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MEANS FOR REGULATING COMBUSTION ENGINES.

APPLICATION FILED JUNE 1, 1912.

1,166,937.

Patented Jan. 4, 1916.

3 SHEETS—SHEET 1.

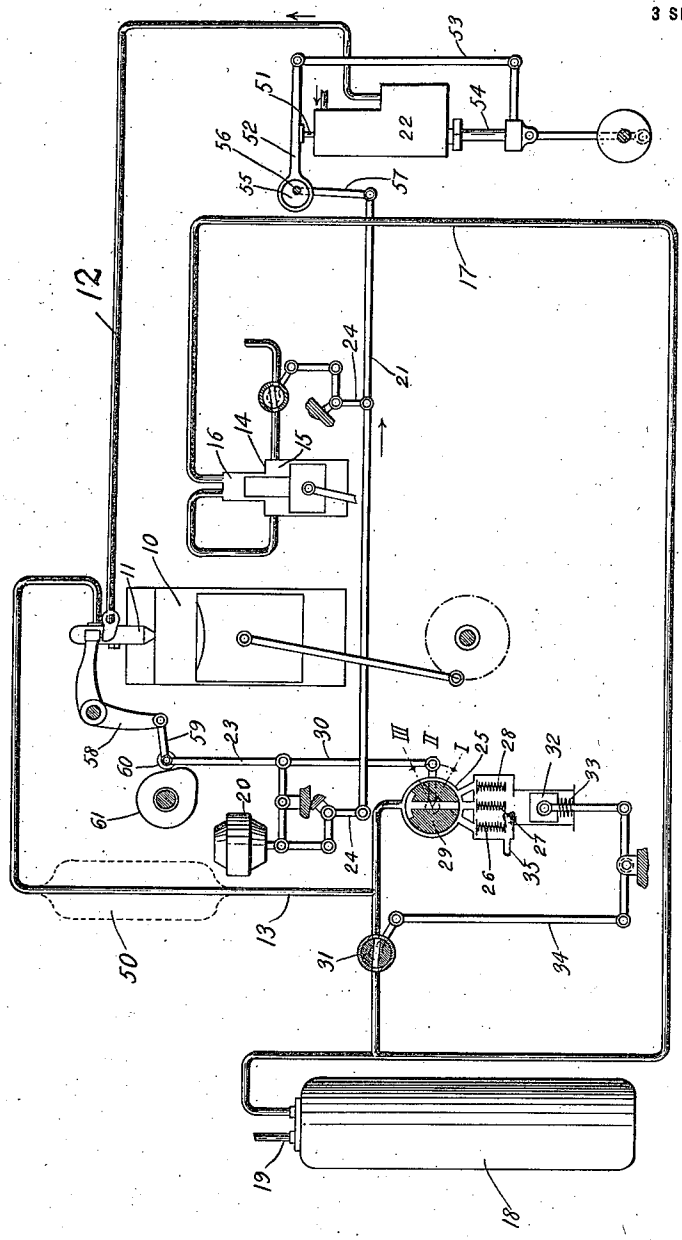

Fig. 1.

