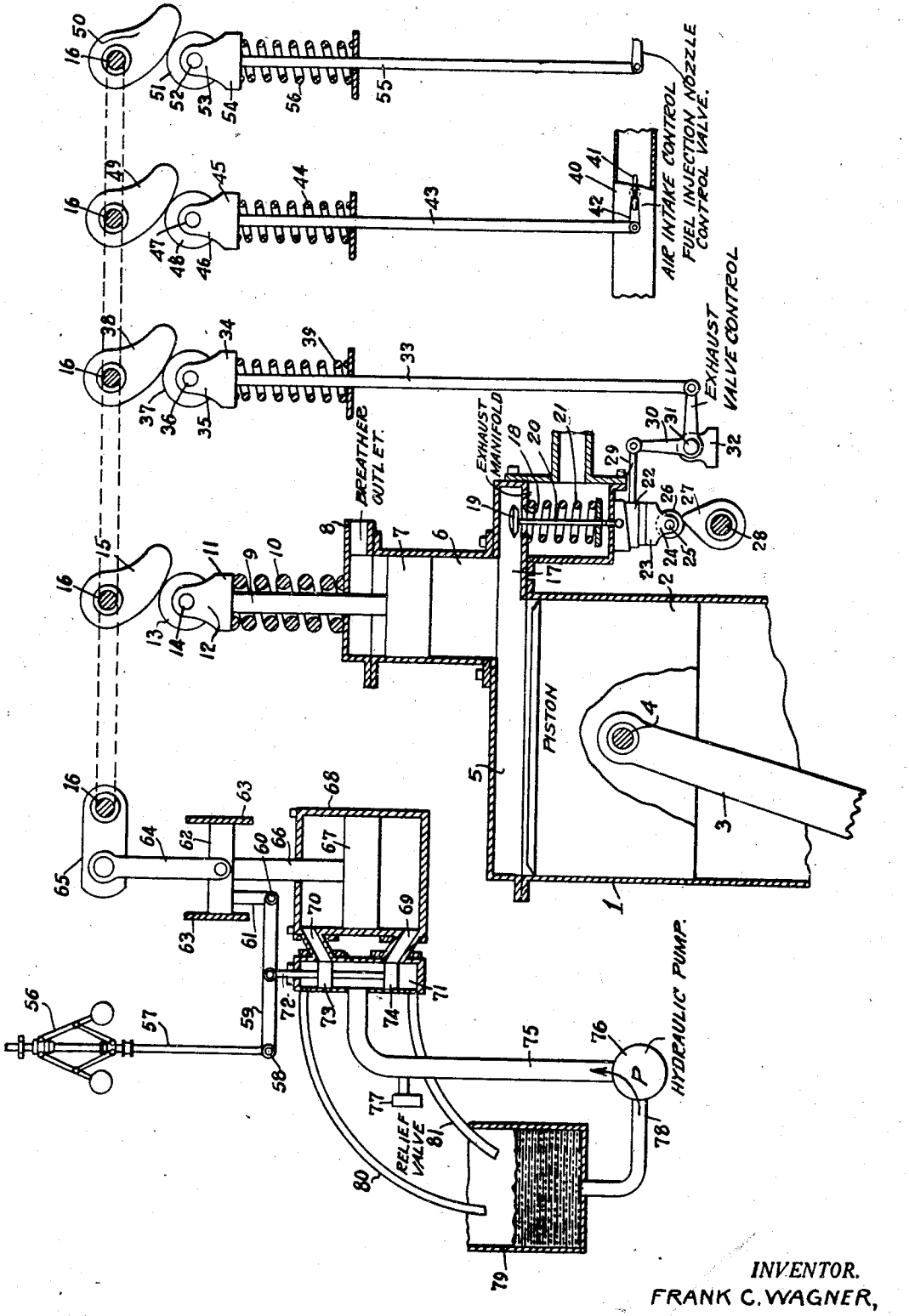
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VARIABLE CLEARANCE VOLUME ENGINE

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# UNITED STATES PATENT OFFICE

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## VARIABLE CLEARANCE VOLUME ENGINE

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3 Claims. (Cl. 123—90)

My invention relates to internal combustion engines, and in particular to Diesel engines.

It is the object of my invention to provide in a constant volume engine, means for varying the clearance volume, and means for throttling the air intake conduit. It is my object to control the clearance volume for either constant compression pressure or constant compression temperature.

