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PUSH ROD STRUCTURE FOR AN INTERNAL COMBUSTION ENGINE

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Fig. 1.

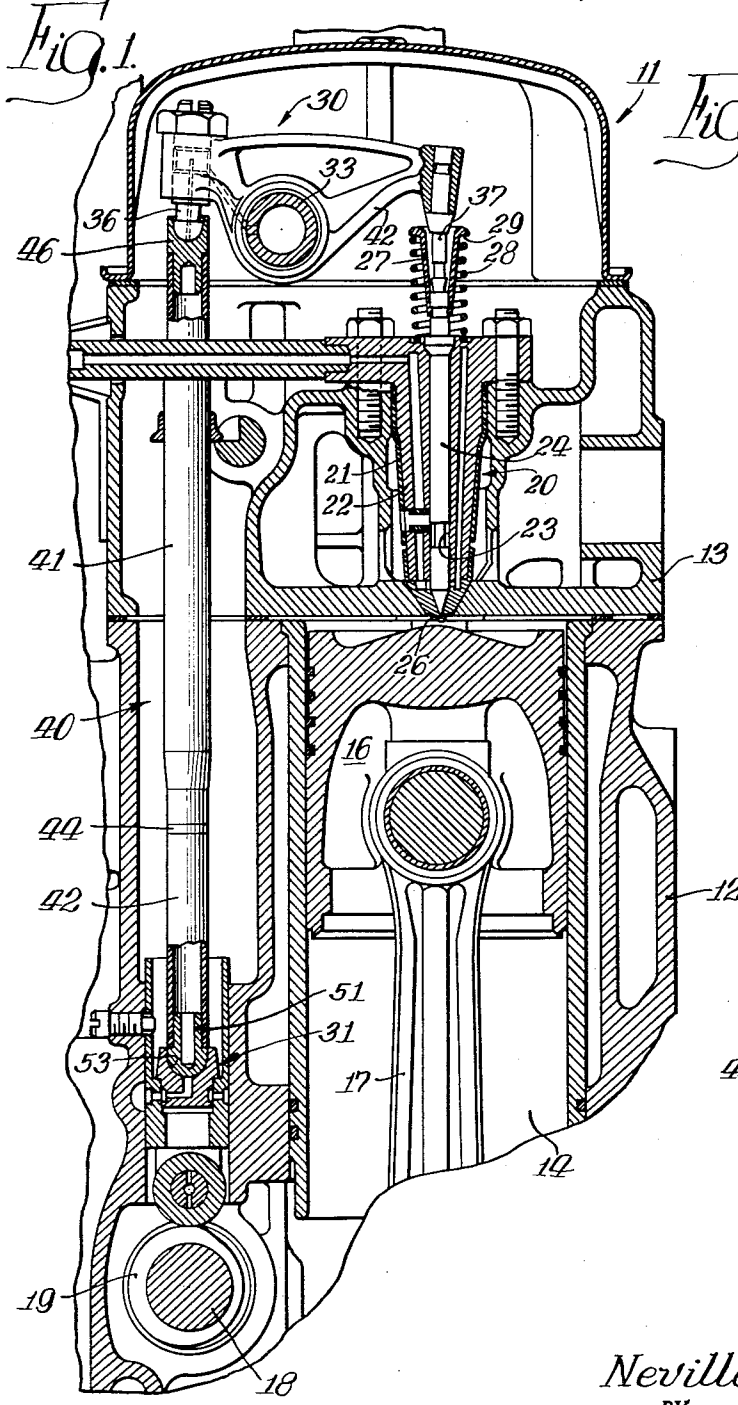
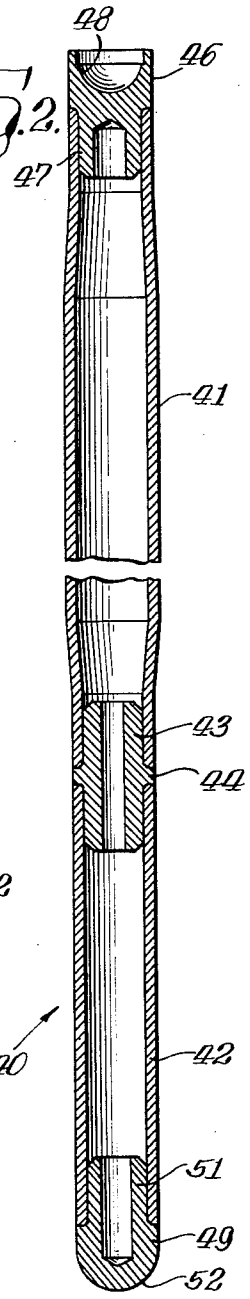


Fig. 2.



