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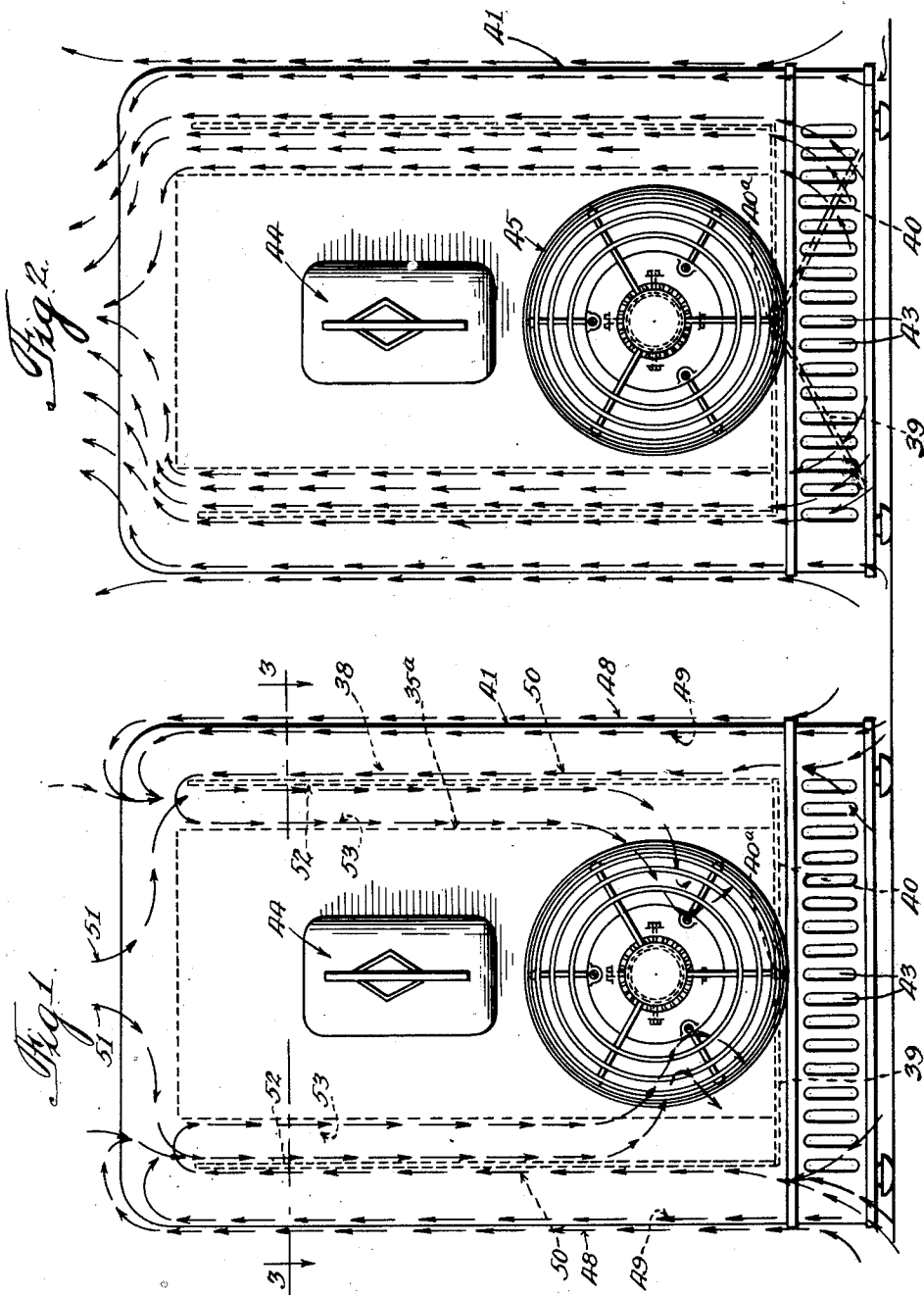
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2,281,874