WITNESSES

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Fig. 2.ª

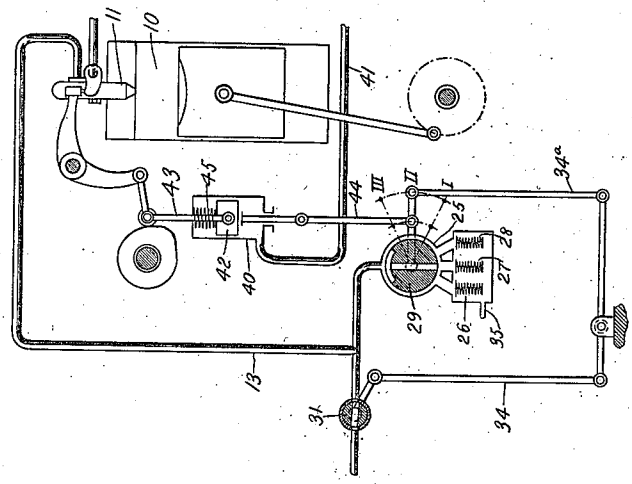
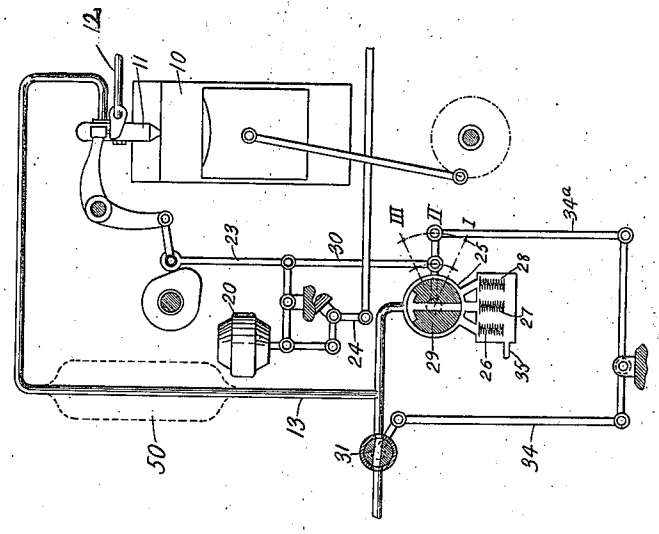


Fig. 1.ª



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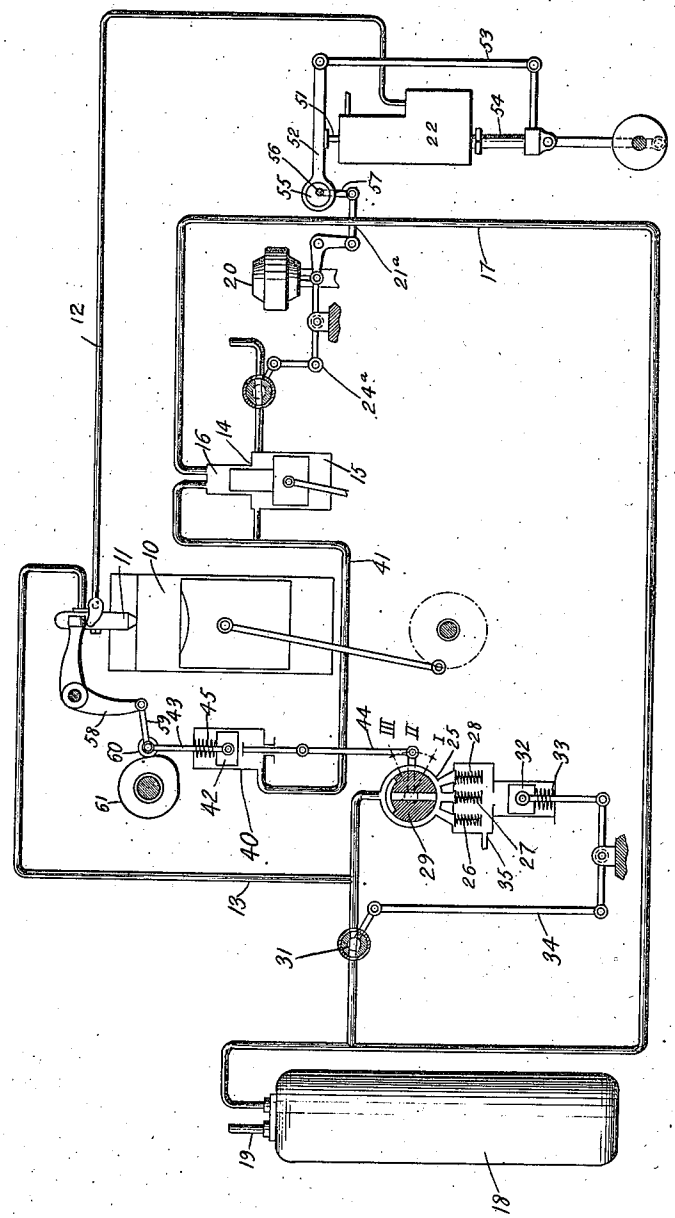

Fig. 2.

