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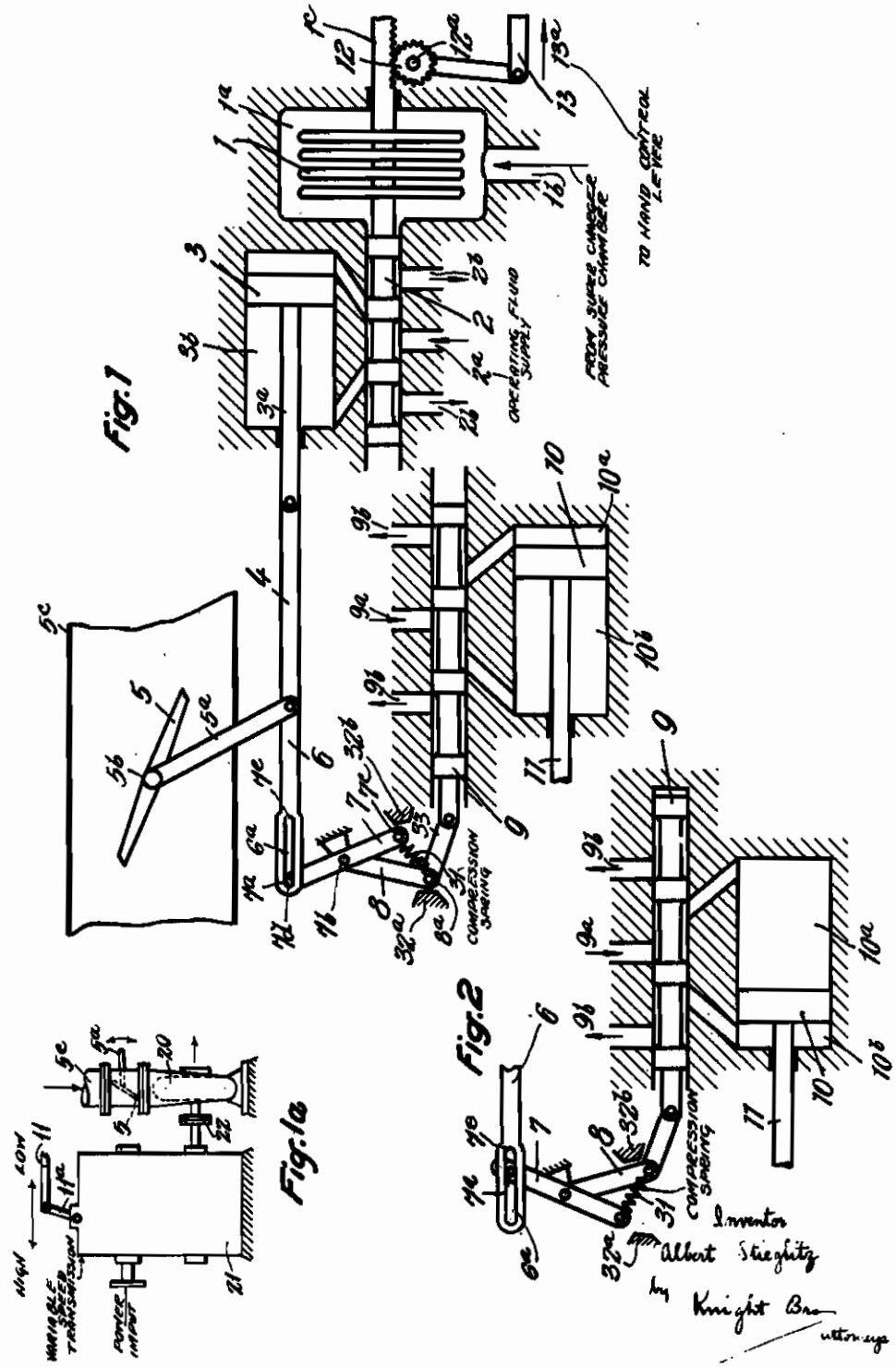
Filed May 4, 1938

