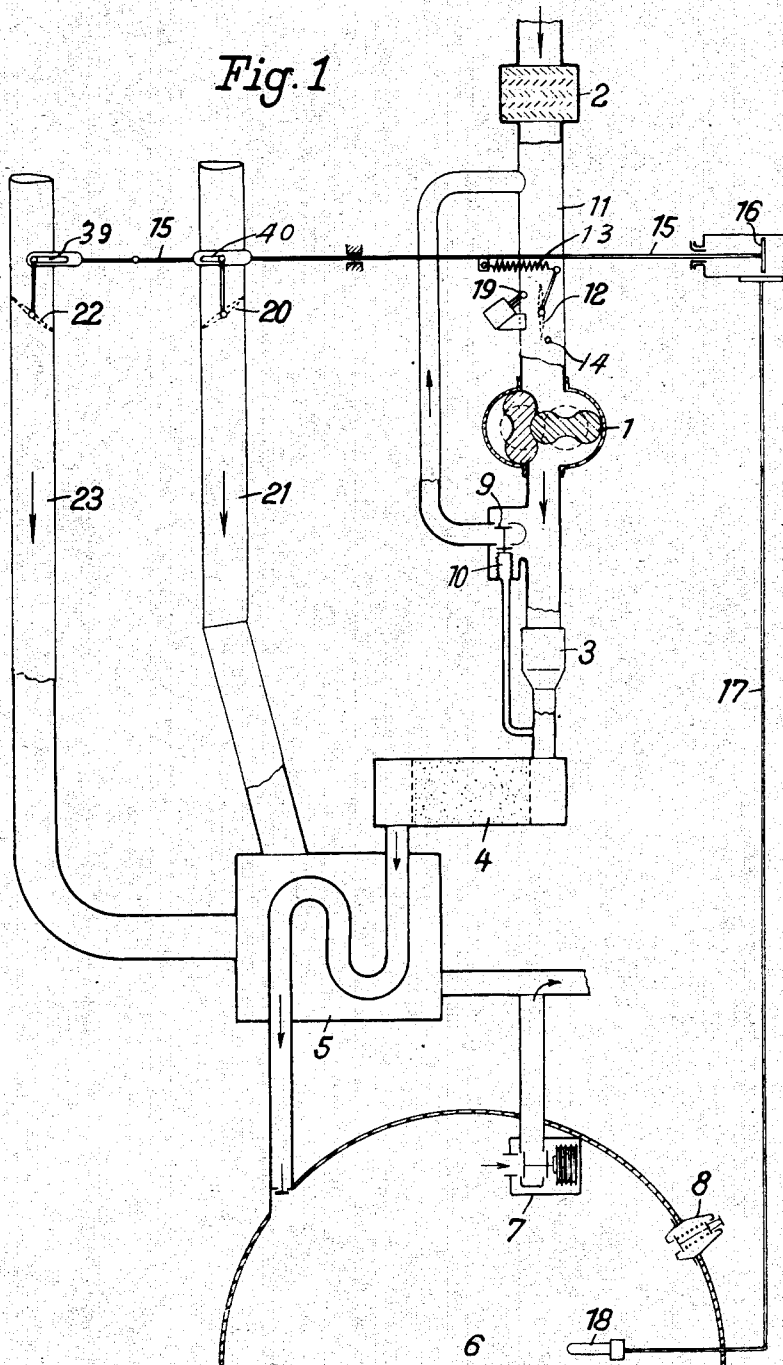


April 13, 1943.

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TO THE CLOSED CABINS OF AIRCRAFT
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2,316,237

