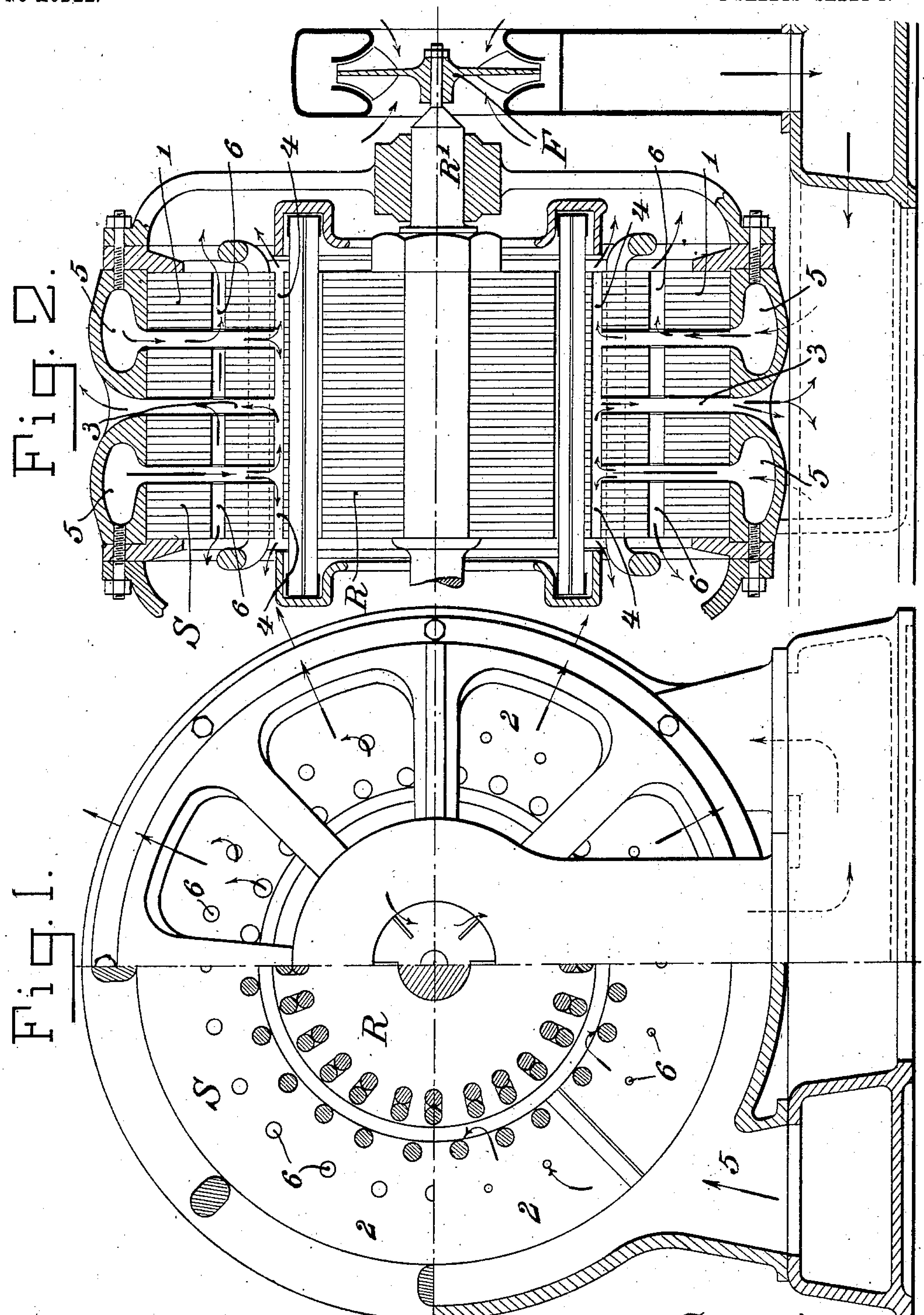
No. 730,401. PATENTED JUNE 9, 1903.

A. C. E. RATEAU.

MECHANICAL VENTILATION OF ELECTRIC MACHINES.

APPLICATION FILED JUNE 28, 1902.

NO MODEL. 2 SHEETS—SHEET 1.



Witnesses:
Jas. C. Wobensmith.
Wilhelm Vogt

Inventor:
Auguste Camille Edmond Rateau
By J. Walter Douglass
Attorney.

