Dec. 30, 1969 W. T. TURNER 3,486,595

INTERNAL COMBUSTION ENGINES

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Fig. 1.

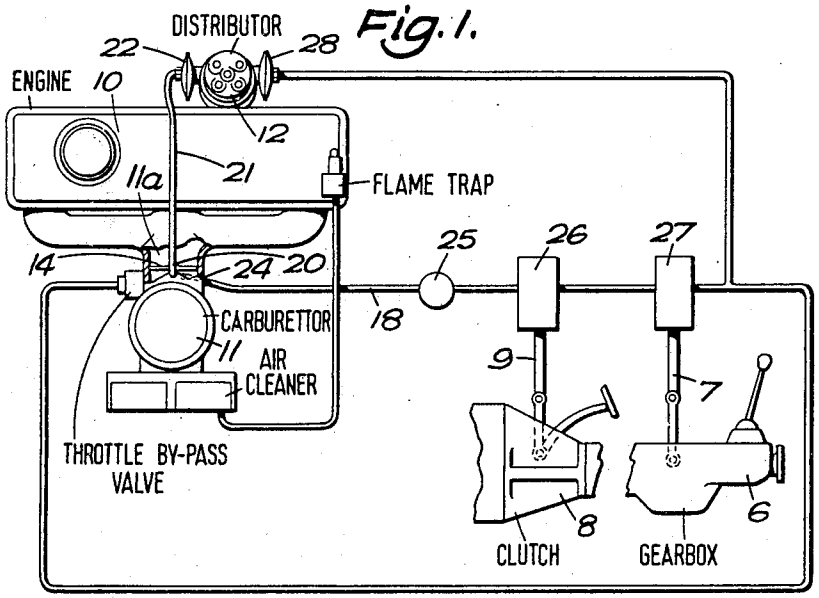


Fig. 2.

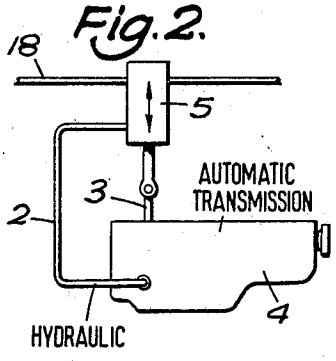


Fig. 3.

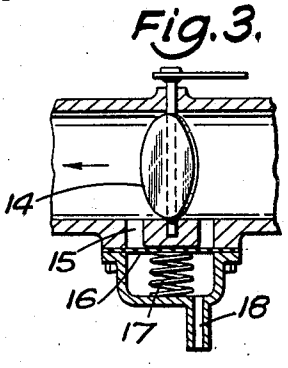


Fig.4.

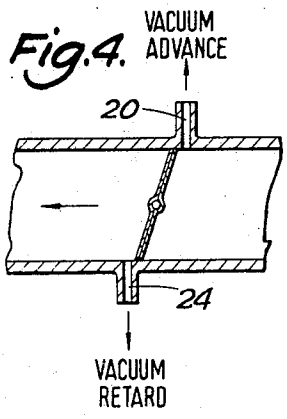


Fig.5.

