Dec. 13, 1960 | H. COANDA | 2,964,306

THERMO-BLOWER

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FIG. 2

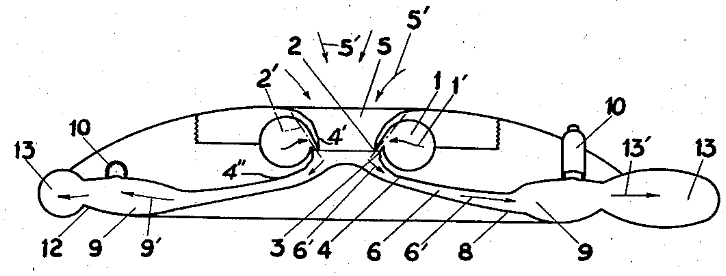

FIG. 1

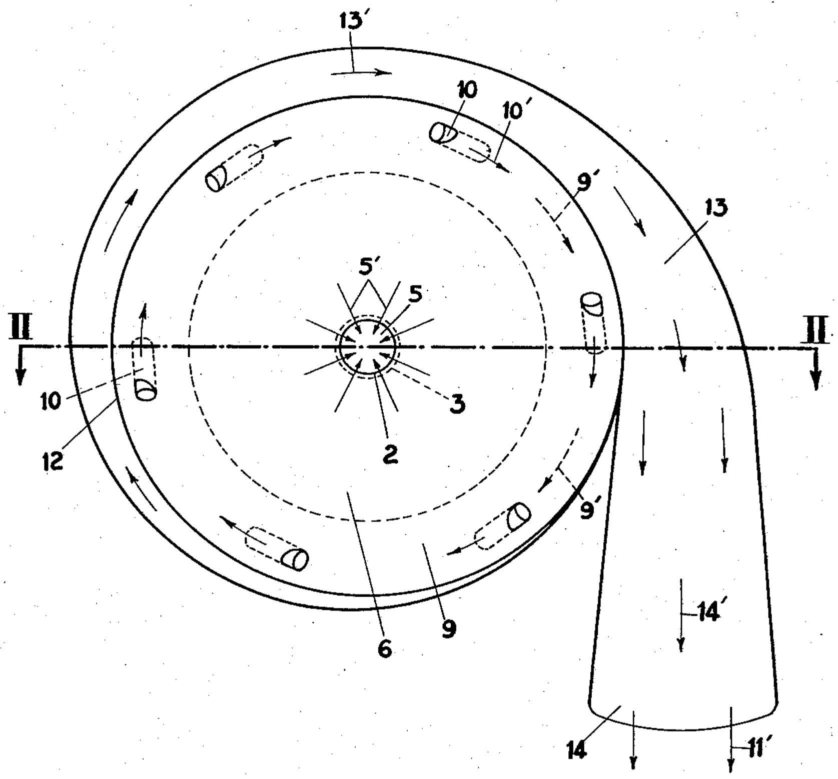

FIG. 3

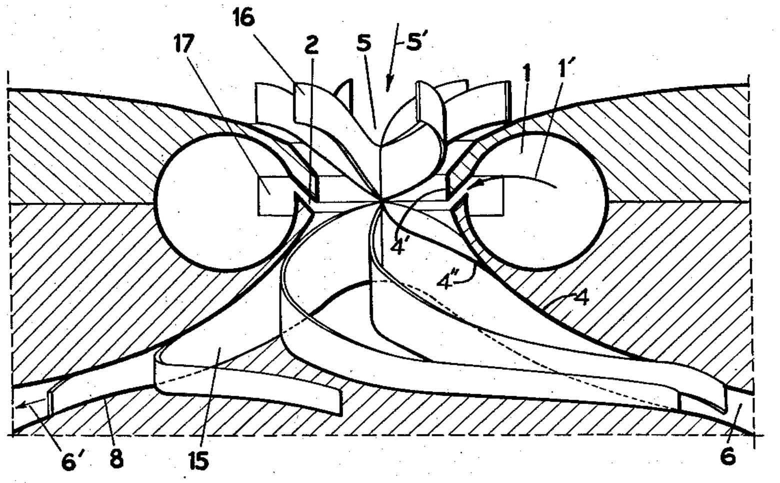

