

Aug. 7, 1945.

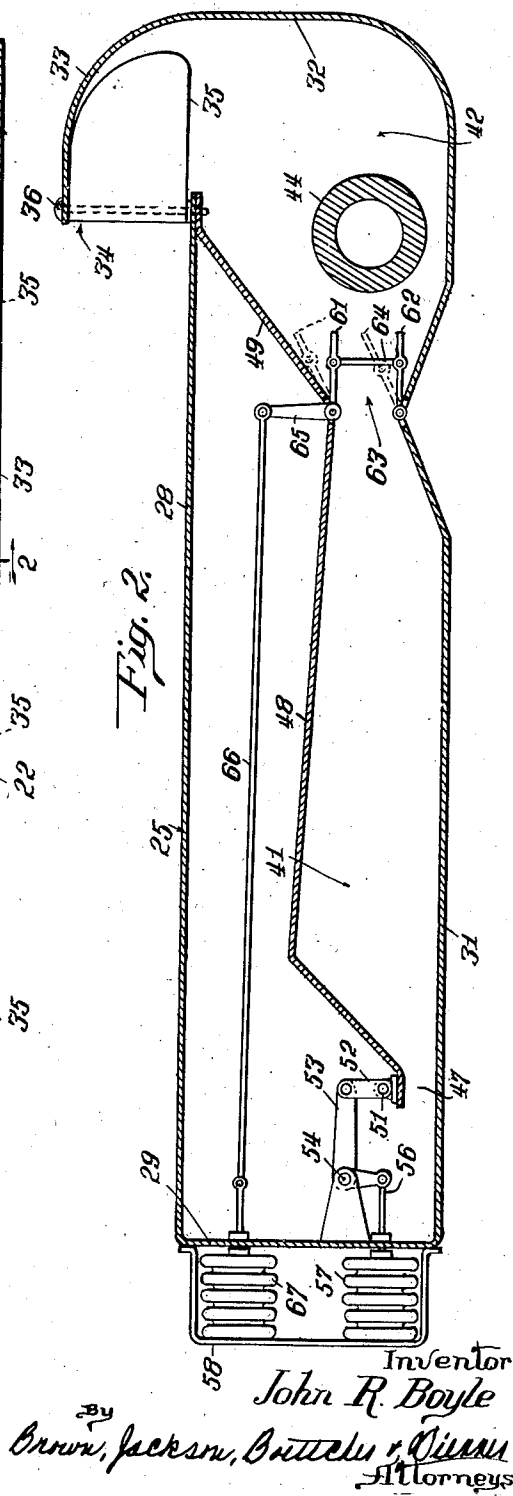
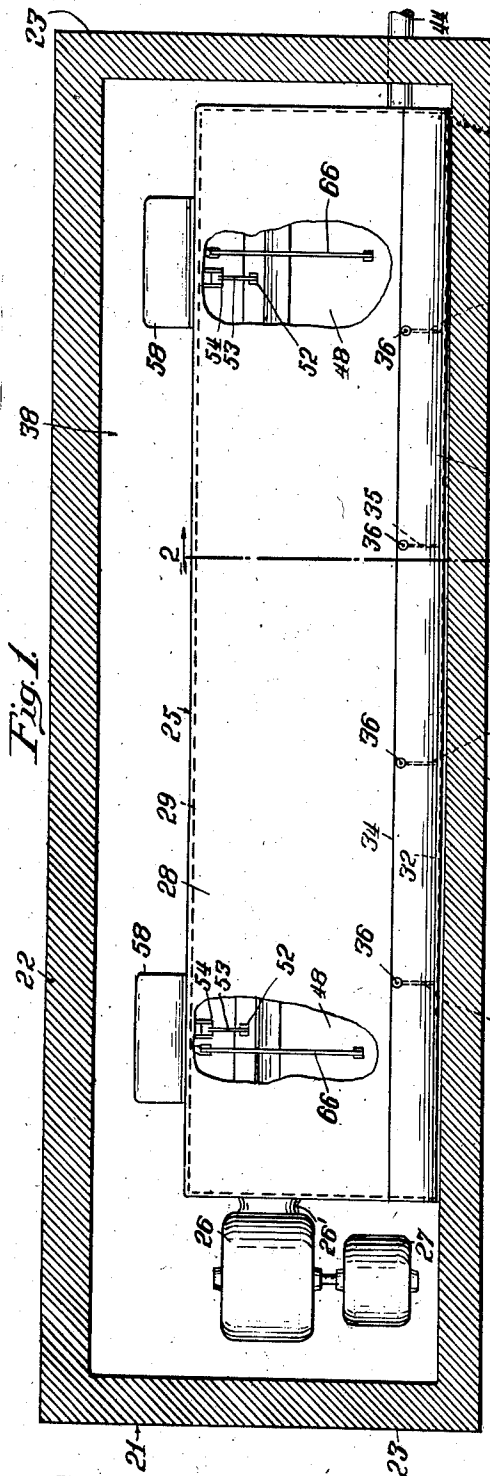
J. R. BOYLE

2,380,935

AIR CIRCULATING APPARATUS

Filed Nov. 26, 1941

3 Sheets-Sheet 1



Inventor
John R. Boyle
By *Brown, Jackson, Butcher & Quinn*
Attorneys

Aug. 7, 1945.