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MEANS FOR REGULATING COMBUSTION-ENGINES.

1,166,937. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed June 1, 1912. Serial No. 700,948.

To all whom it may concern:

Be it known that I, PAUL G. ROESTI, a citizen of the Republic of Switzerland, residing in Winterthur, Canton of Zurich, Switzerland, have invented certain new and useful Improvements in Means for Regulating Combustion-Engines.

This invention relates to the regulation and control of internal combustion engines of the type wherein the fuel is injected by high pressure air into a body of air previously compressed in the cylinder, such as Diesel engines, and its objects are to increase the sensitiveness and quickness of response of such engines to the members which control them, as well as other objects which will hereinafter appear.

The invention effects its control in part or in whole through the injection air pressure, attaining special sensitiveness of action through the provisions for instantaneously varying such pressure and which may be represented by means for controlling the flow in the high pressure line (throttling), or by means permitting variable escape of air from the high pressure line or system, or by both. An arrangement utilizing both of these methods of control, coördinated by connections or common operating means, is herein described for illustration, and such an arrangement is particularly desirable since the flow-controlling and relief provisions coöperate efficiently to bring about as nearly as possible instantaneous changes in the fuel injection in response to load variations, or to manual control, as the case may be.

The device for relieving the pressure may be variously constructed. It may be operated either manually or automatically, and in the latter case it may be operated either directly or indirectly by the engine governor, in accordance with the load variations. Preferably, the automatic control is of such character as to be opened by pressure of the air in the fuel air line and to be self-closing on diminution of the pressure, the pressure at which it yields or the degree of opening, or both, being controlled, either manually or automatically from the engine governor, as just described. Thus, it may consist of a loaded blow-off valve, the resistance of which to the air pressure in the line is adjustable in accordance with varying engine loads through the consequent increase or decrease in engine speed. The most desirable construction, however, is one in which there is a series of such blow-off valves set to respond to different pressures and means, as a turn cock, for placing any one of them in communication with the high pressure air line or system. Thus, the pressure in the fuel air line adjacent the fuel valve may be held more or less definitely at certain predetermined values, corresponding to different engine loads. The suitable pressures for the fuel injection air for different loads may be determined by tests, and the corresponding loads of the blow-off valves set accordingly, and if desired so that by their action alone and without the coöperation of the flow-controlling valve, they will automatically determine the correct pressure in the injection air corresponding to the various engine loads. During normal running when so arranged, and at any load there will be a constant though not necessarily large escape of air from the high pressure system. Adjustment to compensate for increased engine load will then shut off this escape by increasing the resistance of the relief device or by cutting in a blow-off valve of higher resistance, and the pressure in the line will accordingly rise; while on the other hand adjustment to compensate for decreasing load will diminish the resistance of the relief device or cut in a blow-off valve of lower resistance, thereby permitting a freer escape and causing the fuel air pressure to fall. Or the relief provisions and their connections with the engine governor may be so designed that there is no escape from the high pressure system during normal or established running at any load. In this event they serve to reduce the pressure of the fuel air on a decrease in the engine load by opening to permit escape, thereafter closing when running at that load has become established; while on an increase in load they do not operate directly to increase pressure, but oppose a greater resistance to

the escape of air, so that the increased supply, due either to wider opening of suitable flow-controlling means or to increased output of the air compresser, or both, can immediately increase the pressure without opening the relief valve.

It is preferred to increase the pressure, by increased supply through the flow-controlling means, which latter is properly coordinated with the escape or relief provisions for that purpose, and may be operated to cut off the supply either partially or entirely when the relief device is open, thereby guarding against premature replenishment of the pressure reduced by blowing-off. When the resistance to escape is increased, by reason of an increase in the engine load, the passage controlled by the flow regulating means may be enlarged so that the pressure in the air line adjacent to the fuel valve will be immediately increased. It is desirable to interpose the flow-controlling device between the relief provisions and any large receptacle or reservoir in or supplying the injection air line, since then such reservoir may be cut off from the service part of the line which is being vented at decreasing load by the relief device, and opened to said line at increasing load, when the relief device is closed, and it is likewise desirable that both the flow-controlling means and the relief device be located as close as possible to the fuel valve.

