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MAY 25, 1943.
BY A. P. C.

C. R. WASEIGE
PRODUCTION OF COMPRESSED AIR ON BOARD AIRCRAFT
Filed May 21, 1942

Serial No.
443,966

2 Sheets-Sheet 1

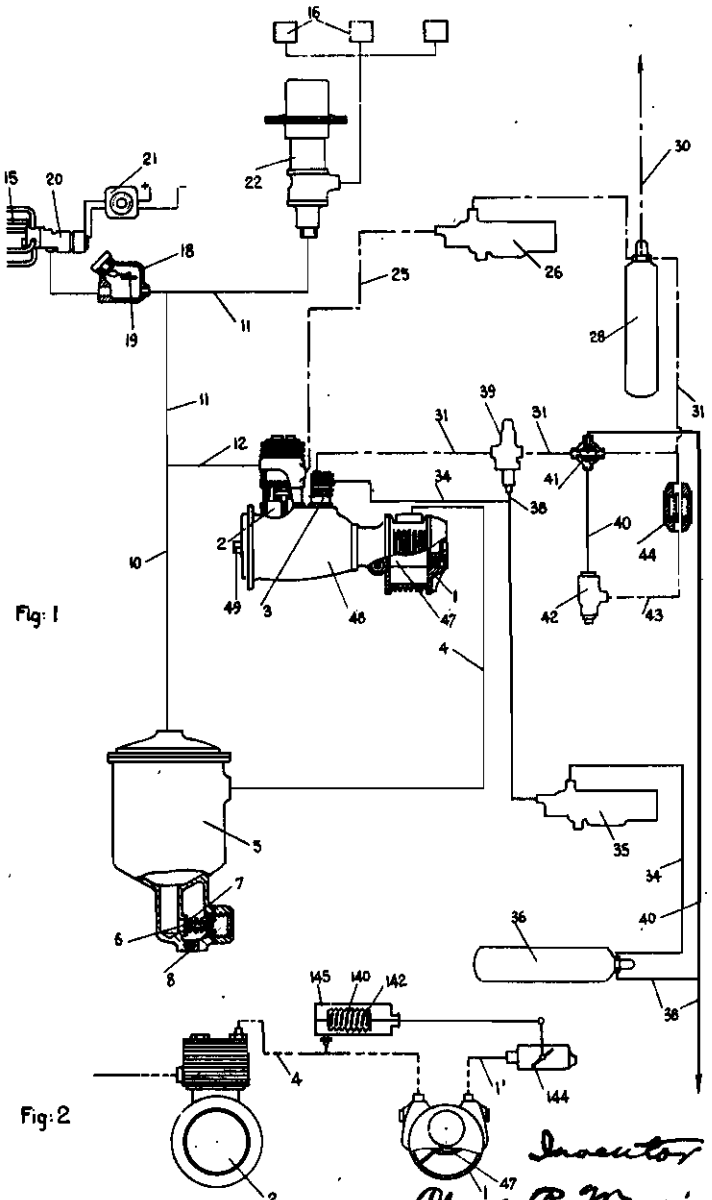

Fig: 1

Fig: 2

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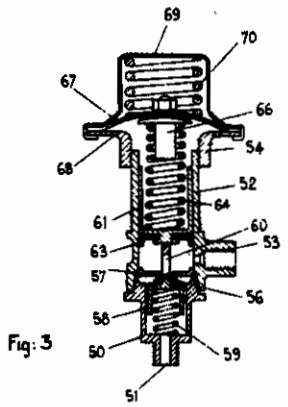