FIG. 4

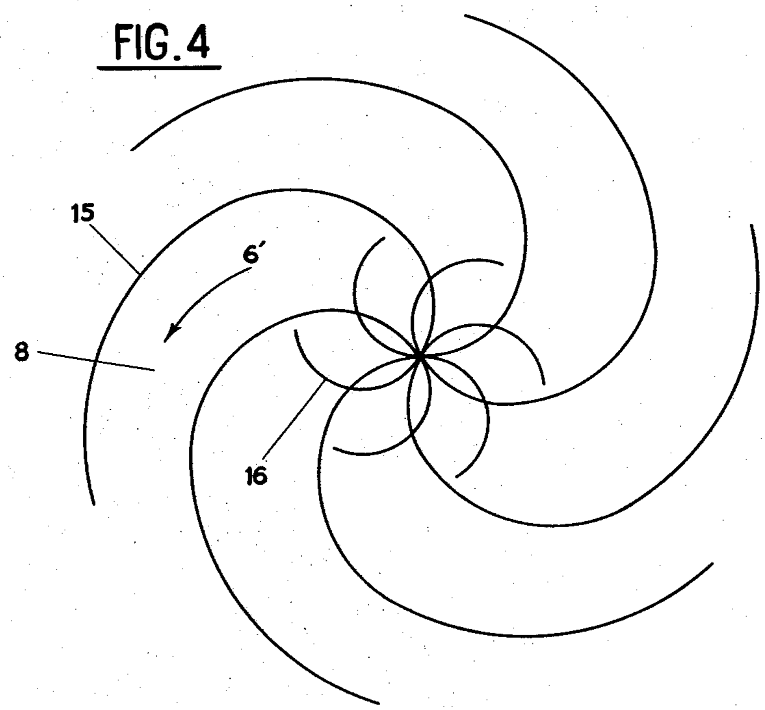

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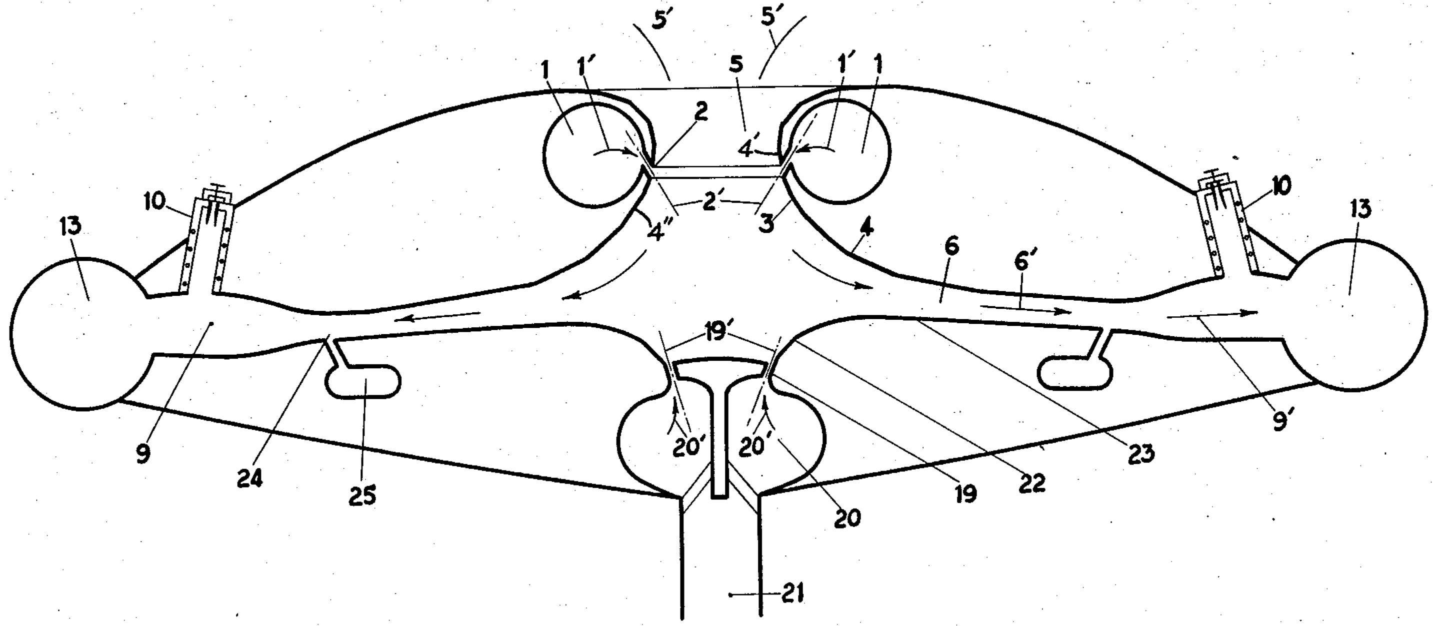
FIG. 5



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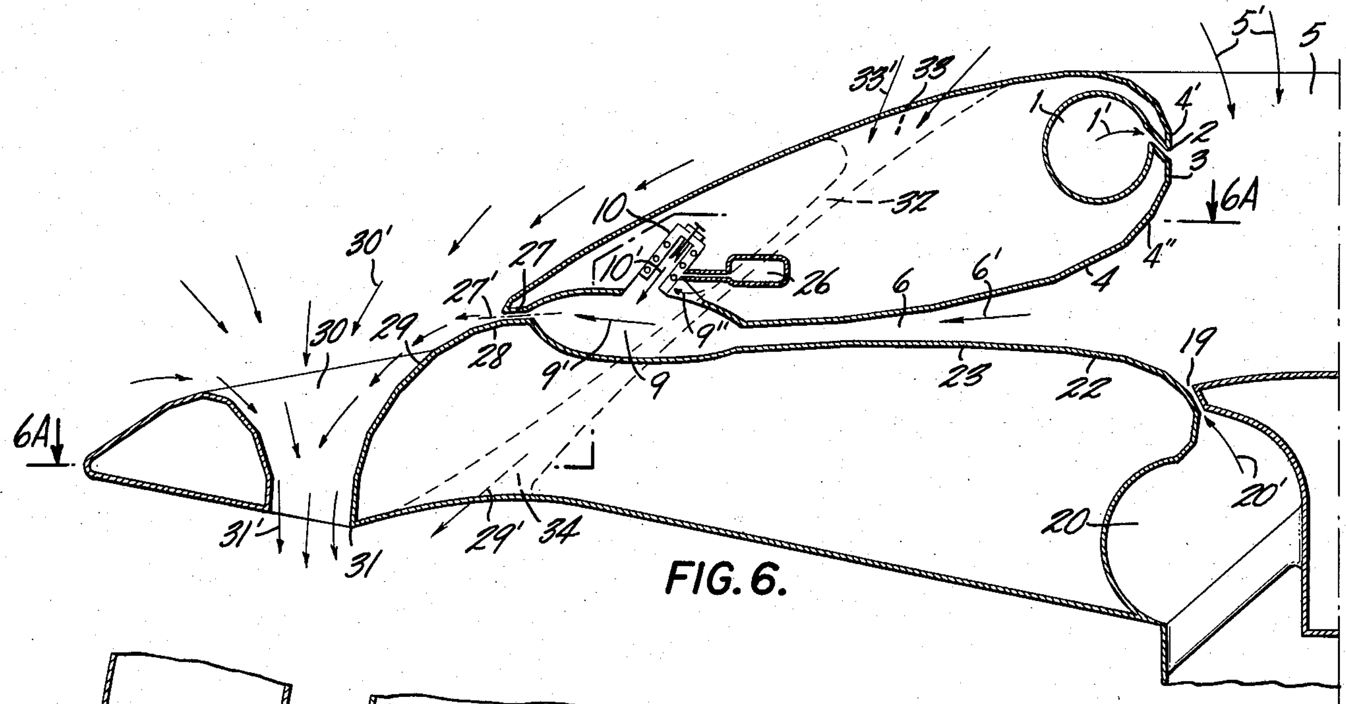


