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PATENT SPECIFICATION

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1 582 336

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(19)

(54) IMPROVEMENTS IN OR RELATING TO VENTILATION AND TEMPERATURE CONTROL APPARATUS

(71) We, DELANAIR LIMITED, a British Company of Abbey Works, Abbey Road, Barking, Essex, do hereby declare the invention for which we pray that a 5 patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to apparatus for 10 ventilation and temperature control of an enclosed space or compartment of a vehicle, such as the driving and/or passenger compartments of cars, lorries, and trucks.

15 According to the present invention, there is provided a ventilation and temperature control apparatus for an enclosed space or compartment of a vehicle comprising a plurality of rotary valves each provided 20 with respective entry ports for admitting two different temperature airflows and at least one outlet port for directing the mixed admitted airflows to a respective delivery conduit each said valve having a 25 valve body co-operating with its associated entry and outlet ports and being rotationally displaceable to vary the proportions of the two different temperature airflows admitted for mixture and also to permit 30 the plurality of valves to vary the proportions of the mixed flows directed to said delivery conduits, adjustment means for said displacements being connected to the bodies of the valves for rotating the valve 35 bodies interdependently and for rotating one of the valve bodies independently whereby to adjust the relative positions of said valve bodies in said interdependent rotation.

40 Thus, in apparatus according to the invention, while there may be a common drive means for rotating the valves interdependently of each other, the means for rotating one of the valves independently 45 need not prevent such interdependent

operation of the valves but can be used simply to adjust the relative starting or end settings of the valves.

In one form of the invention, advantageously the interdependent operation of the 50 valves is effected by automatic control means, and said independent operation is under manual control to allow an occupant to modify the operation of the apparatus.

A further advantage that can be obtained from the use of rotary valves is 55 that low rates of flow can be more closely controlled by arranging that each valve and/or its ports have closure edges oblique to the axis of rotation of the valve whereby 60 closure is effected in a progressive manner along the length of the valve. A given angular movement of the valve near the closure position thus exposes a smaller flow cross-section occupying only part of the 65 length of the valve. Preferably, where multiple delivery points are fed from the same valve, the valve outlet ports are symmetrically arranged relative to a central radial plane of the valve and said oblique 70 closure edges are similarly symmetrically arranged. It is also possible to form said closure edges so that in dependence on the valve setting the total delivery airflow is admitted in different proportions to delivery 75 conduits further downstream.

Sealing of the valves in their closed positions can be achieved in a particularly convenient manner by providing, between the peripheral face of a valve and the adjacent 80 face of its housing, a thin layer of low-friction material on one of said faces backed by a resilient layer urging said low friction layer into contact with the other of said faces when peripherally coincident 85 with said other face.

It is also advantageous, to avoid non-uniform temperature effects, if the valves have mixing vanes projecting inwards of their peripheral sealing faces. 90

According to a further preferred feature of apparatus according to the invention there are both heating and cooling devices for the airflow and the apparatus has means 5 for directing through the heating device at least a part of the air flow from the cooling device and for controlling the airflow to maintain a desired temperature level in said compartment, and means for 10 varying the cooling device temperature whereby to limit the dehumidification of the airflow therethrough at higher temperature levels.

The invention will be more particularly 15 described by way of example with reference to the accompanying drawings, wherein:—

Fig. 1 is partly sectioned side view of an 20 apparatus according to the invention intended for a private passenger vehicle interior,

Fig. 2 is a perspective view of the apparatus in Fig. 1, but with the upper manifold removed,

25 Fig. 3 is a part view from below of the apparatus of Figs. 1 and 2 with a slightly modified form of casing,

Fig. 4 is an illustration of an alternative 30 drive arrangement for the rotary valve bodies,

Figs. 5 and 6 are part views illustrating a modification of the apparatus of the preceding figures in which the operation of the apparatus is controlled manually,

35 Fig. 7 is a view from the rear of the part of the apparatus shown in Fig. 5,

Fig. 8 is a diagrammatic illustration of the control scales for the manually operated arrangement shown in Figs. 5 to 7, and

40 Figs. 9 and 10 are schematic sectioned views, in planes X-X and Y-Y at right-angles to each other, of a modified form of rotary valve for use in apparatus according to the invention.

