June 22, 1965 D. WEISZ 3,190,207

AIR CURTAIN

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FIG. 2.

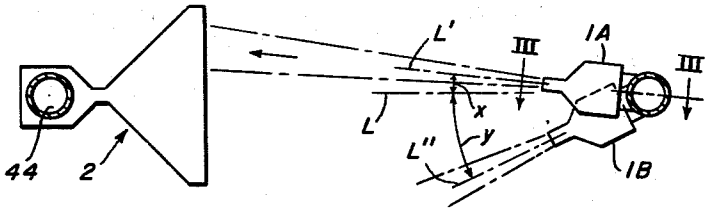

FIG. 1.

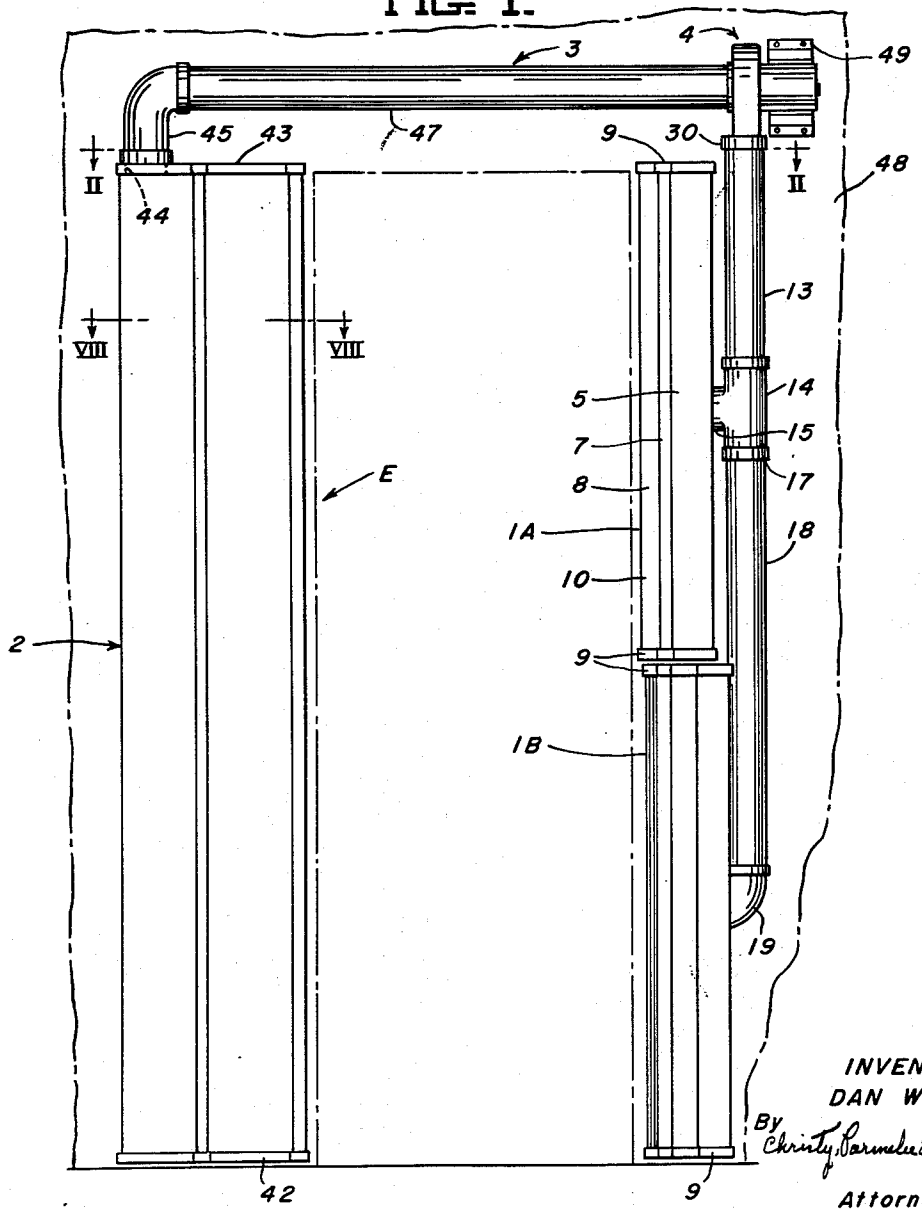

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FIG. 8.