It is an object of the invention to provide in a Diesel engine means for varying the clearance volume in order to reduce the excess air for combustion at partial loads without impairing the temperature of compression as well as to increase the compression and expansion ratios.

Another object is to provide linkage between the variable clearance volume means, the intake throttle, the fuel supply and the exhaust valve actuating linkage so that for each position of the variable clearance volume means there is a corresponding relative position of each of these so proportioned that the best economy and/or efficiency may be obtained at all loads.

Another object is to provide means for operating the variable clearance volume device under all conditions of pressure and temperature usually encountered.

Another object is to provide a means for changing the exhaust valve timing (and cycle of operation if necessary) so as to obtain the full benefit of the increased expansion ratio at partial loads.

Another object is to include in the linkage, means to compensate for various climatic and any other conditions which might necessitate making a change of adjustment.

This application is a division of my application filed January 7, 1935, Serial No. 650.

Referring to the drawing:

The drawing is a diagrammatic view of the essential parts involved in this invention, showing a single cylinder with its variable clearance volume apparatus, its adjustable exhaust, the control mechanism, the intake control and the fuel control.

Referring to the drawing in detail, the reference numeral 1 designates a cylinder having a piston 2 and a pitman 3 pivoted at 4. The interior of the cylinder, above the piston, is designated at 5. A supplementary variable clearance cylinder 6 communicates with the space 5. In this cylinder is a variable clearance piston 7. Above the piston is a breather outlet 8. The piston 7 is provided with a piston rod 9, surrounded by a helical spring 10 which serves to normally move the piston and piston rod upwardly by engagement with the head 11 on the piston rod 9. This head 11 is formed into a yoke 12 carrying a cam roller 13 on the axle 14, which is engaged by the cam 15 mounted on the cam shaft 16 (Figures 1, 5, 6).

In order to display in a single view the relationship of the parts, the several parts have been turned in the diagram so they can be viewed. Although the cam shaft 16 is shown successively in section, nevertheless it is the same cam shaft used for operating the several mechanisms, as hereinafter described.

The upper end of the cylinder 1 communicates with an exhaust passageway 17 having an exhaust port 18 controlled by the exhaust valve 19 (Figure 1). This exhaust valve has a valve stem 20, surrounded by the exhaust valve spring 21. The lower end of the valve stem 20 is provided with a wedge pivoted thereto which cooperates with a second wedge 22, which is engaged by the head 23 carrying a yoke 24 and axle 25, supporting a cam roller 26 which is actuated by the cam 27 and shaft 28.

The wedge 22 serves to vary the length of the stroke of the valve stem 20, therefor varying the opening of the exhaust valve. This wedge is connected by a pitman 29 to the bellcrank 30, which is pivoted at 31 on the block 32. This bellcrank is connected to the pitman 33, which terminates in a head 34 and yoke 35 carrying an axle 36 on which is supported a cam roller 37. This roller is engaged by the cam 38 mounted on the cam shaft 16. A spring 39 serves to maintain the cam roller against the cam.

The intake passageway 40 is controlled by a butterfly valve 41 connected to the lever 42, which in turn, is connected to the rod 43 that is normally moved upwardly by the spring 44. This rod 43 is provided with a head 45, yoke 46, axle 47 and a cam roller 48 engaging the cam 49 on the cam shaft 16. The cam shaft 16 also carries the cam 50, engaging the cam roller 51 supported on the axle 52 in the yoke 53 on the head 54. This head is carried on the rod 55. The roller is actuated against the cam by the spring 56. The rod 55 is connected to the valve control for controlling the amount of fuel that is admitted to the Diesel engine.

A governor 56 actuates the governor rod 57. This rod is pivoted at 58 to a floating lever 59. The floating lever 59 is pivoted at 60 to a compensating rod 61, which is attached to the crosshead 62 which travels in the crosshead guideway 63. This crosshead is connected by a connecting

rod 64 pivotally to a crank arm 65, which is mounted on the cam shaft 16.

The other side of the crosshead 62 is connected by the piston rod 66 to the piston 67 operating in the hydraulic cylinder 68. This cylinder is provided with passageways and ports 69 and 70, which communicate with a cylinder 71 in which there operates a piston rod 72, pivoted at one end to the floating lever 59 and carrying a pair of spaced pistons 73 and 74. This assembly is known as the pilot valve. The cylinder 71 is connected by the hydraulic line 75 to a pump 76. The line 75 is equipped with a relief valve 77. The pump draws its hydraulic supply through the pipe 78 from the reservoir 79. The hydraulic supply is discharged through the pipes 80 and 81 from the cylinder 71.