45 The apparatus shown in the drawings is similar in many respects to that described and illustrated in our U.K. Patent No. 1 490 336 and can be similarly controlled so that reference can be made to that 50 specification for features of the servo control system not shown here.

Like that earlier apparatus, a casing 1 contains an evaporator 2 forming part of a refrigeration unit, air being driven by fans 55 (only the discharge openings 3 for which are shown) through the evaporator and a condensate trap (not shown). Immediately downstream of the condensate trap is a heater 6 for taking heat in known manner 60 from cooling water from an internal combustion engine powering the vehicle.

Upper and lower outlet manifolds 10, 12 of the casing (the upper manifold being shown only in Fig. 1) for the air flow 65 through the casing having the respective

flows through them controlled by upper and lower rotary valves 14, 16. Each valve comprises a cylindrical sector-form valve body 18, 20 respectively, rotatable about axis 24 or 26. The upper valve 14 is able 70 to control the opening of inlet ports 28, 30 and outlet port 32 to the manifold 10. The port 28 communicates directly with the area downstream of the evaporator to provide a cooled airstream and the port 75 30 is placed downstream of the flow from the heater so that it admits a heated airstream. The lower valve 16 similarly has an inlet port 34 for cool air and an inlet port 36 for heated air, with outlet port 38 80 to the outlet manifold 12 that leads to outlets 12a, 12b on opposite sides of the casing, and it will be clear that the angular setting of the valve body in each instance 85 will determine the proportions of heated and cooled air discharged to the associated outlet manifolds.

To provide a suitable seal with the rims or flanges of the porting, each valve body has its outer peripheral face covered by 90 a thin layer of relatively low-friction material, such as nylon, and has under this a resilient layer, e.g. polyurethane foam, that will urge the surface layer yieldably into contact with the porting flanges. 95 These seals are illustrated in Figs. 9 and 10. They may be constructed in a variety of materials and may be on the porting flanges, as at 36a, instead of on the valve bodies. At least the upper valve has mixing 100 vanes 18a projecting radially inwardly on the valve body to assist thorough mixing of the heated and cooled airstreams in the outlet manifold.

Preferably, the closure edges of each 105 valve body extend slightly obliquely to the flanges of the associated porting, as illustrated at 18b in Fig. 2, so that near the fully closed position of each port, an aperture is formed over a progressively changing 110 axial length and there is a more gradual opening and closing of the port. This allows better control of the airflow at small valve openings and the peak torque on the valve body, especially when closing, 115 is reduced, and it will be understood that to obtain this effect the valve body edges and the closure edges of the porting flanges can be oblique to the rotary axis of the 120 valve body. Preferably the oblique formation is generally symmetrical over the axial extent of the valve body if the exits from the outlet manifold are similarly symmetrically disposed, so that similar temperature and flow conditions are obtained at laterally 125 opposite regions of the outlet manifold at small opening settings when the valve aperture extends over only part of the axial length of the valve. The formation of the closure edges can also be so shaped as 130

to influence the proportions of the airflow delivered to different outlet conduits fed from the same manifold, e.g. favouring the side outlets from the manifold at small 5 opening settings in the configuration shown, whereby at such settings a larger proportion of the airflow will pass through said side outlets.