Fig: 3

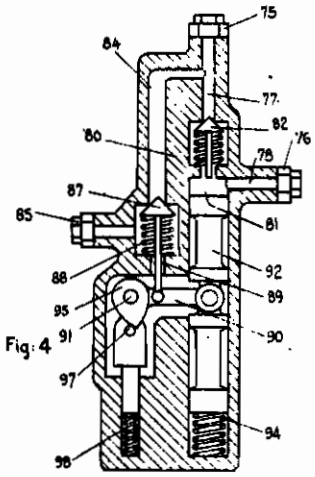

Fig: 4

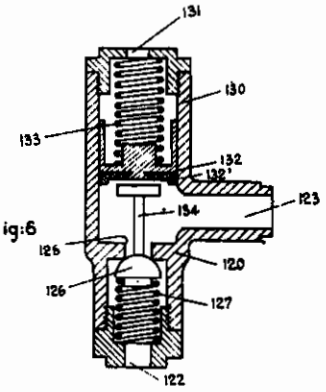

Fig:6

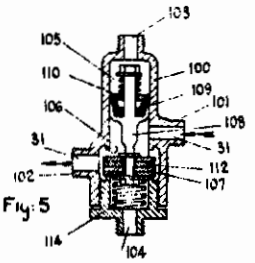

Fig: 5

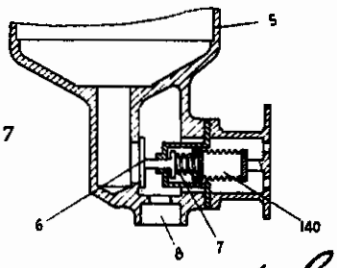

Fig: 7

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ALIEN PROPERTY CUSTODIAN

PRODUCTION OF COMPRESSED AIR ON BOARD AIRCRAFT

Charles Raymond Wascige, Rueil, France; vested in the Alien Property Custodian

Application filed May 21, 1942

My invention relates to plants for the production of compressed air on board aircraft.

As is well known, it is necessary to provide on board aircraft of the modern types sources of air compressed at widely different pressures the outputs of which, whether continuous or non-continuous, may be either small or very large according to utilisations. Therefore the plants for the production of compressed air must be correspondingly arranged, as a result of which great difficulties are encountered owing to the reduction of atmospheric pressure and air density at great heights.

It has been previously proposed to fill an air tank or reservoir to the required maximum pressure and to combine the same with pressure relief devices capable of supplying air at the several required pressures. One air supplier or generator would be necessary in such case. However, such an air generator which ought to be such as to ensure considerable air deliveries as for example the low pressure air delivery as used for de-icing the leading edges of aircraft wings and at the same time high air pressures which may reach fifty kilograms per square centimeter would be heavy, cumbersome and hard to cool while absorbing an unduly high power.

The present invention has for its principal object to provide for use on board aircraft an improved plant or installation for the production of compressed air, the said plant being such as to fulfill the requirements while being free from the aforesaid disadvantages.

A further object of my invention is to provide such a plant or installation comprising at least two air generators, one of which draws the atmospheric air and feeds the second generator, a valve being arranged in the air circuit of the first generator so as to determine the pressure at which the second generator is fed in terms of the flying height or altitude, the said pressure being preferably maintained substantially constant in absolute value.

Owing to the superfeed or supercharge of the second generator as thus provided, the plant can supply air at the required pressure regardless of the altitude of flight or the aircraft for feeding the several servo-contrivances.

Advantageously the said valve is arranged on the pressure side circuit of the first generator which then feeds both the second generator and that part of the plant to which its delivery pressure is suited.

The valve may also be arranged in the suction circuit of the first generator so as to more or less throttle the air inflow which feeds the same.

The adjustment of the valve is preferably controlled by some form of manometric capsule or cartridge of any approved type.

In a preferred constructional form, the plant further comprises a third generator adapted to deliver air at a pressure higher than that of the second generator delivery, the pressure side circuit of which feeds both the said third generator and that part of the plant to which its delivery pressure is suited. The three generators will be respectively termed "low pressure", "medium pressure" and "high pressure".

Such generators may be of any suitable approved type. The low pressure generator may advantageously comprise either a pump of the volumetric type or the supercharging compressor for the engine, the latter being necessarily arranged to that effect before the carburettor, as known per se.

The several air generators are preferably aligned and so arranged as to build a self-contained assembly actuated by a single shaft.

Moreover, it is known that heretofore the suction of the low pressure pump has been used for revolving the gyroscopes of the instruments mounted on board the aircraft, the necessary depression to that effect representing about two hundred grams. When it is now borne in mind that at an altitude of ten thousand meters, the atmospheric pressure amounts up to two hundred and sixty grams only, it will be understood that even when using a pump capable of producing an almost absolute vacuum, it is impossible to ensure over a certain altitude proper operation of the said instruments.

According to an advantageous feature of the invention and with a view to obviating the aforesaid disadvantage, the gyroscopes associated with the instruments mounted on board the aircraft are fed by the delivery side of the low pressure generator, eventually through a pressure relief device.

My present invention has also for its object certain accessory contrivances adapted particularly to the novel plant and notably an automatic cock or valve, certain of these accessory contrivances such as the pressure relief devices, pressure-limiting valves and the like being combinable with a manometric capsule or cartridge which may be either empty or filled with air at ground atmospheric pressure, so that the adjustment may be varied when the aircraft flies at varying altitudes.