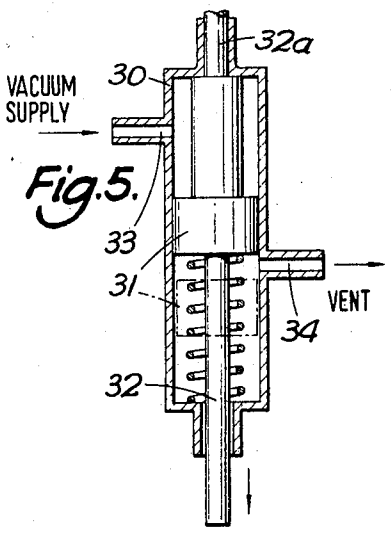
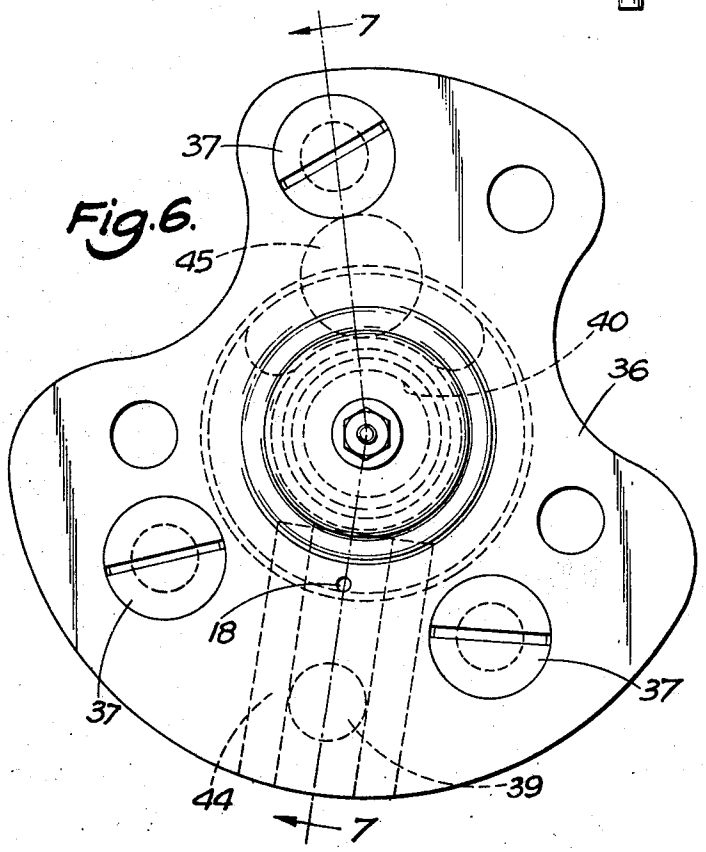


Fig.6.



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INTERNAL COMBUSTION ENGINES

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Fig. 7.

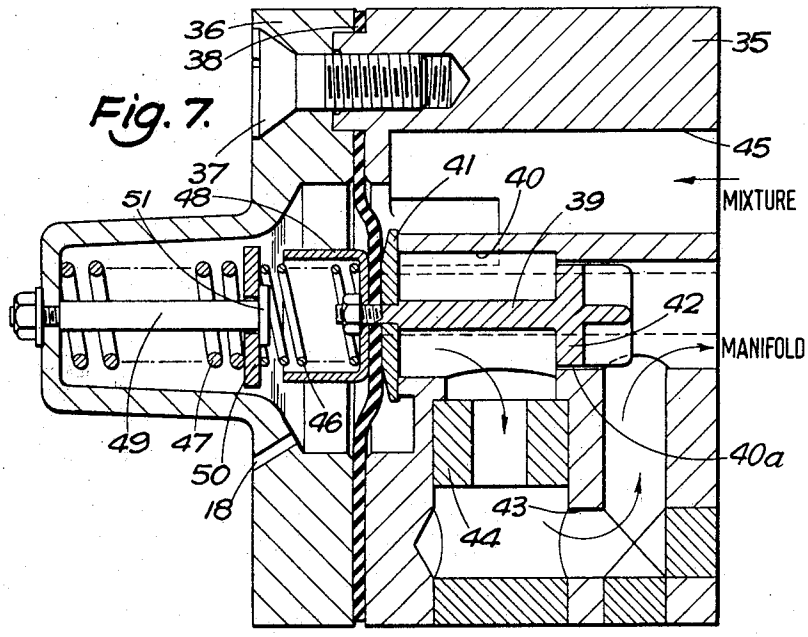
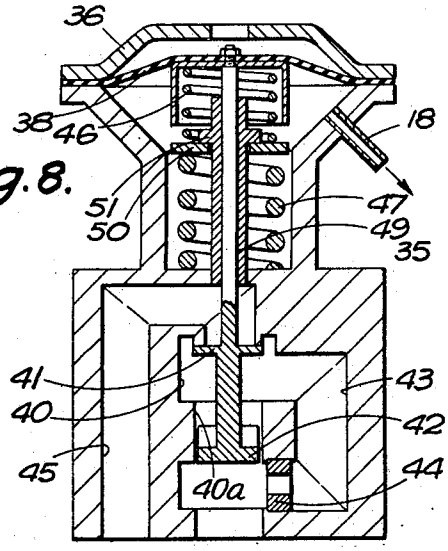


Fig. 8.