The distribution of the air flows from 10 the respective manifolds may be performed in a similar manner to that described in the specification of the aforementioned UK Patent 1 490 336. Thus, there is a face-level 15 ventilaiton flap valve 40 in the upper manifold 10 operated in dependence on whether the upper level discharge is to be directed onto the screen or onto the occupants, and distribution trunking (not shown) from the upper manifold with further valves, e.g. 20 to the screen and to side vents in the fascia panel. Associated with the side extensions 12a of the lower manifold 12 there may be trunking extending rearwards of the driver's seat if rear-seat passengers are to 25 have a direct supply of foot-level air.

Means are provided to allow the relative 30 proportions of the mixed flows of heated and cooled air in the upper and lower manifold to be varied differently from each other. The drive mechanism by which this is achieved is shown in Fig. 2. On the spindle of the lower valve body 20 there is a toothed wheel 44 connected by a toothed belt 45 to a drive wheel 46 on 35 shaft 47. The wheel 44 carries a crank 48 connected to a crank 49 on the spindle of the upper valve body 18 by a linkage comprising a first link 50, a pivot plate 51 mounted on a pivot 52, and a second link 40 53. Rotation of the drive gear 46 thus rotates both valve bodies in opposite directions.

In addition, the pivot plate 51 is connected only indirectly to the casing, its 45 pivot 52 being on a carrier plate 54 that is itself pivoted to the casing at 55. A lever 56 pivoted on a bracket 57 fixed to the casing is connected by a further link 58 to the carrier plate, so that movement of 50 the lever to pivot the carrier plate 54 will also pivot the plate 51, and with it the crank 49 and upper valve body 14, independently of the lower valve body. Thus, with the drive belt and the lower valve 55 body 20 stationary, operation of the lever will cause the upper valve body 18 to rotate in one direction or the other advancing or retarding the valve setting in relation to the setting of the lower valve. In other 60 words, the relative temperatures of the air discharge at upper and lower levels can be varied by this adjustment.

There is also scope for varying the relative proportions of hot and cold air through 65 one outlet manifold as compared with the

other, in a manner that is controlled by the movement of the drive wheel 46, by suitable choice of the angular extents and positions of the valve porting and the valve bodies, and by choice of the ratio of 70 angular movements of the upper and lower valve bodies by the drive wheel. In this connection also, ventilation flap 40 is displaceable from a closed position to a fully open position 40a to increase the proportion of the outflow delivered to face level, as would be required when the apparatus 75 is operation in a cooling mode.

The ventilation flap 40, the drive wheel 46 and the level 56 can be manually controlled or can be controlled by a servo control system as described in UK Patent No. 1 490 336 through similar mode and temperature controls. In the example of Figs. 1 to 3, the flap and drive wheel are 80 automatically operated but the lever 56 is adjusted manually, for example when it is required to adjust the temperature difference between the upper and lower level discharges. As may be seen in Figs. 1 and 90 3 in particular, the automatic control arrangement comprises a rotary cam shaft 62 which can be fixed to or form part of shaft 47 and it will be noted that co-ordinated movement of the valve bodies 95 can be obtained simply by the rotation of the two spindles on which they are mounted, so simplifying the transmission of the control drive thereto. Moreover, it is possible to obtain the movements with 100 a substantially constant torque load whereas lever flap valves each require an increased force at the end of their travel to obtain adequate sealing, although it is convenient in the present example to use 105 such a valve 40 also.

The apparatus also includes an adjustable thermostat 76 of a commercially known type with capillary sensing element 76a, for controlling the evaporator temperature. The thermostat has an adjustment lever 77 the setting of which is determined by a cam 78 on the cam shaft 62, which has the effect of automatically raising the evaporator temperature at positive 110 heating settings of the cam shaft. The purpose of this arrangement is to retain more of the moisture content in the throughflow of air when higher temperature levels are set. 120

If an evaporator thermostat is set to a temperature immediately above freezing point, the airflow from the evaporator will have about 100% relative humidity at that temperature but when the air temperature 125 is then raised its relative humidity reduces sharply. Thus, at such a setting the evaporator may produce air that is uncomfortably dry when the air temperature is raised to substantially higher values. By 130

adjusting the evaporator temperature upwards when the air is subsequently required to be heated to an outlet temperature in the upper part of the range obtainable from the apparatus, more of the original moisture content is retained in the air after it has passed through the evaporator and a more comfortable relative humidity can be obtained in the outlet air flow.