FIG. 6.

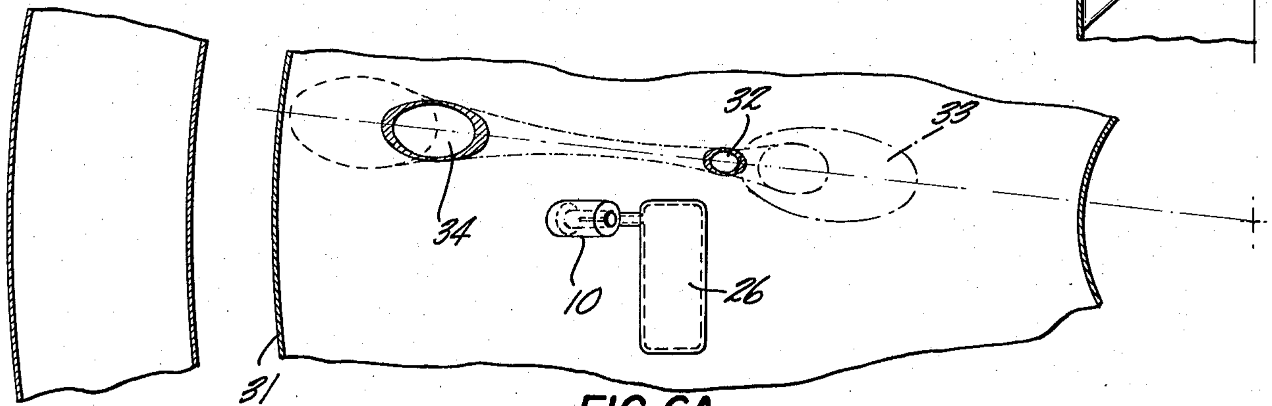


FIG. 6A.

