Sept. 7, 1965 E. R. RUTENBER ETAL 3,204,624

MOMENTARY ENRICHING DEVICES TO IMPROVE THE STARTING OF INTERNAL COMBUSTION ENGINES USING FUEL INJECTION

Filed Aug. 15, 1963

2 Sheets-Sheet 1

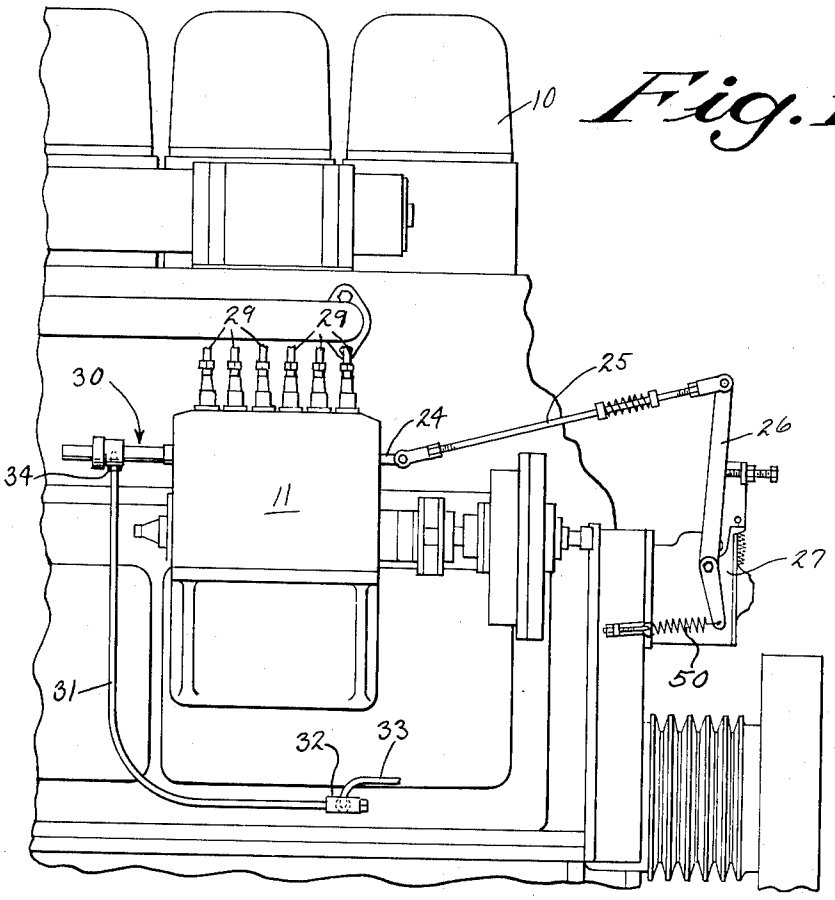


Fig. 1

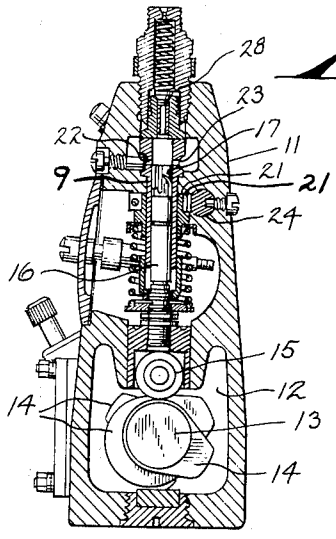


Fig. 3

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Fig. 2

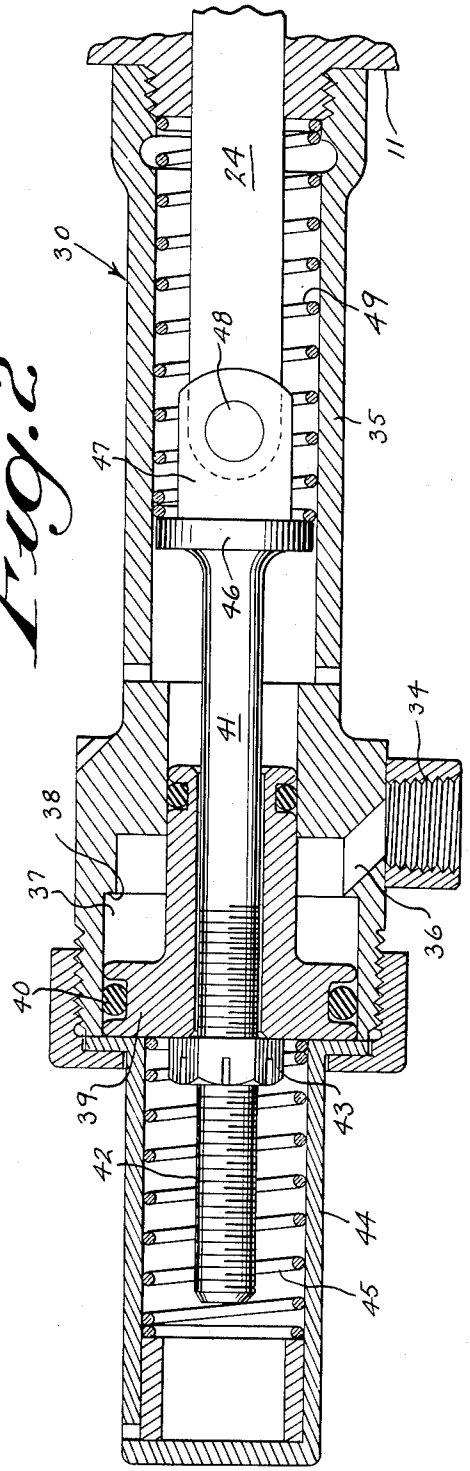
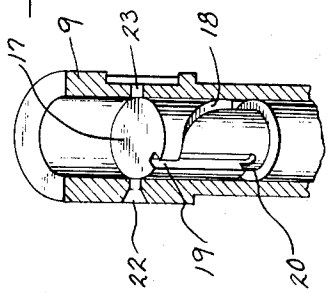


Fig. 4



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MOMENTARY ENRICHING DEVICES TO IMPROVE THE STARTING OF INTERNAL COMBUSTION ENGINES USING FUEL INJECTION

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6 Claims. (Cl. 123—179)

This invention relates to improvements in momentary enriching devices to improve the starting of internal combustion engines using fuel injection.

The general object of the present invention is to provide an improved device, applicable both on the conventional diesel engines and on ordinary engines having fuel injection, for causing momentary enriching to improve starting.

In conventional diesel engines it is customary for fuel pumps to be provided with "full load stops" which are for the purpose of limiting the fuel quantity for a maximum power setting. With the present invention the improved device is substituted for the usual "full load stop" and is so constructed that it performs its novel momentary enriching function as well as the "full load stop" function.

A more specific object of the invention is to provide an improved device for use in connection with a fuel pump wherein there is means permitting movement of the fuel pump control rack to enriching position whenever the engine stops, to be ready for enrichment upon starting, and wherein oil pressure is utilized in a novel manner to promptly return the device to non-enriching or "full load" position as soon as the lubricating oil pressure is up to normal.

A more specific object of the invention is to provide an improved device as above described wherein a piston arrangement is utilized and wherein there is a spring for urging the piston to such a position, whenever the engine is out of operation, as to permit the parts of the mechanism to automatically assume an "enriching" position when the engine is dead, to thereby aid in starting, the arrangement being such that lubricating oil pressure acts on the piston to return it and the associated parts to non-enriching or "full load" position as soon as the lubricating oil pressure is up to normal after starting.