Fig. 3 in the accompanying drawings illustrates the location of the cam shaft 62 on the casing, as well as its drive motor 64 with reduction drive gear 66. A feedback 15 potentiometer of the servo system (operating as described in the specification of the earlier UK appln. already referred to) can be on the opposite side of the casing to the belt 45 and have its movable part 20 mounted directly on the lower valve body spindle, but it can be placed elsewhere, e.g. on the upper valve body spindle, or on the cam shaft itself.

The arrangement of the electrical and 25 vacuum switches on the servo motor assembly is generally similar to that described in our earlier UK patent and preferably, for economy of manufacture, the vacuum switches are of labyrinth construction and the electrical switches comprise printed circuits.

Fig. 4 illustrates an alternative operating mechanism for the valve bodies 18, 20 in which respective toothed gear wheels 44, 35 59 are mounted on the lower and upper valve body spindles respectively. The upper wheel 59 meshes with a further gear wheel 60 that is fixed to a gear wheel 61 connected to the gear wheel 44 by a tooth 40 belt 45a that, as before, passes round the drive wheel 46. The tension of the belt is maintained by a spring-loaded idler wheel 63. As before, rotation of the drive wheel will cause rotation of both valve bodies in 45 opposite directions. The pair of wheels 60, 61 is mounted on a link arm 65 that is itself pivoted on the axis of the upper valve body 18 and a control member (not shown) is connected to the lower end of the link 50 arm to pivot the gear pair about the upper valve body axis. The upper valve body can thus be rotated independently of the drive belt and the lower valve body to cause relative advance or retardation of the valve 55 settings in the same way as the first described example.

Figs. 5 to 8 illustrate details of an alternative, manual control arrangement, operating without cooling means (i.e. the 60 evaporator 2 could be omitted) and in which the settings are obtained by two rotary knobs on the vehicle dash, mounted on spindles 72 (Fig. 5) and 74 (Fig. 6). The 65 dial indicator scales associated with these knobs are shown in Fig. 8.

The left-hand spindle 72, which in the automatic arrangement would control a potentiometer for varying the setting of the camshaft 62 through the motor 64, now controls the airflow. It has an off 70 position in which there is no airflow, through the apparatus, i.e. the fans are isolated from their electrical supply (which may alternatively be achieved using the right-hand knob) and either the valve 75 bodies are in positions blocking all airflow or a vacuum-switch control operating a valve (not shown) at the entry to the fans is de-energised to close the valve and so prevent air entering due to ram effect when 80 the vehicle is travelling at speed. (Similar provision is of course made for blocking air flow in an off position with the automatic control arrangement and there the valve closure can be arranged to cause 85 recirculation of the air in the compartment).

The left-hand spindle 72 also has three fan speed settings, namely low, medium and high. Accordingly, with hot water 90 from the engine cooling system flowing through the heater, for a given setting of the rotary valves a greater or lesser amount of heat is carried by the airflow from the unit, in dependence upon the fan speed 95 setting.

The right-hand spindle 74 determines the proportions of the airflows that go through and that bypass the heater matrix as well as the proportions of the upper and lower 100 level discharges. It also has an off position in which it may act to close a stop valve (not shown) in the heater water circuit, although such a valve will not necessarily be provided. The spindle 74 extends to a 105 pair of bevel gears 82 on the output shaft of which there is the drive wheel 46 of the toothed belt 45 that rotates the valve 14, 16. Turning the knob anticlockwise from the off position opens the heater water valve, if 110 such a valve is provided, and the first setting reached is a demist-defrost position at which the valves are set so that the heater bypass ports are blocked and only heated air can escape from the upper manifold 10 while the lower manifold 12 is closed.

