination, a compressor, a motive power agent for driving it, a means sensitive to variations in the volume of fluid entering the compressor, comprising a casing and a device therein which moves in accordance with changes in the volume of fluid passing therethrough, a regulator for controlling the speed of the said agency, and a connection which transmits the movements of the said device to the regulator.

11. In combination, a compressor, an elastic-fluid motor for driving it, a float which rides on the fluid entering the compressor and as its volume increases moves in one direction and as it decreases moves in the opposite direction, a guide for the float, a valve means controlling the admission of fluid to the motor, and a connection for transmitting motion from the float to the valve means.

12. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to changes in the volume of fluid entering the compressor, a regulator for controlling the motor, which is under the control of said means, and a shut-off valve in the supply conduit of the motor.

13. In combination, a compressor, a motive power agent for driving it, a regulator means for said agent, a weighted float connected to the regulator means which rides on the fluid passing through the compressor and is subjected to a difference in pressure on opposite sides, the weight of the float and attached parts being balanced under conditions by the said difference in pressure.

14. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a regulator for controlling the motor, a conduit, a float located in the conduit and acted upon by the column of fluid passing through said apparatus which changes its position as the velocity of the fluid column changes, and which coöperates with the regulator to control the motor.

15. In combination, a centrifugal apparatus for imparting pressure to a fluid, an elastic fluid motor for driving it, a valve mechanism for controlling the speed of the motor, a fluid conveying conduit, and a float located in the conduit which is movable in response to changes in the volume of fluid passing therethrough and which determines the effective action of the valve mechanism.

16. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a mechanism for controlling the speed of the motor, a fluid conveying conduit, a conical member forming a part of the conduit, a float located in said conical member and which moves in response to changes in the volume of fluid passing therethrough, and a means for transmitting the movements of the float to the controlling mechanism to control the effective action of the latter.

17. In combination, a centrifugal apparatus for imparting pressure to a fluid, a motor for driving it, a regulator for controlling the speed of the motor, a float located in and moved by the fluid passing through said apparatus which coöperates with the regulator to control the motor, and means for varying the effective action of the float.

In witness whereof, I have hereunto set my hand this fourteenth day of August, 1908.

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"4. In combination, a compressor, a motive power agent for driving it, means responsive to the volume of fluid entering the compressor, a regulator for controlling the admission of energy to the motor, which is sensitive to the action of the means, and a device for modifying the action of the regulator to prevent the speed of the said agent from exceeding a predetermined value.

"6. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to variations to the volume of fluid passing through the compressor, a valve mechanism for controlling the admission of fluid to the motor, which is sensitive to movements of the means, and a speed governor that assumes control of the valve mechanism to the exclusion of said means under predetermined conditions."

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"3. In combination, a compressor, a motor connected to and driving the compressor, a regulating means, and an element located in a passage through which fluid acted upon by the compressor flows for automatically causing the regulating means to increase the amount of energy supplied to the motor when the volume of fluid passing through the compressor decreases below normal and to decrease the amount of energy supplied when the said volume increases.

"4. In combination, a compressor, a motive power agent for driving it, means responsive to the volume of fluid entering the compressor, a regulator for controlling the admission of energy to the motor, which is sensitive to the action of the means, and a device for modifying the action of the regulator to prevent the speed of the said agent from exceeding a predetermined value.

"6. In combination, a compressor, an elastic-fluid motor for driving it, a means sensitive to variations to the volume of fluid passing through the compressor, a valve mechanism for controlling the admission of fluid to the motor, which is sensitive to movements of the means, and a speed governor that assumes control of the valve mechanism to the exclusion of said means under predetermined conditions."

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