April 28, 1953 A. BÜCHI 2,636,341

AIR-BYPASS OR SURGE CONTROL FOR SUPERCHARGED INTERNAL-COMBUSTION ENGINES

Filed March 5, 1947 2 SHEETS—SHEET 1

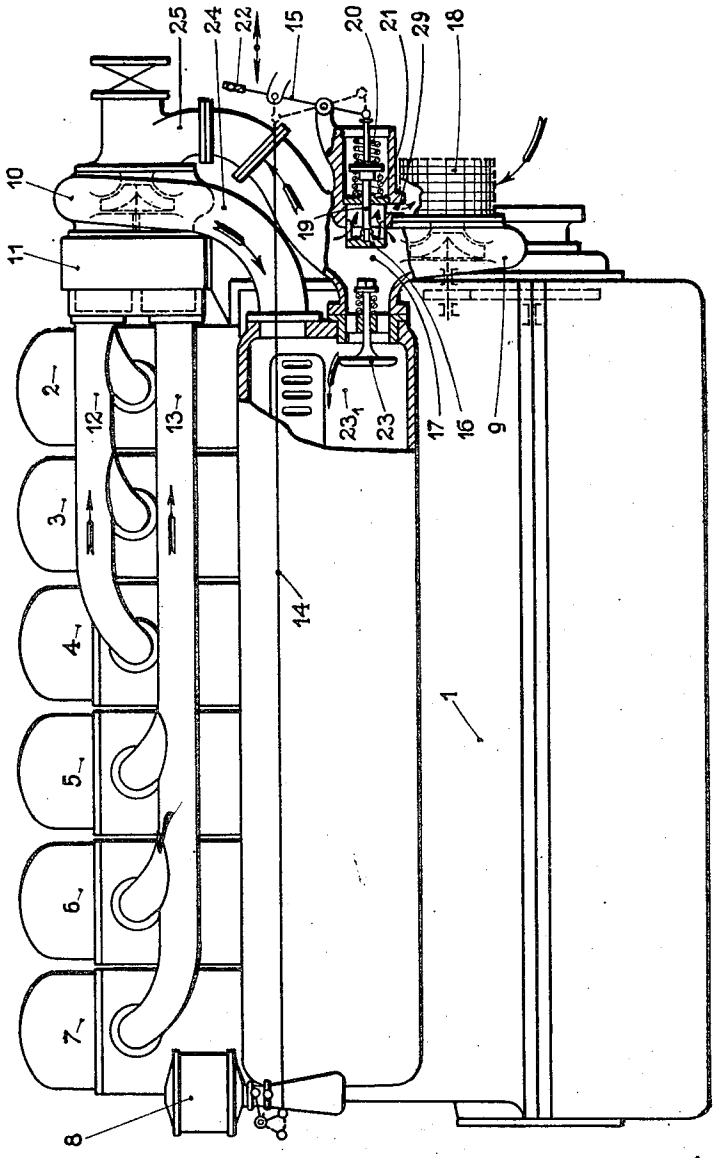


FIG. 1

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FIG. 2

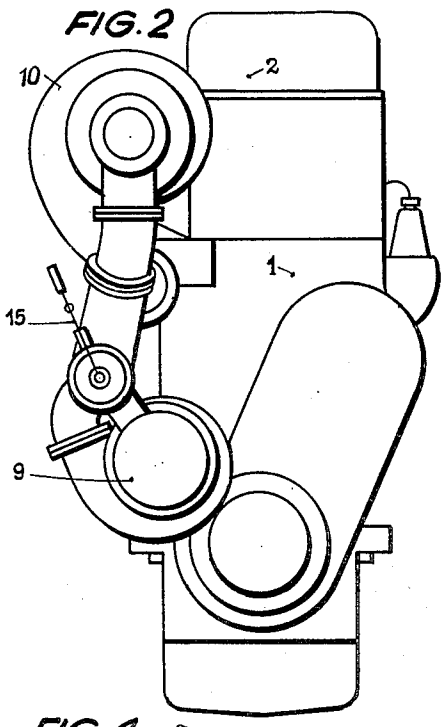


FIG. 3

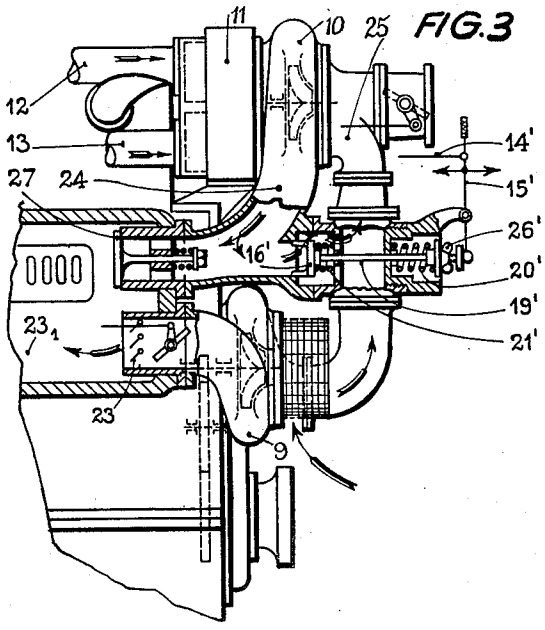


FIG. 4

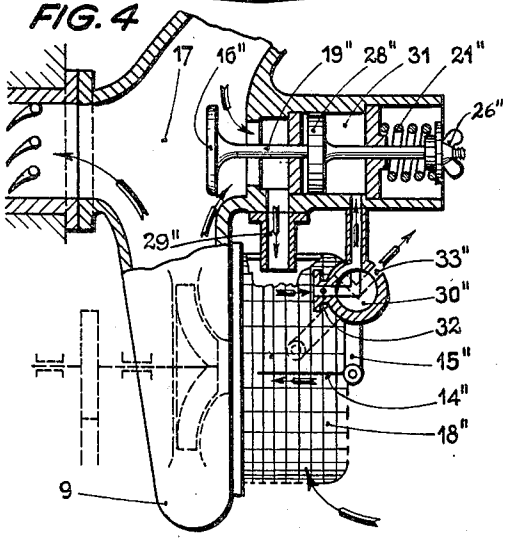
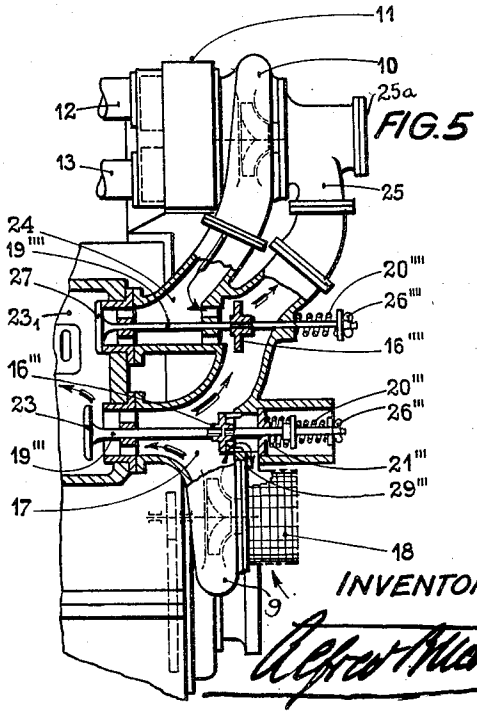


FIG. 5



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AIR-BYPASS OR SURGE CONTROL FOR SUPERCHARGED INTERNAL-COMBUSTION ENGINES

Alfred Büchi, Winterthur, Switzerland

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5 Claims. (Cl. 60—13)

1

My present invention relates to improvements in surge-preventing arrangements on supercharged internal combustion engines comprising a plurality of charging blowers, of the centrifugal and/or axial type, at least one thereof being driven by the engine exhaust gases. Such engines are of the type in which the charging blowers—in accordance with the state of operation of the engine—are cut in or out relative to the air supply, so that at least one thereof delivers directly into the engine.

The subject matter of my present invention consists in control gears, riggings or arrangements adapted to prevent—at any given piping connection of the blower delivery lines with the engine—the occurrence of irregularities (such as surging) in the delivery of at least one of the charging blowers. Such controls, which, for example, may comprise devices for blowing off part of the pressure fluid delivered by the respective blower into a space of lower pressure or other devices serving for the same purpose, may be adjusted either directly by means of the engine governor or by means of the pressure of a pressure fluid supplied by the engine, such as the exhaust gases, the charging air or the lubricating oil and the like. Such controls also, however, may be operated in common in engines comprising elements (adjustable automatically or from the outside) for piping the output from different kinds of charging blowers directly to the engine or to the other kind of blower.