From the foregoing it will be perceived that variable relief provisions may constitute the sole or main instrumentality for quickly varying the pressure in the part of the air injection line near the point of fuel injection. On the other hand, variable flow-controlling means, such as a suitable throttle valve, may constitute the primary means for varying the pressure in the service end of the fuel air line, being operated, directly or indirectly, by the engine governor, and preferably being assisted by the coördinated action of the relief device.

A further feature of the invention relates to the control of any of the regulating provisions of the engine indirectly from the engine governor by means of a pneumatic relay device, such means preferably comprising the air compressor which serves the engine, (and the output of which is regulated by the governor in accordance with varying loads) and a motor or device operated by variations in pressure delivered by said compressor. For example, instrumentalities that may be controlled in this manner are the fuel admission means to the engine cylinder, the variable relief device, and the flow-controlling device.

Having thus generally described certain features, embodiments and modes of operation of the invention, I shall now proceed to a description of certain specific illustrative cases, reference being had to the accompanying diagrammatic drawings, wherein:

Figure 1 shows one arrangement, Fig. 1[a] a modification thereof, Fig. 2 another embodiment, and Fig. 2[a] a modification of the last.

A working cylinder of an internal combustion engine of the Diesel type is indicated at 10, its fuel valve, which may be of usual design, being represented at 11. As is well understood, the fuel is atomized and injected by air pressure into the body of air previously compressed in the cylinder.

12 is the fuel line leading to the fuel valve and 13 is the high pressure air line conducting the air for atomizing and injecting. A pump is provided for supplying this high pressure air, preferably a multiple stage compressor, as shown at 14, 15 being the low pressure side thereof and 16 the high pressure side, from which the fuel air is conducted by piping 17, to the reservoir or holder 18, and to the fuel injection air line 13. From a suitable connection 19 compressed air may be delivered from the holder to other lines for any desired purpose, for instance, for starting.

The engine governor is represented at 20. It may be of the usual type and may be incased as indicated. By linkage of any suitable character, indicated at 21, it controls the inlet valve of the fuel pump 22, thereby regulating the amount of fuel for each combustion charge as will be well understood. The particular form of mechanism for controlling the pump 22 is not essential. A well-known arrangement is indicated, in which the suction valve 51 is connected to a lever 52, which is operated by a link 53 from the piston rod 54. The hub of the arm 52 is rim-journaled on an eccentric bearing 55, which is rocked about the center 56 by the crank arm 57 forming part of the linkage 21. It will be understood the drawing is schematic. By other suitable linkage, indicated at 23, the governor controls the extent, time, or duration of opening of the fuel valve 11, or all of them. Such automatic control of the fuel valve is well understood in the art and need not be described with particularity. Suffice it to say that 58 is a bell crank lever connected to the fuel valve and having a link 59 pivoted thereto and bearing a roller 60, which intercepts the valve-opening cam 61, the linkage 23 being pivotally connected to the link 59 so as to vary the extent to which the roller 60 intercepts the projection of the cam. The output of the air pump 14 is also automatically regulated by the governor to the same general end, linkage 24 being indicated for the purpose of more or less throttling the intake of the air pump, according to the position of the governor.

The numeral 25 represents in general, the

means for venting the high pressure air line above referred to. For purpose of illustration these provisions are shown as including three spring-pressed blow-off valves 26, 27, 28, and a turn cock 29 adapted to place the fuel air line 13 in communication with any one of these blow-off valves, according to its rotary position. The blow-off valves, of which there may be more or less than the number shown, are set to yield at different predetermined pressures, so as to regulate the pressure in the fuel air line accordingly. For example the valve 26, corresponding to position I, may serve to hold the pressure in the air line 13 at or below forty atmospheres, the valve 27, corresponding to position II at or below fifty atmospheres, and the valve 28, corresponding to position III, may yield to an injection air pressure of say sixty atmospheres.

