Apr. 24, 1923. 1,452,619

J. B. SPEED

COMPRESSION OF GASES

Filed April 27, 1920

Fig. 1

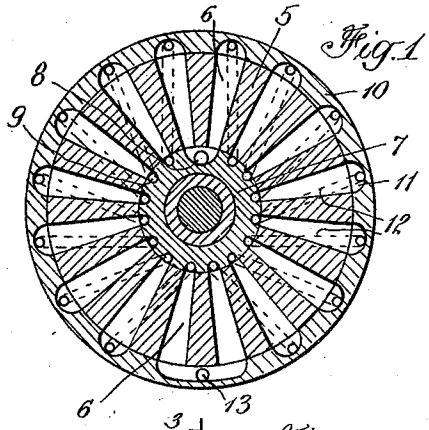


Fig. 7

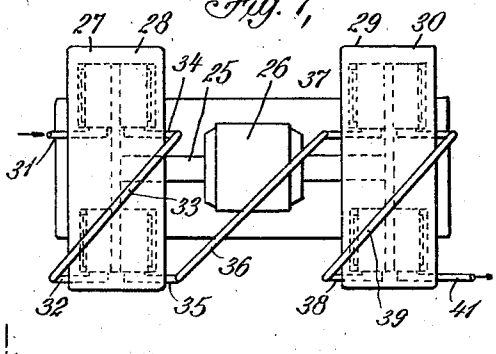


Fig. 2

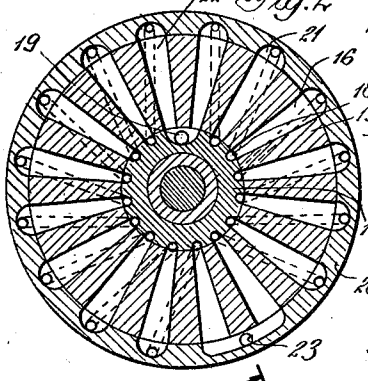


Fig. 3

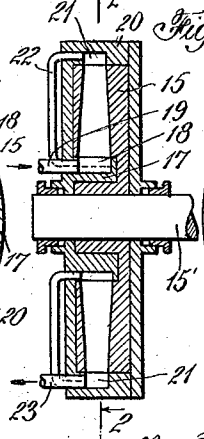


Fig. 4

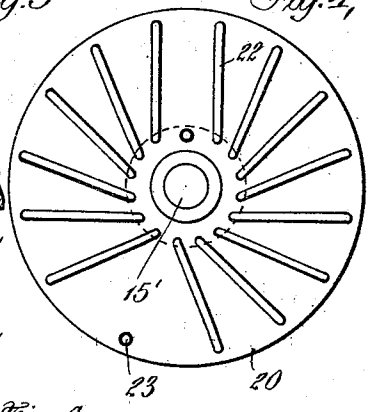


Fig. 5

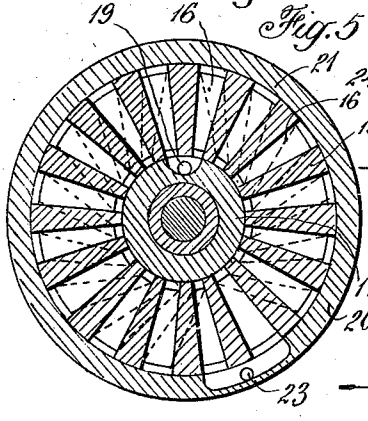
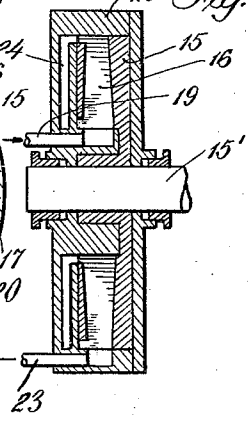


Fig. 6



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UNITED STATES PATENT OFFICE.

JAMES BUCKNER SPEED, OF NEW YORK, N. Y.

COMPRESSION OF GASES.

Application filed April 27, 1920. Serial No. 376,979.

To all whom it may concern:

Be it known that I, JAMES BUCKNER SPEED, a citizen of the United States, residing at New York city, in the county of New York, State of New York, have invented certain new and useful Improvements in the Compression of Gases; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the compression of gases and particularly to a method and apparatus permitting utilization of centrifugal force in raising gases from a lower to a higher pressure; it being understood that my invention comprehends the treatment of gases at pressures above or below atmospheric.