Other objects and features of the invention will

moreover appear from the continuation of this description and with reference to the accompanying drawings which exemplify the invention and in which:

Figure 1 is a diagrammatic illustration of a plant or installation according to the invention;

Figure 2 is a partial view of a modification of this plant;

Figures 3 to 6 represent on a larger scale several members comprised in the plant shown in Fig. 1, namely in Fig. 3 a regulating valve, in Fig. 4 a regulator, in Fig. 5 an automatic cock or valve, and in Fig. 6 a pressure relief device;

Figure 7 represents a constructional modification of the valve adapted to limit the "low pressure" delivery pressure.

In the constructional form represented in Fig. 1, the plant or installation comprises three air generators, namely a low pressure generator 1, a medium pressure generator 2, and a high pressure generator 3.

The low pressure generator 1 freely sucks the atmospheric air and has its delivery pipe 4 connected to a purifier or scrubber 5 of any approved type capable of removing from the air the oil or water particles carried by it.

The purifier or scrubber 5 is provided at its lower end with a pressure-regulating valve 6 urged by a spring 7 against its seat. This valve establishes communication between the inner chamber of the purifier and the atmosphere through an aperture 8 when the pressure in the said chamber exceeds a predetermined pressure corresponding to the tension of the spring 7.

The compressed air leaves the purifier 5 through a pipe 10 which bifurcates into a pair of branch pipes 11, 12, one of which designated by 11 feeds servo-contrivances or like devices, while the other branch pipe 12 constitutes the feed pipe for the medium pressure generator 2. It has been assumed in this example that there are two of such servo-contrivances fed by low pressure, namely the piping 15 of the de-icing device and the gyroscopes associated with the steering instruments, 16. The piping of the de-icing device are fed through a cock 18 comprising a chamber inclosing a closing shutter 19 rockably mounted on a pivot and controlled by some rigging (not shown) so as to either close or open the air flow without causing any braking effect. An electric distributor 20 fed through a rheostat 21 directs through the pipes 15 the air which must reach the several pneumatic chambers arranged on the leading edges of the aircraft wings, the pulsation of the said chambers performing the de-icing action. The air is supplied to the gyroscopes associated with the steering gear 16 through a pressure-regulating valve 22 a constructional form of which will be described hereafter with reference to Fig. 3.

The medium pressure generator 2 which is fed by the low pressure generator through the pipe 12 is constituted by a compressor of usual type and forces through a pipe 25 (drawn in dot and dash lines) and preferably through a regulator 26 the compressed air into a reservoir 28. The regulator 26 of which a constructional form will be described hereafter with reference to Fig. 4 provides a communication with the open atmosphere of the delivery pipe 25 as soon as the pressure in the reservoir 28 exceeds a predetermined limit. The air escapes from the reservoir 26 through a pair of outlet pipes 30, 31. The pipe 30 feeds the servo-contrivances which must be fed at medium pressure as for example the brakes, the automatic weapons, etc. while the pipe 31 supplies the excess air to the inlet of the high pressure air generator 3.

The generator 3, thus fed, forces the compressed air through a pipe 34 (drawn in thick solid lines) and preferably through a regulator 35 into a reservoir 36. The regulator 35 is of a type similar to the regulator 26 and establishes a communication between the delivery side of the generator 3 and the free atmosphere when the pressure in the reservoir 36 exceeds a predetermined limit. Moreover, the pipe 34 is advantageously connected through a pipe 38 to a distributor 39 inserted in the pipe 31. The distributor 39 of which a constructional form will be described hereafter with reference to Fig. 5 is so arranged as to shut off the upside part of the pipe 31 and to set up a communication between the atmosphere and the inlet side of the generator 3 when the outlet side of the latter is brought into communication with free atmosphere by the action of the regulator 35. The circuit resumes normal condition as soon as the pressure is reinstated in the delivery pipe 34. An undue output of the generator 2 is thus avoided when the generator 3 is inoperative.

The air compressed under a high pressure leaves the reservoir 36 through a pipe 38 which feeds those servo-contrivances which require high pressure actuation.

In Figure 1 is also shown a means of using the reserve of air compressed under a high pressure contained in the reservoir 36 for feeding those servo-contrivances which are actuated at medium pressure. To that effect, a branch pipe 40 connected to the pipe 38 leads through a cut off valve 41 inserted in the pipe 31 intermediate the distributor 39 and reservoir 28 to a pressure reducer or reliever 42. The cut off valve 41 is manually controlled; its two alternative positions correspond respectively to the interruption of the air flow through the pipes 31 and 40. The pressure reducer 42 of which a constructional form will be described hereafter by way of example with reference to Fig. 6 supplies medium pressure compressed air to a pipe 43 in which is inserted a non-return valve 44 of known type adapted to permit the air to flow in one direction only. The pipe 43 is branched off the pipe 31 intermediate the cut off valve 41 and reservoir 28 which can be therefore fed by medium pressure compressed air from the high pressure compressed air reserve contained in the reservoir 36. Any undue by-passing of the circulating flow of air is prevented by the cut off valve 41.

