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MACHINES FOR COMPRESSING GASES
BY CENTRIFUGAL EFFECT
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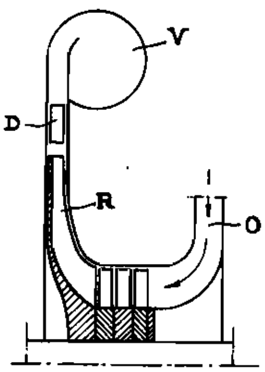
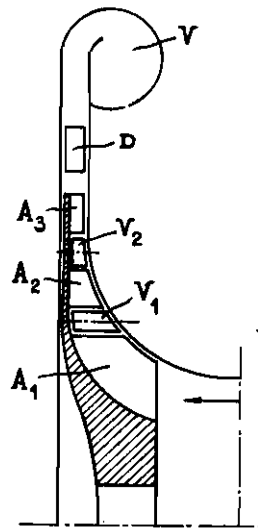
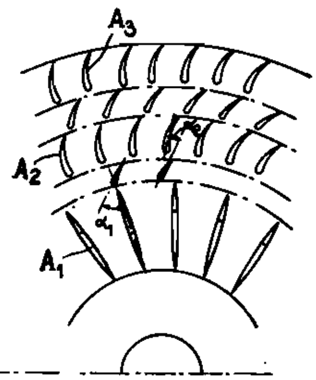
.Fig.1.



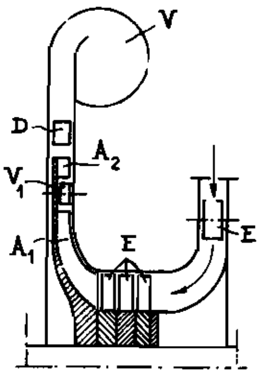
.Fig.2.



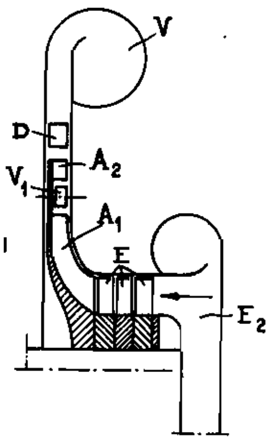
.Fig.3.



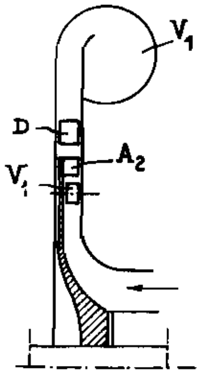
.Fig.4.



.Fig.5.



.Fig.6.



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ALIEN PROPERTY CUSTODIAN

MACHINES FOR COMPRESSING GASES BY CENTRIFUGAL EFFECT

Josef Szydlowski, Saint Pe de Bigorre, France; vested in the Alien Property Custodian

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The present invention concerns machines for compressing gases by centrifugal effect, such as turbo-compressors and in particular the turbo-compressors utilised for supercharging the internal combustion engines on board aircraft.

Machines of this kind impart to the gas sucked in, a vis viva which is converted into static energy or pressure at the outlet.

It has been attempted, for all the applications of these machines, to obtain a high compression ratio, for a minimum cumbersomeness and weight, with an output as high as possible.

Fig. 1 of the accompanying drawings is a diagram of a known machine shown in axial half-section. The gas, for instance air, sucked through an inlet orifice O is drawn along in a rapid rotary movement by the blades of a rotor R and ejected at high speed into a manifold V or recovery volute chamber. Between the rotor and the volute chamber V, is interposed a suitable fixed blade D or diffuser, the function of which is to increase the output of the conversion of the vis viva of the air into static pressure.

The compression ratio between the inlet and the outlet increases with the angular speed of the rotor. This speed has for upper limit, the value which corresponds to a linear speed of the air at the end of the blades equal to the local speed of sound. Beyond this speed, the output of the machine rapidly lowers.

For avoiding this obstacle, it has been proposed to couple in several stages, machines working one after the other. That of the upper stage sucks in the air previously compressed by the machine at the stage immediately underneath.

A unit is thus obtained which is capable of ensuring a high compression ratio, whilst limiting in each machine, the compression work and, consequently, the angular speed of the rotor.

This arrangement however presents various inconveniences. In particular, the weight and cumbersomeness are exaggerated and, owing to the complication of the entire air circuit, the adiabatic and mechanical outputs are poor.