AIR CONDITIONING AND CIRCULATING APPARATUS

Original Filed May 20, 1939

3 Sheets-Sheet 1



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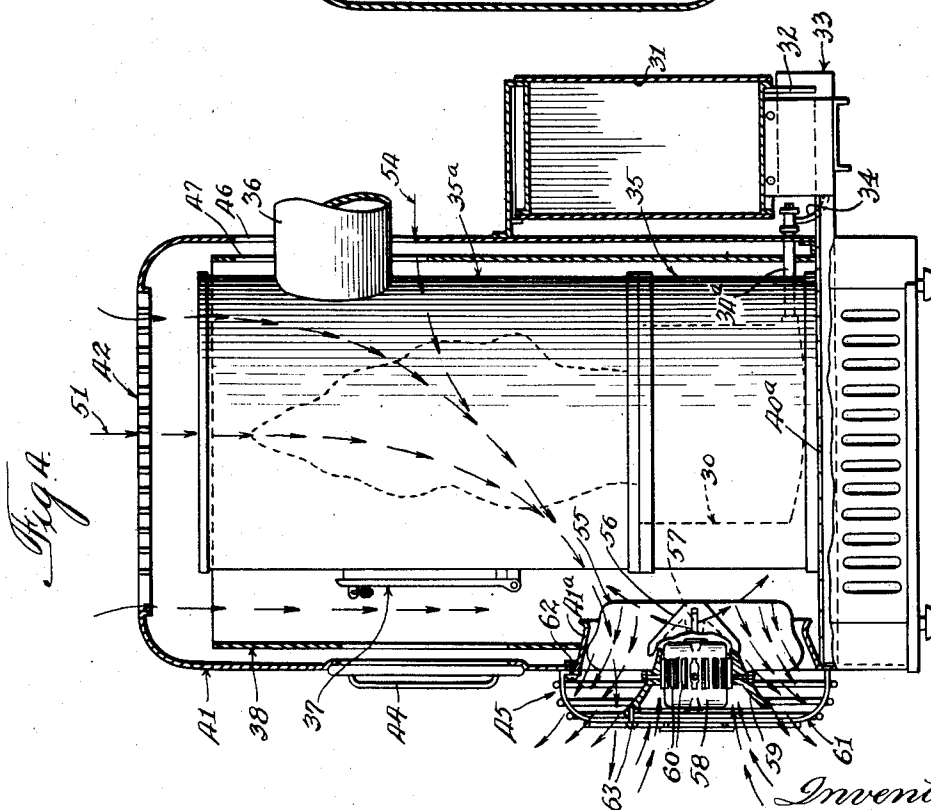
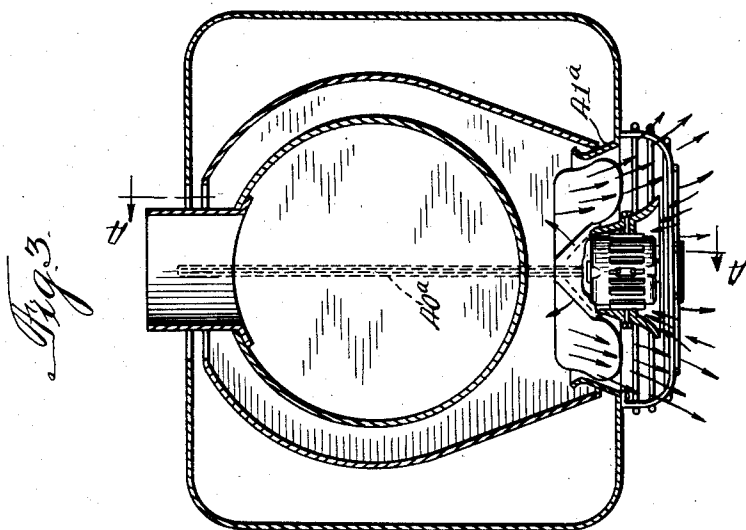
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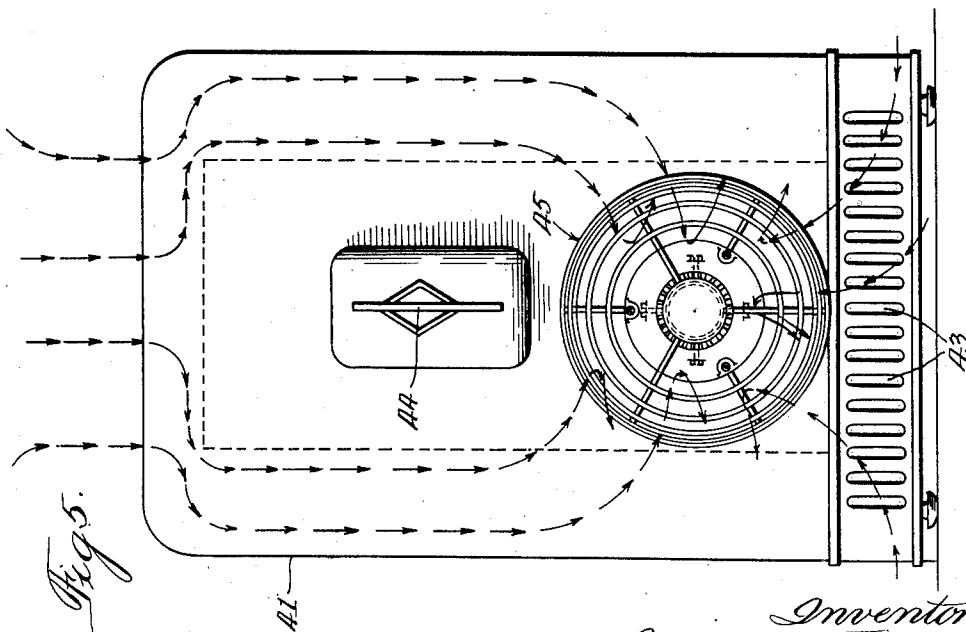
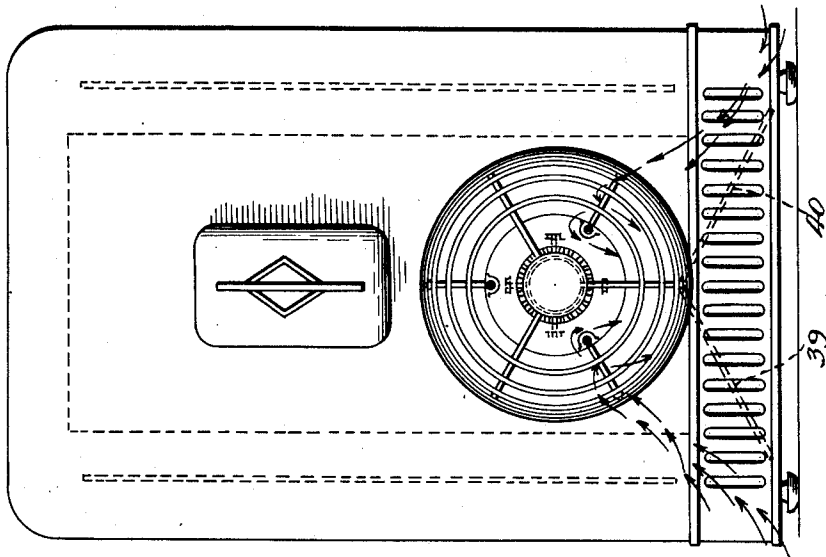
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3 Sheets-Sheet 3