FIG. 7

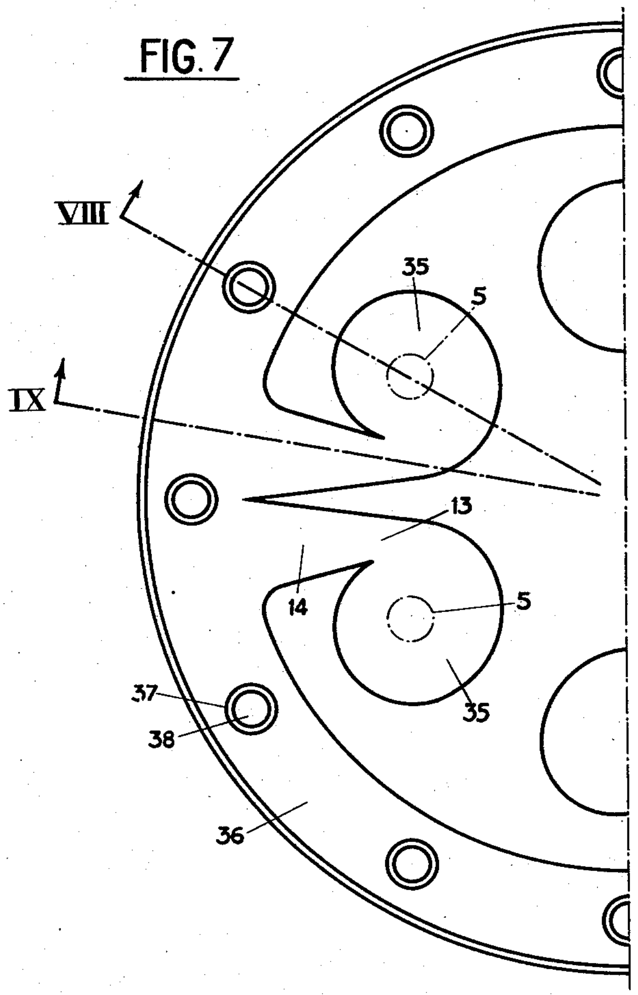


FIG. 8

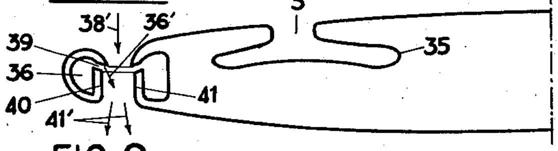


FIG. 9

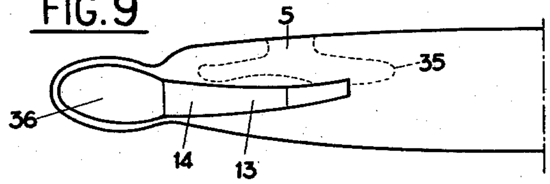


FIG. 10

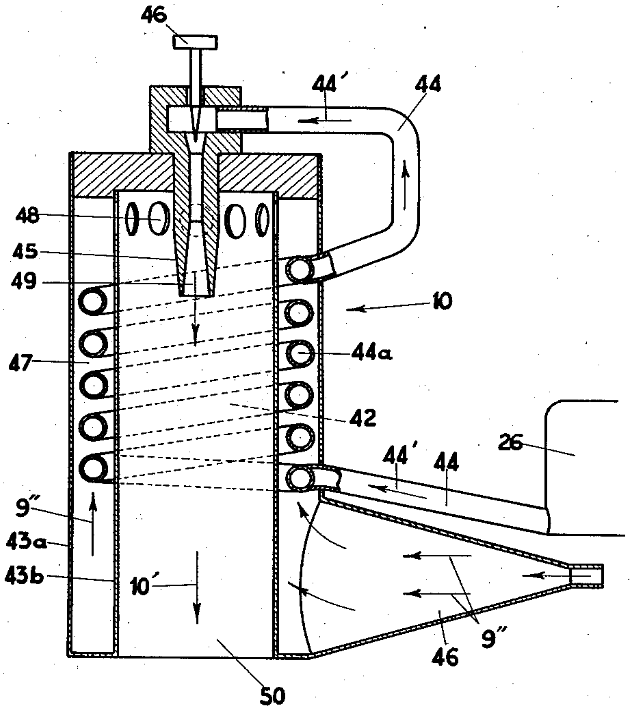


FIG. 11

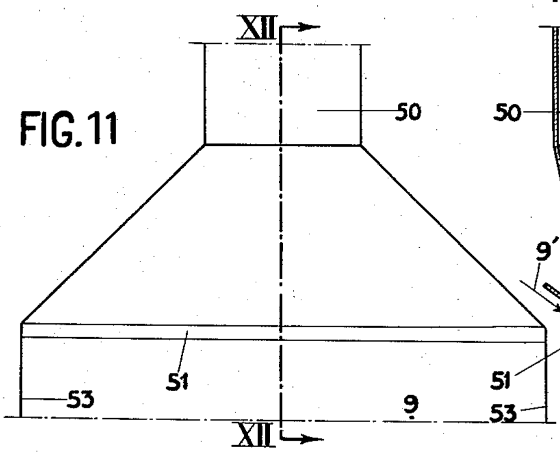
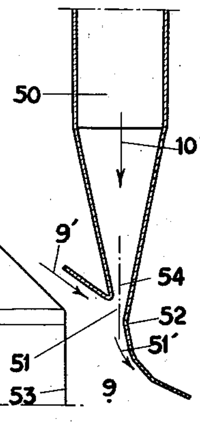


FIG. 12



United States Patent Office

2,964,306

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2,964,306

THERMO-BLOWER

Henri Coanda, Paris, France, assignor to Sebac Nouvelle S.A., Lausanne, Switzerland, a corporation of Switzerland

Filed Apr. 30, 1957, Ser. No. 656,098

Claims priority, application France May 23, 1956

6 Claims. (Cl. 263—19)

The invention has for its object a thermo-blower device, that is to say a machine by which a mass of gas may be directed in a predetermined direction at a given speed, making use of an added quantity of heat.

In his co-pending United States patent application Ser. No. 560,833 filed January 23, 1956, now abandoned, the applicant has described a thermo-compressor and in his co-pending United States patent application Ser. No. 598,441 filed July 17, 1956, now Patent No. 2,920,-448, the applicant has described a method of effectively setting into motion at high speed a fluid mass, and a thermo-blower for carrying this method into effect; such a thermo-compressor and such a thermo-blower enable masses of gas to be given a pre-determined direction with a given speed.

The thermo-compressor and the thermo-blower described in the above mentioned patent applications employ the physical effect known as the "Coanda effect," which has been described, for example in the U.S. Patent No. 2,052,869 issued September 1, 1936 to Henri Coanda. It will be recalled that the Coanda effect occurs when a stream of fluid (a gas or a liquid) under pressure leaves a chamber through a slot which has a lip which is extended by a wall, the profile of which progressively diverges either in a continuous manner (curved profile) or in a non-continuous manner (profile formed by facets), from the direction of emergence of the pressure fluid through said slot. The stream of fluid which is discharged through said slot has a tendency to follow the wall extending the lip, and induces some of the surrounding fluid to join the stream. It is thus possible to set in motion and direct a large quantity of ambient fluid with a small mass of fluid under pressure.

The present invention has for its object a new application of the Coanda effect with a view to the production of a thermo-blower which has practically no moving parts, that is to say which is a true static blower, embodiment which has very many advantages. It is well-known that most of the known types of compressors comprise members in rotating and/or reciprocating movement, which limit their speed of operation and the temperature which can be permitted in the case in which there is a combustion, since the metallic members in motion are subjected to a substantial creep beyond a certain temperature. In addition, when there are parts in movement, it is essential to provide clearances, and these clearances increase during the course of operation and this has an adverse effect on the efficiency of the apparatus. Finally, the maintenance of a rotating or reciprocating motion requires an expenditure of energy which is a pure loss.

The present invention thus enables a static thermo-blower to be produced, the efficiency of which is constant, which does not require any energy to maintain the movement of its parts, which is subject practically to no wear, and which reduces to a minimum the costs of upkeep and of repairs.

A thermo-blower in accordance with the invention is

essentially characterised by the fact that it comprises in combination: at least one receiver adapted to discharge, into an inlet or neck thereof communicating with the surrounding air, a compressed gas through a slot one of the extended lips of which progressively diverges from the direction of emergence of said gas through said slot. The pressure fluid tends to carry along with it by the application of the Coanda effect, a supplementary or additional mass of the ambient gaseous fluid through said inlet. A passage in the blower receives the mixture of the gas discharged under pressure through said slot and the additional ambient fluid which is set in movements, a chamber is provided into which the said passage discharges; thermal means for increasing the energy of the mixture in the chamber; and a collector which evacuates from said chamber the mixture, the energy of which has been thus increased and which leads it to a place of utilization.