2 Sheets-Sheet 1



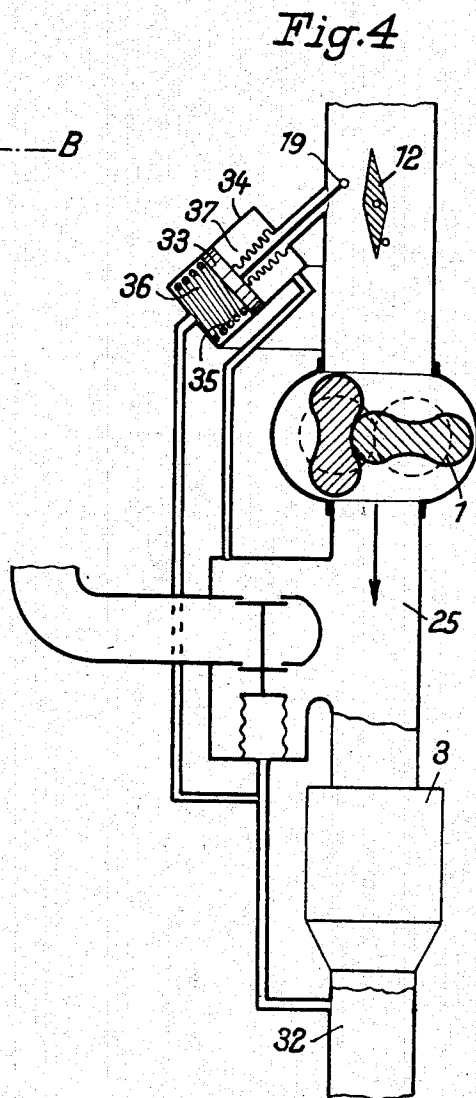
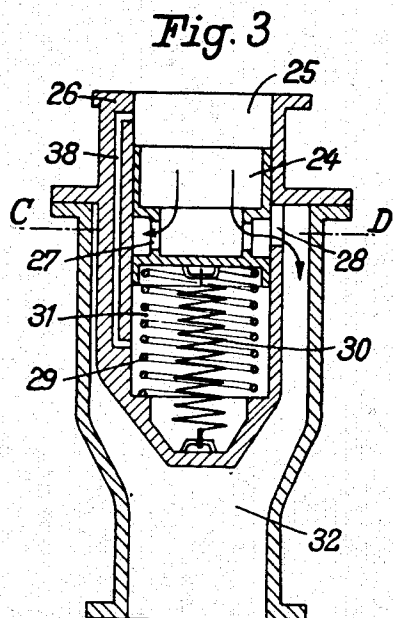
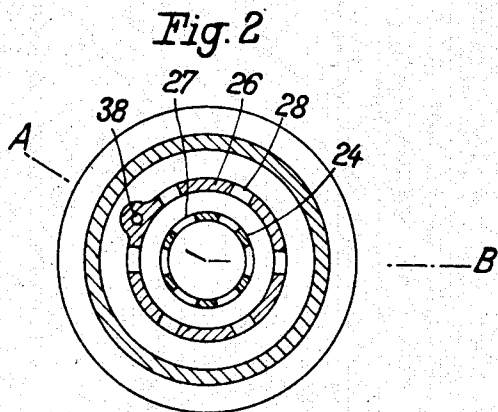
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SIEGFRIED GRÜNERT and
HANS JDE by their Attorneys
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UNITED STATES PATENT OFFICE

2,316,237

MEANS FOR CONTROLLING THE SUPPLY OF AIR TO THE CLOSED CABINS OF AIRCRAFT

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In Germany November 25, 1939

9 Claims. (Cl. 128—204)

The invention relates to novel and improved means for controlling the supply of air to the closed cabin of an aircraft.

An object of the invention is the maintenance of a constant amount of air at any altitude of the aircraft, this amount of air being blown into the cabin as fresh air by means of a compressor.

A further object is to provide novel means for either heating or cooling the air fed into the cabin.

Further objects of the invention will become obvious from the description hereinafter given.

Heretofore it has been common practice to take the fresh air required for the cabins from a separate compressor or from the supercharger of the driving engine in connection with an additional breathing air compressor, valves having been provided in the induction and delivery pipes, which valves have usually been controlled by the air pressure prevailing in the cabin. While the desired air pressure is hereby maintained in the cabin, the amount and temperature vary, especially with displacer type compressors, thus rendering air conditioning of the cabins more difficult.

The present invention provides for a control of the supply of air, permitting the control of pressure, quantity, and temperature of the raised air to be accomplished largely independently of each other and possibly even fully automatically in addition in the case of displacer type compressors.

