DECOMPRESSION CONTROL FOR INTERNAL COMBUSTION ENGINE

Original Filed July 19, 1967

FIG. 4

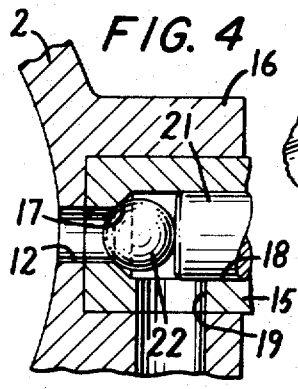
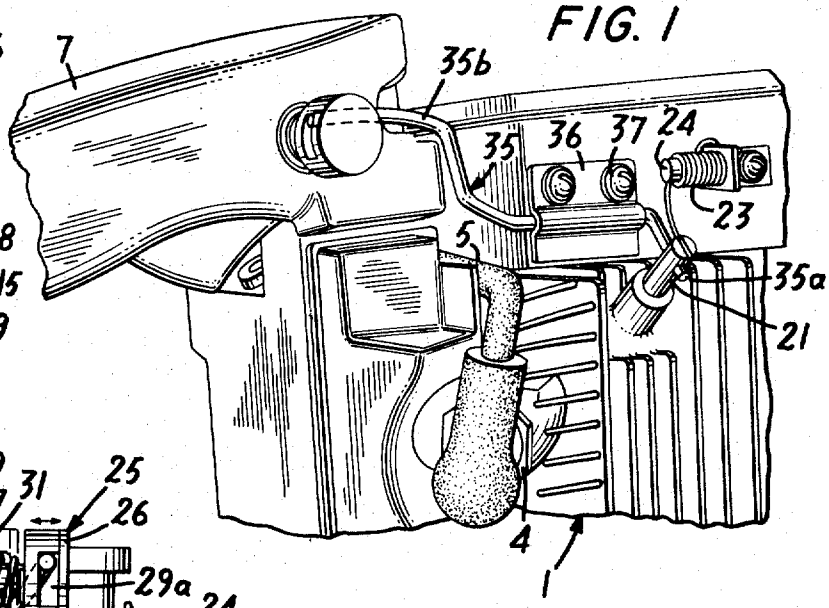