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PUSH ROD STRUCTURE FOR AN INTERNAL COMBUSTION ENGINE

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This invention relates to internal combustion engines, and more particularly to a temperature compensated push rod structure.

One of the problems in connection with internal combustion engines is that of unequal changes in the size and clearances between the various parts of the engine with changes in temperature. Such changes result from the fact that the various parts are constructed from different materials or operate at different temperatures and hence expand to different extents as the engine goes from a cold starting condition to a normal or hot running condition. In the case of cyclically movable parts of the engine, such changes in size affect operation of the engine. One instance is in connection with the intake and exhaust valves.

A similar and more critical area where size variations occur, in diesel type engines, is in the means for actuating the plungers of the fuel injectors. Such injectors are usually mounted in the cylinder head of the engine, which is usually of cast iron as is the cylinder block, and are actuated by the cam shaft of the engine through a hardened steel push rod and a rocker arm. Inasmuch as the push rod is of hardened steel and thus has a greater coefficient of expansion than cast iron, it becomes apparent that if the parts are adjusted for correct operation when the engine is cold, incorrect adjustment occurs when the engine heats up, thus affecting the stroke of the plunger and consequently the amount of fuel injected and the timing thereof.

Accordingly, it is a general object of the present invention to provide an improved internal combustion engine in which the cyclically movable parts are relatively unaffected by temperature changes of the engine.

Another object is to provide an improved internal combustion engine having a cylinder block and head and utilizing a cam-operated linkage for effecting movement of a member controlling an opening to a cylinder of the engine, in which such linkage is compensated for a difference in expansion between the cylinder block and head on the one hand and the linkage on the other hand, throughout the operating temperature range of the engine.

A more specific object is to provide a novel push rod structure for the linkage for actuating an injector plunger in a diesel type internal combustion engine having a cylinder block and head, in which the push rod structure varies in length with changes in temperature of the engine to substantially the same extent as the cylinder block and head, throughout the operating temperature range of the engine.

These and other objects will become apparent from the following detailed description and the accompanying sheet of drawings, in which:

FIG. 1 is a fragmentary vertical sectional view of a diesel-type internal combustion engine embodying the features of the present invention; and

FIG. 2 is an enlarged longitudinal sectional view of one of the push rods used in the engine of FIG. 1.

In FIG. 1, a diesel-type internal combustion engine 11 is illustrated, which comprises cylinder structure including a cylinder block 12 and a cylinder head 13, the former having a plurality of cylinders 14 therein. Piston structure including a piston 16 and connecting rod 17 is carried in each cylinder 13. A cam shaft 18 having a

plurality of cams 19 thereon is mounted in the lower portion of the block 12 for actuating the intake and exhaust valves (not shown) of the engine 11 and for actuating injection means, indicated generally at 20, for injecting metered quantities of fuel into the cylinders 14. The fuel injection means 20, in this instance, comprises a plurality of fuel injectors 21 each comprising an injector body 22 having a central bore 23 in which a reciprocably mounted plunger 24 is disposed, for forcing fuel from a chamber in the lower end of the bore 23 through a nozzle 26 into the cylinder. The intake and exhaust valves and the fuel injector plungers 24 comprise cyclically movable means for controlling openings in the cylinder structure, namely, the valve ports and fuel injector nozzles, respectively.

The upper end of the injector plunger 24 is shown as having a cup 27 secured to the upper end thereof, and a compression spring 28 is disposed around the cup 27 between a lip 29 around the upper end of the cup 27 and the upper surface of the injector body to urge the injector plunger 24 upwardly of the injector body 22. Downward movement of the injector plunger 24 to the position shown in FIG. 1 is effective to inject metered quantities of fuel from the chamber at the lower end of the injector into the cylinder.

In order to provide such downward movement of the injector plunger 24, the engine 11 includes moving means 30 for effecting this result. The moving means 30 in this instance comprises linkage between the cam 19 and plunger 24 which includes cam-operated means in the form of a tappet 31, a rocker arm 32 that is mounted for pivotal or rocking movement on a shaft 33, and push rod structure 40 interconnecting the rocker arm 32 with the tappet 31. The rocker arm 32 is shown as including an adjustable push rod engaging screw 36 at one end and an injector plunger engaging extension or link 37 at its other end.

With the foregoing structure it will be apparent that if the screw is adjusted, when the engine 11 is cold, so that the lower end of the plunger 24 completely fills or bottoms in the chamber at the lower end of the injector 21 when the tappet 31 is on the high point of the cam 19, such adjustment will change after the engine heats up to normal operating temperatures. This is due to the lesser expansion of the cylinder block 12 and head 13, which are normally cast iron, relative to the expansion of a push rod made of hardened steel. The push rod structure 40 of the present invention overcomes this problem in that it equalizes the expansion of the push rod structure and that of the cylinder block and head, regardless of the temperature of the engine.