If a displacer type compressor—for instance, a Root's blower—is driven by the power plant at an almost constant speed, the weight of air raised by it decreases in proportion to the density of the atmospheric air as the altitude of flight increases, while the volumetric efficiency of the compressor remains constant. Therefore the displacer type compressor must be so designed as to raise at least the designated amount by weight at the designated altitude. To maintain an almost constant amount by weight of air which for obvious reasons is desirable for the airing of cabin, the excess air raised at altitudes below the designated height will be either throttled down on the suction side or blown off on the delivery side. According to the present invention, an automatic, quantitative control of the cabin air is obtained in a manner that, for instance, for a constant amount by weight of fed air, a resistance is placed behind the displacer type compressor, this resistance acting as a throttle and having the effect that, if the displacer type compressor raises an amount

by weight of air exceeding that absorbed by the resistance, the pressure prevailing between the displacer type compressor and resistance will rise and the surplus air will be blown off through a blow-off valve without materially affecting the amount by weight of air fed into the cabin. An independence of altitude of this automatic, quantitative control will be obtained by controlling the blow-off valve by a controlling means operating only on the difference in pressure prevailing before and behind the resistance. Furthermore, with a view to obtain the greatest possible economy, the difference in pressure causing the blowing off is made only slightly higher than the pressure gradient required for the quantitative control. By means of a profitable utilization of the heat content or energy of pressure of the overflowing air, the economy of control may be further enhanced. If the utilization of the overflowing air is not worth while, the surplus air is either blown off into the open air or passed again into the induction pipes of the displacer type compressor. The latter measure will be preferably adopted if silencers are provided in the induction and delivery pipes and it is intended to save such a silencer in the by-pass pipes or to reduce the loss of pressure in the silencer provided on the suction side.

If the strictest maintenance of a constant amount by weight of air is insisted upon, a controlling means of special design, as described more particularly hereinafter, may be substituted for the resistance.

The pressure in the cabin is generally controlled by pressure valves operating independently of altitude and, above the nominal altitude, by blow-off valves. To make the amount of air as independent of the controlling principle of the cabin pressure as possible, a controlling means will be used which operates, within the ranges of pressure occurring, practically independently of the static pressure prevailing at the outlet of the controlling means.

The temperature of the raised air is determined, except by the interior efficiency of the compressor, by the ratio of pressure between the atmospheric pressure and final pressure of the compressor. Beyond it, the temperature of the raised air may still be elevated by additional throttling of the compressor. However, to prevent the reliability of operation of the compressor from being impaired by the increases in temperature sometimes required for heating purposes, the present invention provides that the closing of the throttle on the suction side is lim-

ited by a stop which is adjusted to the permissible working temperatures of the compressor, to a permissible low pressure or to a permissible ratio of pressure of the compressor or the like, or adjusts itself automatically.

If the amount of breathing air is so selected that at the nominal altitude, say, the minimum heating requirement of the cabin is supplied by the normal work of compression and if at this altitude a certain reserve is still available in respect of the permissible pressure ratio of the compressor, a full-automatic control of air conditioning in the cabin may be achieved by providing a heat feeler which remotely controls the throttle of the displacer type compressor to the effect that in the case of deviations of the cabin air temperature from the nominal value first the throttle of the compressor is more or less closed. On reaching the final movement of the throttle closing, the further controlling impulses originating either from the operator or heat feeler will have the effect that either a heating apparatus for the breathing air or a direct heating of the cabin or a heater in the cabin will be switched in and now controlled by the heat feeler.

It may also occur that, with the throttle of the breathing air compressor fully opened, the air fed into the cabin is already too hot, e. g., if the cabin is intensely heated by solar radiation at a great altitude or if flying takes place in tropical regions or in summer near the ground. In such cases the invention provides that, after the throttle of the breathing air compressor is fully opened, the further controlling impulses, originating either from the operator or heat feeler, switch in a cooling device for the breathing air. Such a cooling device may consist either in a simple heat exchanger or special cooling or refrigerating equipment.

To explain the invention, an embodiment thereof is shown diagrammatically in the drawings by way of example.

Fig. 1 shows the structure of the whole equipment.

Fig. 2 is a sectional view on the line A—B, showing the controlling means adapted to keep the amount of air constant.

Fig. 3 is a sectional view on the line C—D in Fig. 2.

Fig. 4 is an enlarged view showing part of the equipment.

The breathing air compressor 1 draws the air through the silencer 2 and forces this air through a controlling means 3 adapted to keep the amount of air constant, through the filter or silencer 4, and through the heat exchanger 5 into the altitude chamber 6 of the aircraft. The air pressure in the chamber 6 is controlled by a pressure valve 7 and blow-off valve 8 respectively. Between the breathing air compressor 1 and controlling means 3 adapted to keep the amount of air constant, a blow-off valve 9 is provided which is controlled through the control box 10 by the differential pressure of the controlling means 3 adapted to keep the amount of air constant and blows off the surplus air. The overflowing amount of air is fed again into the induction pipe 11 of the compressor between the silencer 2 and compressor 1. To control the temperature of the breathing air, a throttle valve 12 is provided in the suction pipe 11 of the compressor, this throttle valve being kept open, e. g., by an elastic force shown for example as a spring 13 counteracting a fixed stop 14. With this embodiment of the invention, the throttle 12 is operated by a rod 15 and distribution pis-

ton 16 which is controlled by a distant actuating device 17 through a heat feeler 18 from the chamber, the throttle being closed as the temperature in the cabin drops. Thereby the temperature of air rises.