In the explanation which follows, I assume that the reader is familiar with charging devices for internal combustion engines such as are the subject of my Patent No. 2,296,268, issued September 22, 1942.

Several forms of invention are shown, by way of example, in the accompanying drawings, in which

Fig. 1 shows a side elevation of a motor, partly in section through a control rigging,

Fig. 2 is a front view of the motor of Fig. 1, and

Figs. 3–5 illustrate other forms in partial sections and partly in elevation.

The internal combustion engine 1 in Figs. 1 and 2 possesses six cylinders 2—7, a governor 8, and two charging blowers 9 and 10. Blowers 9 and 10 are shown in the drawings as being of the radial type. However, it will readily occur to any person skilled in the art that other types of similarly acting blowers could be substituted for the radial blowers here shown. Power to drive blower 9 may be supplied by the engine crankshaft, as shown, or by a power source independent of the engine. The blower 10, however, is driven by the exhaust gas turbine 11, to which turbine exhaust gases from the engine cylinders are conducted through the exhaust manifolds 12 and 13.

The control rigging according to my present invention, now, is so adapted that—when blower 9, with bypass-valve 16 closed, otherwise would be subjected to surges—governor 8, by way of the

2

rigging 14, 15, opens the circular valve 16, thus opening the delivery space 17 of blower 9 to the air-intake structure 18 by way of duct 29. Blower 9 is surging when it is of relatively large capacity, and when the exhaust-turbine driven blower 10 is sucking little or no air. Such latter case, again, may arise upon starting the engine or at low load and/or low speed, in spite of valve 23 being open. The entrance chamber for the charging air to engine 1 is designated by 23_1.

Lever 15 may be connected to valve rod 19, either fastly or (as shown in Fig. 1) loosely, so that the latter is actuated by rod 14 only for opening valve 16, in that, when governor 8 — with engine 1 idling—is slowed, rod 14 is pushed to the right. Governor 8, therefore, is not instrumental in closing valve 16. When governor rod 14—with the load on engine 1 increasing—moves to the left valve 16 automatically is closed again by the spring 21, acting against the spring 20.

A handle 22 may be provided on lever 15 to permit, when required, of holding open or closing circular valve 16 independently of governor 8.

In the form of invention according to Fig. 3, a circular valve 16' is so built into the delivery line 24 of the exhaust-turbine driven blower 10 as to permit of establishing communication between delivery line 24 and suction line 25 of blower 10. Valve 16' here again (as in Fig. 1) is actuated by governor 8 by way of rigging 14', 15', and comprises a guide stem 19', a helical spring 21' tending to push valve 16' to the left into closing position, and a helical spring 20' tending to push valve 16' to the right into open position. Spring disc 26' is adjustably mounted on stem 19' to permit of adjusting the tension of springs 20' and 21'.

Valve 16' is opened—in accordance with my present invention—when, as seen from Fig. 3, delivery line 24 of blower 10 to entrance chamber 23_1 is closed by the valve 27, as shown, but engine 1 and thus also exhaust turbo-blower 10/11, having been started already, is not capable yet of building up sufficient pressure to open valve 27. If bypass valve 16' were not opened at this stage of operation, blower 10 would be subjected to surges, which condition will be prevented by means of my present invention.

Fig. 4 shows a form of invention, wherein the bypass valve 16'' is actuated by means of a piston 28'' secured to valve stem 19''. Piston 28'' is pushed to the left, biased by a pressure fluid (charging air, exhaust gases, lubricating oil and the like). Valve 16'' thus is opened and at least part of the air in delivery space 17 may escape through duct 29'' into air-intake 18'' of blower 9. A wing nut 26'' is mounted on the outer end of stem 19'', and is pushed by a spring 21'' to the right, i. e. said spring tends to close valve 16''.

The pressure fluid is supplied through the circular valve 30'' into the cylindrical space 31. In Fig. 4, valve 30'' is shown in a position in which the pressure fluid is permitted to flow

from 32 into space 31, and which corresponds to the position of lever 15'' shown in full lines. Lever 15'' is set, e. g., by a governor (not shown) by means of the rod 14''.

In the position of lever 15'' shown by dotted lines, the admission of pressure fluid at 32 is closed, and cylinder space 31 is drained through the aperture 33''. The pressure of spring 21'' then closes valve 16''. The latter is opened again in the same way as described in connection with Fig. 1.