Serial No. 205,992

2 Sheets-Sheet 1



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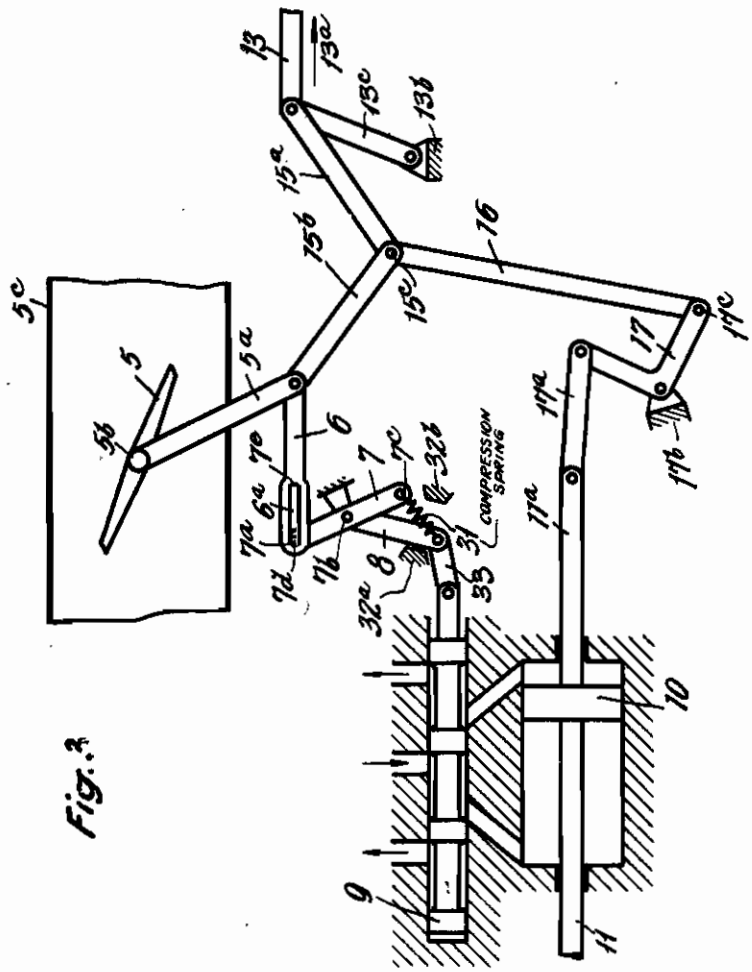

Fig. 2

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REGULATING DEVICES FOR SUPERCHARGERS OF INTERNAL COMBUSTION ENGINES

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This invention relates to regulating devices for superchargers of internal combustion engines, the supercharger being driven by the engine through a gearing having at least two steps.

A supercharger for an internal combustion engine assists the output of the engine by compressing the combustion air or the mixture of air and fuel. In the case of aircraft the supercharger is furthermore intended to maintain the output at high altitudes. The regulation is then effected by influencing the charging pressure by means of a throttle valve which controls the suction side of the supercharger. The speed transmission for the drive of the supercharger is so chosen that the desired maximum output is attained at the desired altitude. Consequently, at lower altitudes and on the ground the suction inlet of the supercharger must be throttled down in order that the maximum permissible charging pressure shall not be exceeded. This is naturally uneconomical and disadvantageous since it is accompanied by losses and increased fuel consumption. Furthermore, the charging air is heated by the partial idle running of the supercharger, and the danger of knocking is thereby increased.

These difficulties can be considerably reduced by subdividing the transmission ratio of the supercharger drive by means of a change-over gear. The maximum throttling is thereby reduced and two or more speed ranges are provided for the supercharger.

With a view to ensuring ready and correct actuation of the gearing, with consequent complete utilization, there is provided, according to the invention, an automatic operation which effects the change-over of the gear ratio at the correct instant and in accordance with working conditions. The changing over of the ratio is initiated at the end of a fixed range of regulation of the internal combustion engine by stops connected to the regulating system. Since, as the following investigation shows, the change-over is mainly dependent upon the position of the throttle determining the charging pressure, the change-over preferably takes place by means of the system for controlling the throttle.