Centrifugal force has been utilized heretofore in compressing gases, but the total change of pressure in a single stage has been comparatively slight and increase of pressure by staging has been possible only by multiplying the units and thereby increasing the bulk and initial cost of the apparatus employed. It has been inpracticable, therefore, to adapt centrifugal pumps to numerous uses requiring a relatively wide range between the initial and final pressures of the gas and to thus take advantage of the simplicity which characterizes pumps of the centrifugal type.

The object of the invention is to provide a method of compressing gases centrifugally through integrating stages in which the gas progressively increases in pressure between the inlet, while traveling in a plurality of paths from the inlet to the outlet, and to provide as well the apparatus for accomplishing the desired object.

Further objects and advantages of the invention will be apparent as it is better understood by reference to the accompanying diagrammatic drawing in which,

Fig. 1 is a section through a form of apparatus adapted to the practice of the method;

Fig. 2 is a similar view illustrating a slightly modified form of the apparatus, being a section on the line 2—2 of Fig. 3;

Fig. 3 is a transverse section through the apparatus on the line 3—3 of Fig. 2;

Fig. 4 is a view in elevation of the structure illustrated in Fig. 2;

Fig. 5 is a section through another form of apparatus;

Fig. 6 is a transverse section through the structure illustrated in Fig. 5; and

Fig. 7 is a plan view illustrating the coupling of a plurality of units such as are illustrated in the preceding figures.

The fundamental conception of the invention is the possibility of adding the effects of centrifugal force applied to a gas until the pressure has been increased through the desired range. It is known, for example, that if a gas is confined in a rapidly whirling chamber or is subjected to the action of rapidly whirling blades therein, the pressure at the periphery of the chamber will bear a certain definite ratio to the pressure at the axis, depending on the velocity of rotation and the diameter. The gas thus forced to the periphery of the chamber will pass through an outlet, if one is provided, while additional portions of gas are drawn through an inlet disposed, for example, at the axis of the apparatus. A plurality of pumps, such as have been described may be connected in series and increase the range between the initial and final pressures, but such a system is extremely complicated for any considerable amount of compressing and therefore, undesirable.

The pressure developed at the periphery of a whirling chamber is relatively slight, but if a rotating body is provided with a plurality of independent radial channels with outlets and inlets connected successively by stationary passages, the gas leaving the first whirling channel at a given pressure enters the second channel by way of the stationary passage at the same pressure and is discharged at a higher pressure from the second whirling passage. If then we continue the integration of pressures, the desired pressure may be readily attained.

At first glance, it might appear that the purpose would be accomplished by connecting all of the channels in series about the rotating body and to provide an outlet from the last chamber of the series. Such, however, is not the case, and a pump so constructed could not achieve the desired object because the last channel would reach the in-

let, while it contained gas at a pressure exceeding the initial pressure at the inlet and no gas could consequently enter the system. This difficulty may, however, be readily met by arranging the outlet at a point substantially diametrically opposite the inlet and by so arranging the whirling channels and the stationary passages, that two series of channels are provided through which the gas passes independently from a common inlet to a common outlet. In such a pump the gas in one series of channels proceeds in the general direction of rotation of the rotating body while the remainder works its way in the reverse direction with reference to the body.

The essential details of the invention will be readily understood by reference to the drawing in which 5 indicates a rotor provided with a plurality of radial channels 6. The rotor 5 rotates a clockwise direction viewing Figs. 1 and 2 about a fixed hub 7 having an inlet 8 and a plurality of recesses 9 corresponding to the channels 6. The inlet 8 communicates with one of the recesses 9. A fixed casing 10 surrounds the rotor 5 and a plurality of recesses 11 are formed therein to correspond with the channels 6. Each recess 11 is connected by a pipe 12, for example, with a succeeding recess 9 in the hub and it will be noted that the pipes 12 are directed oppositely from the inlet to convey the gas in opposite directions about the rotor. The casing 10 is also provided with an outlet 13 communicating with one of the recesses 11 and arranged in substantial opposition to the inlet.