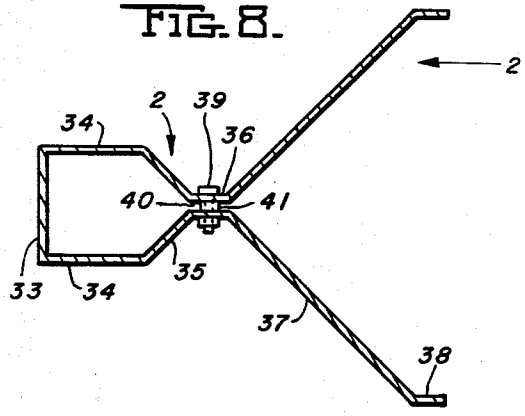


FIG. 4.

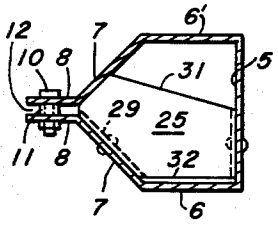


FIG. 5.

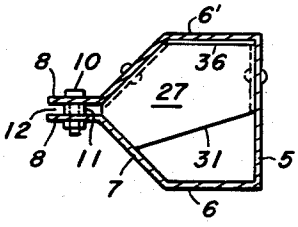


FIG. 6.

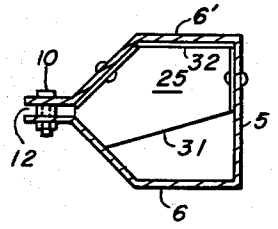


FIG. 7.

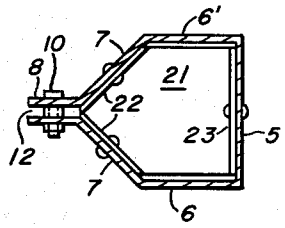


FIG. 10.

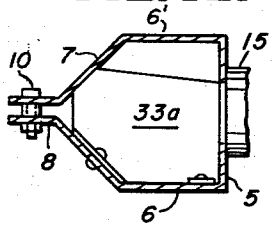


FIG. 9.

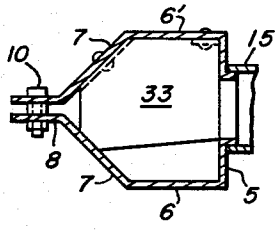
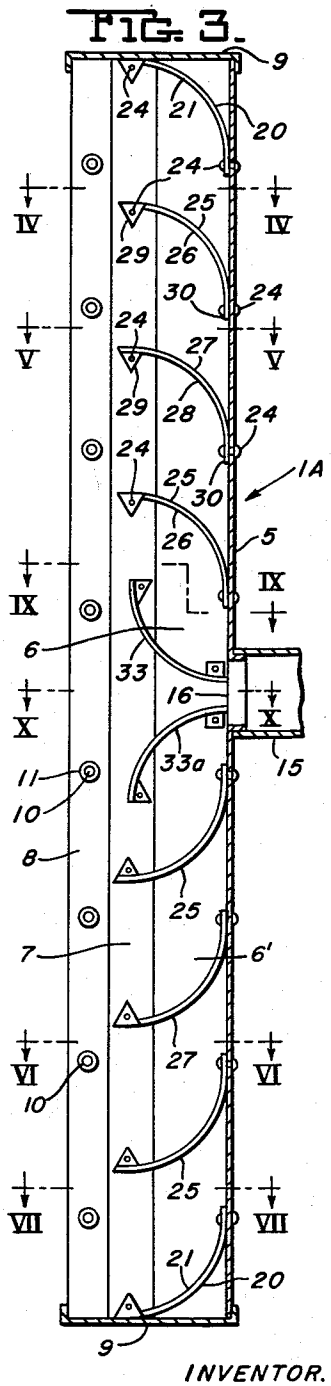


FIG. 3.



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3,190,207

AIR CURTAIN

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Filed Nov. 6, 1962, Ser. No. 235,662
3 Claims. (Cl. 98—36)

The present invention relates generally to providing an air curtain across an entrance or exit opening to an enclosed area being controlled as to temperature and from which dust and insects are to be substantially excluded. More specifically the invention relates to apparatus for establishing and maintaining an air drape across an opening to an enclosed area in conjunction with a movable member which is normally employed to close off such opening against entrance to or exit from such an enclosed area.

Such air curtains have heretofore been known for use where insects or dust are to be excluded and have usually required substantial modification of the entrance opening to provide for suitable flow and collection of the air moving over the said opening for the intended purpose.