No. 730,401. PATENTED JUNE 9, 1903

A. C. E. RATEAU.

MECHANICAL VENTILATION OF ELECTRIC MACHINES.

APPLICATION FILED JUNE 28, 1902.

NO MODEL. 2 SHEETS—SHEET 2.

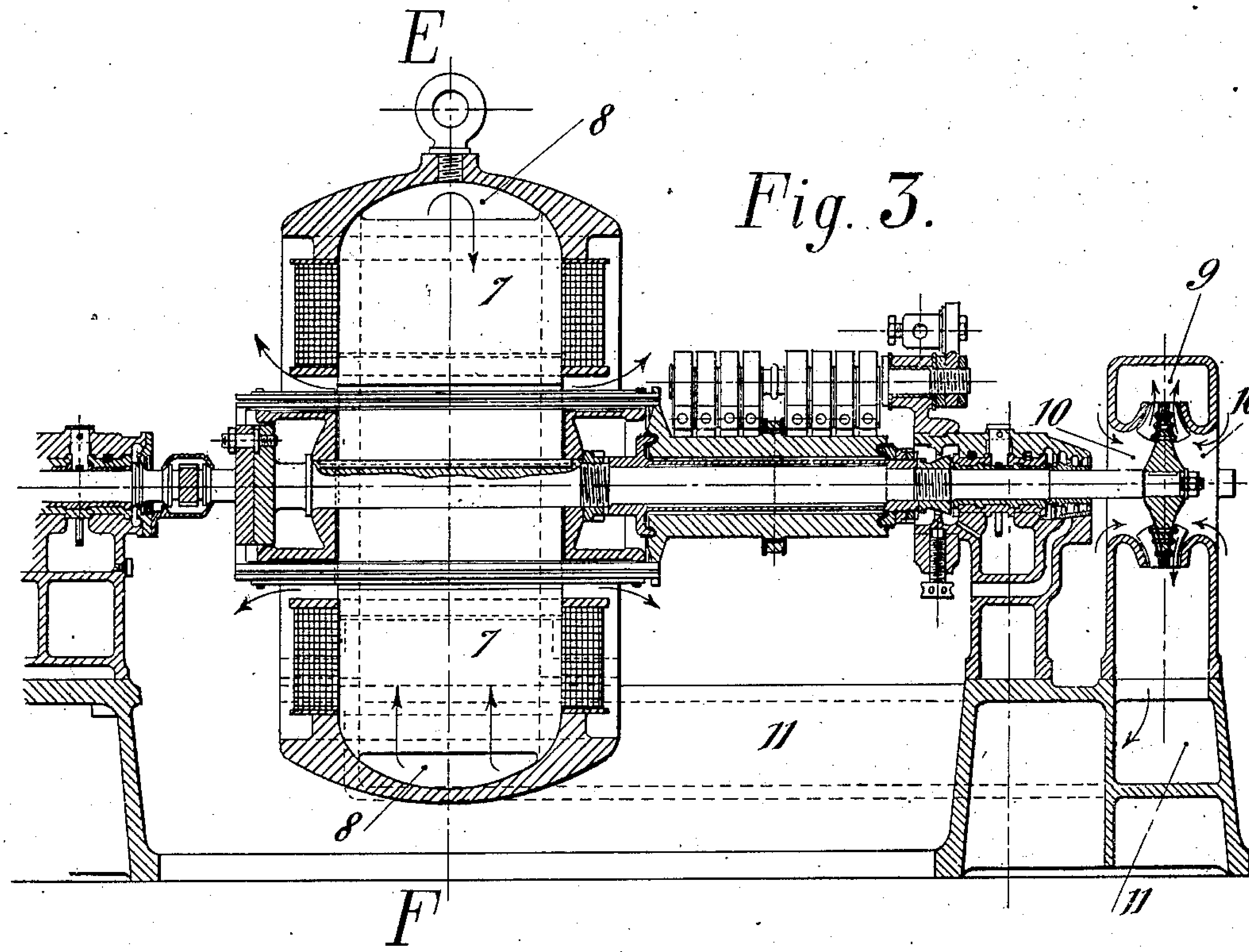


Fig. 3.