In a preferred embodiment of the invention the thermo-blower is of substantially circular cross-section and it comprises: an annular receiver containing the compressed gas and arranged around the neck of an entry portion constituted substantially by a convergent-divergent discharge-nozzle and discharging in the vicinity of the neck of said nozzle through a circular slot. The slot has a lip extended by a wall whose surface progressively diverges in each radial plane from the direction of emergence of the compressed gas from said receiver through said slot. A circular passage adapted to receive from said inlet the mixture of the driving gas and the driven gas. A chamber receives the gaseous mixture from said channel; and a ring of burners in communication with said chamber increase the energy of the mixture of gases circulating in said chamber while giving it a gyratory motion. Finally a collector, prefererably of the spiral type, collects the gases rotating inside the chamber and directs the gases with the desired speed and in the desired direction towards a place of utilization. The collector is extended by a divergent passage when so required.

There may of course be provided more than one slot supplied with gas under pressure in order to effect the setting into motion of the ambient gas towards the circular passage.

In certain forms or embodiments, blades or fins may be provided disposed in said entry portion and/or inside said circular passage so as to give the gases a movement of rotation before their arrival in the annular chamber. Fins or blades may also be provided in the receiver in order to give a rotational movement also to the gases passing out of the receiver by the above-mentioned slot.

For certain applications, the gaseous mixture may be caused to pass out of the chamber, which is generally annular, through a slot, usually of circular shape, and which also comprises a lip which is extended by a wall, a surface of which progressively diverges away, in a radial plane, from the direction of emergence of said mixture through said slot of the chamber, in order to orient the mixture in the desired direction and to draw in a further quantity of ambient gas, which finally enables the desired mass of gas to be obtained, having the speed required and the chosen direction.

In certain cases, a number of thermo-blowers of one of the above-mentioned types may be provided on the same apparatus, these thermo-blowers discharge a gaseous mixture under pressure into a collector. The gaseous mixture passes out of said collector through a series of annular slots each arranged around a mouth and each comprising a lip, the extended wall of which progressively diverges from the direction of emergence of the gas through said slot (in each radial plane of the said slot), all the mouths being arranged parallel (in order to discharge through these mouths a series of parallel jets of gas), or having convergent axes.

There will now be described, by way of illustration of the possibilities of carrying the invention into effect, a few embodiments thereof, given by way of example and without any implied limitation of the scope of the invention, these embodiments being shown in the accompanying diagrammatic drawings, in which:

Fig. 1 is a plan view of a first form of embodiment of a thermo-blower in accordance with the invention.

Fig. 2 is a diametral cross-section, taken along the line II—II of Fig. 1;

Fig. 3 is a cross-section similar to that of Fig. 2, showing a device for guiding the gases, which can be provided in the thermo-blower in accordance with the first form of embodiment;

Fig. 4 shows diagrammatically a plan view of the guiding device shown in Fig. 3;

Fig. 5 is a cross-section similar to that shown in Fig. 2, and relating to a second form of embodiment of a thermo-blower, in accordance with the invention;

Fig. 6 is a diametral half cross-section of a third form of embodiment of a thermo-blower in accordance with the invention and of one of its alternative forms;

Fig. 6A is a sectional view taken along lines *6a*—*6a* of Fig. 6;

Fig. 7 is a longitudinal half cross-section of a multiple thermo-blower comprising a number of units according to the first form of embodiment;

Fig. 8 is a cross-section along the line VIII—VIII of Fig. 7;

Fig. 9 is a cross-section taken along the line IX—IX of Fig. 7;

Fig. 10 shows in cross-section a form of embodiment of a burner which can be used in the thermo-blowers shown in the preceding figures, and especially in that shown in Fig. 6;

Fig. 11 gives a plan view of a particular form of embodiment of the coupling between a burner and the chamber into which the gases from the burner are discharged;

Finally, Fig. 12 is a cross-section taken along the line XII—XII of Fig. 11.

In Figs. 1 and 2, there has been shown a first form of embodiment which comprises a single annular slot. In this form of embodiment, gas under pressure is led into or produced in the annular receiver **1** from which it is discharged, as shown by the arrows **1'**, through an annular slot **2**, one of the lips **3** of which is extended by a wall **4**, the surface of which moves or diverges progressively away, in every radial plane, from the direction of the axis of the outlet of the gases from the receiver **1** (direction shown by the chain-dotted line **2'**).

The wall **4** is annular and has a constricted annular portion forming a neck **4'** with a converging annular portion forming a converging inlet passageway **5** leading into one end of said neck and a diverging annular portion **4''** forming a diverging outlet passageway leading out from the opposite end of said neck **4'**. The annular slot **2** extends around said neck and is directed toward said outlet passageway.

Due to the action of the physical effect generally known as the Coanda effect and described for example in the above mentioned U.S. Patent No. 2,052,869, the gas under pressure passing out of the receiver **1**, due to the effect of the lip **3** extended to follow the wall **4**, draws-in further quantities of gas (for example ambient air) through the inlet **5**, this additional gas being shown by the arrows **5'**.

The gaseous mixture **6'** (of the compressed gas **1'** discharged from the slot **2** and the additional gas **5'**) passes into a circular passage or space **6** formed, as a continuation of said outlet passageway, between the extended wall **4** and a second wall **8**. The circular passage **6** opens into an annular chamber **9** which surrounds it and in which the energy of the gaseous mixture is increased by the action of burners **10** which are shown to a larger scale in Fig. 10, these burners having mainly the effect, by the discharge of the burnt gases **10'**, of imparting to the gaseous mixture **64** a movement of rotation inside the chamber **9**, this movement being shown by the arrows **9'**.