J. R. BOYLE

2,380,935

AIR CIRCULATING APPARATUS

Filed Nov. 26, 1941

3 Sheets-Sheet 2

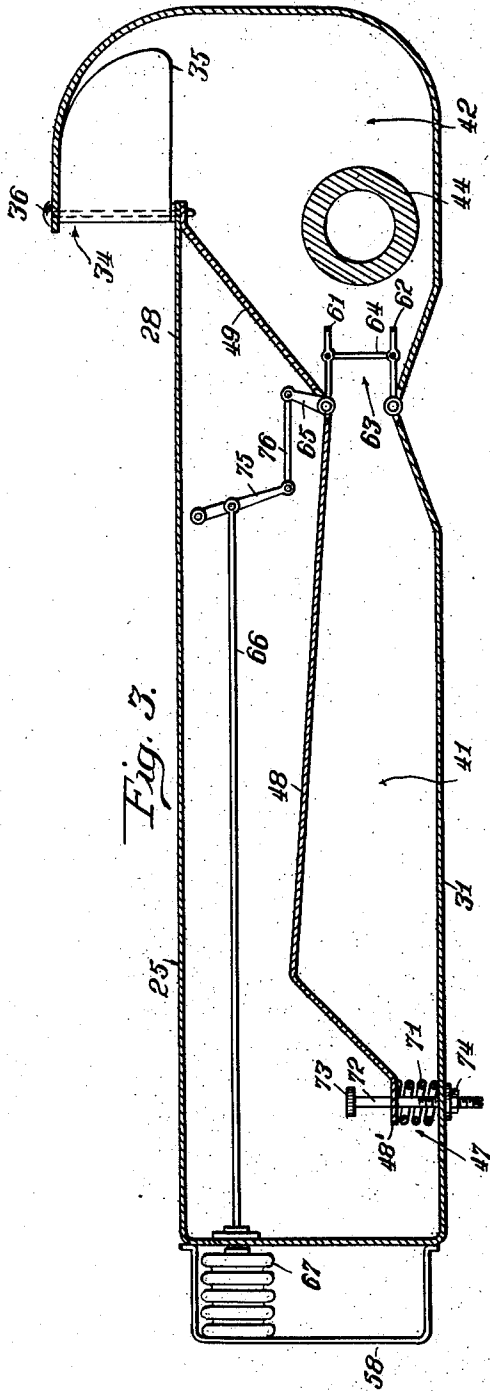


Fig. 3.

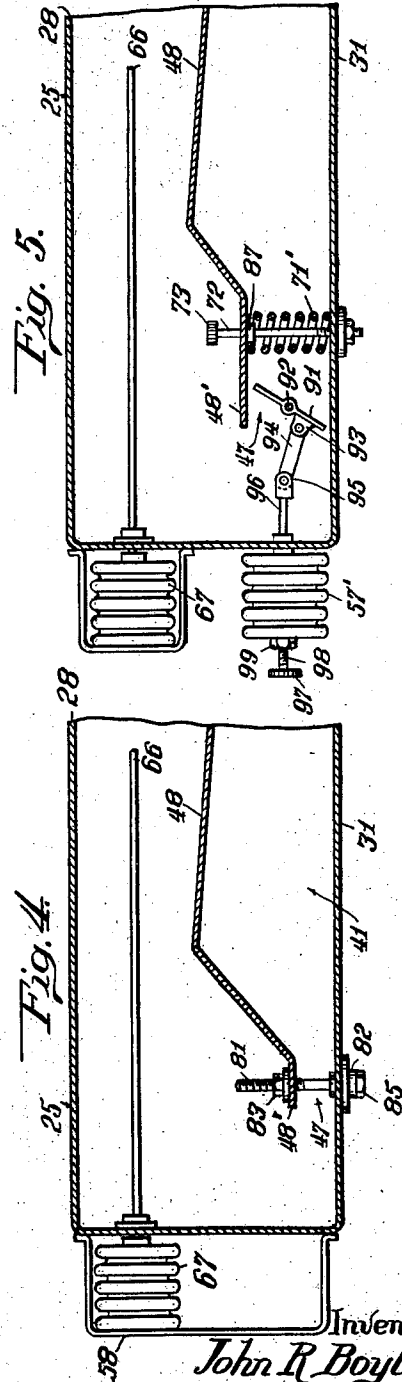


Fig. 5.

Fig. 4.

Inventor
John R. Boyle

By
Brown, Jackson, Butler & Quinn
Attorneys

Aug. 7, 1945.

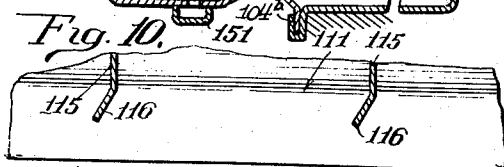
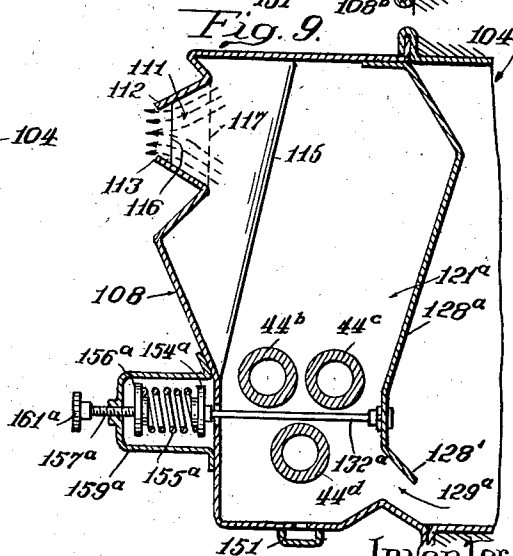
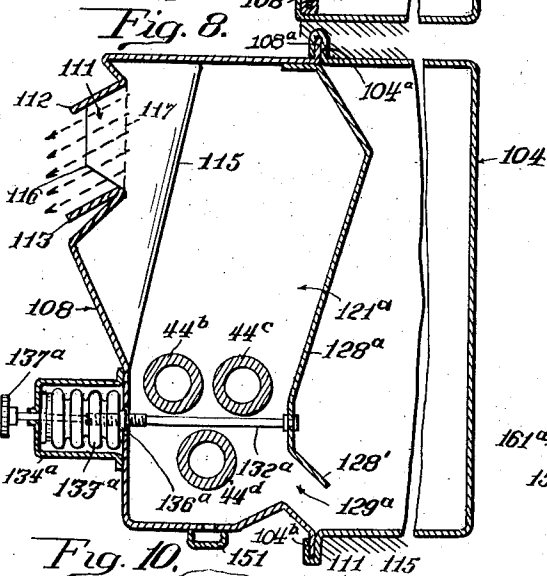
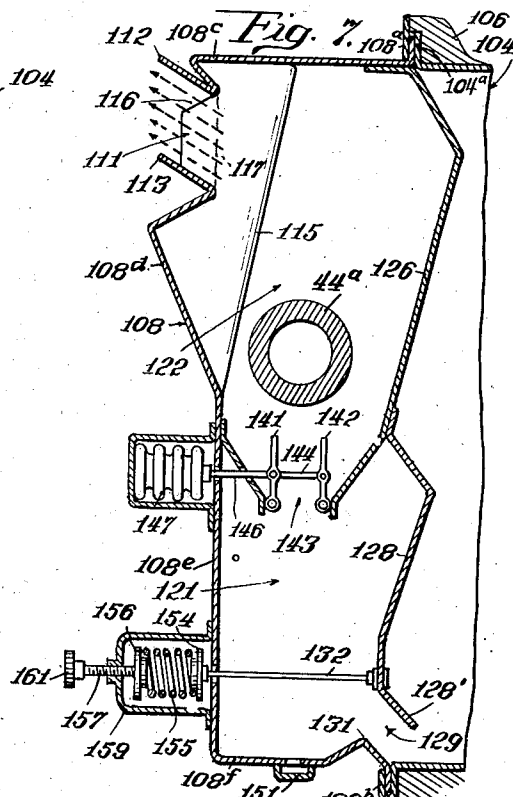
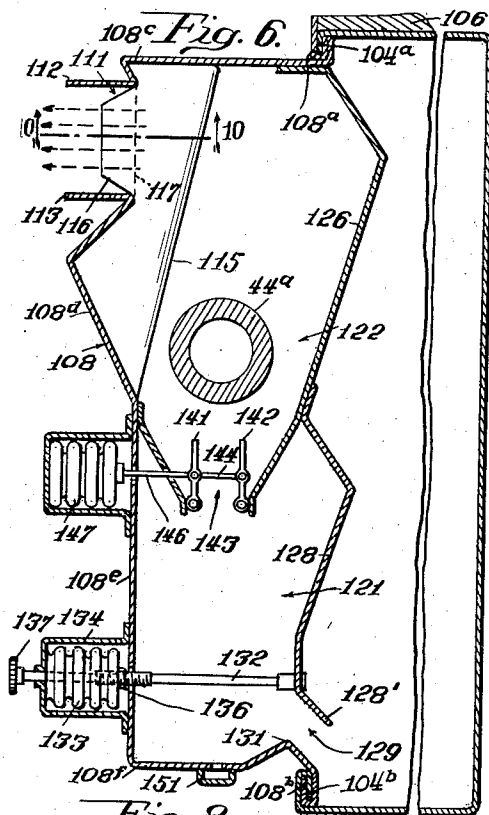
J. R. BOYLE