The present invention is intended for use under such adverse conditions as restraint to movement of cold air from within a refrigerated area at 0° F. temperature which air may be under pressure greater than atmospheric in some portions thereof, or under less adverse conditions such as entrances to produce houses, air conditioned restaurants and supermarkets.

One object of the invention is to provide an air curtain across an opening to a cooled enclosure which may be installed at one face of the opening with a minimum of modification of the opening or surrounding building structure.

Another object of the invention is to provide apparatus for disposing an air curtain across an opening to such areas which air curtain is adjustable as to air volume, velocity and direction of flow.

Another object of the invention is to provide an air curtain which is adjustable so as to provide a variable air density and velocity as required to restrain flow of cold air from a cooled enclosure.

A further object of the invention is to provide an air curtain.

These and other objects of the invention will be made apparent from the following description and the drawing forming a part thereof, wherein:

FIG. 1 shows a side elevation of the apparatus in relation to the access opening into the area being protected by the air curtain;

FIG. 2 shows a transverse section through FIG. 1 on lines II—II illustrating the adjustability of the jet duct;

FIG. 3 shows a vertical section on lines III—III of FIG. 2 illustrating the air deflectors within the upper portion of the jet duct;

FIGS. 4 and 5 show a transverse section through FIG. 3 along lines IV—IV and V—V illustrating disposition of the air deflectors;

FIG. 6 shows a transverse section along lines VI—VI of FIG. 3 illustrating the air deflectors adjacent the lower section of the air jet duct;

FIG. 7 shows the bottom air deflector in the jet duct of FIG. 3; and

FIG. 8 shows a transverse section, through the receiving duct at lines VIII—VIII of FIG. 1; and

FIGS. 9 and 10 are transverse sections through the jet duct of FIG. 3 at the air inlet.

Referring now in detail to the drawing, the apparatus providing the air curtain includes two vertically aligned air jet or discharging ducts indicated generally as **1A** and **1B** at one side of the entrance opening of an area to be protected and at **2** indicates generally the air receiving duct adjacent the opposite side of said entrance. These ducts are connected by a suitable conduit system indicated generally as **3**. Within the conduit **3** is a suitable fan indicated generally as **4**. The general mode of operation of the foregoing apparatus is to have fan **4** withdraw air from the interior of receiving duct **2** and discharge it under pressure into jet ducts **1A** and **1B** so as to be discharged therefrom across the area entrance opening E towards the receiving duct **2**. Preferably the ducts **1A**, **1B** and **2** are of a vertical height equal to or greater than the vertical height of entrance opening E.

The theory of operation of the apparatus is that ducts **1A** and **1B** will direct a curtain of air across opening E, which is received in duct **2** for recirculation by fan **4**. This air curtain is of sufficient volume and velocity to substantially exclude dust and insects from the area being protected and to retard passage of cooled air between 0° F. and atmospheric temperature from said area. It is well known in the art of refrigeration that air increases in weight per unit volume as the temperature of the air decreases. It necessarily follows then that the colder air within the area being protected is adjacent the floor of the area and exerts a greater pressure against the air curtain than does the air adjacent the top of the said area. The opposing air curtain discharging and air curtain receiving faces of the said ducts must be both proportioned and disposed relative to each other to meet the requirements of the air temperatures within the area being protected by the air drape. The hereinafter described details of construction and operation of the apparatus will vary depending upon operating conditions.

Referring now to the air discharging or jet ducts **1A** and **1B**, each comprises a rear wall **5** having at each side thereof side walls **6** and **6'** terminating in converging portions **7** and outwardly extending portions **8** disposed in spaced relation. Each duct **1A** and **1B** is provided with a pair of end closure plates **9**. The duct portions **8** are connected by fasteners **10** with spacers **11** mounted upon the fasteners **10** between the spaced duct portions **8** to control the spacing thereof. Since the entrance opening E has variations in height between 6 feet and 11 feet or more the spacers **11** may readily be provided with different thicknesses to control decreasing of the width of opening **12** between duct portions **8** as the height of the duct increases and maintain the desired air velocity without increase in fan capacity. The duct openings **12** are referred to herein as jet openings since they define the initial thickness of air stream emitting therefrom. As shown in FIGS. 1 and 2, the fan **4** is connected with duct **1A** by means of conduit section **13** and T member **14**. As shown in FIGS. 1 and 3, outlet **15** of T **14** is connected with the interior of duct **1A** by means of opening **16** in duct rear wall **5** and substantially intermediate the top and bottom ends of wall **5**. Duct **1B** is connected with outlet **17** of T **14** by means of conduit section **18** and

elbow member 19. One end of elbow 19 engaging an inlet member, not shown, in rear wall 5 of duct 1B. To provide for relative rotation of ducts 1A and 1B, as hereinafter discussed conduit sections 13 and 18 are provided with swivel connections to members 14 and 19.