By way of completion of the description of this constructional form, the construction of certain of its constitutive parts will now be described.

The low pressure generator 1 which might be constituted by the compressor used for feeding the aircraft engine and branched off upside the carburetor is here shown as comprising a vacuum pump of the volumetric type essentially made up (as also illustrated in Fig. 2 which is a front view partly broken away of a generator belonging to the same type) of a body or casing and eccentered rotor 47 inclosed therein and fitted with vanes or blades.

The medium and high pressure generators 2 and 3 which may be of the centrifugal type are shown constituted by compressors including pistons and cylinders mounted on a common casing 48 to which the pump cylinder 1 is secured. The three generators 1, 2, 3 are aligned and driven

by a common actuating shaft 49 so as to form a self-contained assembly.

As illustrated in Fig. 3 which, as above stated, shows a constructional form of the regulating valve 22, the latter comprises a body made up of three parts, one of which (50) carries the air inlet union 51, while the second part (52) is screwed upon the former and comprises substantially a cylindrical tube fitted at its upper end with the air outlet union 53 and the third part (54) is screwed upon the part 52 and forms a cap fitted upon its top end.

The part 50 of the regulating valve 22 forms the housing of a disc valve 56 the seat 57 of which is situated above it and underneath the union 53. The valve 56 is carried by a sleeve 58 upwardly urged by a spring 59. A rod 60 connected to the sleeve 58 is urged by the spring 59 into contact with a projection on a sleeve 61 slidably fitted in the tube 52. The lower end of the sleeve 61 is provided with a gasket 63 tightly applied against the inner wall of the tube 52. A spring 64 accommodated in the sleeve 61 urges the same into a direction corresponding to the opening of the valve 50 and is abutted through the medium of a head member 66 on a membrane 67 carried by the flange-shaped third part 54 of the valve 22, holes 66 being formed in said part 54. The membrane 67 is of distortable character and forms one of the walls of a sealed chamber 69 in which vacuum prevails and which contains a spring 70 which urges the same downwardly (looking at the figure) that is to say in such a direction as to compress the spring 64. As will be understood, the pressure of the air that flows past the valve 56 exerts itself on the gasket 63, whereby when the said pressure imparts to the gasket a stress larger than the action of atmospheric pressure thereon and the tension of the spring 64, the sleeve is lifted and closes the valve 56. Re-opening of this valves takes place under the action of the spring 64 as soon as the air pressure prevailing inside the union 53 lowers again.

Furthermore, the membrane 67 is distorted by the spring 70 thereby enhancing the tension of the spring 64 when the atmospheric pressure diminishes, so that the effort exerted on the sleeve 61 and consequently the limit pressure of the air inside the union 53 are independent from the altitude or vary in terms of the altitude according to a determined law. The supply of the air that has flown through the regulating valve 22 to the servo-contrivances is thus ensured under the most suitable conditions.

In Fig. 4 is shown a constructional form of the regulator 26 or 35 of known type adapted to be traversed by the compressed air flowing between the unions 75 and 76 extending in the form of ducts 77 and 78 formed in the body 90 and leading to a chamber 81. A stop valve 82 is provided intermediate the union 75 and chamber 81. A duct 84 connected to the duct 77 upside the valve 82 leads to a union 85 freely communicating with the atmosphere. A needle valve 87 housed in the duct 84 is urged towards its seat by a spring 88. The needle valve 87 is connected to a rod 89 pivotally connected to a lever 90 one end of which is pivotally connected in turn to a stationary pin 91 while its opposite end is pivoted to a piston 92 subjected to the air pressure in the chamber 81 and urged in the opposite direction by a weighted spring 94.

A wedge-shaped cam 95 fixedly secured to the lever 90 co-operates with a block 97 which is applied against it by a spring 96.

It will be understood that normally the compressed air as forced by the generator flows through the regulator between the unions 75 and 76. Just as soon as the pressure of this compressed air exceeds a limit as defined by the tension of the spring 94, the piston 92 is shifted against the antagonism of this spring and rocks the lever 90. The latter lifts off the needle valve 87 and sets the union 75 into communication with the atmosphere, the chamber 81 being then shut off by the valve 82 from the atmosphere. By co-operating with the cam 95, the follower block 97 soon breaks the balance when the lever 90 is rocked.