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INTERNAL COMBUSTION ENGINES

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Int. Cl. F16d 23/00; F02d 31/00; F02p 5/04
U.S. Cl. 192—092 10 Claims

ABSTRACT OF THE DISCLOSURE

An internal combustion engine having a carburettor, an inlet passage connecting the carburettor to the engine, a butterfly valve in the inlet passage arranged to open and close the passage, a bypass around the butterfly valve having vacuum operated valve means arranged to open the bypass when subjected to vacuum, an ignition system having vacuum operated means for retarding the ignition, a port in said inlet passage adjacent the butterfly valve so that when the butterfly valve is closed the port is on the engine side of the valve and when the butterfly valve is moved a small amount into an open position the port becomes on the other side of the valve said port being connected to the two vacuum operated means through cut-off means actuated by a transmission unit associated with the engine arranged to prevent a vacuum reaching the vacuum operated means when the engine is idling.

This invention relates to internal combustion engines and more particularly to spark ignition engines.

The invention provides an internal combustion engine having a carburettor, an inlet passage connecting the carburettor to the engine, a butterfly valve in the inlet passage arranged to open and close the passage, a bypass around the butterfly valve having vacuum operated valve means arranged to open the bypass when subjected to vacuum, an ignition system having vacuum operated means for retarding the ignition, a port in said inlet passage adjacent the butterfly valve so that when the butterfly valve is closed the port is on the engine side of the valve and when the butterfly valve is moved a small amount into an open position the port becomes on the other side of the valve whereby when the engine is decelerating with the butterfly valve closed said port is exposed to the resulting vacuum in the inlet passage, said port being connected to the two vacuum operated means through cut-off means arranged to prevent a vacuum reaching the vacuum operated means when the engine is idling.

The term small amount is intended to mean a rotation of the butterfly valve of 2 to 3 degrees.

Preferably said cut-off means are operated to prevent said vacuum reaching the two vacuum operated means by means actuated by a transmission unit associated with the engine when the unit is inoperative.

The cut-off means may comprise two valves in series in said connection between the port and the two vacuum operated means, and said transmission unit may comprise a gear box and clutch one of said valves being arranged to be open when the clutch is engaged and the other of the valves being arranged to be open when a gear is engaged.

Alternatively the cut-off means may comprise a single valve in said connection between the port and the two vacuum operated means, and said tranmission unit may comprise an automatic gear box said valve being opened when the automatic gear box is operative.

The single valve map, for example, be actuated by a mechanical linkage associated with said automatic gear box.

Alternatively said single valve may be arranged to be actuated by hydraulic fluid pressure through a conduit connected to an hydraulic circuit of said automatic gear box which is arranged to effect opening of the valve when the gear box is operative.

In any of the arrangements referred to above a petrol trap may be included in said connection between the port and the vacuum operated means.

Also in any of the arrangements referred to above said vacuum operated valve means may comprise a diaphragm valve arranged to be opened by a vacuum against the action of spring means.

Alternatively first said bypass may have a flow restrictor to control the flow of mixture therethrough and there may be an additional bypass around the flow restrictor having additional valve means, the vacuum operated means for opening the valve means in the first said bypass being arranged to operate the additional valve means so that the additional bypass is opened at a higher vacuum level than the first said bypass, and said restrictor being arranged to allow sufficient mixture to flow through the first said bypass so that the engine develops substantially the same power with only the first said bypass open and the ignition retarded as with the bypass closed and the ignition normal.

In the latter arrangement spring means of greater and lesser resilience are arranged in series between said vacuum operated means and a stationary part to oppose movement of said vacuum operated means to open said valves, means being provided for limiting compression of the spring means of lesser resilience so that said vacuum operated means open the valve means controlling the first said bypass against the action of the spring means of lesser resilience and open the valve means of the additional bypass against the action of the spring means of greater resilience.

The invention also provides a carburettor of the kind having a butterfly valve in an air inlet passage in which there is a port in the passage which port is on the downstream side of the valve when the valve is closed and is arranged so that on a very small opening movement of the valve, the port will become upstream of the valve. Such a port will provide a vacuum signal whenever an engine to which the carburettor is attached is either decelerating or idling.