In Fig. 1, the turn-cock is shown as operated by the governor 20 through the linkage 30. In the event of increasing engine speed, due to decreased load, the cock 29 is turned say, from valve 26 to valve 27 or from valve 27 to valve 28, and vice versa, under increasing load. The relations may be such that at normal or established running at any load, the corresponding blow-off valve then in communication with the fuel air line 13 will remain closed or substantially closed, whereupon a decrease in the engine load operating through the governor will produce prompt reduction in the pressure in the air line 13 by turning the cock 29 into communication with the blow-off valve of next lower resistance, for example, the valve 26, which at once opens. On the other hand, turning of the cock 29 in response to an increased load, to place the blow-off valve of next higher resistance, for example the valve 28, in communication with the air line 13, would not of itself increase the pressure in the fuel air line, but this would be brought about somewhat more slowly by the increased output of the pump 14 under control of the governor, or promptly by means of the flow-controlling member which is shown at 31, and which may then be opened to afford a larger passage for the flow of high pressure air, from the compressor or holder 18, the resulting increase in pressure in the fuel air line being held by virtue of the higher resistance of the blow-off-valve selected by the governor. The flow-controlling organ 31 may be of any suitable character, and for best results is located behind and comparatively near the relief provisions. Where a holder, such as 18, is employed, it should be interposed between such holder and the relief provisions. Its control is coördinated with that of the relief provisions in a suitable manner. In Fig. 1 it is controlled indirectly from the governor 20 by means of the pressure of the air escaping from the blow-off valves, which is caused to act upon a piston 32 against the tension of a spring 33, to move the organ 31 through suitable linkage 34. The exhaust air may be allowed to pass off more or less freely, as indicated at 35, and it may either escape into the atmosphere or be utilized in any suitable manner. As already indicated, the flow-controlling valve 31 may be operated like a throttle valve, to increase the area of communication between the supply and the air pipe leading to the fuel valve, at the same time that the relief provisions move to the position determining a higher pressure therein. Conversely, when the relief provisions are operated to yield at a lower pressure or to permit a freer escape, the valve 31 may be moved to decrease the aforesaid area of communication. In this way the pressure in the holder 18 or in the piping 17 is partially or entirely cut on or off from the fuel injection means when the relief provisions are brought into play to effect a quick change of the fuel injection pressure. It will be observed that any increase or decrease in the injection air pressure is accompanied by a corresponding increase or decrease in the amount of fuel supplied, by virtue of the simultaneous control of the fuel pump by the governor; also that the output of the fuel air pump 14 and the duration and extent of opening of the fuel valve 11 are correspondingly affected. When used in conjunction with the variable relief provisions the flow-controlling organ 31 is also useful in maintaining a certain pressure in the holder 18, by closing more or less, so as to prevent loss of compressed air from this holder when the relief provisions open or permit freer escape. Fig. 1[a] illustrates an arrangement differing from that of Fig. 1 in that the flow-controlling valve 31 is operated directly from the governor 20, by means of suitable linkage 34[a], which will be clearly understood from the drawing.

In the arrangements of Figs. 1 and 1[a], the fuel pump, the fuel air pump, the fuel valve, and the means for venting the pressure in the injection line near the region of fuel injection are all regulated directly and mechanically by the governor.

Fig. 2 illustrates the control of any one or more of these factors indirectly from the governor, through the pneumatic relay device above referred to, and in the particular arrangement shown in Fig. 2 the suction valve of the fuel pump 22, as before, is controlled mechanically from the governor, as by suitable linkage 21[a]. By suitable further linkage 24[a] the governor also controls mechanically the intake to the compressor 14, thereby regulating the output of said pump and the pressures in its several stages, in