FIG. 1



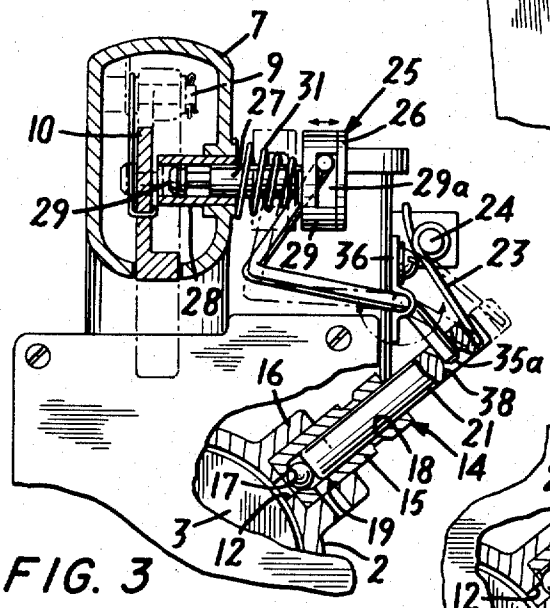


FIG. 3

FIG. 5

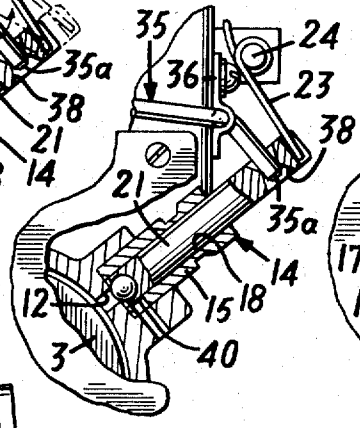


FIG. 6

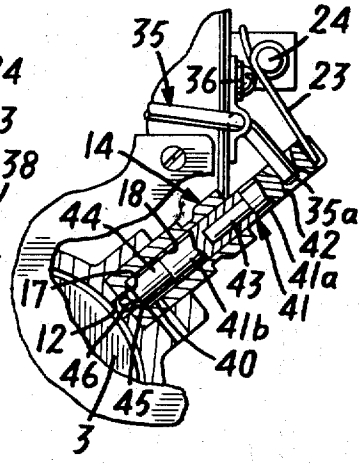
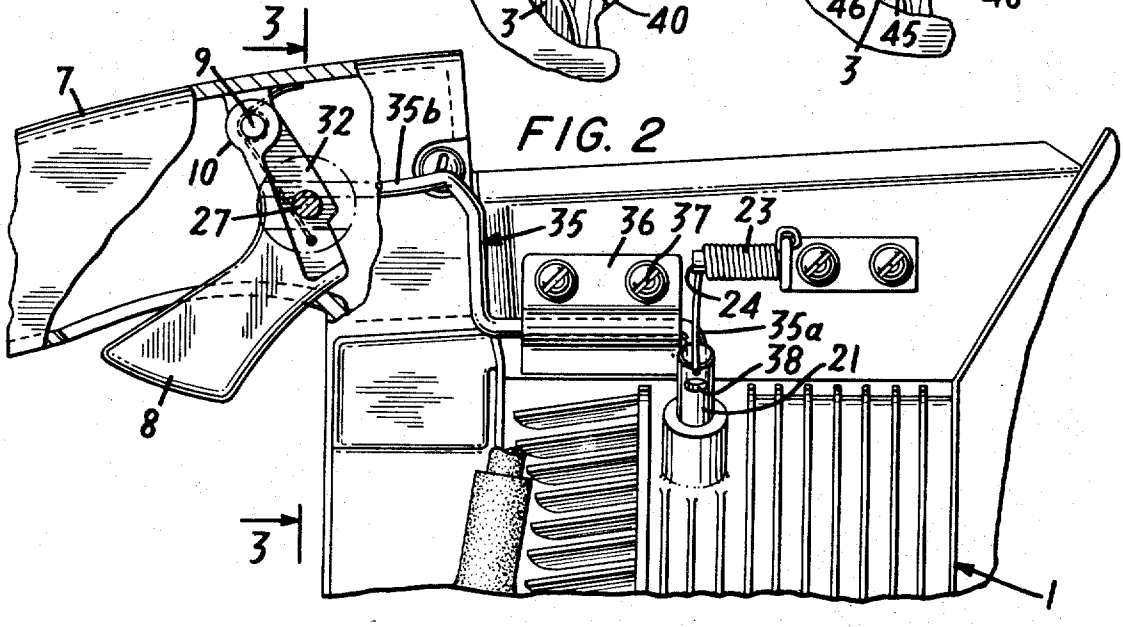


FIG. 2



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DECOMPRESSION CONTROL FOR INTERNAL COMBUSTION ENGINE

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Int. Cl. F01l *13/08*

U.S. Cl. 123—182 12 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

To facilitate starting, an internal combustion engine is provided with a decompression port located at a selected distance from the top of the cylinder so as to decrease compression during cranking of the engine. The port is controlled by a valve which is normally closed and which preferably comprises a ball shaped valve member pressed against an annular valve seat. A unitary locking element holds the engine throttle control member in selected position for starting and also holds the decompression valve open. As soon as the engine starts, actuation of the throttle control member releases the locking element and thereby results in the automatic closing of the decompression valve.

The present invention relates to internal combustion engines and particularly to means for facilitating the starting of such engines. The invention is particularly applicable to small 2-cycle engines of the kind used for chain saws and other portable tools, lawn mowers, outboard motors, etc.

In order to increase the horsepower rating and efficiency of small internal combustion engines while keeping the weight of the engines at a minimum, it is desirable to operate the engines at a high compression ratio. The resistance offered by this high compression makes it difficult to turn the engines over during cranking.

In order to facilitate the starting of internal combustion engines, it has heretofore been proposed to provide means for relieving, at least in part, the compression in the engine cylinder during cranking. Compression is relieved by means of a port in the engine cylinder permitting the exhaust of gases from the cylinder during at least a part of the compression stroke. The decompression port must, of course, be closed during normal operation of the engine as it would otherwise result in an objectionable loss of power and efficiency. Accordingly, the port is provided with valve means which is opened during cranking of the engine and must be closed after the engine has started.

While a decompression valve makes it easier to crank an internal combustion engine, it is disadvantageous in that it requires the operator to actuate an additional control device. This is particularly objectionable in hand-held power tools such as chain saws. The operator is required to hold the tool with one hand—preferably resting it on a supporting surface—while pulling the starter cable

with the other hand. The addition of an extra control requiring the operator's attention complicates the starting procedure.

