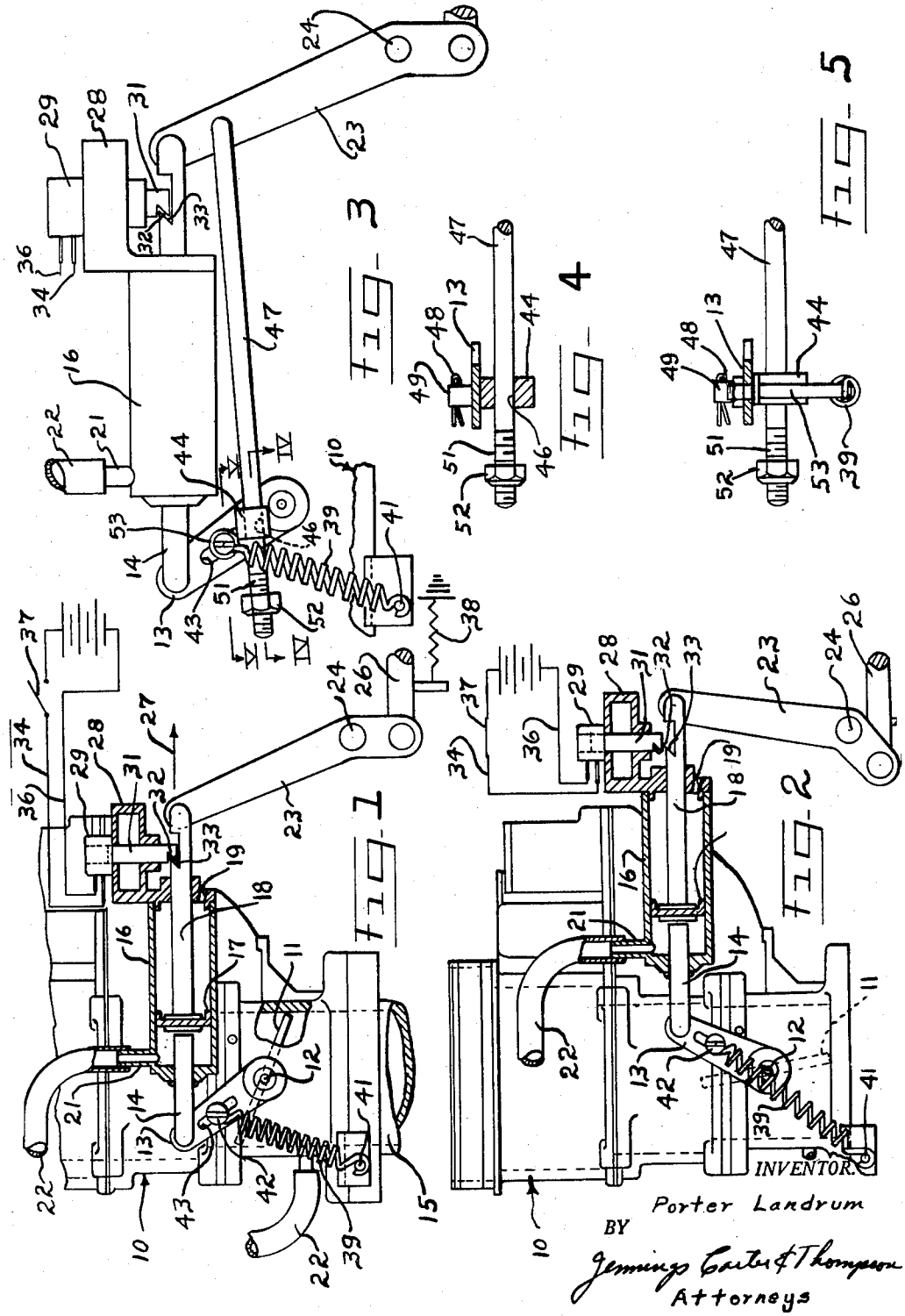
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VACUUM RESPONSIVE THROTTLE CONTROL FOR INTERNAL COMBUSTION ENGINES

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VACUUM RESPONSIVE THROTTLE CONTROL FOR INTERNAL COMBUSTION ENGINES

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6 Claims. (Cl. 123—103)

My invention relates to pressure responsive throttle control apparatus for internal combustion engines and the like.