Towards the external wall **12** of the chamber **9**, the speed of the gaseous mixture **9'** reaches its maximum value, and the gaseous mixture is collected in a collector **13** of spiral shape, which can eventually be extended by a divergent passageway **14** so as to lead the mixture of gases, with a speed which is not too high (the reduction in speed taking place inside the divergent passageway **14**), to the place in which it is desired to utilise it. In the drawing, there has been represented by the arrows **13'**, **14'** and **11'** respectively, the gaseous mixture which circulates rapidly in the collector **13**, slowing-down in the divergent passageway **14**, and finally the usable gaseous mixture passing out of the divergent passageway.

It can clearly be seen that a compressed gas leaves the receiver **1** through the slot **2**, carrying with it the additional air **5'** and that the mixture of compressed gas and additional air moves in a circular passage **6**, extended by an annular or toric chamber **9**, in which the mixture is given a supplementary impulse by the burners **10**, the gaseous mixture with the maximum speed being collected in the spiral collector **13**.

In order to increase the spiral motion of the gaseous mixture, there is an advantage in placing in the device shown in Figs. 1 and 2, fins or blades arranged in spirals, so that the gases **6'**, which pass into the chamber **9** have already a movement of rotation. Fins of this kind have been shown diagrammatically in Figs. 3 and 4.

Centrifugal fins **15** are generally provided and are fixed in the circular passage **6** against the wall **8** and, in addition, centripetal fins **16** are preferably disposed in the inlet **5** in order to give the driven gas **5'** a movement of rotation which assists the rotating motion of the mixture **6'** of the driven gas **5'** and the gas **1'** passing out of the slot **2**.

In addition, small fins **17** can be arranged in the interior of the receiver **1** in order to give the gas **1'** passing out under pressure through the slot **2** a movement of rotation similar to that of the driven gas **5'** in order that the flow of the two gases **1'** and **5'** may not act in opposition at their confluence.

In the case in which all three types of fins **15**, **16** and **17** are provided, the gaseous mixture **6'** passes into the chamber **9** of Figs. 1 and 2 with a high speed of rotation, and it only remains for the burners **10** to accelerate this rotary movement.

In Fig. 5, there has been shown a second form of embodiment which comprises two annular slots **2** and **19** instead of the single annular slot **2** of the first form of embodiment. The diametral cross-section shown in Fig. 5 is similar to the diametral cross-section of Fig. 2, and the corresponding parts have been given the same reference numbers in Figs. 2 and 5.

In the form of embodiment shown in Fig. 5, gas under pressure passes not only into receiver **1** but also into the receiver **20**, through the conduit system **21**. The compressed air passes out of the receivers **1** and **20** respectively through the slots **2** and **19**, each of these slots having one of the lips **3** or **22** respectively extended by a wall (**4** or **23** respectively) the profile of said wall diverging continually away (in each radial plane) from the direction of discharge **2'** or **19'** of the gas under pressure, through the slots **2** or **19** respectively.

The mass of air or gas **5'** to be drawn-in through the mouth **5** is set into motion by the above-identified Coanda effect, by the combination of the gases **1'** and **20'** discharged through the two slots **2** and **19**, and it thus becomes possible to set in motion a mass of air **5'** which is much greater than in the embodiment of Fig. 1.

The mixture **6'** of the compressed gas passing out of the slots **2** and **19** and the driven air **5'** passes through the circular channel **6** into the annular chamber **9**, as in the first form of embodiment of the invention shown in Figs. 1 and 2.

Burners 10 apply a gyratory force to the mixture 9', and from the periphery of the chamber 9, this mixture passes into the spiral collector 13 which leads to the place of use.

Just before the gaseous mixture 6' passes into the chamber 9, it is an advantage to spray water into it, and to this end there have been shown jets or nozzles 24 supplied from an annular reservoir 25. There may be employed for example the atomising device described in the U.S. Patent No. 2,770,501 issued November 13, 1956 to Henri Coanda. The conversion of the atomised water to steam in the gaseous mixture increases the volume of this mixture (when considered in the same conditions of pressure and temperature), and this is an advantage.

In certain applications, the gaseous mixture passing out of the collector 13, through a divergent 14 where such is provided, does not have the mass and/or the direction desired. It is then permissible to discharge this mixture through one of a number of slots, each slot comprising a lip which is extended by a wall having a profile which moves continually away (in a radial plane) from the direction of discharge of the said mixture through the said slot, in order to give the mixture the desired direction and in order to draw-in further quantities of ambient gas through the application of the Coanda effect. Devices of this kind are provided in the embodiments shown in Fig. 6 on the one hand and Figs. 7, 8 and 9 on the other.

In the embodiment shown in Fig. 6 and Fig. 6*a* in full lines by a diametral half cross-section, several modifica- are made to the embodiment of Fig. 5. In Fig. 5 and Figs. 6 and 6*a* the same reference numbers have been given to the corresponding parts.

In the form of embodiment of Figs. 6 and 6*a*, as in that of Fig. 5, the gaseous mixture 6' which circulates in the circular passage 6 results from the setting in motion of a mass of gas 5' by the gas under pressure 1' passing out of the receiver 1 through the slot 2, and by the compressed gas 20' passing out of the receiver 20 through the slot 19, the slots being disposed as previously described with reference to Figs. 1, 2 and 5. This mixture 6' passes into the annular chamber 9 (where it is represented by the arrow 9') in which a portion of the mixture is divided off at 9'', so as to supply the burners 10 which are supplied with fuel from a reservoir 26. The burnt gases pass out in the direction of the arrows 10' and give the gaseous mixture 9' a gyratory motion in the toric chamber 9, thus increasing the energy of the said gaseous mixture.