2,380,935

AIR CIRCULATING APPARATUS

Filed Nov. 26, 1941

3 Sheets-Sheet 3



Inventor
John R. Boyle

By *Brown, Jackson, Butcher & Quinn*
Attorneys

UNITED STATES PATENT OFFICE

2,380,935

AIR CIRCULATING APPARATUS

John R. Boyle, Chicago, Ill., assignor to Westerlin and Campbell Company, Chicago, Ill., a corporation of Illinois

Application November 26, 1941, Serial No. 420,460

22 Claims. (Cl. 257—2)

The present invention relates to air circulating apparatus adapted to be associated with an air circulating duct for the purpose of governing the velocity, pressure, temperature, direction or flow, etc., of the air issuing from said duct. My improved apparatus can be utilized as a part of an air circulating system or air conditioning system arranged to discharge air or to circulate air in a room, conditioning chamber, display case, or other enclosure.

The structure of the present invention takes the general form of an improved controllable grille or register which governs the volume, velocity, direction of flow, etc., of the issuing air, and which also contemplates the use of improved thermal control means for governing the temperature of such issuing air.

One of the features of the invention is a unique construction and arrangement of plenum chamber which is incorporated in the apparatus at a point between the duct and the grille or other discharge opening. This plenum chamber reduces the velocity and changes the direction of flow of that portion of the air stream which is being diverted from the main air stream flowing through the supply duct. This diverted air stream should not issue from the grille or discharge opening at too high a velocity, otherwise it will be objectionable from the standpoint of drafts. Furthermore, this diverted air stream should issue from the grille or discharge opening in a direction approximately at right angles to the grille and to the length of the duct, otherwise the distribution of the air will be uneven and the effectiveness of flow from the grille will be greatly reduced. The above arrangement of plenum chamber greatly improves the performance of the apparatus with regard to this reduction of velocity and change of direction of flow.

Another feature of the invention resides in an improved volume control for governing the volume of the air which is thus diverted from the main air stream of the duct for discharge out through the grille or discharge opening into the room. This volume control may be arranged to respond to temperature, static pressure, or manual regulation in different preferred embodiments which I shall hereinafter describe.

Another feature of the invention resides in an improved thermal control means for governing the temperature of the air issuing from the discharge opening or grille. This thermal control may be for the purpose of heating the air or cooling the air, depending upon the requirements of the particular installation. I preferably ac-

complish this thermal control by having the diverted air impinge against a thermal exchange conduit, and then varying the effective area of impingement of the air against said conduit.

Another feature of the invention resides in an improved arrangement of deflecting vanes or fins associated with the discharge opening and capable of being readily positioned for directing the issuing air stream at substantially any desired angle with respect to the room or other enclosure.

Another feature of the invention resides in the ability to manufacture and install the apparatus at relatively low cost, the construction being largely sheet metal and being preferably of unit lengths which can be readily joined together when a long continuous structure is desired.

Other features, objects and advantages of the invention will appear from the following detailed description of certain preferred embodiments thereof.

In the accompanying drawings illustrating these embodiments:

Figure 1 is a horizontal sectional view through a conventional refrigerated display case for meats and the like, showing one embodiment of my invention arranged for cooling the circulated air;

Figure 2 is a transverse sectional view through the air supply duct, plenum chamber, cooling coil and grille or discharge opening;

Figure 3 is a sectional view similar to Figure 2 but showing a modified construction wherein the volume control is responsive to static pressure;

Figure 4 is a fragmentary sectional view, similar to Figures 2 and 3, showing a modified construction wherein the volume control is responsive to manual adjustment;

Figure 5 is a sectional view similar to Figure 4, showing a modified construction wherein the volume control is responsive to temperature, static pressure and manual adjustment;

Figures 6 and 7 are vertical sectional views of other modified constructions utilizing two plenum chambers;

Figures 8 and 9 are vertical sectional views of still further modified constructions utilizing a single plenum chamber; and

Figure 10 is a horizontal sectional view taken approximately on the plane of the line 10—10 of Figure 6.

The display case 21 of Figure 1 is of any typical construction comprising side and end walls 22 and 23 of heat insulating material. The front and top walls are provided with the usual glasspanels

or windows, not shown, for displaying the meats or other commodities contained within the case.

The air circulating system comprises the long air supply duct 25 which extends substantially throughout the entire length of the display case along the bottom surface of the display space. A blower 26, driven by an electric motor 27, is positioned at one end of the case and has its outlet 26' connected to discharge into the end of the duct 25. The duct is of conventional sheet metal construction comprising the top wall 28, side wall 29, and bottom wall 31. The bottom wall 31 is curved upwardly at the other side of the duct structure to form a grille casing or outlet casing, as indicated at 32, which casing is continued upwardly and backwardly as indicated at 33 to form the grille slot or discharge opening 34. This discharge outlet 34 extends substantially the entire length of the duct 25, and located at spaced points along its length are outlet deflector vanes 35. These have a tight frictional mounting on supporting pins or bolts 36 which extend down through the outlet wall 33 and top wall 28 of the duct. The deflector vanes 35 can be manually turned to different deflecting angles for securing the desired distribution of air to different points in the display case. A return air space 38 is defined between the vertical side wall 29 of the air supply duct and the adjacent vertical wall 22 of the case, through which air space or channel the return air is recirculated back to the blower 26.