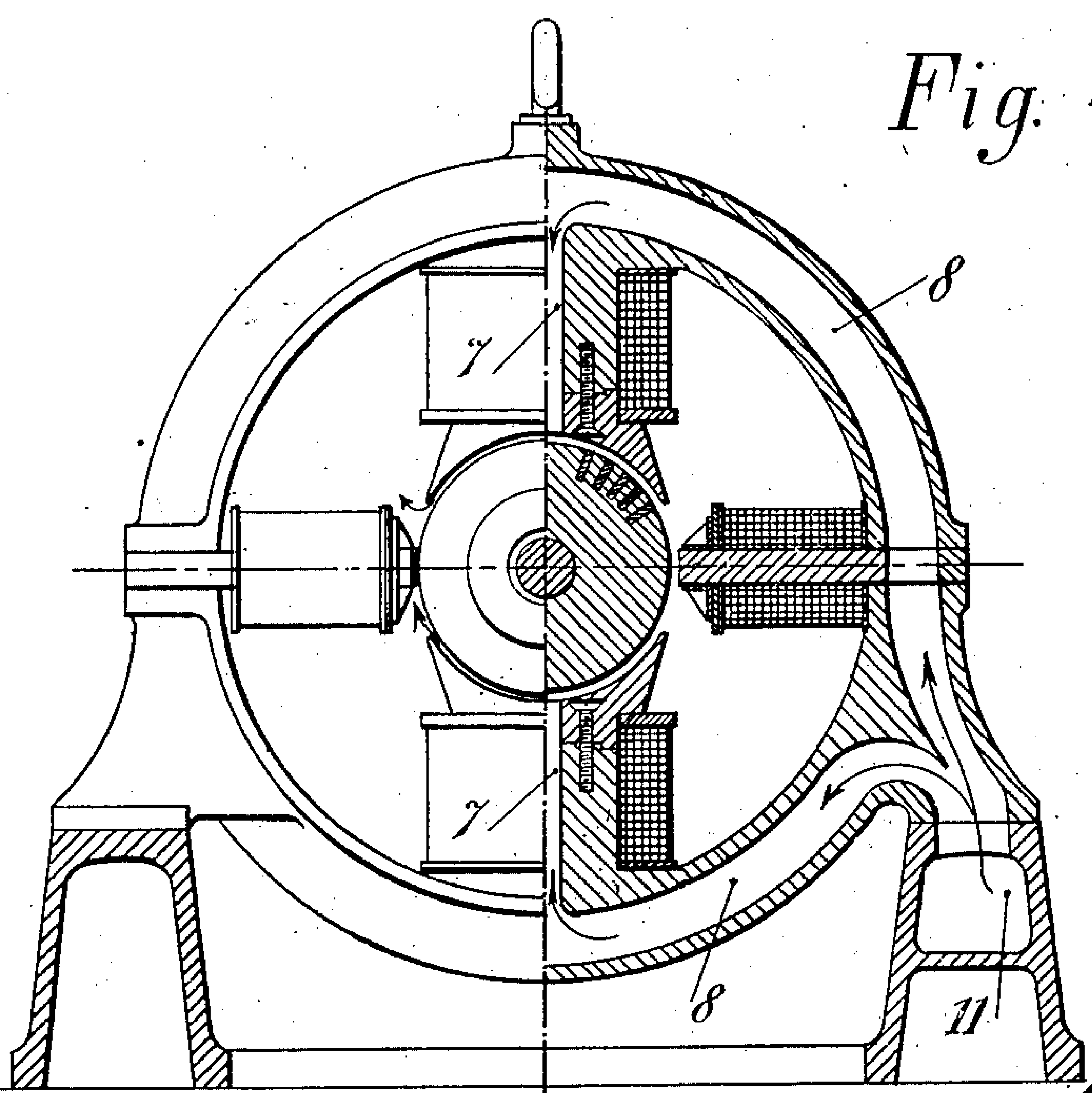


Fig. 4.

Witnesses:
Wilhelm Vogt
Jas. C. Wobensmith

Inventor:
Auguste C. E. Rateau,
By J. Walter Douglass
Attorney.

No. 730,401. Patented June 9, 1903.

UNITED STATES PATENT OFFICE.

AUGUSTE CAMILLE EDMOND RATEAU, OF PARIS, FRANCE.

MECHANICAL VENTILATION OF ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 730,401, dated June 9, 1903.