Fig. 6.



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## UNITED STATES PATENT OFFICE

2,281,874

## AIR CONDITIONING AND CIRCULATING APPARATUS

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3 Claims. (Cl. 126-110)

This application is a division of application Serial No. 274,793, for "Air conditioning and circulating apparatus" filed by applicant on May 20, 1939.

This invention relates to an air conditioning and circulating apparatus and has special reference to an apparatus for maintaining the air in a room or other enclosure at a substantially uniform temperature for the purpose of comfort and for circulating the air in the room or other enclosure for the purpose of ventilation, both purposes being desirable for the healthy condition of the human body.

In order to economize in heat and to secure a uniform temperature throughout the room or other enclosure, it has been found necessary to force the circulation of the air therein and at the present time, although air conditioning apparatus is available, it is comparatively costly. The present invention is directed to an air conditioning and circulating apparatus which is practical, economical, durable and which will circulate conditioned air into every portion of the room or other enclosure and maintain a substantially uniform temperature at the floor and at the ceiling.

The present air conditioning and circulating apparatus is of the forced air circulating type which may be disposed directly in a room or other enclosure at any position therein consistent with the arrangement of the fixtures thereof. In order for the apparatus to function successfully in the room to be heated, it is desirable that the casing thereof be relatively cool so that it will not be uncomfortable to the touch and the present apparatus conforms to this requirement. The air of lower temperature has contact first with the outside walls of the apparatus which are the heat transfer surfaces of lower temperature and progressively the air comes in contact with heat transfer surfaces of higher temperatures interiorly of the apparatus. The movement of the air is directed by action inducing a suction flow, the air moving unit being preferably installed in the front of the apparatus at the lower end thereof.