The present invention allows of obtaining a high compression ratio whilst avoiding the above mentioned inconveniences. It mainly consists in providing on one and the same rotor of a single machine, rings of concentric blades, that is to say of increasing diameters from the up side to the down side, between which are arranged fixed rings of blades which are simply guiding blades.

It is first of all obvious that a machine thus constituted causes the air to be subjected to an evolution comparable to that to which it is subjected in known compressors having stages. The air delivered by the first rotating ring, approaches the intermediate fixed blades which slow it down, the effect of which is to increase its static pressure.

The admission of the air into the second ring of rotating blades takes place at this static pressure and the kinetic energy imparted to the mass of air in said second rotating ring is again converted into pressure in the following fixed ring. The pressure thus increases from one to the other as in known stage machines.

Fig. 2 shows in axial half-section a machine according to the invention. The rotor of the machine comprises three rings or concentric sets of blades A^1, A^2, A^3. Two rings of fixed blades V^1 and V^2 are arranged between the rings A^1 and A^2 and A^2 and A^3.

In Fig. 3 which is a corresponding partial end view. α^1 is the angle of the air streams relatively to the vector radius of the machine, at the outlet of the set of blades A^1; α^2 is the angle corresponding to the air streams after they have been deviated by the fixed set of blades V^1.

It will immediately be seen that if α^2 is smaller than α^1, the movement of the air is slowed down and a part of its kinetic energy is converted, by the set of blades V^1, into potential energy. On the other hand, it will be seen that the set of blades of the stage immediately above A^2, is fed with a lower circumferential speed (proportional, for an equal output, to $tg\alpha^2$). The application of the theorem of the impulse moments then shows that the increase of pressure produced by the set of blades A^2 is so much the greater as α^2 is smaller. The conclusion is the reverse if α^2 is greater than α^1.

If the blades of the fixed rings V^1 and V^2 are pivotally mounted on suitable spindles, by setting them accordingly, the rotating set of blades immediately following them can be charged or discharged at will.

When the invention is applied to the supercharging of an aeroplane engine, from the ground up to the so-called balance altitude, this circumstance is particularly advantageous. The required compression ratio is in fact very variable according to the altitude at which the aeroplane is flying. The blades such as V^1 and V^2 can be adjusted in such a manner that they slow down the air or accelerate it. The following set of blades (A^2 or A^3) might then be discharged, even until it operates as a turbine.

The torque borrowed from the engine will thus be reduced to the strict minimum necessary for supplying the engine at its nominal admission pressure. This reduction of the torque is so much the more substantial as the aeroplane flies at a lower altitude.

By limiting the number of stages to two, the compressor of the present invention has a diametral cumbersomeness equal or scarcely greater than a single-stage compressor of the same category. The longitudinal cumbersomeness remains the same as that of a single-stage machine.

Figs. 4 to 6 are views similar to Fig. 2 for embodiments of turbo-compressors improved according to the invention. In the example of Fig. 4, the rotor comprises, in the manner known per se, helical blades E on the up side of the set of blades A^1 and A^2 according to the invention. These sets of blades E are adapted to bring the air without shock to the inlet of the set of blades A^1. The air is admitted in the machine through shutters E^1 which can be set, also in the known manner and which, in the machine according to the invention, add an adjustment of the pressure ratio to that produced by the ring V^1.

The adjustment by means of the shutters E^1 can be done away with and the intermediate blades V^1 between both stages need only be maintained as regulating system. In this case helical wheels E are preceded only by an axial or radial axial channel provided or not with a fixed guiding set of blades.

The control of the orientation or setting of the blades such as V^1V^2 can be, in the various embodiments, independent for each ring, or can be obtained by combining the controls of the various rings. Said control can be automatic from any desired variables.

The admission of air can also be effected through a volute chamber E^2, opening into an axial or radial channel (Fig. 5). The inlet shutters E^1 are done away with and the angle of incidence of the first helical wheel E is constant. Its value results from the suitable adaptation of the main section of the volute chamber to that of the channel. This method of construction is more particularly suited to radial type engines.

A single-stage and simply radial compressor can also be devised (Fig. 6) obtained by doing away with all the driving members preceding the fixed intermediate sets of blades V^1. The admission of air takes place, in this case through the axial channel occupied by the helical wheels E in the preceding examples. This channel can open directly to the free air or be connected to an inlet volute chamber or to a radial channel.

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