Fig. 5 shows a form of invention, wherein the valves 16''' and 16'''' are directly connected with valves 23 and 27 respectively. The latter close independently of each other, in that they are automatically opened or closed when a higher pressure exists in the engine entrance-chamber 23_1 than blowers 9 and 10 respectively are capable of building up in their state of operation. The arrangement, further, may be such that the valve 16''' is opened when valve 23 also is opened. Valves 16''' and 23 also may close approximately at the same time. Such may be the case, when the engine is started, or when it is running under low load.

Valve 27, however, is closed, when valve 16'''' is open, so that the air then is bypassed from the delivery chamber 24 into the suction chamber 25 of the same blower 10. Valves 23, 16''' and 27, 16'''', respectively, are biased into certain desired positions by the springs 20''', 21''' and 20'''' respectively. The wing nuts 26''' and 26'''' permit adjusting the spring actions. The elements 16''', 16'''' may be spaced as desired from valves 23, 27 respectively on their common spindles. A closure plate 25a is placed over the horizontal end of the turbo-blower entrance pipe section 25.

Arrangements according to Fig. 5 are capable of operating all together automatically at all operating stages of engine 1. They cut the delivery lines of the blowers in and out properly, and at the same time prevent the occurrence of the phenomenon of surging in the kinds of charging blowers used.

Wherever the term "independently driven" is employed to describe "blower" or "blowers" in the claims, I intend to comprehend a blower or blowers which are not driven by an exhaust gas turbine, but rather, by gearing with the engine shaft, or by some other power rotating unit, such as an electric motor.

What I claim and desire to secure by Letters Patent is:

1. In a supercharged internal combustion engine provided with at least one turbo blower driven by the exhaust gases of the engine to supply air under pressure to the air intake chamber of the engine, an auxiliary independently driven blower to supply air to said chamber, a first valve in the line between the auxiliary blower and the chamber closed in response to pressure in the chamber at high turbo blower speeds to direct the air from the auxiliary blower to the intake side of the turbo blower, a second valve between the turbo blower and the chamber adapted to close off the turbo blower from the chamber at low turbo blower speeds, the combination therewith of control means to prevent surging in each blower, comprising a bypassing valve to permit escape of air behind the auxiliary blower into the atmosphere, a relief valve in the delivery line of the turbo blower, said relief valve leading back to the intake side of the turbo-blower, means connecting the said first valve to the

by-passing valve to open and close said by-passing valve simultaneously with the opening and closing of said first valve, and means connecting the second valve with the relief valve in such manner as to close said relief valve as the second valve opens and to open said relief valve with the closing of the second valve whereby at a predetermined pressure in the turbo blower line to the air intake chamber said second valve is closed and the relief valve leading to the intake side of the turbo blower is simultaneously opened, and full operation of said turbo blower results in the opening of said second valve and the closing of said relief valve, and with the building up of pressure in the air intake chamber there results further a closing of said first valve and a simultaneous closing of the by-passing valve behind the auxiliary blower to stop the escape of any pressure into the atmosphere.

2. The combination as described in claim 1 wherein adjustable spring means are provided to oppose the opening of at least one of said first and second valves, thereby to permit a variance in the pressure conditions under which said valve opens.

3. The combination described in claim 1, wherein the engine is provided with a governor and said governor is connected by linkage to the said second valve, for alternative operation by the engine governor of said second and relief valves in response to engine speed and load.

4. The combination described in claim 1, wherein manual means are additionally provided to operate said relief and second valves as described.

5. In an internal combustion engine supercharged by an exhaust gas turbine driven blower and by an independently driven auxiliary blower, said engine having an air intake chamber for the engine cylinders, a conduit from the outlet of said turbine driven blower to said chamber, said auxiliary blower having an air intake and a first air supply line extending from its outlet to said chamber and a second air supply line from its said outlet to the entrance to the turbine driven blower, an arrangement for preventing surging in the auxiliary blower, said arrangement comprising a valve in said first air line, said valve being closed in response to the creation of a predetermined air pressure condition in the chamber as compared with the air pressure condition in said first air line, a relief valve between the auxiliary blower outlet and the atmosphere, said relief valve being connected with said valve in the first air line to open and close simultaneously with the last said valve, whereby when both said valves are closed the air output of the auxiliary blower is directed through the second air line to the intake of the exhaust gas turbine driven blower, and when both said valves are opened, air from the outlet side of the auxiliary blower is permitted to flow at a predetermined rate back to the air intake of the auxiliary blower thereby to prevent surging of the last said blower.

ALFRED BÜCHI.

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