In my co-pending application, Serial No. 563,064, filed February 2, 1956, now Patent No. 2,853,985, "Pressure Repsonse Throttle Control Means for Internal Combustion Engines and the Like," I show and describe a form of throttle control mechanism which is especially adapted to permit the employment in an internal combustion engine of compression ratios heretofore thought to be impracticable. That is to say, the invention shown and described in the above mentioned application permits the use of compression ratios on the order of 12 to 1, without danger of injuring the engine or its parts at low speed. The principles of the apparatus disclosed in the above identified application are perfectly satisfactory. However, I have found that a more efficient operation of the same and a better control over the throttle may be obtained by the addition to said apparatus of means to urge the throttle toward closed position with a force which decreases as the throttle opens. Thus, the vacuum responsive device which is connected to the throttle is so proportioned relative to the pull of a spring that the throttle is urged toward closed position with a force which corresponds approximately to 5 inches vacuum. That is, the force of the spring is such, and the size of the vacuum responsive device, which may be a cylinder and piston arrangement, is such that the spring force will be overcome only when there exists 5 inches of vacuum in the manifold, this being impressed on the cylinder. Further, the spring is so connected to the throttle and to the responsive device that the force of the spring progressively decreases as the throttle is opened, whereby at full throttle the spring exerts only enough force to start the throttle moving toward closed position when the accelerator pedal or other control is released. The net result and reason for the foregoing is that through the use of my invention I am enabled to operate the engine with a lower vacuum at high speed whereby the engine is more fully charged at high speed.

In view of the foregoing a prime object of my invention is to provide apparatus which shall be fully effective to obtain the advantages just mentioned.

Another object of my invention is to provide an improved form of locking mechanism by which my improved device is mechanically by-passed when the engine ignition switch is open so that when starting the engine the throttle may be mechanically opened as is customary.

Another object is to provide a modification of my invention which is particularly adapted for use with engines of ordinary compression ratios, namely, in the range of 8 to 1 to 9.5 to 1 and by means of which my improved throttle control device is automatically by-passed, mechanically, whenever the accelerator pedal is fully depressed.

Another object of my invention is to provide apparatus of the character designated which may be applied with equal facility to automobiles of high compression ratio

or ordinary compression ratio, and, which when so applied shall necessitate few changes in the throttle valve control rod system.

Apparatus illustrating features of my invention is shown in the accompanying drawings forming a part of this application in which:

Fig. 1 is a fragmental, longitudinal detail sectional view of my improved apparatus adapted for high compression engines showing the same applied to a carburetor and with the throttle valve thereof in closed position and with the engine ignition switch open;

Fig. 2 is a view corresponding generally to Fig. 1 and showing the apparatus in the position with the throttle at full open position with the ignition switch closed;

Fig. 3 is a side elevational view, partly in section, showing a modified form of my invention which is adapted for use with engines of normal compression ratio, the apparatus being shown in the relative position of Fig. 1;

Fig. 4 is a detail sectional view taken generally along line IV—IV of Fig. 3; and,

Fig. 5 is a detail sectional view taken generally along line V—V of Fig. 3.

Referring now to the drawings for a better understanding of my invention and more particularly to Figs. 1 and 2 I illustrate my improved apparatus in association with an internal combustion engine carburetor indicated generally by the numeral **10**. The carburetor has the usual throttle control valve **11** which is mounted on a shaft **12**. The shaft carries the usual operating arm **13** which is non-rotatably secured to the shaft **12**. The carburetor is mounted on the manifold, a fragment of which is indicated at **15**.