In operation the rotor 5 is caused to rotate through the application of power thereto in any suitable manner while the hub and casing remain stationary. As the rotor 5 rotates a difference in pressure builds up between the inner and outer ends of the radial channels 6 owing to the application of centrifugal force to the air in the channels and as the ends of the channels pass the recesses 11 successively, a portion of the gas is discharged through the connecting pipes 12 to the succeeding channels while additional quantities of gas enter the channels which are momentarily connected to the inlet. Thus gas entering the first channel from the inlet is compressed to the maximum pressure attainable therein and is discharged at that pressure to the second channel where the same forces increase the pressure therein to a corresponding degree and the operation continues until the gas is discharged through the outlet at the opposite side of the casing. As is hereinbefore explained, all of the gas does not follow the direction of rotation of the rotatable body. Substantially half of the gas entering the inlet proceeds through the second series of channels in a direction opposite to that of the rotation of the rotor and is compressed in a similar manner and discharged with the gas from the first series through the outlet. Thus at a given instant when the rotor is, for example, in the position indicated in the drawing, two distinct bodies of gas exist, each under gradually increasing pressure from the inlet to the outlet. The final pressure of the gas at the outlet will be substantially equivalent to the sum of the increments of pressure in the respective channels and by suitably designing the apparatus and constructing it of proper dimensions, a consisiderable range of pressure may be attained. As each channel passes the outlet, it discharges a quantity of gas corresponding to the increment of pressure therein.

In the simplest form of my invention as hereinbefore explained, the outlet is disposed substantially diametrically opposite the inlet. As a matter of practical operation, however, the gas passing through the channels in the direction opposite to the rotation of the rotatable body will not attain the final pressure in the same number of stages as in the channels, where the gas follows the direction of rotation of the rotatable body due to inequality of leakage. Consequently, is becomes necessary to vary the position of the outlet with respect to the theoretically perfect apparatus above described. In Figs. 2 to 4 inclusive of the drawing, a form of my invention is illustrated, therefore, which comprises a rotor 15 supported on a shaft 15′, having a plurality of channels 16 similar to those previously described. A stationary hub 17 is provided with recesses 18 corresponding to the channels 16 and with an inlet 19 through which the gas is drawn at the initial pressure. A stationary casing 20 surrounds the rotor and is provided with recesses 21 corresponding to the channels 16. The recesses 21 are connected by pipes 22 with succeeding recesses 18 in the hub 17 and the pipes are so arranged that the gas entering through the inlet is divided and substantially equal proportions thereof pass through the chambers in the rotor in opposite directions.

The casing 20 is provided with an outlet 23 which as above noted, is offset from the diametrical plane which includes the inlet, and to an extent which will vary depending upon the design and structure of the apparatus. The mode of operation of the invention as last described is substantially identical with that of the structure illustrated in Fig. 1 and the gas is delivered through the outlet at a pressure which represents substantially the sum of the several increments of pressure in the several chambers.

In Figs. 5 and 6 of the drawing, a slightly different form of my invention is illustrated in which the pipes 22 are replaced by cored passages 24. The structure is otherwise iden-

tical with that last described and corresponding reference numerals are applied to the various parts

In Fig. 7 the invention is illustrated as comprising a plurality of elements combined and connected to a single shaft 25 which may be driven, for example, by a motor 26. The units 27, 28, 29 and 30 each conform in detail to the structure illustrated in the preceding figures of the drawing. An inlet 31 permits the entrance of gas at the initial pressure to the unit 27, where it is compressed in the manner hereinbefore described and delivered through an outlet 32 to a pipe 33 which conveys it to the inlet 34 of the unit 28. From the pressure of discharge from the unit 27, the pressure is raised in the unit 28 and the gas at the pressure of discharge of the unit 28 is delivered through an outlet 35 to a pipe 36 which conveys it to the inlet 37 of the unit 29. Here the increase of pressure is repeated and the gas is delivered through an outlet 38 to the pipe 39 which conveys it to the inlet 40 of the unit 30 and the gas is discharged at the final pressure through the outlet 41. The structure shown in Fig. 7 illustrates a further staging of the already staged compression and is capable of a much wider range of pressure than an apparatus of corresponding size made up of separate centrifugal pumps of the ordinary type, each of which is capable of increasing the pressure to a comparatively slight extent.

From the foregoing, it will be understood that I have provided a novel method of compressing from any initial pressure the method being adapted to the compression from atmospheric or higher pressure, and to evacuate a vessel attached to the suction inlet. An apparatus is also provided which is adaptable to the desired purposes and is capable of producing the result in an economical and satisfactory manner. Since the apparatus is centrifugal in principle, it eliminates entirely many of the disadvantageous features of reciprocating pumps and rotary blowers which have been available heretofore for the purpose of varying the pressure of gases between relatively wide limits.