Application filed June 28, 1902. Serial No. 113,565. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTE CAMILLE EDMOND RATEAU, a citizen of the Republic of France, residing at Paris, France, have invented a new and useful Improvement in the Mechanical Ventilation of Electric Machines, which improvement is fully set forth in the following specification.

In high-speed electric machines the evolution of heat produced near to the windings by the action of parasite currents and hysterisis is a great inconvenience. It is therefore necessary to cool as completely as possible by a suitable method of ventilation not only the assemblage of sheet-iron receiving the fixed windings, but also (and this is more important) the space comprised between the fixed and the movable windings, called the "air-space." The ventilation of this very narrow space, in combination with the cooling of the fixed sheet-iron assemblage, always involves certain difficulties, and it is for the object of obviating these that I have invented the hereinafter-described arrangements which form the subject of this patent.

The means for ventilation at present employed are of two kinds. The most usual consists in forming radial gaps in the sheet-iron assemblage in such a manner that the assemblage is formed of annular blocks separated from each other by small spaces. By reason of the increase of the cooling-surface a certain improvement in the ventilation of the machine ensues; but the ventilation nevertheless remains very insufficient, the insulations of the sheet-iron opposing great difficulty to the passage of the heat from one piece of sheet-iron to the other. The second process, less employed, but nevertheless more efficacious, consists in causing the air to circulate in the interior of the moving portion and around the fixed portion by means of fans directly mounted upon the shaft of the machine.

In the novel system of ventilation invented by me an auxiliary fan is also employed; but the system is distinguished from the prior arrangements in that the air fed by the fan is forced to circulate in inner channels formed in the fixed portion of the machine, such channels being arranged in such a manner that not only is the fixed portion cooled, but at the same time also (and this is most important) the periphery of the moving portion.

In a general manner my invention consists, therefore, in forming channels through the fixed sheet-iron assemblage or in forming between them suitably-arranged channels, in which air is caused to circulate by means of a fan. In this manner the air licks the face of all the sheet-iron pieces, as well as the periphery of the moving portion, quite near to where heat is evolved. The surface of contact between the air and the masses to be cooled is, on the other hand, very extended, because the channels may have a superficial area as large as desired. The channels are formed either of holes pierced by a punching-machine in the sheet-iron assemblage in the same manner that the notches for receiving the windings are formed or by gaps of suitable length formed in the succession of sheet-iron assemblages. Of course there is left between the different channels enough metal to insure the passage of the magnetic flux. This arrangement is also applicable to machines having a rotating field the fixed portion of which is continuous and to all other electrical machines in which the poles are insulated, with, however, certain indispensable modifications in the arrangement of the air-channels. The annexed drawings show these two adaptations of my arrangement of ventilation, illustrating the application of the general arrangement first to a motor having a rotating field and then to a continuous-current generator.

In the drawings, Figure 1 is a view, partly in side elevation and partly in section, of a motor having a rotating field structure, together with means for ventilating the rotating field structure, said means embodying main features of my invention. Fig. 2 is a longitudinal section through the axis of the motor. Fig. 3 is a longitudinal section of a continuous-current generator. Fig. 4 shows an end view, partly in section, on the line E F of Fig. 3.

1. *A motor with a rotating field, (shown in Figs. 1 and 2.)*—The arrangement adopted in these kinds of machines for the distribution of the ventilating-channels must fulfil the condition, as previously stated, of thoroughly ventilating the air-space at the periphery of