Thereafter, when the pressure prevailing in the chamber 81 becomes normal again, the regulator operates in the reverse direction and re-establishes communication between the ducts 77 and 76.

In Fig. 5 is shown a constructional form of the distributor 39 whose body 100 respectively communicates sidewise through a union 101 with the upside portion of the pipe 31, through a union 102 with the downside portion of the said pipe 31 (the arrows showing the direction of flow of the air) and endwise through a union 103 with the pipe 36 (connected up to the delivery side of the high pressure generator) and through a union 104 with the atmosphere.

The body 100 is formed with a cylindrical portion 105 which extends between the union 103 and 101 and with a pair of annular seats 106, 107, respectively located on opposite sides of the inner mouth of the union or nipple 102. A valve 108 is slidably mounted in the cylindrical portion 105 and carries a gasket 109 having a convexity facing the union 103. This gasket is elastically applied by a washer 110 against the walls of the cylindrical portion 109.

The slide valve 100 is provided moreover with a disc valve 112 adapted to co-operate with the two seats 106 and 107 and urged towards the seat 106 by a weighted spring 114. When the high pressure compressor delivers air, the air pressure which acts on the gasket 109 counterbalances on the slide valve 108 the action of the spring 114, whereby the valve 112 is applied against the seat 107. The medium pressure air can then freely flow between the unions 101 and 102. However, when owing to the operation of the regulator 35, the compressor 3 forces the air into the atmosphere, the pressure which acts on the gasket 109 falls, whereupon the spring 114 shifts the slide valve 100 and brings the valve 112 into contact with the seat 106, thus shutting off the unions 101 and 102 from each other while establishing communication between the union 102 and consequently the high pressure compressor inlet and the atmosphere through the union 104.

In Fig. 6 is shown a constructional form of the pressure relief device or pressure reducer 42. Such device comprises a body or casing 120 communicating through a union 122 with the high pressure air inlet and through a union 123 with the outlet of the relief air. Both unions or nipples are interconnected by a port 125 forming the part of a shut off valve 126. A spring 127 urges the valve 126 towards its seat. The body 120 is provided opposite the valve 126 with a cylindrical extension 130 the end of which communicates with the atmosphere through a hole 131. A sleeve 132 fitted with a gasket 132' seals the extension 130 and is urged by a spring 133 towards the valve 126 which carries a headed stem

134 opposite the said sleeve. It will be understood that with this arrangement the valve 126 is normally held closed and becomes open when a push is exerted by the sleeve 132 on the headed stem 134 when the air pressure prevailing in the union 123 sinks underneath a predetermined limit. The adjustment of the spring 133 may be varied by means of a manometric cartridge.

It is advantageous, generally speaking, to maintain constant regardless of the altitude of flight, the absolute delivery pressure of the low pressure compressor or alternatively to cause said pressure to vary concomitantly with altitude variations according to a determined law.

To that effect, in the constructional form shown in Fig. 7, the spring 7 associated with the valve 6 of the air purifier or scrubber may be combined with a tight manometric cartridge 140 containing air at the atmospheric pressure, for example at ground level pressure. The expansion of the cartridge 140 when the atmospheric pressure diminishes causes an increase of the tension on the spring 7 and compensates for the effect of the altitude on the valve 6. Alternatively vacuum might prevail inside the cartridge 140 which might then contain such a spring as would distort the same when the pressure diminishes, as shown in Fig. 2; the said spring being defined by reference numeral 142.

In the constructional example represented in Fig. 2, and applicable to a constructional form wherein the low pressure generator 1 serves the sole purpose of feeding the medium pressure compressor 2, the cartridge 140 controls a damper 144 movable in a casing connected to the suction pipe 1' of the generator 1. The cartridge 140 is inclosed in a tight casing 145 communicating with the delivery pipe 4 of the said generator. When the delivery pressure of the generator or pump 1 shows a tendency to increase in the casing 145, the cartridge 140 causes the inflow of air to the pump 1 to be throttled and vice versa. Owing to this arrangement, the pressure at which the air is forced or delivered is rendered invariable.

While I have described what I at present consider preferred embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the spirit and the scope thereof. Thus, in particular, additional pressure relief devices might be provided for feeding certain ancillary devices.

CHARLES RAYMOND WASEIGE.