It is an object of the present invention to provide a unitary control system by which a decompression valve is automatically held in an open position during cranking of the engine and is automatically closed when the engine has started. The operator performs only those functions which he customarily performs in starting the engine. No additional action is required of the operator to effect a reduction in compression during cranking of the engine and re-establishing full compression after the engine has started.

When the engine is running, it is important to maintain the decompression valve tightly closed in order to avoid leakage of gases either during the compression stroke or the firing stroke of the engine. It has been found that with decompression valves of former design, it is difficult consistently to avoid leakage. It is accordingly a further feature of the invention to provide an improved decompression valve which is of simple construction, yet is highly effective in maintaining a fluid tight seal despite the high pressures to which the valve is subjected during operation of the engine.

The invention is applicable to engines provided with hand starting, e.g., by means of the usual pull cord. With hand starting, the decompression system in accordance with the invention materially reduces the effort required for cranking the engine. The invention is also advantageous when applied to engines provided with self starters in that the reduced effort required for cranking the engine makes it possible to use smaller, lighter and less expensive starters.

The invention will be more fully understood from the following description of preferred embodiments illustrated by way of example in the accompanying drawings in which:

FIG. 1 is a fragmentary perspective view illustrating application of the invention to an internal combustion engine,

FIG. 2 is a side view with portions broken away to show internal construction,

FIG. 3 is a view taken partly in section approximately on the line 3—3 in FIG. 2 with portions broken away to show the construction of the decompression valve,

FIG. 4 is an enlargement of a portion of FIG. 3, and

FIGS. 5 and 6 are views corresponding to a portion of FIG. 3 but showing different valve constructions.

In the drawings, there is shown a portion of an internal combustion engine **1** which, by way of example, may be a single cylinder, 2-cycle engine. The engine **1** is illustrated as having a cylinder **2** in which a piston **3** is reciprocable. A spark plug **4** provided in the cylinder head is connected by an insulated wire **5** to a magneto or other source of electricity.

The engine **1** is shown providing with a hollow grip or handle portion **7** with which is associated a member **8** for controlling the speed of the engine, e.g., by regulating the supply of fuel to the engine cylinder. The engine control member **8** is shown in the form of a trigger which is approximately L-shaped as seen from the side (FIG. 2) and is swingable about a pivot pin **9** which projects laterally inside the hollow handle **7**. The trigger **8** is connected to the carburetor or other fuel supply means (not shown) of the engine in such manner that the fuel supply,

nd hence engine speed, is increased when the trigger **8** swung about its pivot **9** in a clockwise direction as iewed in FIG. 2. A spring **10** acts on the trigger **8** to ving it in a counter-clockwise direction to a position in hich only sufficient fuel is supplied to the engine for it › run at idling speed.

In order to reduce the force required for cranking the ngine to start it, the engine cylinder **2** is provided with decompression port **12** which is located in the cylinder all at a selected distance from the head of the cylinder. he location of the decompression port is selected so as › permit the escape of a portion of the fuel-air charge ı the cylinder during the compression stroke while pro-ding compression of the remaining portion of the charge fter the top of the piston passes the decompression port. y way of example, the decompression port is spaced om the head of the cylinder a distance equal to ap-roximately 15 to 25 percent of the stroke of the piston. his location has been found to reduce to an acceptable alue the force required for cranking the engine while ill retaining sufficient charge and compression for relia-le firing of the engine.

The decompression port **12** is controlled by a valve **14** › that the port is open to provide decompression during arting but is tightly closed at other times to prevent akage of gas from the cylinder when the engine is run-ing. The decompression control valve **14** is shown as mprising a valve housing **15** which is screwed or other-ise secured in a boss **16** provided on the cylinder wall. t its inner end, the valve housing **15** is provided with an pening which is aligned with the decompression port **12** ı the cylinder wall and is surrounded by an annular alve seat **17**. The valve seat is preferably of conical ıape with an angle of inclination of, e.g., about 45° FIG. 4). The valve housing **15** is hollow with a cylin-rical bore **18** which is aligned with the decompression ort **12** but of larger diameter. A discharge port **19** opens ırough the side wall of the housing at a location just utwardly of the valve seat **17**. The bore of the valve ousing receives a plunger **21** which is longitudinally slid-ble in the bore. A valve member **22**, shown in the form of spherical ball, is received in the bore between the valve eat **17** and the inner end of the plunger **21**. The ball **22** of hard corrosion resistant material, e.g., stainless steel, nd is of a diameter which is less than that of the bore **8** but greater than the minimum diameter of the valve eat so as to engage the seat as illustrated in FIG. 4. A pring **23** supported on a fixed stud **24** engages in a groove ı the outer end of the plunger **21** and acts to press the lunger inwardly against the ball **22** and thereby press ıe ball into tight engagement with the valve seat **17** to lose the decompression port **12**.