the rotor and at the same time suitably cool the sheet-iron assemblages of the stator. The mechanical processes usually employed for jointly attaining this double object in motors having a rotating field consists in blowing fresh air into the air-gap through one end, which forces the air to then circulate parallel to the axis of the machine and to escape through the opposite end; but it will be understood that it is a process of little value, particularly in the case of machines having a rotating field (asynchronous or other motors) in which the air-gap is radially of an extremely small size, and can consequently only give passage to a very limited volume of air. My arrangement permits also of a much more intense ventilation of air-gaps of very small section, owing to the arrangement shown in the annexed drawings, Figs. 1 and 2, in which S is the stator, and R the rotor. This arrangement consists, essentially, in forming in the fixed assemblages 1 1 of sheet-iron radial gaps 2 2 and 3 3 in odd numbers. (There must be at least three.) The gaps communicate, on the one hand, with the air-gap 4 and, on the other hand, with channels 5, formed in the frame, through which fresh air is fed, preferably by a fan F, fixed upon the shaft R' of the rotor R. The air then passes to the gaps 2 2 of the stator, traverses them, circulating from the periphery toward the axis, then passing to the right and left in the air-gap 4, and finally passing out of the machine either through the ends of the air-gap or through radial gaps 3, interposed between the gaps 2. The section at the inlet into the air-gap for each of the currents distributed by the radial gaps 2 is therefore equal to double the transverse section of the air-gap. Consequently by multiplying the radial gaps the volume of air which traverses the machine may be increased as desired. This ventilation of the air-gap helps to cool the sheet-iron assemblages of the stator. Nevertheless, in order to complete this action I usually combine the ventilation of the air-gap with an inside ventilation of the mass of the fixed assemblages of iron sheets, as indicated in the annexed drawings. For this purpose I form in the iron sheets of the stator longitudinal passages 6 6, which communicate with the gaps 2 2. A portion of the air which circulates in the gaps 2 2 thus passes into the channels 6 6, the size of the inlet-orifices being regulated in such a manner as to distribute the air between the channels and the air-gap in suitable proportions.

2. *Machines having insulated poles, as shown in Figs. 3 and 4.*—In this case the insulation of each pole and its elongated shape in general in the direction of the axis of the machine requires the ventilating-gaps to be arranged also in a longitudinal direction. On the other hand, the cooling of the insulated polar masses being of course more easy than that of a continuous stator one may in this case be content with ventilating the periphery of the armature. For this purpose I form radial channels 7 7 in the axis of the polar pieces. These channels are formed of gaps narrow in the direction of the periphery of the armature and nearly as long as the polar piece parallel to the axis of the machine. They open freely into the air-gap and are connected together at their outer end by a channel 8 8, formed in the frame of the machine. In the example shown in the drawings the fan 9 sucks the air through the holes 10 and forces it into a channel 11, formed in the interior of the frame of the machine, which conducts the air as far as the channel 8, from whence it passes finally into the channels 7 7. The arrows show the path of the air from the fan as far as the periphery of the armature and how it passes out from the air-gap. By this arrangement I succeed in blowing a very large volume of fresh air upon the armature, at the same time leaving the machine as completely free as in the absence of all artificial ventilation. The longitudinal radial channels formed in the polar piece allow a much greater volume of air to be injected than is the case when it is desired, as it is sometimes, to force the air longitudinally into the air-gap from one end of the armature to the other. In effect, in this latter case if p is the length of arc embraced by a pole in the direction of the periphery and e the thickness of the air-gap the section of flow of the air along the armature opposite each pole is $p\ e$, while in my case if l is the length of the pole parallel to the axis, little different from that of the armature, the section of the total flow per pole on both sides of the radial channel is equal to $2\ l\ e$; but in the majority of cases l is greater than p. It will be seen that I at least double the section of the flow of air in the air-gap. On the other hand, the length in which the air licks the peripheral surface of the armature is less in my arrangement, for it is only $\frac{p}{2}$, while in the other it is equal to l. The resistance to its movement is therefore less. It is for these two reasons that my process is much more efficacious than previous processes.

I claim—

1. An electric machine having a field structure formed of fixed assemblages of sheet-iron, separated from each other by radial gaps of odd number forming air-channels, in combination wlth a suitable source of air-supply under pressure in open communication with alternate air-channels, the remaining air-channels being connected by interior channels with the alternate air-channels and in open communication with the atmosphere.

2. An electric machine having a field structure formed of fixed assemblages of sheet-iron, separated from each other by an odd number of radial gaps forming air-channels, said assemblages being pierced longitudinally by channels traversing the radial gaps, in combination with a suitable source of air-

supply under pressure in open communication with alternate gaps, the remaining gaps being connected with said alternate gaps and in open communication with the external atmosphere.

3. In an electric machine, a field structure having radial gaps longitudinally arranged therein, a main air-channel extending peripherally around the field structure and communicating with each gap, a source of air-supply under pressure arranged to pass into said peripheral air-channel in opposite directions so as to force air from the channel into the gaps from the periphery toward the center of the machine, and an outlet from the machine arranged near the center of said machine and in open communication with the radial gaps.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

AUGUSTE CAMILLE EDMOND RATEAU.

Witnesses:

JEAN PIERRE ETIENNE VAUCHER,
EDWARD P. MACLEAN.