The knob of the spindle 74 can be rotated further through a series of settings 120 graduating between high temperature and low temperature discharge. In these different settings the proportions of the discharge between the upper and lower exit manifolds may be arranged to vary so that the proportion discharged from the 125 lower manifold decreased as the temperature reduces and the proportions of heated air reaching each manifold may be arranged to vary so that at high temperature settings, for example, the output 130

through the upper manifold is at a lower temperature than the output through the lower manifold. The user is also able to pivot the lever 56 or the link arm 65 of the 5 upper valve body by a separate manual control (not shown) so as to modify this effect, or the link arm position may be determined by adjustment in the garage.

There is also a ventilation position at 10 the extreme position of anticlockwise adjustment of the control spindle 74 where only unheated bypass air reaches the outlet manifolds and the heater water control valve, if any, is closed, but the flap valve 15 40 is fully opened to allow a maximum flow of fresh air from the fans to face level.

The first-described automatically operated arrangement can be constructed 20 without cooling means, as in the manually controlled arrangement just described, obtaining temperature control by mixing ambient temperature and heated airstreams. It will be clear without further detailed description that it is possible, analogously, 25 to provide a manually controlled apparatus with a refrigeration unit that has a cooling evaporator if air conditioning is required, and with an adjustable evaporator operating 30 temperature also if desired.

Figs. 9 and 10 illustrate an alternative rotary valve that can be incorporated in apparatus according to the invention. This valve has multiple outlet ports as well as 35 multiple inlet ports and in the arrangement shown hot and/or cold air through inlet ports 102, 104 of a casing 100 can be directed through either or both outlet ports 106, 108 that communicate with screen 40 and foot level outlets respectively, drum-like rotary valve 110 having peripheral openings 112, 114 that register with the casing ports in the required sequence and pattern to give appropriately controlled 45 proportions of hot and cold air through the two outlet ports. Such a construction can reduce the number of separate valves required, since in the preceding examples described the airflow is distributed from 50 the rotary valves to foot level, face level and screen by the use of additional valves.

The relatively short axial length of the valve shown in Fig. 10 is suitable for an arrangement in which valves are disposed 55 adjacent opposite sides of the apparatus so that two spaced outputs can be produced that may, if desired, be controlled separately of each other by independent rotation of the spindle 116 of each valve. Figs. 9 60 and 10 also illustrate the sealing means provided in the manner described above between a valve body and the adjacent faces of the valve casing, comprising a soft resiliently yielding underlayer 118 for a 65 low friction surface layer 120.

It will be understood that valves of the form shown in Figs. 9 and 10, with multiple inlets and outlets, can be used simply in ventilation and temperature control apparatus according to the invention to vary 70 the proportions of the two different temperature airflows admitted to the valve and also to vary the proportions of the mixed flows directed to the delivery conduits. 75

WHAT WE CLAIM IS:—

1. A ventilation and temperature control apparatus for an enclosed space or compartment of a vehicle comprising a plurality of rotary valves each provided with respective entry ports for admitting two different temperature airflows and at least one outlet port for directing the mixed admitted airflows to a respective delivery conduit, each said valve having a valve body co-operating 85 with its associated entry and outlet ports and being rotationally displaceable to vary the proportions of the two different temperature airflows admitted for mixture and also to permit the plurality of valves to vary 90 the proportions of the mixed flows directed to said delivery conduits, adjustment means for said displacements being connected to the bodies of the valves for rotating the valve bodies interdependently and for 95 rotating one of the valve bodies independently whereby to adjust the relative positions of said valve bodies in said interdependent rotation.

2. Apparatus according to claim 1 where- 100 in manual means are provided for said independent rotation of said one valve body.