In the embodiment illustrated in Figure 2, the air conveyed through the supply duct 25 is required to pass through a first plenum chamber 41 and through a second plenum chamber 42 before issuing from the discharge outlet 34. One or more lengths of heat exchange conduit 44 extend longitudinally of the second plenum chamber 42. In the present situation wherein the air is to be cooled, these thermal transfer conduits 44 will carry a suitable refrigerant or other cooling medium.

A high velocity throat 47 governs the volume of air entering the first plenum chamber 41 from the supply duct 25. This high velocity throat is made controllable in area in response to temperature, static pressure, or manual adjustment. In the embodiment illustrated in Figure 2, the area of this throat or inlet varies in response to temperature. The two plenum chambers 41 and 42 are separated from the main area of the duct by a movable wall 48 and a stationary wall 49. The movable wall 48 can be flexed upwardly and downwardly for varying the respective area of the high velocity throat 47. The free end of this flexible wall 48 carries a pivot lug 51 which is pivotally connected by way of link 52 with one arm of a bell crank lever 53. The lever has fulcrum mounting at 54 on a suitable bracket or other stationary point of support projecting from the duct wall 29. Pivotally connected with the arm of the bell crank lever 53 is a link 56 which extends to a thermally responsive element preferably consisting of a thermal bellows 57. This bellows is shown as being mounted in a suitable bracket 58 disposed on the outer side of the duct wall 29, where it will be exposed to the flow of return air passing through the return air space 38 back to the inlet of the blower 26. The operating connection between the thermal bellows 57 and the flexible wall 48 is preferably such that when the temperature of the return air rises to a substantially predetermined point or range, the expansion of the bellows 57 becomes operative to open the high velocity throat 47 to a greater degree, for permitting a larger volume of air to flow

from the duct 28 through the plenum chambers 41 and 42 and into the display case.

The volume of air impinging against the heat exchange pipe 44 in the second plenum chamber 42 is also subject to regulation or control through the medium of a pair of deflecting vanes 61 and 62. These vanes are pivotally mounted at the constriction of a high velocity throat 63 which connects the first plenum chamber 41 with the second plenum chamber 42. The two vanes are link connected at 64 and are arranged to be swung upwardly or downwardly through an operating lever 65 connected by a rod 66 with a control unit 67. The control unit is shown as a thermally responsive bellows, similar to the bellows 57, said latter bellows 67 being also mounted on the bracket 58 disposed within the return air duct 38. When the temperature in this return air duct rises to a predetermined point or range, the expansion of the bellows 67 swings the deflecting vanes 61 and 62 downwardly so as to cause the air issuing through the throat 63 to have a greater area of impingement on the heat exchange pipe 44. Assuming this pipe to be conveying a coolant, this greater area of impingement will subject the air to a greater cooling influence for lowering the temperature within the display case. Conversely, when the temperature of the return air falls to a predetermined point or range, the contraction of the bellows 67 swings the deflecting vanes 61 and 62 in an upward direction, toward or into the dotted line positions, for reducing the area of impingement of the air against the conduit 44, or for avoiding any impingement of the air against said conduit, thereby reducing or avoiding the heat transfer action between the air and the conduit. The two thermal bellows 57 and 67 can be adjusted and arranged to handle different ends of the entire range of temperature control, such, for example, as by having the bellows 57 handle the low end of the range and having the bellows 67 handle the high end of the range. As an alternative embodiment, both thermal bellows could be adjusted and arranged to act conjointly over substantially the same portion of the control range. The throat 47 and its movable wall 48 preferably extend through a major portion of the length of the duct 25, and, similarly, the second throat 63 and deflecting baffles 61, 62 preferably extend through a major portion of the length of the duct.

Figure 3 illustrates a modified construction which corresponds substantially to the embodiment illustrated in Figure 2 except that the volume control exercised by the first high velocity throat 47 responds to the static pressure in the duct 25. In this embodiment, a light compression spring 71, or a plurality of such springs disposed at spaced points along the length of the duct, tend to flex the movable wall 48 upwardly to increase the size of the throat 47. This action of the springs is opposed by the static pressure of the air traveling through the duct 25, the greater the static pressure the more the throat is restricted so that the air passing into the plenum chamber 41 is maintained at a fixed volume or rate, or is held within predetermined limits of volume or rate. The spring 71 surrounds a stem or guide 72 which passes up through the bottom wall 31 and through the end flange 48' of the movable wall 48. A limiting stop or head 73 on the upper end of said stem limits the upward flexing movement of the wall. The stem 72 may be adjustable, if desired, as by threading the lower

portion thereof and having this threaded portion pass through a tapped guide boss 74 secured to the bottom wall 31. By screwing the stem upwardly or downwardly within this tapped guide boss the head 73 can be adjusted for a greater or lesser range of movement of the movable wall 48. Adjusting means may also be provided for adjusting the pressure of the spring 71, if desired.

This modified embodiment of Figure 3 controls the volume of air issuing from the duct by controlling the size of the high velocity throat 47, and controls the temperature of the issuing air by controlling the deflecting vanes 61 and 62 in substantially the manner previously described in connection with Figure 2. This modified embodiment illustrates the use of a motion multiplying lever 75 and link 76 for increasing the range of movement of the vane actuating lever 65, which motion multiplying mechanism may be embodied in the construction of Figure 2 if desired.

In the modified construction shown in Figure 4, the high velocity throat 47 is arranged for manual adjustment. In this construction, an adjusting screw 81 has rotatable, non-shiftable mounting in a guide boss 82 carried by the bottom wall 31. The upper threaded end of this screw passes through the end flange 48' of the movable wall 48 and has threaded engagement with a nut hub or bracket 83 which is secured to said flange 48'. Rotation of the head 85 at the lower end of the screw 81 is operative to flex the movable wall 48 upwardly or downwardly for varying the effective area of the throat 47. This modified embodiment can have the same temperature control exercised at the other high velocity throat 63 operative through the medium of the deflecting vanes 61 and 62 to control the area of impingement of the air stream against the heat exchange conduit 44. These deflecting vanes 61 and 62 are arranged to respond to the thermal bellows 67 in the same manner previously described.