direct accordance to the variation of the load. The variation of such pressure, preferably that of the low stage 15, is utilized to control the fuel valve 11 and the turn cock 29 of the relief provisions. To this end a cylinder 40 is connected with the low stage of the pump by a pipe or conduit 41, and a piston 42 in the said cylinder controls the fuel admission by a link 43 and the relief provisions by suitable linkage 44 connected to the turn cock 29. The cylinder 40 and the piston 42 in effect constitute a motor for controlling engine regulation, being more powerful and positive than hand-actuated means. The movement of the piston 42 in one direction can be controlled by a spring 45 or in any usual way, this wholly diagrammatic representation of the regulating motor being merely representative of any suitable type of similar device, and it will be understood that in practice any suitable provisions may be applied to it for increasing the positiveness and steadiness of its action, such, for example, as the addition of dash pot agencies for determining definite rates and limits of the piston's movement. As in Fig. 1, the flow-controlling device 31 is controlled directly by pressure of air allowed to escape from the relief provisions.

In Fig. 2ª suitable linkage 34ª is shown whereby the flow-controlling member also is operated directly and mechanically from the pneumatic relay, the arrangement otherwise being the same.

It will be obvious that means may be provided for cutting out the relief provisions and also the flow-controlling organ 31 if the conditions are such that it is satisfactory to use pressure as it exists in the holder 18 without modification. The venting of the injection air pressure is obviously more effective and accompanied by less loss of air, when the capacity of the piping from valve 31 to the fuel valve is small, but it is nevertheless practicable to employ a larger capacity, when desired for other reasons, as represented by the dotted line reservoir 50 in Figs. 1 and 1ª.

What is claimed as new is:

1. The combination with an internal combustion engine of the Diesel type having a cylinder, means for injecting fuel into air previously compressed therein, and fuel and high pressure air lines leading to said means, of variable relief provisions in said air line, and means to control said provisions in accordance with varying loads.

2. In an internal combustion engine of the Diesel type, the combination with an engine cylinder having full injection means, a pump for compressing air for injecting fuel into the cylinder, and a high pressure air line for conducting the air thus compressed to the injection means, of means for regulating the output of said pump, and a variable relief device in the injection air line between the pump and the cylinder.

3. The combination with an engine of the type described having fuel injection means and a high pressure air line leading thereto, of a variable relief valve device connected with said line.

4. The combination with an engine of the type described, having fuel injection means and a high pressure air line leading thereto, of a plurality of graduated relief valves and means for connecting any one of them with said line.

5. The combination with a cylinder of a Diesel type engine having fuel injection means, a high pressure air line leading to said means and an air compressor connected with said line, of means for varying the output of said air compressor, a variable flow controller in said line, and variable relief provisions connected with said line.

6. In an engine of the type described, the combination with a cylinder having fuel admission means and means for conducting liquid fuel thereto, and a fuel air compressor with pipe connections between said compressor and said fuel admission means, of means for varying the output of said compressor, means for varying the action of the fuel admission means, and variable relief provisions in said pipe connections.

7. In an engine of the type described, the combination with a cylinder fuel injection means therefor and pipe connections for supplying the same with high pressure fuel injection air, of flow-controlling means and variable relief provisions in said connections, and means coördinating the action of said relief provisions and flow-controlling means.

8. The combination with a cylinder of a combustion engine of the type described, its fuel injection means, and connections for supplying the same with fuel injection air, of a flow-controlling device in said connections, a relief device between said flow-controlling device and the fuel injection means, and operating means for coincidently actuating said devices.

9. The combination with a cylinder of a Diesel type engine, its fuel injection means and connections for supplying the same with fuel injection air, of a variable flow-controlling device in said connections, a variable relief device between said flow-controlling device and the fuel injection means, and means for automatically varying the action of said devices in accordance with the load fluctuations.

10. The combination with a cylinder of a Diesel type engine, its fuel injection means, and suitable connections for supplying the same with fuel injection air, of variable means for venting air from said connections, a governor for operating the same automati-

cally in accordance with the load fluctuations, and flow-controlling means in advance of said escape means operated coincidently therewith.

11. The combination with a cylinder and fuel injection means of a combustion engine having suitable connections for supplying the same with fuel injection air, of pressure relief means for said connections and means for controlling the flow of air to said connections, actuated by air vented by the relief means.