3. Apparatus according to claim 1 or 105 claim 2 wherein co-operating closure edges on at least one valve body and its associated valve ports determine the closure of the ports with the rotary adjustment of the body, at least one said closure edge having at least a portion of its length 110 oblique to the axis of rotation of the valve body whereby closure is effected in a progressive manner axially of the valve.

4. Apparatus according to claim 3 where- 115 in said at least one valve body is arranged to control the airflow to a plurality of delivery conduits through outlet ports of the valve that form a symmetrical arrangement with said at least one oblique closure edge. 120

5. Apparatus according to claim 3 or 125 claim 4 wherein said oblique edge or edges is or are arranged to vary the relative proportions of the airflow through respective delivery conduits fed by said at least one valve.

6. Apparatus according to any one of the preceding claims wherein at co-operating faces of at least one of said valve bodies and a valve housing for said body 130

there is provided a thin layer of low-friction material on one of said faces with a resilient layer backing urging said low-friction layer into contact with the other 5 of said faces when coincident with said other face to provide sealing engagement between said faces.

7. Apparatus according to any one of the preceding claims wherein the body of 10 said at least one of said valves comprises inwardly projecting airflow mixing vanes.

8. Apparatus according to any one of the preceding claims comprising cooling and heating devices for said different 15 temperature airflows and conduit means directing through the heating device at least a part of the flow from the cooling device, there being means for controlling the airflows to maintain a desired temperature

level in said space or compartment and 20 said control means further comprising means for varying the temperature of the cooling device whereby to limit the dehumidification of the flow therethrough at higher temperature levels. 25

9. A ventilation and temperature control apparatus constructed and arranged for use and operation substantially as described herein with reference to Figs. 1 to 3 of the accompanying drawings, or Figs. 30 1 to 3 as modified by Fig. 4 and/or Figs. 5 to 8 and/or Figs. 9 and 10 of the accompanying drawings.

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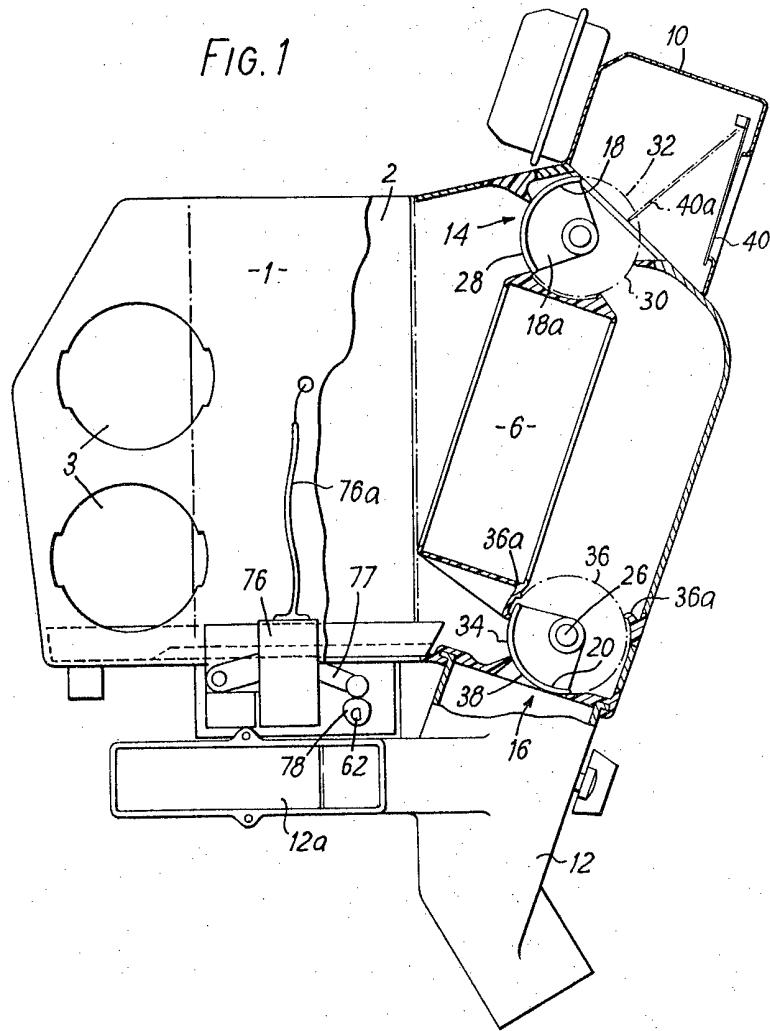
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FIG. 1