To close the throttle valve 12, a variable stop 19 is provided. The controlling rod 15 is provided with slots 39 and 40 at the transmitting points and opens, when the throttle valve 12 is closed, a throttle valve 20 in a heating pipe 21 through which the heat exchanger 5 is fed with hot air or hot gasses; under reverse controlling impulses and with the throttle valve 12 opened, a throttle valve 22 in a cooling air pipe 23 supplying the heat exchanger 5 with cold air is opened.

Figs. 2 and 3 are a diagrammatic view showing the controlling means 3 adapted to keep the amount of air constant and the moving slide 24 of which in the pipe 25 of the flowing through agent acts as a controlling means and produces a dynamic pressure acting directly on the slide 24 as adjusting force. The slide 24 and its guide case 26 are provided with apertures 27 and 28 which, depending on the particular position of slide, overlap each other in such a manner that at high dynamic pressures small sectional areas and at low dynamic pressures large sectional areas are exposed for the passage of air. The return movement of the slide 24 is effected by a spring 29, while a spring 30 serves to increase the sensitiveness of control. The space 31 shut off by the slide 24 is under equal pressure with the pipe 25 through a bore 38 or other suitable means, to the effect that the controlling means operates only on the dynamic pressure of the flowing through agent and works independently of great or small differences in static pressure between the inlet 25 of the controlling means adapted to keep the amount of air constant and outlet 32.

Finally Fig. 4 shows an example of control of the adjustable stop 19 for the throttle valve 12. Here also the difference in pressure occurring between the pipe sections 25 and 32 through the controlling device adapted to keep the amount of air constant has been selected as controlling impulse. The stop 19 follows the movement of a double acting piston 33 which moves, airtightly, in a governor case 34 under the action of a compression spring 35 towards the throttle valve 12. On its piston area in space 36 acts, in addition, the same pressure as in space 32 and on the piston area in space 37 acts the same pressure as in space 25. From this results at great differences in pressure between 25 and 32 a large opening of the throttle valve 12 and at small differences in pressure a slight opening. In a similar way may the adjustable stop 19 be also controlled by other impulses, for instance, by the working temperature of the compressor, in order to take account of its maximum permissible temperature.

We claim:

1. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance.

2. In an aircraft a closed cabin and a com-

pressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means and adapted to maintain in said delivery pipes a constant amount by weight of fed air, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance.

3. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means and adapted to maintain in said delivery pipes a constant amount by weight of fed air, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance, said resistance containing a movable, spring actuated damming means adapted to control the cross section of passage of the resistance.

4. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means and adapted to maintain in said delivery pipes a constant amount by weight of fed air, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance, said resistance containing a movable, spring actuated damming means adapted to control the cross section of passage of the resistance, said damming means being under the action of springs in both directions of movement.

5. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance and means adapted to throttle the current of air before the compressor for controlling the air temperature.

6. In an aircraft a closed cabin and a com-

pressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance and means adapted to throttle the current of air before the compressor, for controlling the air temperature.

7. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance and means adapted to throttle the current of air before the compressor, for controlling the air temperature.

8. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance and means adapted to throttle the current of air before the compressor for controlling the air temperature, and valves controlling additional heating and cooling means moved on reaching the final positions of the means adapted to throttle the current of air by a rod provided with slots at the transmitting points to said valves.

9. In an aircraft a closed cabin and a compressor supplying the cabin with fresh air, and means in the delivery pipes of the compressor producing a resistance to the current of air supplied by the compressor and a difference in pressure before and behind said means, pipes branching off from the delivery pipe before and behind said means and leading to a controlling means adapted to move under the said difference in pressure and to adjust a valve controlling an outlet in the delivery pipe of the compressor before the said resistance, and adjoining the outlet an outlet pipe in which are interposed heat interchange devices for utilizing the energy of the flowing off air.

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