The arrangement of the burners 10 and the members associated therewith will be described in more detail below, with reference to Figs. 10, 11 and 12.

The mixture of the burnt gases 10' and the gas 9' passes out of the chamber 9 through a circular slot 27, one of the lips of which 28 is extended by a wall 29, the profile of which is formed by a series of facets, the direction of which moves continually away, in each radial plane, from the direction of discharge 27' of the mixture of 10' and 9' through the slot 27. By virtue of this arrangement, which enables the Coanda effect to be applied, the gaseous mass passing out of the slot 27 adheres to the wall 29 and carries away a further mass of ambient gas 30' through the annular mouth 30. At the downstream extremity 31 of this mouth, there is thus obtained a considerable mass of a gaseous mixture having the desired direction as shown by the arrows 31'.

In a further alternative embodiment the continuous circular slot 27 may be replaced by a series of slots of arcuate form, separated by solid portions and arranged on the same circle or on separate circles.

In a further alternative form of this embodiment shown in Fig. 6, a series of discharge nozzles 32 may be provided (in Fig. 6, there is shown one such discharge nozzle 32, indicated in broken lines), the convergent intakes 33 of which communicate with the surrounding air, and which pass into the vicinity of the burners 10 and discharge at 34 in the vicinity of the downstream extremity 31 of the mouth 30.

In this alternative form, the gaseous mass 31' carries along an additional mass 29' of ambient gas which passes in the direction of the arrows 33' into the convergent intake 33, and which is heated in the discharge nozzle 32 in the vicinity of the burners 10 at the level of the chamber 9. There is thus obtained a greater total mass of gas by the use of the discharge nozzles 32.

In Figs. 7, 8 and 9, there has been shown an embodiment in which a number of thermo-blowers 35 of one of the foregoing types are provided, for example of the type shown in Figs. 1 and 2, each blower discharging, through a collector 13 and a divergent passageway 14, into a toric channel 36, a mixture of gases under pressure (as is shown especially in Fig. 9). In order to prevent vortex and gyratory motions in the channel 36, the thermo-blowers are preferably arranged in pairs, the collectors and the direction of rotation of the gases being clockwise in one of the thermo-blowers and anti-clockwise in the other thermo-blower of each pair.

The mixture of gases under pressure passes out of the channel 36 through a series of annular slots 37 arranged around convergent-divergent mouths or discharge nozzles 38, and each having a lip 39, the extended wall 40 of which becomes continually further away, in a radial place of the slot. From the direction of discharge of the gaseous mixture through said slot, so that, by the operation of the Coanda effect, the mixture 36' of gas under pressure carries along the ambient gas 38' and so that the mixture 41' of 36' passes out from the divergent extremity 41 of each discharge nozzle 38 downwards (in Fig. 8) with the desired speed. The discharge nozzles 38 may be arranged parallel to each other, or alternatively they may be arranged on concurrent axes.

In Figs. 10 to 12, there has been shown on a larger scale a burner 10 and its possible means of coupling to the chamber 9. The form of embodiment shown of the burner 10 and its associated parts is especially suitable for the thermo-blower shown in Fig. 6.

The burner 10 comprises a cylindrical chamber 42 enclosed by a double wall 43*a*—43*b*. The fuel 44' is led from a reservoir 26, through the piping system 44 of which one portion 44*a* is formed by a coil arranged between the walls 43*a* and 43*b*, to an injector 45 controlled by a needle 46. The fluid of combustion is formed by one portion 9'' of the mass of gaseous mixture 9' which circulates in the chamber 9, this portion being delivered through a divergent nozzle 46 (in order to reduce its speed) into the annular chamber 47 which is enclosed between the two walls 43*a* and 43*b*. This gaseous mixture leaves the chamber 47 through orifices 48 formed in the wall 43*b*, and allows the combustion to take place, after ignition, of the jet of fuel 49 discharged by the injector 45.

The combustion which takes place in the chamber 42 enables the fuel in the coil 44*a* and the air of combustion in the chamber 47 to be pre-heated, which increases the thermal efficiency of the burner. The burnt gases 10' pass out at the extremity 50 of the burner 10.

As shown in Figs. 11 and 12, the coupling between each burner 10 and the chamber 9 can be of flattened shape and the gases 10' may pass out of each burner 10 through a linear slot 51, of which one of the lips 52 diverges from the discharge axis 54 of the gases 10' through the slot 51, as shown at 51', in order to apply a more powerful driving action on the gaseous mixture 9' in the chamber 9. In order to prevent any in-draught from acting on the mass of gas in movement, walls 53 are arranged on the sides of the extended lip 52.

As previously indicated, the burners 10 are preferably orientated in the direction of movement of the gas in the chamber 9, with a slight tendency to discharge towards the external wall 12 in order to facilitate the passage of the gaseous mixture 9′—10′ into the collector 13.

It will of course be understood that a number of changes, improvements or additions may be made to the forms of embodiment described and shown, or certain devices may also be replaced by equivalent devices, without thereby modifying the general scope of the invention.

For example in the form of embodiment of Figs. 7 to 9, the gaseous mixture could pass out of the channel 36 through a series of discharge nozzles having either a fixed direction or being orientable at will in order to obtain the desired effect.