Following is a description of a number of embodiments of the invention reference being made to the accompanying drawings in which:

FIGURE 1 is a view of an engine layout incorporating a manually operated gear box and clutch;

FIGURE 2 is a view showing part of the layout of FIGURE 1 incorporating an automatic gear box;

FIGURE 3 shows a bypass around the carburettor of the layout shown in FIGURES 1 and 2;

FIGURE 4 shows vacuum ports in an inlet passage adjacent the carburettor butterfly valve;

FIGURE 5 shows a vacuum cut-off valve;

FIGURE 6 is an end view of a different form of valve controlled bypass to that shown in FIGURE 3;

FIGURE 7 is a section on the line 7—7 in FIGURE 6; and

FIGURE 8 is a section through an alternative form of valve controlled bypass to that shown in FIGURE 7.

An internal combustion petrol engine **10** is provided with a carburettor **11** and a distributor **12**. The carburettor is connected to the engine by an inlet passage **11***a* and is provided, as shown in FIGURE 3, with the usual butterfly valve **14** and there is a bypass **15** around the

butterfly valve which bypass is opened and closed by a valve in the form of a diaphragm **16** which is normally held closed by a spring **17** and may be opened when vacuum is supplied through a pipe **18**.

The carburetor is provided with the usual port **20** (see FIGURE 4) which is connected by a pipe **21** with a vacuum advance mechanism **22** on the distributor.

The carburetor is also provided with a port **24** which is situated just downstream of the butterfly valve when the valve is closed and is positioned so that as soon as the valve is rotated by 2 to 3 degrees the port is exposed to the pressure upstream of the valve. The port **24** is connected by the pipe **18** to a petrol trap **25**, two valves **26** and **27** to the diaphragm **16** as indicated above and is also connected to a vacuum retarding device **28** attached to the distributor.

The valves **26** and **27** are each of the type shown in FIGURE 5. There is a cylinder **30** in which there is a piston **31** having a piston rod **32** extending from the lower end and a piston rod **32***a* extending from the upper end. The vacuum supplied from the port **24** enters the cylinder through a port **33** and when the valve is in the position shown the outlet port **34** is closed. When the piston rod **32***a* is moved downwardly taking with it the piston **31** the port **34** is then connected to the port **33** enabling the vacuum supply to pass through the valve. The piston rod **32** is not sealed to the housing so that when the piston is in the position shown the port **34** is vented to atmosphere.

The piston rod **32***a* is connected to an operating device. As shown in FIGURE 1 in the case of the valve **26** the operating device is a part **9** which is linked to a mechanism (not shown) of a clutch **8**, the connection being such that the valve is in the open position only when the clutch is engaged and in the case of the valve **27**, the operating device is a part **7** arranged to be moved by a part of a mechanism (not shown) of a gear box **6**, the arrangement being such that the valve **27** is open only when the vehicle is in gear.

In the arrangement shown in FIGURE 2 the clutch **8** and gear box **6** are replaced by an automatic gear box **4** and the valves **26** and **27** are replaced by a single valve **5**. The single valve **5** can be controlled by a mechanism (not shown) associated with the gear box **4** through a mechanical linkage **3**. The mechanism may for example be a gear box control linkage arranged to close the valve when neutral or park is selected and to open the valve in all other positions. Alternatively the single valve could be controlled by a part of a hydraulic circuit of the automatic gear box through a conduit connection **2** the arrangement being such that the valve **5** is closed when the vehicle speed is below a suitably low level e.g. 5 m.p.h.

Referring now to FIGURES 6 to 8 of the drawings each of the assemblies shown is designed to replace the valve **16** shown in FIGURE 3 of the above described arrangements, the remainder of the engine being exactly the same. The assemblies are attached to the carburetor to bypass the butterfly valve.

The first assembly shown in FIGURES 6 and 7 comprises a two part housing **35, 36**. The two parts are held together by screws **37** and a diaphragm **38** is held between the two parts. A valve assembly **39** is attached to the diaphragm and is slidable with movement of the diaphragm in a passage **40** which leads to the engine side of the butterfly in the carburetor through a passage **43** having a flow restrictor **44** and a passage **40***a* which by-passes the flow restrictor.