In the modified construction illustrated in Figure 5, the flow through the high velocity throat 47 is responsive to temperature, static pressure, and manual adjustment. The static pressure response is similar to that described above in connection with Figure 3, comprising a compression spring 71' confined between the end flange 48' of the movable wall 48 and the stationary bottom wall 31. The stem 71 extending through said spring carries the upper end stop 73 for limiting the upward movement of the wall 48, and also carries a lower stop shoulder or collar 87 for limiting the downward movement of the wall 48. Also mounted in the throat 47, preferably anterior of the spring and rod assembly 71, 72, is a balanced damper valve 91 mounted on a horizontal central pivot 92. A pivot lug 93 on the anterior face of this valve has pivotal connection through link 94 with a swivel head 95 mounted on the inner end of the adjustable rod 96. This rod or stem 96 extends outwardly through a thermal bellows 57'. The outer end of said stem carries an adjusting head 97 for rotating the stem, this outer portion being threaded at 98 for screwing inwardly and outwardly of a nut 99 carried by the outer end of the bellows 57'. The bellows may comprise an inner expandible portion through which the rod 96 passes, or a tight fitting joint may be established between the rod and each end of the bellows. It will be evident that rise and fall of temperature in the air stream acting on the bellows will expand or contract the bellows for oscillating the damper 91 toward

open or closed positions. A manual adjustment may be superposed on this automatic temperature control by rotating the adjusting knob 97 so as to thread the stem 96 inwardly or outwardly with respect to the bellows, the inner end of the stem rotating within the swivel head 95. Such manual adjustment shifts the position of the damper valve 91 with respect to the temperature range of movement effected by the bellows. The second high velocity throat 63 with its associated deflector vanes 61 and 62 responds to the other bellows 67 in the same manner previously described.

Figures 6, 7, 8, 9, and 10 illustrate modified constructions wherein the grille and associated apparatus are disposed substantially vertically. These embodiments are particularly adaptable to rooms and other like enclosures wherein the air supply duct is mounted on or recessed into the side wall of the room adjacent to the ceiling. In each of these embodiments, the air supply duct is indicated at 104, and preferably consists of a sheet metal conduit of rectangular cross-section. This conduit is shown as being set back into a recess in the wall 106, but it will be understood that the duct might be disposed externally of the wall. My improved grille structure is preferably made in unit lengths, each of which can be mounted as a single unit, or which can be mounted end to end along a relatively long wall. Such portion of the air duct 104 as is intended to receive one or more of these units of grille structure has its front side left open to receive such unit or units. Each grille section comprises a sheet metal shell or casing 108 having top and bottom mounting flanges 108a and 108b for securing the casing to the duct 104, such as by sliding these flanges endwise into interlocking engagement with cooperating flanges 104a and 104b on the duct, as shown in Figure 6. Said casing also comprises a top wall 108c, an inclined front wall 108d, a vertical front wall 108e, and a bottom wall 108f. The grille slot or opening for discharging the air into the room is indicated at 111, the top and bottom margins of this opening being defined by the upper and lower sheet metal flanges or lips 112 and 113. In the installation of the grille structure, these flanges can be bent to deflect the issuing air stream to different vertical angles, and can be shaped or bent to govern the velocity of the issuing air stream. Figure 6 illustrates the flanges extending horizontally for producing a normal horizontal flow. Figure 7 illustrates the flanges bent upwardly for producing an upwardly deflected blast. Figure 8 illustrates the flanges bent downwardly for securing a downwardly deflected blast. Figure 9 illustrates the flanges bent toward each other for producing a high velocity discharge of the air, and it will also be understood that said flanges can be bent outwardly away from each other to produce a low velocity discharge. It will be understood that any one of the embodiments illustrated in Figures 6, 7, 8, and 9 can have its flanges 112, 113 adjusted to any one of the relations illustrated in the other figures.

Fixedly mounted at horizontally spaced distances along the length of the grille casing are vertically extending vanes 115, these preferably being composed of sheet metal, and being spot welded, soldered, or otherwise secured in the grille casing. The main body of each vane 115 extends substantially at right angles to the length of the grille unit, but projecting forwardly from each vane, within the discharge opening 111, is

a deflection tab or flange 116 which can be bent laterally to right or left along the line indicated by the dotted line 117. By bending these deflection tabs 116 in one direction or the other, any portion of the issuing air stream can be deflected to right or left. In some situations, a portion of the air stream may be deflected in one direction and another portion in the other direction for producing a desired circulation. The horizontal component imparted to the air stream by the bendable tabs 116 can be combined with any desired vertical component or with any desired velocity change effected by bending the flanges 112, 113.

The embodiments illustrated in Figures 6 and 7 each comprise a first plenum chamber 121 and a second plenum chamber 122 arranged in series relation between the air supply duct 104 and the grille opening 111. An inner wall 126 extends downwardly from the top wall 108c and defines the dividing partition between the supply duct 104 and the second plenum chamber 122. A flexible wall 128 extends downwardly from the lower portion of the upper wall 126, and serves to partition the first plenum chamber 121 from the air supply duct 104. A flange 128' projecting angularly from the lower portion of the flexible wall 128 constitutes the controllable portion of a high velocity throat 129 through which the air is conveyed from the supply duct 104 into the lower portion of the first plenum chamber 121. This high velocity throat is made controllable in area in response to temperature, static pressure, manual adjustment, or other control condition. In the embodiment illustrated in Figure 6, the area of this throat or inlet varies in response to temperature. The flexing of the wall 128 to left and right causes the flange 128' to move toward and away from a ridge or crown 131 formed in the bottom wall 108f, thereby varying the effective area of the entrance throat 129. An actuating rod 132 has swiveled connection with the flexible wall 128 and extends outwardly of the casing through the front wall 108e. Here this rod has operative connection with a thermally responsive bellows 133, which is suitably mounted on the front wall 108e, as in a mounting bracket 134. When the temperature within the room or other enclosure rises to a substantially predetermined point or range, the expansion of the bellows 133 becomes operative to open the high velocity throat 129 to a greater degree, for permitting a larger volume of air to flow from the duct 104 through the plenum chambers 121 and 122 and out through the grille opening 111 into the room. If it is desired to superpose a manual adjustment upon the automatic control exercised by the bellows 133, such can be readily accomplished by arranging the actuating rod 132 for a manual threaded adjustment inwardly and outwardly with respect to the bellows 133. For example, the intermediate portion of the rod 132 may be threaded for screwing inwardly and outwardly of a nut 136 carried by the inner end of the bellows 133. The outer portion of the rod extends through the bellows, such as through an inner expansible portion thereof, and carries a knob 137 at its outer end, by which the rod may be rotated for screwing the rod inwardly or outwardly within the nut 136, and thereby adjusting the effective area of the throat 129. If the air circulating apparatus is intended to heat a conditioning enclosure, the expansion of the bellows 134 may be arranged to restrict the throat 129. For example, the bellows 133 might be reversed to have its

inner end stationarily mounted in the bracket 134 and to have its outer end movable and carrying the nut 136.