In order to provide for uniform air pressure from fan 4 within ducts 1A and 1B and uniform emission of air therefrom, suitable baffles are provided within the ducts The shape and location of such baffles may vary but those illustrated in FIGS. 3 to 7 have been found to provide satisfactory, if not optimum results. As shown in FIG. 3, a plurality of baffles are disposed within duct 1A both above and below the air inlet opening 16 in the rear wall 5 thereof. Similar baffles will be also disposed within duct 1B above and below the air inlet opening in the rear wall 5 thereof. Where conditions may dictate that ducts 1A and 1B be of different lengths, these baffles may vary in number and location if necessary to obtain desired results.

Referring now to FIGS. 3, 4, 5 and 7, within the ends of duct 1A are provided baffles 20 disposed adjacent end caps 9 and provided with opposing concave air impinging surface 21. These baffles 20, as shown in FIG. 7, substantially fill the adjacent cross-sectional area of the duct 1B and deflect the impinging air from surface 21 towards the duct converging side wall 7 and opening 12. Suitable baffle flanges 22 and 23 abut the respective adjacent duct walls 7 and 5 and are secured thereto by suitable fastening means such as 24. Baffles 25 (FIG. 4) are also provided with concave air impingment surface 26 deflecting air to duct walls 7 and air inlet opening 16. These baffles 25 are also provided with suitable attaching flanges 29 and 30 for connecting the baffle to the adjacent duct walls 5 and 7 by means of suitable fasteners such as 24. Baffles 27 (FIG. 5) have a concave air impinging face 28 directed towards duct air inlet opening 16 and provided with suitable attaching flanges 29 and 30. A comparison of FIGS. 4 and 5 discloses that baffles 25 and 27 have edge portions 32 disposed adjacent one duct side wall 6 or 6' and edge portions 31 disposed in spaced relation to the opposite duct side wall. As shown in FIG. 3 the baffles 25 and 27 disposed at opposite sides of duct inlet opening 16 may be the same except that their concave faces are disposed in opposing relation and the edge portions 31 are reversed as shown by comparison of FIGS. 4 and 6.

At the inlet openings 15 and 17 of the jet ducts 1A and 1B are provided diffuser slots 32 and 33 which initially divide the portion of the air forwardly towards the jet opening 12 and other portions towards the duct portions above and below the inlet opening. As shown in FIGS. 9 and 10 these diffusers 32, 33 terminate at one end at the duct rear wall 5 and at the opposite end adjacent to, but in spaced relation to the junctures of duct walls 7 and 8. In this manner, air entering between the plates 32, 33 may move forwardly and out opening 12, and also upwardly and downwardly between the ends of 32, 33 and the adjacent junctures of duct walls 7 and 8. Additionally plates 32, 33 are in staggered spaced relation to the adjacent duct walls 6 so that part of the incoming air between 32, 33 can move upwardly and downwardly between duct walls 5 to provide a substantially equal air pressure in the duct at opposite sides of the air inlet openings 15 and 17.

Referring now to FIG. 8 wherein is disclosed a horizontal cross-section through the receiving duct 2 which is comprised of rear wall 33, side walls 34 having converging portions 35 terminating in forwardly extending portions 36 provided with diverging portions 37. The free ends of portions 37 may be provided with forwardly extending portions 38. The duct portions 36 may be connected by suitable fasteners 39 upon which are mounted spacers 40 to define an inlet opening 41. As shown in FIG. 1 the duct 2 is closed at opposite ends by suitable end caps 42, 43 suitably secured in place. End

cap 43 is provided with a suitable opening 44 defined by an upstanding collar 9 (not shown) received within one end of conduit elbow 45 which in turn is connected by conduit section 47 to fan 4. Fan 4 may be supported from enclosure wall 48 by a suitable bracket 49 or by any other suitable means to a suitable support.