Other objects and advantages of this invention will hereinafter be more particularly pointed out and, for a more complete understanding of the characteristic features of this invention, reference may now be had to the following description when taken together with the accompanying drawings, in which latter:

Fig. 1 is a front elevational view of the air conditioning and circulating apparatus incor-

porating the features of this invention, the directional arrows showing the normal forced air circulation with the air mover in operation;

Fig. 2 is a view similar to Fig. 1, the directional arrows showing the circulation of air through the apparatus when the air mover is not in operation and the air conditioning apparatus is operating as a radiant and gravity flow convection heater;

Fig. 3 is a plan sectional view taken on the line 2-3 of Fig. 1;

Fig. 4 is a side elevational view of Fig. 1 showing a portion of the outer casings thereof in section as taken on the line 4-4 of Fig. 3, the circulation of air through the air conditioning and heating apparatus being indicated by directional arrows;

Fig. 5 is a view similar to Fig. 1 of a modified form of air conditioning and circulating apparatus incorporating the features of this invention, the directional arrows indicating the normal forced air circulation with the air mover in operation; and

Fig. 6 is a view similar to Fig. 1, the directional arrows showing the circulation of air when the air mover is in operation and the air conditioner is not in operation so that the apparatus operates as a circulator of cool air.

Referring now to the drawings and more particularly to Figs. 1, 3 and 4 thereof, the air conditioning and circulating apparatus incorporating the features of this invention is shown as comprising a firepot 30 into which liquid fuel is fed from a tank of fuel 31, the fuel being fed through a duct 32 into a flow control mechanism 33 and therethrough to the ducts 34 and 34a connected to the firepot. The firepot 30 is enclosed by a casing 35 having an extension 35a at its upper end to form a combustion chamber above the firepot. The upper end 35a of the casing is provided with a flue 36, which latter is connected to a stack in order to permit the burned gases from the firepot to escape. A door 37 is disposed in the upper end 35a of the casing for the firepot so that access may be had directly to the firepot therethrough.

A shield 38 preferably entirely surrounds the casing 35 and the combustion chamber 35a, and is suitably spaced laterally therefrom, the shield being open at its upper end and being suitably enclosed at its lower end by a fixed plate or, as shown in the drawings, by a pair of pivotally mounted dampers 39 and 40 pivoted as shown at 40a. The dampers 39 and 40 are preferably mounted centrally at the bottom of the apparatus to swing downwardly as shown more par-

ticularly in Fig. 2 by mechanical or automatic means as desired. In the operating condition of the apparatus at present described with reference to Figs. 1, 3 and 4, the lower ends of the shield 38 and casing 35 are closed, the upper end of the shield 38 being open at all times in any condition of use of the apparatus.

The casings 35 and 35a for the firepot forming the combustion chamber thereof, together with the spaced shield 38, are suitably enclosed by a cabinet 41, the walls of the cabinet being spaced from the shield. The upper end of the cabinet is provided with a grille 42 and the side and front walls of the cabinet are provided with louvres 43 which are disposed at the lower end of the cabinet below the bottom of the casing 35 and the shield 38 as well as below the dampers 39 and 40. The front of the cabinet is provided with a door 44 in registration with the door 37 for access to the latter.

As will hereinafter be more particularly disclosed, the air is circulated through the cabinet by action inducing a suction flow, the air mover unit 45 being preferably installed in the front of the cabinet at the lower end thereof. Openings 46 and 47 are provided in the cabinet 41 and the shield 38 respectively about the flue 36. With the dampers 39 and 40 closed and the air mover in operation, there also being a fire in the firepot 30, the air mover unit 45, together with the normal gravity flow of air, causes a rising of a column of air along the outer surface of the cabinet indicated by the arrows 48. A second column of air is caused to rise on the inside of the cabinet, the air column being indicated by the arrows 49. This latter mentioned column of air has intimate contact with the heat transfer walls of the cabinet and moves upwardly within the passage between the cabinet and shield. Similarly a column of air will rise along the outer wall of the shield 38 in the passage between the cabinet and shield in the direction of the arrows 50 to have intimate contact with the heat transfer surfaces of the shield for conditioning the air. The air columns represented by the arrows 48, 49 and 50 are all influenced by gravity as well as by the action of the air mover.