The volume of air impinging against the thermal exchange conduit 44a in the second plenum chamber 122 is also subject to regulation or control through the medium of a pair of deflecting vanes 141 and 142. These vanes are pivotally mounted at the constriction of a high velocity throat 143 which connects the first plenum chamber 121 with the second plenum chamber 122. The two vanes are link connected at 144 and are arranged to be swung into an upright position or into a laterally inclined position through an operating link 146 connected with a control unit, such as the thermally responsive bellows 147. The deflecting vanes 141 and 142 are adapted to vary the volume of the air which is caused to impinge against the thermal transfer conduit 44a in the upper plenum chamber 122. In installations where the air circulating apparatus performs a cooling function, the conduit 44a will carry a suitable refrigerant or other cooling medium, and upon a predetermined rise of temperature within the room or other enclosure the bellows 147 will expand to swing the deflecting vanes 141, 142 into upright positions for causing a greater proportion of the air to impinge against the thermal transfer conduit. Upon a predetermined lowering of the temperature within the room, the contraction of the bellows 147 will swing the vanes 141, 142 to the left for reducing the proportion of the air which is caused to impinge against the conduit 44a. In the converse type of installation wherein the air circulating apparatus is to maintain a relatively high temperature within a conditioning chamber or the like, the operating relation would be reversed, as by reversing the bellows 147 in the manner described above in connection with the bellows 133. In such arrangement, if there were an undesirable drop of temperature, the action of the bellows 147 would be to cause more air to impinge directly against the thermal transfer conduit 44a, which would then be carrying a heating medium.

In the cooling type of installation, there may be a substantial amount of condensate which will precipitate from the side walls of the plenum chambers 121 and 122 and from the relatively cold conduit 44a. In such type of installation, the ridge 131 extending lengthwise of the bottom wall 108f prevents collected moisture from flowing out of the plenum chamber 121 into the air supply duct 104. A drainage trough 151 may be extended along the under side of the bottom wall 108f, and be placed in communication with the bottom of the lower plenum chamber 121 through longitudinally spaced apertures, this drainage trough leading to any suitable drain outlet.

Figure 7 illustrates a modified construction which is substantially identical with that illustrated in Figure 6, except that the first high velocity throat 129 is made responsive to static pressure and to manual adjustment, rather than to temperature and manual adjustment. In this modified construction, the actuating rod 132 extends outwardly of the casing 108 and carries a flanged thrusting head 154 at its outer end. A compression spring 155 has one end centered on this thrusting head, and has its other end centered on an adjustable head 156. The latter head is mounted on a threaded stem 157 which screws through a tapped hub carried by a supporting bracket 159, the outer end of said stem carrying

a knob 161, by which the adjustable head 156 may be shifted inwardly or outwardly to vary the pressure of the spring 155. A sufficient range of adjustment can be given the head 156 and knob 161 to produce the effect of superposing a manual control upon the static pressure control to which the flexible wall 128 is adapted to respond. The greater the static pressure within the supply duct 104, the more the throat 129 is restricted, so that the air passing into the plenum chambers 121 and 122 is maintained at a fixed volume or rate, or is held within predetermined limits of volume or rate.

Figures 8 and 9 illustrate other modified constructions in which only a single plenum chamber 121a is interposed between the air supply duct 104 and the grille outlet 111. In both of these embodiments, the dividing wall 128a is made flexible so as to be capable of varying the effective area of the high velocity throat 129a leading from the supply duct into the plenum chamber. In constructions adapted to effect a thermal exchange between the air and conduit means contained within the grille structure, a single thermal exchange conduit 44a may be disposed within the plenum chamber 121a, substantially as disclosed in Figures 6 and 7, or a plurality of smaller conduits 44b, 44c and 44d may be substituted for the relatively large conduit, and be located within the plenum chamber at points securing the most desirable or effective impingement of the air on said conduits.

The embodiment shown in Figure 8 is arranged to be temperature responsive, and, in addition, has a manual adjustment superposed thereon. This arrangement is similar to that employed for flexing the wall 128 of Figure 6, comprising an actuating rod 132a extending out through the front wall of the casing and responding to the expansion and contraction of a thermally responsive bellows 133a mounted in a bracket 134a. The intermediate portion of the rod 132a may be threaded for screwing inwardly and outwardly of a nut 136a carried by the inner end of the bellows 133a, and the outer portion of the rod may be provided with a knob 137a, by which the rod may be rotated for screwing inwardly and outwardly within the nut 136a. This serves to adjust the effective area of the throat 129a, constituting a manual adjustment superposed upon the automatic temperature adjustment which is brought about by the bellows 133a.

The embodiment illustrated in Figure 9 is similar to that illustrated in Figure 7, to the extent that the flexible wall 128a is arranged to respond to an automatic, static pressure control, and is also arranged to respond to a manually actuated control superposed upon the automatic static pressure control. The actuating rod 132a extends outwardly through the casing 108 and carries a flanged thrusting head 154a at its outer end. A compression spring 155a acts between this thrusting head and an adjustable outer head 156a. The outer head 156a is carried on a threaded stem 157a which screws through a tapped boss carried by the bracket 159a. Rotation of the outer adjusting knob 161a is operative to shift the head 156a inwardly and outwardly to adjust the pressure of the spring 155a. A substantial range of adjustment afforded through the threaded stem 157a and knob 161a enables a manual adjustment to be superposed upon the spring 155a, adequate to effect any ordinary range of manual adjustment that might be desired. It will be understood that the spring 155a also re-

sponds automatically to the static pressures prevailing against the flexible wall 128a, for obtaining the automatic static pressure control referred to above in connection with the preceding embodiment.

While I have illustrated and described what I regard to be the preferred embodiments of my invention, nevertheless it will be understood that such are merely exemplary and that numerous modifications and rearrangements may be made therein without departing from the essence of the invention. In embodiments in which there is to be no heating or cooling of the air within the grille section, the thermal exchange conduits 44, 44a, 44b, 44c, and 44d may be dispensed with.

I claim:

1. In air circulating apparatus, the combination with an air supply duct for supplying air under pressure, of a grille casing extending substantially longitudinally of said air supply duct and adapted to receive air therefrom, a grille slot in said casing through which air is discharged into the room or other enclosure, a thermal exchange conduit in said grille casing, and means responsive to the pressure in said air supply duct for automatically controlling the flow of air through said grille casing.

2. In air circulating apparatus of the class described, the combination of an air supply duct, a grille casing extending substantially longitudinally of said supply duct, a high velocity inlet throat for permitting air to enter said grille casing from said supply duct, a grille slot for permitting air to discharge from said grille casing to the room or other enclosure, a deflecting flange extending substantially horizontally along said grille slot and adapted to be positioned to deflect air issuing from said grille slot in an upward or downward direction, and means for varying the size of said high velocity throat in inverse relation to the static pressure in said air supply duct to control the volume of air passing through said grille casing.