Pivotally connected to the upper end of the arm **13** is a link **14**. The link **14** is secured to the end of a cylinder **16**, the connection being fluid tight as by welding. Inside the cylinder **16** is a piston **17** which is mounted on the inner end of a piston rod **18**. The link **14** projects inwardly of the cylinder to form a stop, thereby limiting the leftward movement of the piston into the cylinder as viewed in Figs. 1 and 2. The cylinder is provided with a vent opening **19**, opening to atmosphere, at the end opposite the link **14**.

The cylinder **16** is provided with a connection **21** which is connected by a flexible conduit **22** to a source of vacuum in the manifold, which conveniently may be just beneath the valve **11**. It will thus be apparent that manifold vacuum is at all times applied to the closed end of the cylinder **16** whereby the piston **17** is urged into the cylinder, against the end of link **14**.

The outer end of piston rod **18** is pivotally connected to a link **23** which in turn is pivotally mounted on a stationary pivot **24** and is connected at its other end to a push rod **26** in turn connected to the accelerator pedal, or other manually operated throttle control means, not shown. Therefore, when the accelerator pedal is depressed the upper end of link **23** moves in the direction of arrow **27**.

The cylinder **16** may carry an extension portion **28**. Mounted on the extension portion is a small solenoid **29** having an armature **31**. The armature **31** carries a notched lower end **32** which is adapted to fit into a corresponding notch **33** formed in the piston rod **18**. The coil of the solenoid is in circuit by means of the wires **34** and **36** with the ignition switch **37** for the automobile engine. The armature **31** is urged by gravity downward and, when the switch **37** is open, the armature drops downwardly, thereby to engage in the notch **33** as shown whenever the accelerator pedal returns to up position under the influence of a spring indicated dia-

grammatically at 38. Thus, when the engine is at rest the cylinder and piston arrangement is by-passed, the throttle arm 13 being mechanically locked to the linkage 23.

From what has been said it will be apparent that the cylinder 16 actually floats on the upper end of arm 13, in the sense that the cylinder 16 moves axially upon movement of the throttle arm. The throttle arm and hence the cylinder are urged toward throttle closing position by means of a spring 39. The spring 39 is anchored at one end to a pivot 41 and is adjustably connected to the arm 13 by means of a screw or other connection 42 which is axially slidable on the arm 13 in a slot 43.

By reference to Fig. 2 it will be seen that at full open throttle position the points of connection of the spring 41 and 42 are such that the spring still tends to urge the throttle closed. However, it will be readily apparent also that the maximum force exerted by the spring 39 is exerted in the position shown in Fig. 1 and that the least effective throttle closing pressure is exerted by the spring 39 in the position of Fig. 2. Therefore, the spring exerts a force tending to urge the throttle toward closed position which progressively decreases as the throttle valve opens.

From the foregoing the method of constructing and using the modification of my invention just described together with the advantages thereof may now be more fully explained and understood. As stated, the form of the invention shown in Figs. 1 and 2 is especially adapted for use on so-called high compression engines, those having a compression ratio on the order of 12 to 1. With the apparatus installed on such engine in the manner shown and with the solenoid connected to the ignition switch it will be apparent that upon starting the engine the depression of the accelerator pedal mechanically opens the throttle valve 11 as in the ordinary arrangement. In other words, in order more efficiently and effectively to start the engine it is desirable that during this period of time the device forming the subject of the invention be mechanically by-passed. As soon as the engine starts it will be seen that the vacuum of the manifold is applied to the closed end of the cylinder 16. With the engine idling and under no load it is understood that the manifold vacuum may be on the order of 18 inches mercury. Let it now be assumed that the automobile is started, from a rest position to accelerate to a speed of around 20 to 25 miles per hour. Under these conditions the operator depresses the accelerator pedal, it being understood that the solenoid has withdrawn the armature 31 from locking position as soon as the engine started. Due to the high vacuum between the closed end of the cylinder 16 and piston 17, rightward movement of link 23 causes cylinder 16 and hence the throttle arm 13 to move to the right as shown in Fig. 1, opening the throttle. However, the instant the throttle opens the manifold vacuum decreases whereby, with a constant rightward position of the piston 17 the cylinder seeks that position relative to the piston 17 which corresponds to the correct throttle opening for the vacuum then existing in the manifold. Therefore, without any conscious control on the part of the operator the throttle is opened to the optimum position corresponding to the existing manifold vacuum and speed and power conditions of the engine. The function of spring 39 is, in effect, to control and permit the foregoing operations to take place. It will be noted that upon the initial rightward movement of cylinder 16 in response to rightward movement of piston 17, spring 39 was exerting its maximum pull. However, due to the high vacuum existing in the cylinder initial rightward movement of the piston 17 and cylinder 16 overcame the force of the spring. This permits the throttle to commence opening. As the piston moves further to the right in response to a desire on the part of the operator for more speed or power, a new set of conditions exists in which the cylinder must again seek a new position, further to the right. Due to the initial off-center relationship between the ends of the spring 39 and shaft 12, the force of the spring decreases as the cylinder moves to the right, permitting the cylinder to follow the piston under lower vacuum conditions than would be required at more nearly closed throttle position.