The aforementioned columns of air 48, 49 and 50 augmented by air passing through the grille 42 and indicated by the arrows 51, form a downdraft column of air wholly influenced by the air mover 45 to have intimate contact as indicated by the arrows 52 and 53 on the inner side of the heat transfer surfaces of the shield 38 and the outer side of the casing 35a, respectively. The downdraft columns of air 52 and 53 by reason of their intimate contact with the heat transfer surfaces of the inner wall of the shield and the outer wall of the casing from the upper ends thereof to the lower ends thereof are thus conditioned for exhaust through the fan opening. As shown more particularly in Fig. 4, a column of air indicated by the arrows 54 is drawn through the openings 46 and 47 communicating with the passages formed between the casing, shield and cabinet to have intimate contact with the heat transfer surfaces of the flue 36, the column of air thus drawn through the openings merging with the air in the passages for subsequent exhaust by the air mover unit.

In the circulation of air through the air conditioning and circulating apparatus as above described, the air of lower temperature has contact first with the heat transfer surfaces of lower

temperature and progressively the air comes in contact with heat transfer surfaces of higher temperatures to obtain an evenly accelerated expansion of air thus reducing turbulence and strains on the materials of the apparatus as well as other features desirable in such devices heretofore and to be hereinafter more particularly pointed out.

Referring now more particularly to Fig. 2 of the drawings when the temperature of the heater rises to a predetermined limit, the air mover 45 may be cut off and the dampers 39 and 40 may be automatically or manually actuated to open the lower ends of the shield 38 and casing 35 thus to admit air from the floor to rise there-through. The columns of air will rise in the spaces between the cabinet and the shield and between the shield and the casing in the manner indicated by the arrows and thus the forced air heater may be transformed into a radiation convection heater. Where, however, a fixed plate is employed in place of the dampers 39 and 40, sufficient air for convection circulation may be admitted through the inoperative air mover unit 45.

The construction of the air conditioning and circulating apparatus disclosed in Fig. 5 is the same as that disclosed in Figs. 1 to 4, inclusive, hereof, with the exception that the shield 38 is omitted. Also, the dampers 39 and 40 may be omitted if desired. The columns of air are moved through the apparatus by suction draft in the manner indicated by the arrows for engagement with the heat transfer surfaces of the casing and cabinet and are diffused through the air mover at a point near the floor.

With respect to the disclosure of Fig. 6, the construction thereof is identical to the construction disclosed in Figs. 1 to 4, inclusive, except that in this condition of use there is no fire in the firepot so that with the dampers 39 and 40 in a lowered position the cool air from the floor is drawn through the fan and circulated in the manner indicated by the arrows and the apparatus is merely operated as a circulator of cool air. It is to be understood, of course, that the apparatus shown and described in Figs. 1, 3 and 4, may operate as a circulator of cool air in the manner indicated by the directional arrows when there is no fire in the firepot.

Referring now more particularly to Figs. 3 and 4, the air mover assembly 45 shown therein comprises a propeller 55 housed in a reentrant portion 41a of the cabinet 41 and having preferably three blades formed preferably integrally with a hollow substantially cone-shaped hub 56.

The hub 56 is provided with an axial aperture for receiving a stud shaft 57 extending from the motor 58, the stud shaft extending from and being a part of the rotor thereof. The open end hollow cone-shaped hub is substantially greater in diameter than the outside diameter of the motor and overlies a portion of the end thereof to act as a shield therefor from the radiant heat from the combustion chamber.

The motor 58 is, in turn, secured within a diffuser 59, the motor preferably having fins 60 extending on the peripheral surface thereof outwardly therefrom to rest against a projecting inner wall of the diffuser and provide a spaced relation between the diffuser and the motor. A fan guard 61 comprising a series of circumferentially and radially extending wires is secured to the outside of the heater cabinet 41 by means of screws 62, and the diffuser in turn is secured to

the fan guard 61 by screws 63, there preferably being a rubber grommet between the wires of the fan guard and the surface of the diffuser to which the fan guard is held. Thus the motor and the propeller thereof are secured to the cabinet through the fan guard. In this construction the propeller blades act to diffuse the air currents exhausting from the cabinet as shown by the directional arrows, and the propeller also acts to induce an air current to flow as shown by the directional arrows into the diffuser 59 for cooling the motor.