A further object of the invention is to provide a momentary enriching device as above described which is relatively simple in construction, inexpensive, and foolproof in operation.

With the above and other objects in view, the invention consists of the momentary enriching device and all of its parts and combinations, as set forth in the claims, and all equivalents thereof.

In the accompanying drawings, illustrating one complete embodiment of the preferred form of the invention, in which the same reference numerals designate the same parts in all of the views:

FIG. 1 is a fragmentary side elevational view of a diesel engine showing the improved device attached to the lefthand side of the fuel pump;

FIG. 2 is a fragmentary longitudinal sectional view showing the enriching device connected to the end of the control rack of the fuel pump;

FIG. 3 is a vertical cross-sectional view through a fuel pump of the type with which the present invention is used; and

FIG. 4 is a perspective view in longitudinal section showing a fuel pump plunger in one position of rotation in its sleeve.

Referring more particularly to the drawing, the numeral **10** designates a conventional diesel engine having

a fuel pump **11**. While the invention will be illustrated and described as particularly applicable to diesel engines, it is to be understood that the invention is also applicable to ordinary engines having fuel injection.

While the fuel pump illustrated is a conventional fuel pump, such as an American Bosch APE, it is necessary to briefly describe portions of the fuel injection pump to obtain a better understanding of the present invention. Any similar fuel pump having a fuel rack control may be utilized. The fuel injection pump is best shown in FIG. 3 and includes a chamber **12** for a cam shaft **13**, which chamber also serves as a reservoir for the lubricating oil. The cam shaft has cams **14** which act on roller lifters **15** to cause reciprocation of the stems **16** of plungers **17**.