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FIG.3

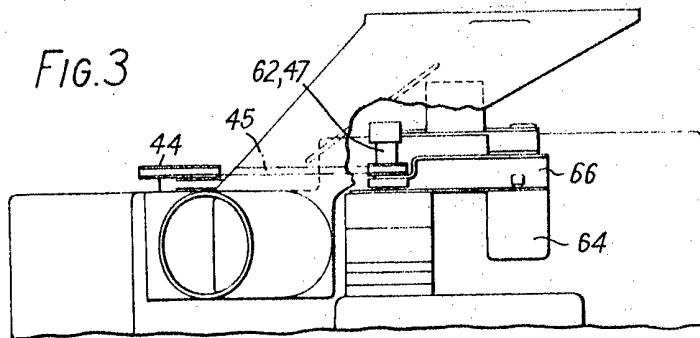
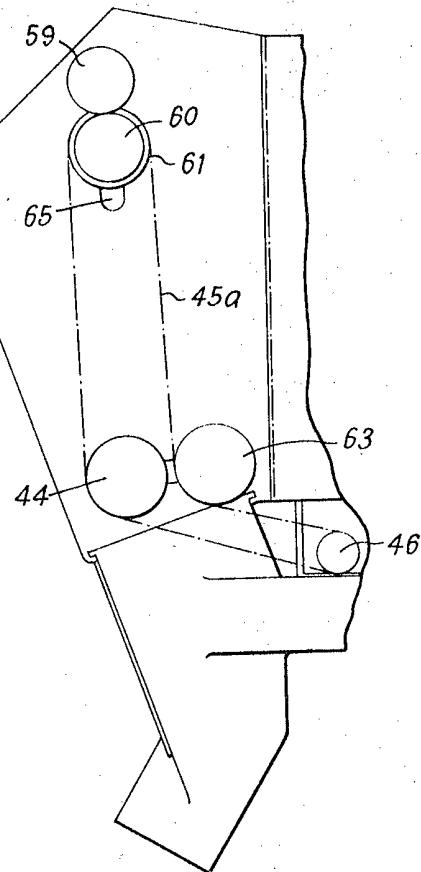