To accomplish the foregoing, the push rod 40 preferably comprises an elongated tube which in this instance is formed in two sections, namely, an upper section 41 which forms the major portion of the rod 40, and a lower section 42, the upper and lower sections 41 and 42 being connected by a tubular plug 43 inserted into the open ends of the adjacent sections. The plug 43 includes a central circumferential flange 44 having a radial dimension substantially equal to that of the wall thickness of the sections 41 and 42 at their adjacent ends to provide a substantially flush outer surface at the juncture.

The upper end of the section 41 may be closed by a plug 46 having a reduced diameter portion 47 adapted to be inserted into the open end of the section 41. The upper end of the plug 46 has a depression or hemispherical seat 48 formed therein, which is adapted to receive and provide a seat for the complemently shaped lower end of the push rod engaging screw 36 (FIG. 1).

The lower open end of the section 42 is similarly closed by a hardened plug 49 having a reduced diameter portion 51 adapted to be inserted therein, the outer or lower end, indicated at 52, of the plug 49 being rounded for engage-

ment in a hemispherical or cup-shaped seat **53** (FIG. 1) in the tappet **31**.

As heretofore mentioned, in order to provide the expansion equalization feature of the present invention, the two sections **41** and **42** of the push rod structure **40** are made of different materials having coefficients of expansion differing from each other and from that of the cylinder block and head. Thus, the upper or major section **41** is made of steel which has a coefficient of expansion greater than that of the cylinder head and block, and the lower section **42** is made of a material having a coefficient of expansion less than that of the cylinder block and head. An example of one such material having these properties is that marketed under the trade name "Invar" and composed of iron, carbon, manganese and nickel. The material is characterized as having a very low coefficient of expansion at elevated temperatures. With these materials, the section **42** is about one-quarter of the total length of the push rod.

Where either the cylinder block **12** and head **13**, or both, are constructed of materials other than cast iron, such as aluminum, the length and type of material used in the compensating section **42** would be varied accordingly.

In order to assure equal expansion of the push rod structure **40** with that of the cylinder block **12** and head **13** during the transient temperature condition when the engine is heating up to normal operating temperature, the present invention further contemplates the diversion of a small portion of the flow of engine lubricating oil from the rocker arm lubricating passages to the upper end of the push rod structure **40** so that the oil flows around the outer surface of the push rod downwardly toward the tappet **31**. This flow is returned to the engine sump. Inasmuch as the engine lubricating oil is at all times maintained substantially at engine operating temperatures, the push rod **40** will heat up at the same rate as the block **12** and head **13**. Equalized expansion of these structures throughout the operating temperature range of the engine is thereby obtained.

I claim:

1. In an internal combustion engine including a cylinder structure comprising a block and a head, cyclically movable means for controlling an opening in said cylinder structure, and means for moving said movable means

including a rocker arm, cam-operated means remote from said rocker arm, and a push rod structure interconnecting said cam-operated means and said rocker arm, said push-rod structure comprising two sections having different coefficients of expansion from each other and from that of said cylinder structure, said rocker arm having a passage for supplying engine lubricating oil to said push rod, whereby with changes in temperature of the engine, the expansion of said push rod structure is substantially equal to that of said cylinder structure to maintain the movement of said movable means constant throughout the temperature variation range of said engine.

2. In an internal combustion engine of the diesel type including a cylinder structure comprising a block and a head, fuel injections means carried by said head and including a reciprocable fuel injector plunger for delivering a charge of fuel to said cylinder structure, and means for moving said plunger including a rocker arm, cam-operated means remote from said rocker arm, and a push rod structure interconnecting said rocker arm and said cam-operated means, said push rod structure comprising two sections having different coefficients of expansion from each other and from that of said cylinder structure, said push rod structure being positioned to receive a flow of engine lubricating oil along its outer surface to control the temperature thereof, whereby with temperature changes of said engine the expansion of said push rod structure is maintained substantially equal to that of said cylinder structure and the length of the stroke of said injector plunger remains substantially constant throughout the temperature variation range of the engine.

3. The combination according to claim 1, wherein said rocker arm and the top of said push rod structure have engaging bearing surfaces, and said rocker arm is provided with a passage for supplying the engine lubricating oil to said surfaces to lubricate the same, the oil thereafter flowing downwardly along the outer surface of said push rod structure to control the temperature thereof.

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