The construction and operation of the air conditioning and circulating apparatus thus far described contemplates the provision of a shield preferably entirely surrounding the combustion chamber of the heating element, the shield being open at the top to permit the inflow and downdraft of air so as to permit intimate contact with the heat transfer surfaces of the casing of the combustion chamber. Openings at the lower front of the cabinet and shield permit the disposition of an exhaust fan therein to cause the downdraft and, further, to exhaust the air from the apparatus. Other openings in the shield and cabinet near the upper rear thereof are of substantially greater diameter than the flue 36 to permit an inflow of air to the passage to merge with the air therein.

A hinged pair of dampers 39 and 40 is provided at the bottom of the shield to close the opening therethrough when the heater is functioning as a forced air heater and the dampers are opened when the heater is to function as a radiant and convection heater by gravity action circulation. These dampers may be operated either by mechanical or by manual means immediately upon the stopping or starting of the exhaust fan or when the temperature of the heater reaches critical points.

An outer cabinet houses the shield and casing from the combustion chamber to provide another heat transfer surface with which the air to be conditioned and circulated contacts, the top of the cabinet having a grille and the bottom being provided with louvres or otherwise having openings to permit the inflow of air from the top and the bottom, the inflow of air from the bottom rising in the passage thus formed between the cabinet and shield to contact the heat transfer surfaces of the outer surface of the shield and the inner surface of the casing. This flow of air between the cabinet and the shield rises to the top of the cabinet or above the upper end of the shield to be moved by suction draft downwardly through the space formed between the casing for the combustion chamber and the inner wall of the shield, the downflow of air contacting the heat transfer surface of the casing of the combustion chamber and the inner surface of the shield. Such a flow as is above described is both counterflow and tortuous path flow, counterflow because the air of lowest temperature first contacts the heat transfer surfaces of lowest temperature and leaves the apparatus at the point of contact with the heating surface of highest temperature, and tortuous path flow because the air entering the inlet openings of the cabinet at points remote from the discharge opening cannot pass directly to the exhaust opening but must first move upwardly in the space between the cabinet and the shield and thence downwardly between the shield and the casing thus contacting all heat transfer surfaces of the apparatus.

From the above it will be apparent that the inner and outer heat transfer surfaces of both the cabinet and shield as well as the heat transfer surfaces of the flue and of the casing for the combustion chamber are intimately contacted by the air moving through the spaces therebetween so as to most efficiently and effectively extract the heat from the surfaces thereof. The spacing of the shield and cabinet from the combustion chamber casing allows the conversion of the radiant heat from the casing to heat which is conducted to the air contacting therewith. This movement of the paths of air, therefore, converts radiant heat from the combustion chamber to convection heat. The conversion of radiant heat to convection heat provides a form of preheating the air which subsequently is raised to its ultimate temperature by the conduction of heat from the walls of the casing forming the combustion chamber. Therefore, the hottest air is brought into contact with the hottest surfaces and the coolest air is brought into contact with the coolest surfaces prior thereto.

The use of a suction fan and its disposition at the lower front end of the cabinet is such as to most efficiently move the air through the apparatus as determined by dividing the horse power by the quantity of air moved. The space between the combustion chamber, shield and cabinet is such that the velocity of the air movement is substantially uniform at every point in the path of the air stream from the inlet openings of the cabinet to the exhaust opening effecting, therefore, an efficient heat transfer. The fan as an exhauster secures a more effective spreading and circulation of the air because in that condition the fan is operating as a free air circulator, the upstream area which is between the shield and the cabinet being of sufficient cross sectional area relative to the fan's capacity that the fan is operating under a minimum suction and exhausting against a negligible pressure.

As a result of the arrangement of the elements of the apparatus, the kinetic energy is substantially all velocity pressure, which is to say, the air is moving with a minimum of turbulence. The velocity pitch of the propeller or fan is preferably very near the geometric pitch of the fan resulting in little turbulence being created at the point of contact of the blades and the air so that all of the air coming to the working face of the fan is moved out through the orifice thereof at maximum velocity and has therefore a maximum of energy to penetrate, agitate, turbulate, and circulate the air within the downstream area served.

The purpose of using an exhaust fan is to handle and move a greater quantity of air per unit of power input. It is a characteristic of all propeller fans to absorb least power per cubic foot of output when the fan is operating against no pressure. When the total energy of the fan has been converted to wholly static pressure, the power curve has reached the highest point. When the fan is exhausting into an enclosure such as a cabinet of the present type, a pressure is built up therein so that the fan is operating against static pressure. Some of the energy of the fan is thereby used to overcome pressure and the remaining energy is used to move the air through the heater. Since it is desirable to obtain the greatest quantity of air for the least power input, it necessarily follows that the fan should not be subjected to pressure conditions.