The spring 39 is so tensioned and set that the vacuum in the manifold can never fall below 5 inches at or near closed throttle position. However, as the throttle opens the pressure of the spring decreases. Therefore, above low speed-high manifold vacuum conditions, the force of the spring tending to close the throttle decreases. Therefore, at intermediate and high speeds when the vacuum may again build up considerably above 5 inches to the neighborhood of 18 inches in normal operating conditions, the spring offers only enough force to return the throttle toward closed position. The spring is thus so positioned and tensioned that it permits a high compression ratio engine to be operated safely both at low speeds and high speeds. Thus, at low speed-high vacuum conditions my improved vacuum control prevents the sudden opening of the throttle thereby to overload the engine with fuel and damage it. On the other hand, as the engine speed increases my improved throttle control permits the throttle to open precisely to the correct point corresponding to the vacuum, whereby optimum throttle setting prevails at all engine speeds and conditions.

Referring now particularly to Figs. 3, 4 and 5 I show a slightly modified form of my invention which embodies a mechanical linkage arrangement to by-pass the entire apparatus when the accelerator pedal is completely depressed. In these figures the cylinder and piston arrangement together with the solenoid lock are identical with those already described.

Mounted on a side of the throttle arm 13, to pivot thereon is a block 44 having a hole 46 therein for slidably receiving a link 47. The block may be secured to the arm 13 by means of a cotter pin 48 passing through an extension part 49 thereof. The outer end of link 47 is threaded as indicated at 51 and is provided with a lock nut 52 which is an adjustment nut. The other end of the link 47 is pivotally connected as indicated to the arm 23.

Outstanding from the side of the throttle arm 13 is a pin 53 to which the upper end of the spring 39 is connected. The pin projects outwardly far enough so that in opening the throttle the spring passes over, and clear of, the block 44.

The modification shown in Figs. 3, 4 and 5 is adapted for use in connection with engines of ordinary compression ratio such as 8 to 1 to 9.5 to 1. The object is that the accelerator pedal may be completely depressed mechanically to by-pass the cylinder and piston arrangement. This is afforded by the link 47 so that when the nut 52 comes against block 44, as when the accelerator pedal is depressed completely, arm 13 is moved independently of the cylinder and piston arrangement, fully opening the throttle. The solenoid lock arrangement is identical with the one already described.