Referring now to FIG. 2 of the drawing and considering line L as bisecting the opposing ducts 1A, 1B and 2, the duct 1A may be deflected to one side of line L as desired in amount X and duct 1B deflected to the opposite side of line L as desired in amount Y. This duct movement being made possible by the swivel connections of conduit sections 13 and 18 with fan 4, T member 14 and elbow 9. The amount and direction of the deflection will be determined by the location of ducts 1A, 1B and 2 relative to opening E in area wall 48. Should the area being cooled have a door closing opening E and the door would swing outwardly relative to the said area, the described apparatus would be mounted within the area and the air stream from duct 1A would be deflected to blow slightly outwardly from the area opening E, with the air stream from duct B directed across opening E and inwardly of the area. Should the said door closing opening E be disposed within the said area, then the apparatus would preferably be mounted upon the outer face of the wall 48 on said area. In this latter instance the direction and degree of deflection of ducts 1A and 1B may change.

The principal purpose of the air curtain is to restrict passage of cooled air from the refrigerated or air conditioned area through the entrance or exit opening E. An auxiliary, yet important, purpose is to exclude insects and airborne dust from entering said area. Within a refrigerated area the colder and heavier air is adjacent the floor of the area and the warmest air is at the ceiling or roof of the area. Since the air stream emitted from the openings 12 of ducts 1A and 1B normally increase in thickness as it approaches receiving duct 2 such change in direction of the air stream may be sufficient for all purposes, under certain operating conditions. On the other hand, where there is a substantial amount of traffic through opening E and the temperature within said area is within the range between 32° F. and 0° F. better restraint against the air adjacent the area floor passing through the opening E would be obtainable where the air stream from duct 1B is directed at some angle inwardly of the area and the air from duct 1A directed at some angle outwardly through openings E. Under various operating conditions obtaining during test of the apparatus it appeared that upwards to 5° deflection of the air stream from duct 1A towards the warm side of opening E and from 10 to 45° deflection of the air stream from duct 1B inwardly towards the cold side is sufficient. The degree of deflection of the jet air from duct 1B normally increasing with the increase of pressure from the air adjacent the floor of the cold room. The apparatus is considered to be more efficient when mounted within the area being protected.

The size of the openings 12 in ducts 1A and 1B are subject to variation depending upon the height of the ducts, the volume and pressure of air provided by the fan. Tests have demonstrated that a jet stream of air from ducts 1A and 1B provided with a width of 3/8" at 12 and a door opening height of 6 feet emitting air having a velocity of 1100 to 1500 feet per minute at about 6 inches from the opening gave satisfactory results. As the height of the door opening and consequently the height of the ducts 1A and 1B increased, the width of opening 12 should be reduced to obtain the same results with the same air volume and pressure from the blower fan. Thus between 6 feet and 11 feet of door opening height the slot opening 12 will decrease from about 3/8" to about 3/16" with the capacity of the fan remaining constant. At the opposite side of the door opening the velocity of the air at receiving duct 2 is

preferably between 600 to 800 feet per minute. The duct **2** also increases in height with the height of the door opening, however, it has been found desirable to maintain the width of opening therein at a constant relation, that is about ¾" at the bottom and about ¼" at the top.

It will be understood that the details of construction herein given are by way of example and not limitation. It will be understood by those skilled in the art that many variables are present and modification of the exact details of construction herein given will be readily indicated to one having such skill.

Referring now to the operation of the herein described apparatus, the pair of ducts **1A** and **1B** are preferably disposed at one side of a door opening and the duct **2** disposed at the other side of the said door opening and within the room area to be protected. The ducts preferably have a height of not less than that of the door opening, with the air intake slot of the receiving duct having an area of about twice that of the air discharge slots of the air jet ducts. The air receiving duct and the air jet ducts are closed except for the air receiving and discharging slots referred to. A suitable conduit and blower system is connected with the top of the receiving duct to exhaust air therefrom by said fan and blow same into the air jet ducts **1A** and **1B**. Preferably the air is introduced into ducts **1A** and **1B**, intermediate the ends thereof. Within each duct **1A** and **1B** are diffuser plates **32, 33** presenting convex faces to incoming air and spaced baffle members **20, 25, 27** presenting concave faces to the incoming air. These baffle and diffusing members are alternately spaced from opposite sides of the ducts causing the air to flow from the mid-portion of the ducts in alternately inclined upwardly and downward directions to prevent stratified air flow and to substantially uniformly pressurize the ducts throughout their lengths. In this manner the outlet openings emit a substantially uniform density of air at any vertical cross-section therethrough for maximum efficiency. The broad inwardly converging face of the receiving duct **2** carries the air to the inlet opening **41** and passing therethrough to the interior of the duct and filling same with a substantially uniform longitudinal volume of air. This air is in turn withdrawn therefrom by the blower fan and discharged into the aforementioned ducts **1A** and **1B**.