FIG.4



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FIG. 5

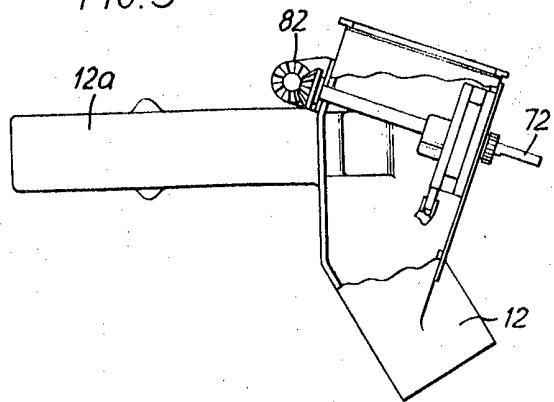


FIG. 6

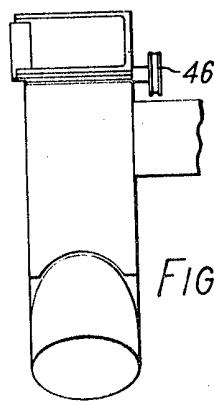
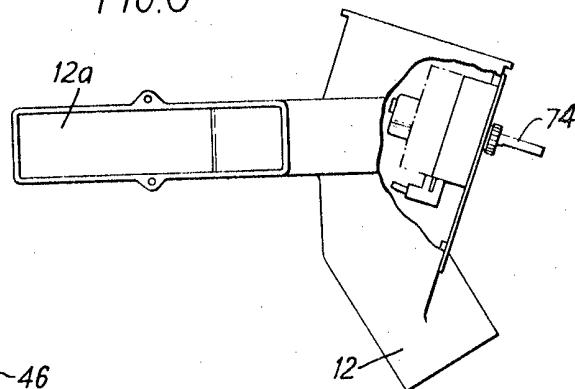


FIG. 7

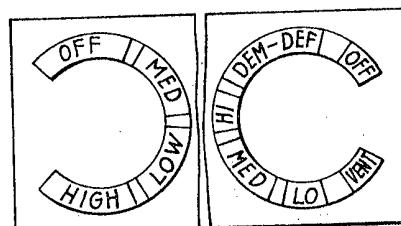


FIG. 8

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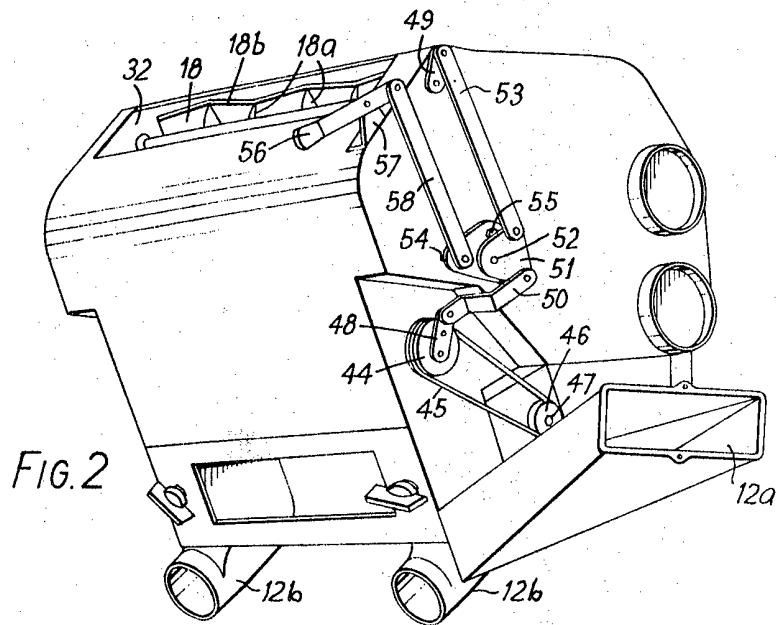


FIG. 2

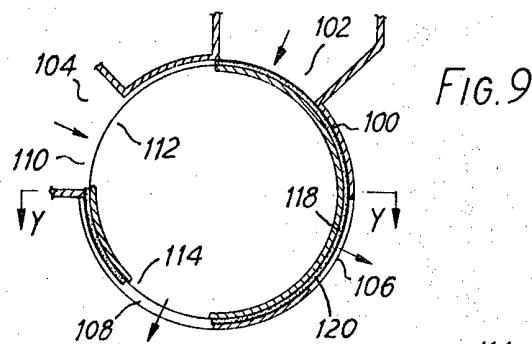


FIG. 9

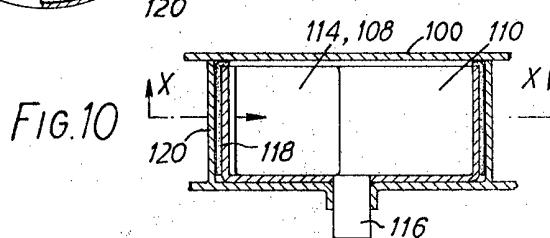


FIG. 10