From the foregoing it will be apparent that I have devised an improved vacuum responsive throttle control mechanism for internal combustion engines. As applied to automobiles my invention is particularly useful and I have found that I greatly increase the fuel economy without materially decreasing the performance of the automobile. With the modification shown in Figs. 1 and 2 I have successfully operated an automobile with a 12 to 1 compression ratio engine without the usual fuel knock or "pinging" during any conditions of acceleration. I have successfully applied the invention shown in Figs. 1 and 2 to a 1956 model, 8 cylinder Chevrolet automobile in which the cylinder heads were machined off thereby to give a mechanical compression ratio of 12 to 1. Dynamometer and other performance tests show a marked improve-

ment in operation, efficiency and general engine smoothness. With the spring **39** applied as shown I am enabled to obtain a true response of the throttle to all vacuum conditions throughout all speed and load conditions of the engine from idle position of the throttle to full open position. My invention permits the use of fuels of ordinary octane rating namely, 80 to 95 octane numbers, in an engine having a compression ratio of 12 to 1 without danger of damaging the engine at low speeds. At the same time, my invention assures that maximum power is obtained from such fuel at wide open throttle and full power delivery, namely, during the time when the maximum compression ratio of the engine is being utilized.

From the foregoing it will be apparent that I have devised an improved throttle control system for internal combustion engines which is especially adapted for use with automobiles.

While I have shown my invention in but two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In a throttle valve control system for internal combustion engines having an intake manifold, a manually operable throttle control for selecting a maximum desired open position of the throttle valve, means to move the throttle valve from a partially open position to said desired open position comprising a fluid pressure responsive device having a movable part operatively connected to the throttle valve, means operatively connecting the device in fluid pressure transmitting relation with the manifold, and means urging the throttle valve toward closed position with a force which is greater at partially closed throttle valve position than at full open throttle valve position.

2. In a throttle valve control system for internal combustion engines having an intake manifold, a manually operable throttle control for selecting a maximum desired open position of the throttle valve, means to move the throttle valve from a partially open position to said desired open position comprising a fluid pressure responsive device having a movable part operatively connected to the throttle valve, means operatively connecting the device in fluid pressure transmitting relation with the manifold, and means urging the throttle valve toward closed position with a force which progressively decreases as the throttle valve opens.

3. In a throttle valve control system for internal combustion engines having an intake manifold, a manually operable throttle control for selecting a maximum desired open position of the throttle valve, means to move the throttle valve from a partially open position to said desired open poistion comprising a fluid pressure responsive device having a movable part operatively connected to the throttle valve, means operatively connecting the device in fluid pressure transmitting relation with the manifold, means urging the throttle valve toward closed position with a force which progressively decreases as the throttle valve opens, and means mechanically to lock the movable part of said device operably to the throttle valve when starting the engine.

4. In a throttle valve control system for internal combustion engines having an intake manifold and an electric ignition system circuit including a switch therein, a manually operable throttle control for selecting a maximum desired open position of the throttle valve, means to move the throttle valve from a partially open position to said desired open position comprising a fluid pressure responsive device having a movable part operatively connected to the throttle valve, means operatively connecting the device in fluid pressure transmitting relation with the manifold, means urging the throttle valve toward closed position with a force which progressively decreases as the throttle valve opens, and electrically releasable means in said circuit effective mechanically to lock the movable part of said device operably to the throttle valve when said switch is opened.

5. The combination with a carburetor for an internal combustion engine having a manual throttle operator and a throttle valve mounted on an oscillatable shaft together with an arm fixedly connected adjacent one end to the shaft for rocking the shaft, of a fluid pressure cylinder having one end closed and one end open to atmosphere, means pivotally connecting the closed end of the cylinder to the end of said arm opposite the end connected to the throttle shaft, a piston in the cylinder, a piston rod projecting from the end of the cylinder opposite the closed end, means connecting the piston rod to the manually controlled throttle operator, a flexible line connecting the closed end of the cylinder to the manifold of the engine, and a spring stationarily anchored at one end and having its other end connected to the arm intermediate the ends of the arm and urging the arm toward closed throttle position, said ends of the spring being relatively disposed with respect to the radius of rotation of the arm that as the arm moves from throttle valve closed position to throttle valve open position the force exerted by the spring on the arm decreases.

6. Apparatus as defined in claim 5 in which there is means operatively interposed between the manually controlled throttle operator and said cylinder for directly opening the throttle when the operator is moved to full throttle open position.

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