The aforementioned velocity of the air stream from the jet ducts **1A** and **1B** at a distance of **6** inches from the jet duct openings **12** indicates a continuous curtain of air flowing across the room opening readily excluding insects and dust from penetrating therethrough. The relatively high air velocity of 600 to 800 feet per minute at the receiving duct clearly establishes the air curtain as moving continuously across the room opening and not diffusing into the room or outside atmosphere in amounts to destroy the efficiency of the curtain for its intended purpose.

The maximum air velocities and air volumes hereinbefore described are intended for restraining outflow of refrigerated air at below freezing and as low as 0° F. Additionally such low temperature air between 0° F and 32° F. is under greater than atmospheric air pressure within the room area. The ready adjustability of either or both ducts **1A** and **1B** permits modification in the direction of flow of the air drape as well as its velocity to effect its intended functions. It will be understood that apparatus of similar construction but operating with less air volume and/or presure may be utilized where less severe temperature and presure differentials prevail between the interior of the cooled room or area and the outside atmosphere.

It is acknowledged that the baffles within the jet ducts **1A** and **1B** may be substantially modified in both shape and relation to the duct and to each other, and the apparatus could perform to some degree under less severe conditions than room temperatures between 0° F. and 32° F. However, the specific arrangement disclosed performed with a high degree of efficiency under such severe conditions and are recommended in such cases.

The herein described apparatus may be readily adapted for automatic or manual control of its operation. For manual control the fan motor is connected to suitable power lines, which connection is controlled by a manually operated switch. Additionally, in such cases where the entrance to the protected room area is provided with a door which may be closed for substantial periods of time, any suitable wiring diagram connecting the fan motor to power lines, may be equipped with a conventional switch which is actuated from open to closed position by movement of the door from closed to open position or vice versa. The compactness and details of construction of the ducts enables the apparatus to quickly reach operating efficiency after the fan is actuated.

I claim:

1. Apparatus for establishing and maintaining a moving curtain of air transversely of a door opening leading to a room refrigerated to temperatures below 32° F., which air curtain is of sufficient velocity and direction to retard escape of refrigerated air from the said room area and exclude entrance of dust and insects, comprising,

(a) a vertically disposed air discharge duct disposed adjacent one side of the said door opening and provided with a vertically extending opening directing a high velocity vertical air stream across the full height thereof and towards a vertically disposed air receiving duct located adjacent the opposite vertical side of said opening for restricting passage of cold air from said room, means for adjustably mounting said air discharge duct,

(b) a vertically disposed air receiving duct adjacent the opposite side of said door opening comprising a front face defined by a continuous vertical rectangular shaped opening of substantially the width of the adjacent air curtain to be received therein and of a height substantially that of said door opening, rearwardly converging sidewalls at opposite sides of said rectangular shaped opening defining a vertical constricted throat opening, a vertically extending air collecting and transmitting chamber having a closed bottom portion and a top portion connecting with said throat opening, and

(c) air conduit means connecting said ducts and embodying suitable fan means to draw air in the desired volume through said receiving duct and discharge it at the desired velocity through said discharge duct to maintain an air curtain of the desired characteristics.

2. Apparatus as defined in claim **1** wherein said air discharge duct comprises

(a) two separate spaced vertically aligned portions having closed top and bottom walls, a rear wall and forwardly extending converging side walls defining an air discharge opening,

(b) spacer means disposed between the free ends of said converging duct side walls for regulating the width of said air discharge opening,

(c) a connection between each said air discharge duct portion rear wall and said air conduit means for filling each duct portion with air and,

(d) means forming part of said connection providing limited vertical rotary movement between the respective ducts and adjacent air conduit means.

3. Apparatus as defined in claim **1**, wherein the discharge duct portions above and below said air inlet opening are provided with vertically spaced concave baffle members extending forwardly from the rear wall of the duct towards the duct outlet opening, each said baffle members terminating short of one duct side wall and adjacent the opposite duct side wall so as to cause the

incoming air to pass between one baffle member and an adjacent duct side wall and to pass between an suceeding adjacent baffle member and the opposite side wall during passage towards the end wall of the duct.

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