The left hand end of the passage **40** is normally closed by a valve plate **41** on the valve assembly which seats on the end of the passage **40** but when not so seated the passage **40** is in communication with a passage **45** leading to the carburetor side of the butterfly valve. The passages **45** and **40** form with the passage **43** a first by-pass around the buterfly valve and with the passage **40***a* form an additional by-pass around the butterfly valve.

The valve assembly has a valve member **42** which closes the passage **40***a*.

There are two springs **46, 47** which both act on the diaphragm **38** to urge the diaphragm to the right in FIGURE 7.

The spring **46** is a light spring which is received within a cup **48** attached to the diaphragm and the spring **47** is a heavier spring which surrounds a rod **49** attached to the part **36**. The plate **50** is slidable along the rod as far as a stop **51** on the rod and the spring **47** acts on the plate. The spring **46** acts between the plate and the diaphragm.

The left hand side of the diaphragm is connected by a conduit **18** to the port **20** adjacent the carburettor butterfly valve as shown in FIGURE 1.

In use of the assembly the springs normally maintain the valve **39** in a position shown with the valve plate **41** preventing any flow from the passage **45** to the passage **40** and either the passage **43** or the passage **40***a*. As soon as the depression to the left of the diaphragm becomes stronger than the spring **46** to the valve assembly moves to the left until the cup **48** abuts the plate **50**.

In this position mixture can flow from the passage **45** into the passage **40**. As the valve member **42** is still closing the passage **40***a* the mixture by-passes the valve member **42** through the passage **43** and flow restrictor **44**.

The restrictor is arranged to be of such a size that the power produced by the engine will be the same when the valve plate **41** closes the passage **40** so that there is no flow of mixture from the passage **45** to the passage **40** as when the valve plate **41** is moved to allow the mixture to flow into the passage **40** and thence through the passage **43** past the flow restrictor with the ignition retarded.

When the depression to the left of the diaphragm is sufficient to overcome the spring **47** the valve moves further to the left so that the valve member **42** allows mixture to flow along the passage **40***a* to supplement the flow through the additional by-pass **43**.

It is necessary to have the two routes for the mixture as the desired size of the restrictor is smaller than the size necessary for complete combustion of the mixture when the manifold depression is at a high value. The alternative assembly shown in FIGURE 8 is the same in principle as that of FIGURES 6 and 7 except that the manifold depression and the spring act on the reverse side of the diaphragm **38** and the valve assembly **39** is arranged to open progressively as the valve moves away from the diaphragm.

The operation of the engine will now be described.

It is an object of the system to reduce the hydrocarbon emission from the exhaust of the engine when the engine is decelerating. When a petrol engine, equipped with a carburettor, decelerates from high speed with closed throttle, the high depression in the inlet manifold causes any fuel previously deposited there to evaporate immediately and also causes substantial quantities of exhaust gas to be drawn back into the inlet manifold with the result that the engine either ceases to fire altogether or at best the cylinders fire erratically and intermittently. A comparatively high concentration of unburned hydrocarbon vapours is therefore emitted from the exhaust pipe. It is necessary to reduce this emission level in order to comply with the legislation in various countries for controlling air pollution by motor vehicles.

The desired effect is achieved by opening the throttle in effect during deceleration. This reduces the depression in the inlet manifold and produces a mixture which the engine can fire normally and evenly. However in order to take away the power which the engine then produces the ignition spark must be retarded at the same time. In the engine described the time when the engine is decelerating is detected by two factors working in combination.

When the throttle valve is closed the engine must be either idling or decelerating and the difference between these two conditions can be detected by the fact that when the vehicle is idling either the clutch will be disengaged or the gear will not be engaged or in the case of an automatic gear box the gear will be in an inoperative condition.

It is necesary to explain here that the problem of reducing the exhaust emission during deceleration could be overcome if the throttle were opened and the spark retarded when the engine is idling as well as when the engine is decelerating but there is introduced a further problem that during prolonged idling much more heat than is normal would be rejected to the engine coolant system which would therefore become overloaded and the higher temperature level of the exhaust gases leaving the engine cylinders may also cause damage to the parts which those gases flow over.