The change-over point for producing a higher speed of the supercharger is always definitely determined by the completely open position of the throttle valve. On the other hand, the change-over from a high supercharger speed to a lower speed must take place at a definite partially closed throttle position.

If H_1 represents the adiabatic level of delivery of the supercharger in the first step, H_2 that of the supercharger in the second step, and H_v the adiabatic level of loss of the partially closed throttle, then the following equation applies for the change-over point:

$$H_1 = H_2 - H_v$$

The outputs of the supercharger are then proportional to the square of the speed, the level of loss of the throttle is proportional to the square of the velocity of the air in front of the throttle, and thus approximately also to the square of the speed. If α is the ratio of the transmission of the two steps or stages, then:

$$Cn^2 = C\alpha^2 n^2 - C_v n^2$$

or

$$C_v = C(\alpha^2 - 1)$$

C_v, and therefore the position of the throttle, are consequently independent of the speed.

Two arrangements, each according to the invention, are shown diagrammatically and by way of example in the accompanying drawings.

In the arrangement shown in Fig. 1 the throttle valve is manually adjustable by means of a rack and pinion 12, 13 acting on the valve 2 of a control servomotor, and the regulator for the supercharger pressure is operated directly from this control system. A vacuum device or capsule 1 is arranged in a space subjected to the supercharging pressure, axial variations in length of the capsule 1 acting upon the control valve 2. The piston valve 2 regulates the supply of oil under pressure to the cylinder of a servo piston 3 connected by a link 4 to the throttle valve 5 in such a manner that movement of the working piston 3 causes the valve 5 to turn about its pivot. A rod 6 connected to the link 4 co-operates with a dead centre toggle switch 7, 8 in such a manner that at the end of the regulating range the switch 7, 6 changes over and thus the alteration of the step or speed ratio is effected as hereinafter described. The rod 6 has an elongated slot corresponding in length to the range or regulation and engaged by a stud carried by the lever 7. The toggle switch 7, 8 is connected to a piston valve 9 of a second servomotor whose piston 10 changes over the two-step gearing by means of the piston rod 11. The gearing can, for example, be changed over by applying or releasing a brake.

In Fig. 1 the gearing is in the first step. If the throttle valve 5 is now further opened, the lever 7 is turned clockwise as viewed in the drawing until it passes a dead centre position, whereupon the spring snaps the lever 7 into another position, as shown in Fig. 2, on the opposite of

the dead centre to that shown in Fig. 1. From this position, however, the lever 8 as also the piston 9 are shifted to the right by the action of the said spring, and the servo piston 10 is set in movement. In Fig. 2, therefore, the toggle mechanism as also the second servomotor are in the positions for the second step or gear ratio.

It will be appreciated that, if desired, the toggle switch 7, 8, may act directly on the change speed gearing.

Fig. 3 shows an embodiment in which the throttle valve 5 is actuated directly by hand by means of the rod 14 and the two links 15. The links 15 are supported by means of a rod 16 and a bell-crank lever 17 connected to the piston rod 11 of the servo piston 10. In this arrangement the piston 10 moves only in the event of a change-over of the gearing. With this embodiment also, on the movement of the throttle valve 5 into the fully open position, the toggle switch 7, 8 and the piston valve 9 are changed over so that the piston 10 is set in movement. On movement of the piston 10, however, the throttle valve 5 is again moved toward its closed position by the piston rod 11 acting through the lever 17, link 16 and lever 15 so that the charging pressure remains approximately the same as before the change-over. The change-over from high speed to a lower speed takes place in the same way at a partlally closed position of the throttle valve 5. On the changing over taking place, the throttle valve 5 is again almost completely opened by the piston 10 acting through the system 11, 17, 16, 15.

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