As shown in FIG. 4, the plungers **17** have a lower helix **18** and a vertical slot **19**, and below the helix is an annular groove **20**. Each plunger operates in a barrel sleeve **9** having an inlet port **22** and a bypass port **23**. This type of plunger gives a constant beginning of injection and a variable ending of delivery. The ports **22** and **23** are closed on the upward stroke by the top edge of the plunger head. The time of opening the ports **22** and **23** is varied by the relation of the helix to the ports, as is well known in this type of injection pump, and this in turn is controlled by the position of rotation of the plunger head **17**. Bypassing occurs when the helix uncovers the port. Bypassing also occurs when the vertical slot **19** is in registration with the bypass port **23**.

Referring again to FIG. 3, the upper end of each control sleeve **21** is provided with an adjustable gear segment **21'** which is operated by a horizontally reciprocating control rack **24**. While longitudinal movement of the control rack may be manual in certain injection pumps, it is usually connected through linkage **25** and **26** (see FIG. 1) with a governor **27** so that the governor action causes reciprocation of the rack **24** in one direction or the other and resulting rotation of the plunger heads **17**, through suitable connection between the control sleeves and plungers **16**, to vary the quantity of fuel delivered by the injection pump, this fuel being forced out through the delivery valves **28** through conduits **29** connected with said valves, and leading to the injector nozzles in the combustion chambers of the engine **10**.

Connected to the fuel injection pump **11** on the side opposite the governor is the improved enriching device **30**. It is in a position in alignment with a projecting end of the control rack **24** as is clear from FIG. 2. A lubricat- the oil line **31** leads from the oil gallery **32** of the engine, there being an oil conduit **33** leading to the gallery from the engine oil pump. The oil line **31** is connected to an inlet **34** of the casing **35** of the enriching device, which inlet is connected by a port **36** with the smaller diameter portion of the piston chamber **37**, said smaller diameter portion being behind an annular stop shoulder **38**. The piston **39** is fitted with a suitable O-ring **40** and has a rod **41** extending slidably therethrough, said rod having a threaded end **42** for receiving an adjustable full load stop nut **43**. Said threaded end **42** projects into a cup-shaped housing portion **44** for a spring **45**. The spring acts on the piston **39** to urge it against the annular stop shoulder **38** when the engine is out of operation as will be hereinafter explained. The piston forms a movable abutment for the stop nut **43**.

The opposite end of the stem **41** carries a head **46** with a projecting apertured lug **47** which is pivotally connected as at **48** to the end of the rack member **24** of the fuel injection device, there being a spring **49** acting in a lefthand direction on the head **46** to urge the parts toward shutoff position in case there should be a breakage or disconnection in the linkage **25–26** of the governor. Thus, the spring **49** is a safety feature.

Operation

In operation, when the engine is operating, the fuel pump **11** normally pumps fuel through the outlet lines **29** to the usual injector nozzles in the combustion chambers of the engine **10**. When the engine is dead, the spring **45** has urged the piston **39** to enriching position against the stop shoulder **38**. This permits the governor spring **50** (see FIG. 1) to move the rod **41** and control rack **24** toward the right (referring to FIG. 2) to a point where the stop nut **43** abuts the piston **39**. This movement of the rack **24** rotates the plunger head **17** to the full delivery or enriching position of the fuel injection pump, with the ducts **19** (FIG. 4) completely out of registration with the fuel ports. As soon as the engine **10** starts, the lubricating oil pressure promptly reaches normal so that it can act through the line **31**, inlet **34**, and port **36** to move the piston **39** back to the full load position of FIG. 2. This causes return movement of the rack **24** to rotate the fuel pump plunger heads **17** to bring them into the "full load" position and stop the enrichment which previously took place for starting, and which occurred only when the piston was against the annular stop shoulder **38**. It is thus apparent that the nut **43** acts as the "full load stop" which was previously used on fuel injection pumps prior to the present invention.

An important feature of the present invention, therefore, is the piston **39** which is automatically moved by the spring **45** to enrichment permitting position whenever the engine stops, said movement taking place because the pressure of the lubricating oil in the line **31** is no longer acting in a reverse direction against the piston. This piston movement prepares the engine for enrichment whenever it is again started, the piston arrangement automatically providing for return of the rack **24** and control sleeves **21** to non-enriching position as soon as the lubricating oil pressure is up to normal upon startig of the engine.

Various changes and modifications may be made without departing from the spirit of the invention, and all of such changes and modifications are contemplated as may come within the scope of the claims.

What we claim is:

1. In combination with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and said engine having a pressure lubricating oil system, a momentary enriching device for improving starting of the engine comprising a piston rod having a pulley connection with said control member and having a full load stop thereon, spaced outwardly from said pulley connection, a fluid cylinder having a piston therein through which an intermediate portion of said piston rod is slidable, said piston being located between said pulley connection and full load stop and being movable in the cylinder from an enriching position to a full load position and forming a shiftable abutment for said full load stop, means normally urging said piston to enriching position whenever the engine is dead, and a conduit connecting said pressure lubricating oil system of the engine to said cylinder in such a position as to automatically move the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop during such movement to pull the piston rod and control member to full load position.