What I claim is:

1. A thermoblower comprising in combination, a first annular wall having a constricted annular portion forming a neck, a converging annular portion forming a converging inlet passageway leading into one of said neck and a diverging annular portion flaring radially outwardly and forming a diverging outlet passageway leading out from the opposite end of said neck, a second wall spaced from said outwardly flaring portion of said first wall to define between said walls an outwardly flaring annular space forming a continuation of said outlet passageway and an annular chamber which surrounds said annular passageway and into which said annular passageway opens, the neck portion of said first wall having formed therein an annular slot extending around said neck and directed toward said outlet passageway, said slot having spaced lips, an annular receiver surrounding said neck and communicating with said slot, said receiver being adapted to receive gaseous fluid under pressure which is discharged through said slot into said neck, the lip of said slot on the side toward the outlet end of said neck and an adjacent annular portion of said first wall defining a surface which progressively diverges from the direction of emergence of said pressure fluid through said slot so that a stream of fluid discharged through said slot tends to follow said surface and to induce adjacent fluid in said neck to join in the stream, thereby drawing additional gaseous fluid through said inlet passageway and neck, said stream of pressure fluid and additional fluid flowing outwardly through said discharge passageway and annular passageway and discharging into said annular chamber, heating means disposed to heat said fluid in said annular chamber, and thereby increase its kinetic energy, means defining a discharge outlet opening outwardly from said annular chamber and means for collecting fluid discharged from said chamber and directing it toward a place of utilization.

2. A thermoblower according to claim 1, in which said heating means comprise a plurality of burners, means to provide fuel to the burners, and further including for each burner a speed-reducing divergent device communicating with said chamber for providing some of the gaseous fluid in said annular chamber to a respective burner to support combustion therein.

3. A thermoblower according to claim 1, in which said heating means comprise a plurality of angularly spaced burners each having a cylindrical housing with an open end through which hot gases are discharged mounted on one of said walls defining said annular chamber with said open end opening into said chamber, each said burner having a longitudinal axis inclined to said wall on which the burner is mounted in a direction toward said discharge outlet opening so that hot gases issuing from said burners mix with gaseous fluid in said annular chamber and implement flow of the resulting mixture toward said discharge outlet opening.

4. A thermoblower according to claim 3, in which said housings each have a flattened divergent end portion having said open end in communication with the annular chamber, said end portion having said open end formed as a linear slot opening into the annular chamber, said linear slot having in an axial section through said housing end portion an extended lip surface which progressively diverges from the direction of emergence of gases into said annular chamber from the respective burners so that the gases tend to follow said surface into said chamber.

5. A thermoblower comprising in combination, a first annular wall having a constricted annular portion forming a neck, a converging annular portion forming a converging inlet passageway leading into one end of said neck and a diverging annular portion flaring radially outwardly and forming a diverging outlet passageway leading out from the opposite end of said neck, a second wall to define between said walls and outwardly flaring annular space forming a continuation of said outlet passageway and an annular chamber which surrounds said annular passageway and into which said annular passageway opens, the neck portion of said first wall having formed therein an annular slot extending around said neck and directed toward said outlet passageway, said slot having spaced lips, an annular receiver surrounding said neck and communicating with said slot, said receiver being adapted to receive gaseous fluid under pressure which is discharged through said slot into said neck, the lip of said slot on the side toward the outlet end of said neck and an adjacent annular portion of said first wall defining a surface which progressively diverges from the direction of emergence of said pressure fluid through said slot so that a stream of fluid discharged through said slot tends to follow said surface and to induce adjacent fluid in said neck to join in the stream, thereby drawing additional fluid through said inlet passageway and neck, said stream of pressure fluid and additional fluid flowing outwardly through said discharge passageway and annular passageway and discharging into said annular chamber, heating means disposed to heat said fluid in said annular chamber and thereby increase its kinetic energy, means defining a discharge outlet opening outwardly from said annular chamber and spiral-shaped means for collecting fluid discharged from said chamber and directing it toward a place of utilization, and said collecting means having walls diverging toward said place of utilization.

6. A thermoblower comprising in combination, a first annular wall having a constricted annular portion forming a first neck, a converging annular portion forming a converging inlet passageway leading into one end of said first neck and a diverging annular portion flaring radially outwardly and forming a diverging outlet passageway leading out from the opposite end of said first neck, a second wall spaced from said outwardly flaring portion of said first wall to define between said walls an outwardly flaring annular space forming a continuation of said outlet passageway and an annular chamber which surrounds said annular passageway and into which said annular passageway opens, said second wall having a constricted annular portion forming a second neck substantially coaxial with the first-mentioned neck and a portion defining a first receiver communicating with said constricted annular portion disposed leading into said second neck and adapted to receive gaseous fluid under pressure, the neck portion of said first wall having formed therein an annular slot extending around said first neck and directed toward said outlet passageway, said slot having spaced lips, an annular second receiver surrounding said first neck and communicating with said slot, said second receiver being adapted to receive gaseous fluid under pressure which is discharged through said slot into said first neck, the lip of said slot on the side toward the outlet end of said first neck and an adjacent annular portion of said first wall defining a surface which progressively diverges from the direction of emergence of said pressure fluid through said slot so that a stream of fluid discharged through said slot tends to follow said surface and to induce adjacent fluid in said first neck to join in the stream, thereby drawing additional fluid through said inlet passageway and neck, means coaxial with said second neck forming an annular second slot extending around said

second neck, the second wall having an annular portion disposed forming an outlet of said second neck defining a surface which progressively diverges from the direction of emergence of said pressure fluid through said second annular slot so that a stream of fluid discharged through said second slot tends to follow said surface and to induce adjacent fluid in said passageway to join in the stream, said streams of pressure fluid and additional fluid flowing outwardly through said discharge passageway and annular passageway and discharging into said annular chamber, heating means disposed to heat said fluid in said annular chamber and thereby increase its kinetic energy, means defining a discharge outlet opening outwardly from said annular chamber and means for collecting fluid discharged from said chamber and directing it toward a place of utilization.

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