12. The combination with a cylinder and fuel injection means of a Diesel type engine and means for supplying said means with high pressure injection air, of governor controlled means connected for automatically and variably venting such supply.

13. The combination with a cylinder and fuel injection means of a Diesel type engine, a compressed air reservoir, and a fuel air line connecting said reservoir and fuel injection means, of a variable relief device connected with said line, and flow-controlling means coördinated with said relief device between the same and said reservoir.

14. In a Diesel type engine, the combination with a cylinder, fuel injection means therefor, and a supply of high pressure air connected with said injection means, of means for controlling the flow of said high pressure air, relief means intermediate said flow-controlling means and the fuel injection means, and means for varying the period of admission of the fuel to the cylinder.

15. In a Diesel type engine, the combination with the working cylinder, fuel injection means, and a fuel air compressor having connections to said fuel injection means, of means for varying fuel admission to the cylinder, means for varying the output of said compressor, means for controlling the flow of high pressure air to the fuel injection means, and relief means intermediate the flow-controlling and fuel injection means.

16. The combination with a cylinder and fuel injection valve of a Diesel type engine, a fuel line to said valve, and a high pressure air line leading from a supply of high pressure air to said injection valve, of a governor, a throttle valve in said line controlled by the governor, a fuel pump also controlled by said governor, and governor-controlled means for timing the operation of the fuel valve.

17. The combination with a cylinder of an engine of the Diesel type, means for injecting fuel into air previously compressed in said cylinder, and a high pressure air system connected with said injection means, of a compressor connected with said system, a governor and connections for automatically regulating the output of said compressor, a variable relief device in the high pressure air system, and pneumatic means for operating said relief device.

18. The combination of the cylinder and fuel injection means of an engine of the Diesel type, a high pressure air line leading to said injection means, an air compressor for supplying said line, a governor and connections for automatically regulating the output of said compressor, a flow-controlling device in said high pressure air line, and pneumatic means whereby the said governor operates said flow controlling device.

19. The combination of the cylinder and fuel injection means of an engine of the Diesel type, a high pressure air system for supplying said means with fuel injection air, an air compressor, a governor and connections for automatically regulating the output of said compressor in accordance with varying engine loads, a flow-controlling device in said high pressure system, a relief device intermediate said flow-controlling device and the engine, and a pneumatic device connected with said compressor and operating said flow-controlling and relief devices from said governor.

20. The combination with an internal combustion engine having a fuel injection valve, an air compressor, and a high pressure line from the compressor to said fuel injection valve, of a flow-controlling organ in the high pressure line and means whereby said organ is controlled by variations in pressure at the compressor.

21. The combination with an internal combustion engine having a fuel injection valve, an air compressor, a high pressure line from the compressor to said fuel injection valve, and means for regulating the compressor, of a flow-controlling organ in the high pressure line and means whereby said organ is controlled by variations in pressure at the compressor.

22. The combination with an internal combustion engine having a fuel injection valve, an air compressor, a high pressure line from the compressor to said fuel injection valve, and means for regulating the compressor, of a throttle valve in the high pressure line, and a pneumatic device in communication with a low pressure portion of the compressor controlling said throttle valve.

23. Regulating means for Diesel engines comprising in combination with a fuel injection valve and an air compressor driven by the engine for supplying high pressure air to said fuel injection valve, a throttle valve controlling the intake of the compressor, a throttle valve controlling the flow of the injection air to the injection valve, and means for controlling the last-mentioned throttle valve and in turn controlled by variations in pressure at the pump due

to movement of said throttle valve in the inlet.

24. The combination with an internal combustion engine having a fuel injection valve, an air compressor, a high pressure line connecting the compressor with said fuel injection valve, and a governor controlling the air compressor, of means for controlling the flow in the high pressure line, and a line connecting said means with a low pressure stage or passage of the compressor.

In testimony whereof, I have signed this specification in the presence of two witnesses.

PAUL G. ROESTI.

Witnesses:
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