Hence it is necessary to detect the difference between decelerating and idling conditions of the engine.

When the engine is operated with the throttle valve closed vacuum from the engine manifold passes from the port **24** along to the petrol trap **25** which traps any petrol in the line and thence via the valves **26** and **27** or single valve **5** to operate the diaphragm **16** in the bypass **15** or to act on the diaphragm **38** to lift the valve plate **41** to open the bypass **43** and subsequently to open the bypass comprising the passages **40, 45** and at the same time to operate the vacuum retard device **28** to retard the sparks. If the gear is disengaged or if the clutch is disengaged then one or other of the valves **26** and **27** will be closed or if the automatic gear box is inoperative the valve **5** will be closed so the vacuum is prevented from passing to either the vacuum operated means for the bypass valves or to the vacuum retarding device. Hence if the engine is idling and not decelerating the engine will run normally.

I claim:

1. An internal combustion engine having a carburettor, an inlet passage connecting the carburettor to the engine, a butterfly valve in the inlet passage arranged to open and close the passage, a bypass around the butterfly valve having vacuum operated valve means arranged to open the bypass when subjected to vacuum, an ignition system having vacuum operated means for retarding the ignition, a port in said inlet passage adjacent the butterfly valve so that when the butterfly valve is closed the port is on the engine side of the valve and when the butterfly valve is moved a small amount into an open position the port becomes on the other side of the valve whereby when the engine is decelerating with the butterfly valve closed said port is exposed to the resulting vacuum in the inlet passage, said port being connected to the two vacuum operated means through cut-off means arranged to prevent vacuum reaching the two vacuum operated means when the engine is idling.

2. An internal combustion engine as claimed in claim **1** wherein said cut-off means are operated to prevent said vacuum reaching the vacuum operated means by means actuated by a transmission unit associated with the engine when the unit is inoperative.

3. An internal combustion engine as claimed in claim **2** wherein the cut-off means comprise two valves in series in said connection between the port and the two vacuum operated means, and said transmission unit comprises a gear box and clutch, one of said valves being arranged to be open when the clutch is engaged and the other valve being arranged to be open when a gear is engaged.

4. An internal combustion engine as claimed in claim **2** wherein the cut-off means comprise a single valve in said connection between the port and the two vacuum operated means, and said transmission unit comprises an automatic gear box, said valve being arranged to be opened when the automatic gear box is operative.

5. An internal combustion engine as claimed in claim **4** wherein the single valve is actuated by a mechanical linkage associated with said automatic gear box.

6. An internal combustion engine as claimed in claim **4** wherein said single valve is arranged to be actuated by hydraulic fluid pressure which is supplied through a conduit connected to a hydraulic circuit of said automatic gear box, the arrangement being such that the valve is opened when the gear box is operative.

7. An internal combustion engine as claimed in claim **1** wherein a petrol trap is included in said connection between the port and the two vacuum operated means.

8. An internal combustion engine as claimed in claim **1** wherein said vacuum operated valve means comprise a diaphragm valve arranged to be opened by a vacuum against the action of spring means.

9. An internal combustion engine as claimed in claim **1** wherein the first said bypass has a flow restrictor to control the flow of mixture therethrough and there is an additional bypass around the flow restrictor having additional valve means, the vacuum operated means for opening the valve means to the first said bypass being arranged to operate the additional valve means so that the additional bypass is opened at a higher vacuum level than the first said bypass and said restrictor being arranged to allow sufficient mixture to flow through the additional bypass so that the engine develops substantially the same power with only the bypass open and the ignition retarded as with the bypass closed and the ignition normal.

10. An internal combustion engine as claimed in claim **9** wherein spring means of greater and lesser resilience are arranged in series between said vacuum operated means and the stationary part to oppose movement of said vacuum operated means to open said valves, means being provided for limiting compressions of the spring means of lesser resilience so that said vacuum operated means open the valve means controlling the bypass against the action of the spring means of lesser resilience and open the valve means in the additional bypass against the action of spring means of greater resilience.

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U.S. Cl. X.R.

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