Various changes may be made in the details of construction and no attempt is made herein to illustrate such details, it being the purpose of the present application to claim broadly the method and apparatus whereby the desired result is accomplished and sufficient information has been embodied in the foregoing discussion to enable any person skilled in the art to design and build apparatus conforming to the principles set forth.

It is to be understood that the term "radial" as applied to the chambers is to be considered in the broad sense of generally radial in direction, whereby the gas travels from the axis of rotation outwardly in accordance with the principles of the application of centrifugal force.

I claim:

1. A method of augmenting the pressure of a gas, which comprises subjecting the gas to successive increments of pressure resulting from the application of centrifugal force thereto, while the gas is travelling in a plurality of paths oppositely directed about an axis of rotation.

2. A method of augmenting the pressure of a gas, which comprises subjecting the gas to successive increments of pressure resulting from the application of centrifugal force thereto, while the gas is travelling in a plurality of paths oppositely directed about an axis of rotation and discharging the gas corresponding to the final increment of pressure in each path.

3. In an apparatus for augmenting the pressure of gases, the combination of means for successively applying centrifugal force to the gas, thereby causing it to travel in a direction away from an axis of rotation, and means for removing the gas from the influence of said force, and returning it toward the axis after each increment of pressure, the last mentioned means being arranged so that the gas travels in a plurality of paths oppositely about the axis of rotation.

4. In an apparatus for augmenting the pressure of gases, the combination of means comprising a plurality of channels disposed for rotation about an axis, means for rotating the channels whereby the gas is successively subjected to increments of pressure by the application of centrifugal force and means for withdrawing the gas from the influence of said force and returning it toward the axis after each increment of pressure, the last mentioned means being arranged so that the gas travels in a plurality of paths oppositely directed about the axis of rotation.

5. In an apparatus for augmenting the pressure of gases, the combination of means comprising a plurality of channels disposed for rotation about an axis, means for rotating the channels whereby the gas is successively subjected to increments of pressure by the application of centrifugal force and means for withdrawing the gas from the influence of said force and returning it toward the axis after each increment of pressure, the last mentioned means being arranged for the passage of the gas in the direction of and contrary to the direction of rotation of the channels.

6. In an apparatus for augmenting the pressure of gases, the combination of a rotor having a plurality of radially disposed channels, a stationary hub having an inlet for gas, a stationary casing having an outlet for gas, and communicating means whereby the

gas is delivered successively following each increment of pressure to the succeeding channels and travels in two paths oppositely directed about the axis of rotation.

7. In an apparatus for augmenting the pressure of gases, the combination of a rotor having a plurality of channels, a stationary hub having an inlet for gas, a casing having an outlet for gas, said inlet and outlet being arranged in substantially diametrically opposed relation, and communicating means whereby the gas is delivered successively following each increment of pressure to the succeeding channels and travels in two paths between the inlet and the outlet, said paths being oppositely directed about the axis of rotation.

8. In an apparatus for augmenting the pressure of gases, the combination of a rotor having a plurality of radially disposed channels, a stationary hub having an inlet for gas, a casing having an outlet for gas, said inlet and outlet being arranged in substantially diametrically opposed relation, and communicating means between said casing and hub whereby the gas is delivered successively following each increment of pressure to the succeeding channel, said communicating means being arranged to permit the gas to pass in two generally peripheral directions from the inlet to the outlet.

9. In an apparatus for augmenting the pressure of gases, the combination of a rotor having a plurality of radially disposed channels, a hub having an inlet for gas, a casing surrounding the rotor and having an outlet for gas arranged in substantially diametrically opposed relation to the inlet, recesses in the hub and casing corresponding to the channels and communicating means between the successive recesses in the casing and hub respectively, the last mentioned means being arranged to permit the gas to travel in two directions from the inlet to the outlet.

10. In an apparatus for augmenting the pressure of gases, the combination of a rotor having a plurality of radially disposed channels, a stationary hub having an inlet for gas, a casing having an outlet for gas, said outlet being slightly offset from the diametrical plane including said inlet and communicating means between said casing and hub whereby the gas is delivered successively following each increment of pressure to the succeeding channels and travels in two paths between the inlet and the outlet, said paths being oppositely directed about the axis of rotation.

In testimony whereof I affix my signature.

JAMES BUCKNER SPEED.