3. In air circulating apparatus of the class described, the combination of a substantially horizontal air supply duct recessed into the wall of a room near the ceiling, a grille casing extending substantially longitudinally of said supply duct and overlying said air supply duct on the room side, a plenum chamber defined between said grille casing and said air velocity duct, a high velocity inlet throat extending longitudinally of said supply duct and grille casing for permitting air to enter said plenum chamber from said supply duct, said inlet throat comprising a movable wall adapted to be shifted to vary the size of said throat, a grille slot for permitting air to discharge from said plenum chamber to the room, deflecting flanges extending along the top and bottom edges of said grille slot and adapted to be bent upwardly or downwardly for varying the effective size of said grille slot or for deflecting in an upward or downward direction the air issuing from said grille slot, said plenum chamber being of sufficient volume to effect a marked reduction of velocity of the air entering said chamber through said throat, and means for shifting the movable wall to vary the size of said throat.

4. In air circulating apparatus of the class described, the combination of a substantially horizontal air supply duct recessed into the wall of a room near the ceiling, a grille casing extending substantially longitudinally of said supply duct and overlying said air supply duct on the room side, a plenum chamber defined between

said air supply duct and said grille casing, a partition separating said plenum chamber from said supply duct comprising a movable wall, said movable wall defining one side of a high velocity inlet throat through which air passes from said supply duct to said plenum chamber, a grille slot in said grille casing for permitting air to discharge from said plenum chamber to the room, said plenum chamber being of sufficient volume to effect a marked reduction of velocity of the air entering said chamber through said throat, and temperature responsive means for automatically shifting the movable wall to vary the size of said throat.

5. In air circulating apparatus of the class described, the combination of an air supply duct, a grille casing extending substantially longitudinally of said supply duct, a plenum chamber in said grille casing, a partition separating said plenum chamber from said supply duct comprising a movable wall, said movable wall defining one side of a high velocity inlet throat through which air passes from said supply duct to said plenum chamber, a grille slot in said grille casing for permitting air to discharge from said plenum chamber to the room or other enclosure, said plenum chamber being of sufficient volume to effect a marked reduction of velocity of the air entering said chamber through said throat, and spring means coacting with said movable wall for causing said wall to shift and vary the size of said inlet throat automatically in response to the static pressure in said supply duct.

6. In air circulating apparatus for a room or like enclosure, the combination of a substantially horizontal air supply duct mounted on a wall of said room near the ceiling, a grille casing extending substantially longitudinally along the room side of said supply duct and adapted to receive air therefrom, means for controlling the flow of air from said duct to said casing, a grille slot in said casing through which air is discharged, and deflecting means associated with said grille slot and adapted to be set to deflect the air laterally at a predetermined angle or angles relatively to the length of said slot.

7. In air circulating apparatus for a room or the like, the combination of a substantially horizontal air supply duct recessed into a wall of said room near the ceiling, a grille casing extending substantially longitudinally with respect to said supply duct and detachably secured thereto, said grille casing adapted to receive air from said duct, means for controlling the flow of air from said duct to said casing, a grille slot in said casing through which air is discharged, and deflecting flanges extending along the top and bottom edges of said grille slot and adapted to be bent upwardly or downwardly for deflecting the air upwardly or downwardly or for controlling the velocity of flow through said slot.

8. In air circulating apparatus for a room or the like, the combination of an air supply duct recessed into a wall of said room near the ceiling, a grille casing extending along the length of a considerable portion of said air supply duct on the room side thereof and receiving air therefrom, cooperating interlocking flanges on said duct and said casing for detachably securing the two together, a plenum chamber defined in said casing, a restricted inlet through which the air passes from said supply duct to said plenum chamber, means for controlling the flow of air through said restricted inlet, a discharge slot in said grille casing through which the air is discharged into the room or other enclosure, fins disposed in said

plenum chamber and extending across said grille slot substantially at right angles thereto, deflecting tabs carried by said fins and projecting outwardly of said slot, said tabs adapted to be bent laterally for deflecting the issuing air horizontally with respect to the length of said slot, and deflecting flanges extending along the top and bottom edges of said grille slot and adapted to be bent upwardly or downwardly for deflecting the issuing air vertically with respect to the length of said slot.

9. In apparatus of the class described, the combination of an air supply duct, a register casing extending lengthwise of said duct, cooperating locking flanges on said supply duct and on said register casing adapted to be slid endwise into interlocking engagement with each other, a plenum chamber in said register casing, a flexible wall separating said plenum chamber from said supply duct, the lower edge of said flexible wall defining one edge of a restricted throat extending longitudinally of said supply duct and register casing and establishing communication between the lower portions thereof, means for shifting said flexible wall to adjust the effective area of said throat, an outlet slot extending lengthwise of said register casing adjacent the upper portion thereof, and deflecting means associated with said outlet slot for deflecting the air issuing therefrom.

10. In air circulating apparatus including a substantially horizontal air supply duct recessed into the wall of a room near the ceiling, the combination therewith of a grille section detachably secured to said duct on the room side thereof and adapted to receive air from said duct, governing means acting on the flow of air passing through said grille section, temperature responsive means for automatically actuating said governing means, and means for superposing a manual control upon the automatic control exercised by said temperature responsive means.

11. In air circulating apparatus including an air supply duct, the combination therewith of a grille section adapted to receive air from said duct, governing means acting on the flow of air passing through said grille section, means responsive to the static pressure in said air supply duct for automatically actuating said governing means, and means for superposing a manual control upon the automatic control exercised by said pressure responsive means.

12. In fluid circulating apparatus, the combination of a fluid supply duct having an aperture in one wall thereof, a grille section fitting over said aperture, cooperating locking flanges on said supply duct and on said grille section adapted to be slid endwise into interlocking engagement with each other, said grille section comprising a plenum chamber, an inlet opening leading from said supply duct to said plenum chamber, an outlet opening leading from said plenum chamber, means coacting with said inlet opening for controlling the fluid flow from said supply duct to said plenum chamber and means coacting with said outlet opening for controlling the fluid flow issuing from said plenum chamber.

13. In air circulating apparatus for installation directly in a room to be air conditioned, the combination of an air duct extending along one wall of the room for supplying air under pressure, a grille structure separable from said duct extending longitudinally of said air duct on the room side of said duct, cooperating interlocking flanges on said duct and on said grille structure adapted to be slid endwise into interlocking engagement

with each other, said grille structure having a discharge opening through which air is discharged into the room, a plenum chamber interposed between said duct and said discharge opening, a regulatable volume control device for governing the volume of air issuing from said duct into said plenum chamber, and thermal control means for governing the temperature of the air issuing from said discharge opening, said thermal control means comprising a thermal exchange conduit disposed between said volume controlled device and said discharge opening and against which the air under pressure from said duct is adapted to impinge in its flow from said duct to said discharge opening.