*Methods of operation*

The governor 56 operates the governor rod 57 and in doing so moves the lever 59, lowering the valve stem 72 and permitting the valve 73 to uncover the port 70, and permitting the valve 74 to uncover the port 69. Hydraulic pressure from the pump 76, passing through the pipe 75, will enter through the port 69 and lift the piston 67, while the fluid above the piston will make its exit through the port 70, line 80 to the reservoir 79. This results in the movement upwardly of the piston rod 66 and associated crosshead 62, with the connecting rod 64 and crank 65 for rotating the cam shaft 16 in order to adjust the position of the cams 15, 38, 49 and 50. The result is that according to the speed of the governor the clearance volume in the main cylinder is adjusted, the exhaust is adjusted, the intake for air is adjusted and the fuel admitted to the cylinder is adjusted.

In connection with the exhaust valve timing, where the claims and description refer to "duration of the opening of said exhaust", it is also desired to include in the meaning "the point of opening". The wedge mechanism shown is merely a simple means of controlling the exhaust valve and it may be necessary to have a compound means, that is, a mechanism capable of controlling both the duration and the point of opening separately.

Whereas in the claims and description, the position of cam shaft 16 is controlled "according to the speed of the engine", no doubt this phrase is used because of the assumption that there must be a governor, and the ordinary interpretation of a governor is to control speed. There may be used "load" rather than "speed" because the primary object of the invention is economy of Diesel or internal combustion engines at varying loads regardless of speed.

It will be understood that where "air intake valve" is mentioned, it should not be limited to any particular type of valve, but includes any type of valve or other mechanism for controlling the quantity of intake air.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of my claims and my invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a Diesel engine having a cylinder with an associated exhaust manifold with an exhaust valve therein and a cam shaft with an exhaust valve cam thereon adapted to cause operation of said exhaust valve; means for varying the duration of exhaust valve opening comprising connecting means between said exhaust valve cam and said exhaust valve including a member with a roller engaging said exhaust valve cam and wedge means slidably adjustable to vary the distance between said exhaust valve and said roller, and means to slidably adjust said wedge means including an engine speed responsive centrifugal governor, a rotatably adjustable auxiliary cam shaft, a wedge adjusting cam on said auxiliary cam shaft, hydraulic means operatively connecting said centrifugal governor with said auxiliary cam shaft, and a linkage connecting said wedge adjusting cam with said wedge means, whereby said centrifugal governor, responsive to the speed of the Diesel engine, will vary the duration of exhaust valve opening through adjustment of said wedge means by rotation of said rotatable auxiliary cam shaft.

2. In a Diesel engine having an associated exhaust manifold with an exhaust valve therein and a cam shaft with an exhaust valve cam thereon adapted to cause operation of said exhaust valve; means responsive to the speed of the engine for varying the duration of exhaust valve opening comprising connecting means between said exhaust valve cam and said exhaust valve including a member engaging said exhaust valve cam and wedge means associated therewith and slidably adjustable to vary the effective length of said exhaust valve, and means to slidably adjust said wedge means including a bell crank operatively connected thereto at one end, a push rod connected at one end to the opposite end of said bell crank, cam engaging means at the opposite end of said push rod, a rotatably adjustable auxiliary cam shaft, a cam on said auxiliary cam shaft engaged by said cam engaging means, and engine speed responsive means for adjusting said auxiliary cam shaft to vary the effective length of said valve and vary the duration of the exhaust valve opening.

3. In a Diesel engine having an associated exhaust manifold with an exhaust valve therein and a cam shaft with an exhaust valve cam thereon adapted to cause operation of said exhaust valve; means responsive to the speed of the engine for varying the duration of exhaust valve opening comprising connecting means between said exhaust valve cam and said exhaust valve including a member engaging said exhaust valve cam and wedge means associated therewith and slidably adjustable to vary the effective length of said exhaust valve, and means to slidably adjust said wedge means including a bell crank operatively connected thereto at one end, a push rod connected at one end to the opposite end of said bell crank, cam engaging means at the opposite end of said push rod, a rotatably adjustable auxiliary cam shaft, a cam on said auxiliary cam shaft engaged by said cam engaging means, and means for adjusting said auxiliary cam shaft including a crank arm thereon, a servomotor operatively connected to said crank arm, and a centrifugal governor driven by said engine and operatively connected to said servomotor.

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