A more efficient transfer of heat from surfaces to air is obtained in an air conditioning unit where a suction draft is employed than if the fan exhausts directly against the heat transfer surfaces. In the former instance, a low pressure area is created adjacent to the leading edge of the fan and air tending to move into this area of lower pressure from all directions sets up a uniform air movement through all passages in the apparatus insuring intimate contact between the air and all heat transfer surfaces at comparatively low and equal velocity. When the air is discharged against the heat transfer surfaces, the area of contact of the air column is not much greater than the cross sectional area of the disc swept out by the fan. A relatively small area of the heat transfer surface is therefore subjected to a high velocity of relatively cool air. The velocity energy in the flow of air is lost by impact with the heat transfer surface, and the air is disbursed, losing its directional energy and seeking the paths of least resistance so that when there are paths of varying resistance, a great proportion of the air will flow around and not into contact with the heat transfer surfaces. Since the hottest surfaces produce the greatest resistance to the flow of air because of the expansion of the air caused by the heat, it follows that the least air will be had where the greatest heat can be secured. Because of the non-uniformity of the air distribution, internal stresses and strains within the metallic structure are set up due to non-uniformity of expansion and contraction resulting in premature metallic fatigue and consequent short life thereof.

In the use of an exhaust type fan, the air will move in the general direction of the fan, the movement being relatively slow so as to remain longer in intimate contact with the heated surfaces. Contractions and expansions will be had in every direction with no consequent warping or cracking of the metal structure of the heater. Where the air is forced into the heater, as aforesaid, some relatively great portion of the air column never contacts a heated surface and therefore particles leave the heater at widely varying temperatures resulting in air stratification.

While several embodiments of this invention are herein shown and described, it is to be understood that various modifications thereof may be apparent to those skilled in the art without departing from the spirit and scope of this invention and, therefore, the same is only to be limited by the scope of the prior art and the appended claims.

I claim:

1. In an air conditioning and circulating apparatus, the combination of a fuel burner having an enclosed casing therefor forming a combustion chamber, a cabinet enclosing said casing and being spaced therefrom to form an air passage between said casing and said cabinet,

said cabinet having openings for permitting the entrance of air to said passage, a flue communicating with the upper end of said combustion chamber and extending therefrom through an opening in an outside wall of said cabinet, said opening being of substantially greater cross sectional area than the cross sectional area of said flue to permit the entrance of air from outside said cabinet and about said flue to circulate about said combustion chamber casing and to mix with the air in said air passage, and an air mover disposed in an opening at the lower end of said cabinet for exhausting air from the apparatus and for creating a suction draft through said air passage.

2. In an air conditioning and circulating apparatus, the combination of a fuel burner having an enclosed casing therefor forming a combustion chamber, a shield spaced from said casing to form an air passage, a cabinet enclosing said shield and casing and being spaced therefrom to form a second air passage between said shield and said cabinet, said cabinet having openings for permitting the entrance of air to said second air passage, said second air passage communicating with said first mentioned air passage at the upper end thereof, a flue communicating with the upper end of said combustion chamber and extending therefrom through openings in said cabinet and in said shield, said openings each being of greater cross sectional area than the cross sectional area of said flue to permit the entrance of air to said passages, and an air mover disposed in an opening at the lower end of said cabinet in communication with said first air passage for exhausting air from the apparatus and for creating a suction draft through said air passages.

3. In an air conditioning and circulating apparatus, the combination of a casing for housing an air conditioning unit, a shield spaced from said casing to form an air passage therebetween, a cabinet enclosing said shield and casing and being spaced to form a second air passage between said shield and said cabinet, said cabinet having openings for permitting the entrance of air to said second air passage, said second air passage communicating with said first mentioned air passage at the upper end thereof, a damper at the bottom of said shield permitting when open the entrance of air into said first air passage from the bottom thereof, and an air mover disposed in an opening at the lower end of said cabinet in communication with said first air passage for exhausting air from the apparatus and for creating a suction draft through said air passages, the opening of said damper when said air mover is not in operation converting said apparatus from a forced air circulating heater to a radiant and gravity flow convection heater, and, when said air mover is in operation, to a circulator of cool air.

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