14. In air circulating apparatus for a room or the like, the combination of an air supply duct extending substantially horizontally of the room along one side wall adjacent to the ceiling, said duct having a horizontal flow of air therethrough under pressure from a source of air supply, a grille structure secured to the room side of said duct and extending along the major portion of the length of said duct within said room, said grille structure defining a plenum chamber therein extending along the length of said duct and grille structure, a flexible wall separating said plenum chamber from said duct, a high velocity inlet throat defined along the lower edge of said flexible wall for admitting air under pressure from said air duct into the lower portion of said plenum chamber, means for shifting said flexible wall to adjust the effective area of said throat whereby to control the volume of air entering the lower portion of said plenum chamber from said air duct, a horizontal grille slot formed in the room side of said grille structure discharging from the upper portion of said plenum chamber and extending throughout the major portion of the length of said grille structure, and deflecting flanges extending along the top and bottom edges of said grille slot and adapted to be bent upwardly or downwardly for varying the effective size of said grille slot or for deflecting in an upward or downward direction the air issuing from said grille slot, said grille structure producing a velocity of air flow into the room substantially at right angles to the direction of air flow through said air supply duct.

15. In air circulating apparatus of the class described, the combination of an air duct for supplying air under pressure, a grille or discharge opening through which said air is discharged into the room or other enclosure, a plenum chamber interposed between said duct and said grille for passing substantially all of the air flowing from said duct to said grille, said plenum chamber reducing the velocity and changing the direction of flow of the air diverted from said duct, volume control means for governing the volume of substantially all of the air flowing from said duct to said grille, means responsive to the static pressure in said air duct for regulating said volume control means, thermal control means for governing the temperature of the air issuing from said grille, said thermal control means comprising a thermal exchange conduit against which the air is adapted to discharge in its flow from said duct to said grille, and temperature responsive means for regulating the effective area of impingement of the air against said thermal exchange conduit.

16. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room adjacent the ceiling thereof and

having a substantially horizontal grille slot therein for discharging air into said room near the ceiling in the form of a thin sheet of air distributed over a relatively wide area of the room, an air supply duct extending lengthwise along said grille casing for communication therewith along the major portion of the length of said grille casing, said air supply duct having air supplied thereto under pressure for discharge into said grille casing, a relatively long volume damper extending substantially horizontally between said supply duct and said grille casing and having its lower edge movable for volume adjustment, and means for moving the lower edge of said volume damper to control the volume of air transferred from said air supply duct to said grille casing.

17. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room adjacent the ceiling thereof and having a relatively long substantially horizontal grille slot therein for discharging air into said room near the ceiling in the form of a thin sheet of air distributed over a relatively wide area of the room, an air supply duct extending lengthwise along said grille casing for communication therewith along the major portion of the length of said grille casing, a relatively long damper disposed between said supply duct and said grille casing having a movable lower edge, means cooperating with said movable lower edge to define a relatively long horizontally extending inlet throat between said supply duct and said grille casing, said inlet throat being disposed adjacent the lower portion of said grille casing and said grille slot being disposed adjacent the upper portion of said grille casing, whereby a plenum chamber is defined in said grille casing between said inlet throat and said grille slot to change the velocity head of the air to a pressure head, and means for adjusting said damper.

18. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room adjacent to the ceiling thereof and having discharge means for discharging air into said room near the ceiling in the form of a thin sheet of air distributed over a relatively wide area of the room, an air supply duct extending lengthwise along said grille casing for communication therewith along the major portion of the length of said grille casing, a relatively long controllable volume damper disposed between said grille casing and said air supply duct, and means cooperating with said volume damper to define an inlet throat for admitting air from said duct to said grille casing, said inlet throat admitting air into said grille casing at a point spaced substantially from the point where said discharge means discharges air from said grille casing, whereby a plenum chamber of substantial volume is defined between said inlet throat and said discharge means so as to reduce the velocity and change the direction of flow of the air passing from said duct to said discharge means.

19. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room and having a substantially horizontal slot therein for discharging air into said room in the form of a thin sheet of air distributed over a relatively wide area of the room, deflecting flange means extending lengthwise of said grille slot and adapted to be positioned to vertically deflect the air issuing from said grille slot, an air

supply duct extending lengthwise along said grille casing for communication therewith along a substantial part of said grille casing, said air supply duct having air supplied thereto under pressure from a source of supply, and a relatively long volume damper movably mounted between said supply duct and said grille casing for controlling the volume of air transferred from said duct to said grille casing.

20. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room and having a substantially horizontal grille slot therein for discharging air into said room in the form of a thin sheet of air distributed over a relatively wide area of the room, deflecting flange means extending substantially transversely of said grille slot and adapted to be positioned to laterally deflect the air issuing from said grille slot, an air supply duct extending lengthwise along said grille casing for communication therewith, said air supply duct having air supplied thereto under pressure from a source of supply, a volume regulating damper movably mounted between said supply duct and said grille casing, and means for moving said damper to different positions.

21. In air circulating apparatus for a room or the like, the combination of a relatively long grille casing extending substantially horizontally in said room adjacent the ceiling thereof and having a substantially horizontal grille slot therein for discharging air into said room near the ceiling in the form of a thin sheet of air distributed over a relatively wide area of the room, an air supply duct extending lengthwise along said

grille casing for communication therewith along the major portion of the length of said grille casing, said air supply duct having air supplied thereto under pressure from a suitable source of supply, an inlet throat defined between said air supply duct and said grille casing, a controllable volume damper governing the size of said inlet throat, a thermal exchange conduit in said grille casing adjacent to said inlet throat whereby air passing through said throat into said grille casing impinges against said thermal exchange conduit, and means for moving said volume control damper.

22. In a duct system of air circulation for a room or the like, the combination of a supply duct extending substantially horizontally of said room in an overhead position, said duct adapted to receive air under pressure from a source of supply, a relatively long narrow grille casing extending substantially horizontally in said room in an overhead position lengthwise along said supply duct, a substantially horizontal plenum chamber defined between said supply duct and said grille casing, a relatively long restricted throat establishing communication from said supply duct to said plenum chamber, said plenum chamber and said restricted throat cooperating to reduce the velocity and change the direction of flow of the air passing from said supply duct into said plenum chamber, and relatively long substantially horizontal discharge means in said grille casing for discharging the air from said plenum chamber into the room at an overhead level in the form of a thin sheet of air distributed over a relatively wide area of the room.

JOHN R. BOYLE.