2. In combination with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and said engine having a pressure lubricating oil system, a momentary enriching device for improving starting of the engine comprising a piston rod having a pulling connection with said control member and having a full load stop thereon spaced outwardly from said pulling connection, a fluid cylinder having a piston therein through which an intermediate portion of said piston rod is slidable, said piston being located between said pulling connection and full load stop and being movable in the cylinder from an enriching position to a full load position and forming a shiftable abutment for said full load stop, spring means acting only on said piston and normally urging said piston to enriching position whenever the engine is dead, and a conduit connecting said pressure lubricating oil system of the engine to said cylinder in such a position as to automatically move the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop during such movement to pull the piston rod and control member to full load position.

3. In combination with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and said engine having a pressure lubricating oil system, a momentary enriching device for improving starting of the engine comprising a piston rod having a pulling connection with said control member and having a full load stop thereon, a fluid cylinder having a main portion and having a smaller diameter portion with an annular shoulder between said portions, a piston through which an intermediate portion of said piston rod is slidable, said piston being located between said pulling connection and full load stop and being movable in the main portion of the cylinder from an enriching position against said shoulder to a full load position and forming a shiftable abutment for said full load stop, means normally urging said piston to enriching position against said shoulder whenever the engine is dead, and a conduit connecting said pressure lubricating oil system of the engine to said smaller diameter portion of the cylinder in such a position as to automatically move the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop during such movement to pull the piston rod and control member toward full load position.

4. In combination with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and said engine having a pressure lubricating oil system and having means normally urging said movable control member inwardly to enriching position, a momentary enriching device for improving starting of the engine comprising a piston rod having a pulling connection with and projecting from an end of said control member and having a full load stop nut adjustably threaded thereon and spaced outwardly from said pulling connection, a fluid cylinder having a piston therein through which said piston rod is slidable, said piston being located between said pulling connection and stop nut and being movable in the cylinder from an enriching position to a full load position and forming an abutment for said full load stop nut, spring means normally urging said piston to enriching position whenever the engine is dead to thereby permit independent movement of the movable control member inwardly to enriching position, and a conduit connecting said pressure lubricating oil system of the engine to said cylinder in such a position as to automatically move the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop nut during such movement to pull the piston rod and control member to full load position.

5. For use with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and having a projecting end normally urged inwardly to enriching position, and said engine having a pressure lubricating oil system, a momentary enriching device for improving starting of an engine comprising: a piston rod having an outer portion and having an inner end connectable to the projecting end of said movable control member to form a pulling connection therewith,

a full load stop member adjustably carried by an outer portion of said piston rod, a tubular casing having an inner portion connectable to the fuel pump to enclose said projecting end of the movable control member and its connection with the piston rod, said casing having an outer portion forming a fluid cylinder, a piston which is located inwardly of said full load stop slidable in said fluid cylinder and through which said piston rod is slidable, said piston being movable in the cylinder from an enriching position to a full load position and forming an abutment for the full load stop member, and means normally urging said piston inwardly to thereby permit independent movement of the movable control member inwardly to enriching position, said cylinder having a pressure port connectable with the pressure lubricating oil system of the engine and located in such a position as to provide for pressure movement of the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop member during such movement to pull the piston rod and control member to full load position.

6. For use with an internal combustion engine having a fuel injection pump with means including a movable control member for metering the delivery of fuel to the engine and having a projecting end normally urged inwardly to enriching position, and said engine having a pressure lubricatin oil system, a momentary enriching device for improving starting of an engine comprising: a piston rod having an outer portion and having an inner end connectable to the projecting end of said movable control member to form a pulling connection therewith, a full load stop member adjustably carried by an outer portion of said piston rod, a tubular casing having an

inner portion connectable to the fuel pump to enclose said projecting end of the movable control member and its connection with the piston rod, said casing having an outer portion forming a fluid cylinder, a piston which is located inwardly of said full load stop slidable in said fluid cylinder and through which said piston rod is slidable, said piston being movable in the cylinder from an enriching position to a full load position and forming an abutment for the full load stop member, means normally urging said piston inwardly to thereby permit independent movement of the movable control member inwardly to enriching position, said cylinder having a pressure port connectable with the pressure lubricating oil system of the engine and located in such a position as to provide for pressure movement of the piston to full load position following starting of the engine, said piston being positioned to act on said full load stop member during such movement to pull the piston rod and control member to full load position, and a cover for the stop member and portion of the piston rod which projects beyond the piston removably connected to an outer end of said casing.

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