In accordance with the invention, unitary control means provided for holding the fuel member **8** in proper posi-on for starting and simultaneously holding the decom-ression valve **14** in open position. As illustrated by way f example in the drawings, the control means comprises ocking means for releasably locking the fuel control ıember **8** in selected position and connections between ıe locking means and the decompression valve **14** to old the valve open against the action of the spring **23** hen the locking means is in locked position. The locking ıeans is shown in the form of a push-button **25** having head portion **26** and a stem portion **27** which is slidable ı a bushing **28** extending through a hole in one side all of the hollow hand grip portion **7**. At its inner end, ıe stem **27** is provided with a reduced portion terminat-ıg in a head **29** of approximately the same cross section-l dimensions as the stem. A coil spring **31** surrounding ıe stem **27** acts between the side wall of the hand grip ortion **7** and the head **26** to bias the push-button to an uter position as shown in solid lines in FIG. 3.

The locking element **25** is so located and proportioned ıat when the fuel control member **8** is moved to a posi-on to provide the desired amount of fuel for starting the

engine and when the push-button **25** is pushed inwardly against the action of spring **31** to the position shown in dotted lines in FIG. 3, the head portion **29** at the inner end of the stem **27** engages a web portion **32** on the fuel control member **8** so as to hold the push-button in its inner position and thereby hold the fuel control member **8** in engine starting position.

The locking element **25** is suitably connected to the plunger **21** of the decompression valve **14** so as to hold the plunger out against the force of spring **23** and thereby hold the valve in open position when the locking element is in locked position as indicated by broken lines in FIG. 3. In the example illustrated in the drawings, the connection is by means of a lever **35** having an intermediate portion which is rotatably supported by a bracket **36** secured to a stationary portion of the engine, e.g., by screws **37**. An arm **35a** at one end of the lever **35** extends into a hole **38** provided in the plunger **21** near its outer end. An arm **35b** at the other end of the lever **35** extends into an opening **29a** in the head portion **26** of the locking elemtnt **25**. The shape and location of the lever **35** are such that when the locking element **25** is pushed inwardly to its locked position as shown in broken lines in FIG. 3, the lever is rotated in the bearing provided by bracket **36** so as to swing the arm **35a** in a counter-clockwise direction as seen in FIG. 3 and thereby move the plunger **21** outwardly against the bias of its spring **23**. The valve member **22** is thereby released from its seat **17** to open the valve. The effective length of the lever arm **35b** is greater than that of arm **35a** to provide a mechanical advantage valve without requiring excessive pressure on the push button **25**.

In preparation for starting the engine, the operator grasps the handle **7** and, with his middle finger, applies pressure to the trigger **8** to swing it about its pivot **9** in a clockwise direction as viewed in FIG. 2. With his forefinger, he then pushes the locking element **25** to its inner position and then releases the trigger **8** which, under pressure of the spring **10**, returns toward idle position until the web portion **32** engages the reduced portion of the stem **27** of the locking element **25**. Engagement of the head portion **29** on the inner end of stem **27** with the web portion **32** of the trigger **8** retains the locking element **25** in locked position and thereby holds the trigger **8** in position to supply the proper amount of fuel for starting. Movement of the locking element **25** to locked position has simultaneously opened the decompression valve **14** by reason of the connections provided by the lever **35**. The engine is then ready for starting and is suitably cranked either by hand or by a starter. As soon as the engine starts, the operator applies pressure to the trigger **8** to regulate the speed of the engine as desired. The web portion **32** of the trigger **8** is thereby disengaged from the head **29** at the inner end of stem **27** of the locking element so that the locking element is moved by its spring **31** to its outer position as shown in solid lines in FIG. 3. By reason of the interconnection provided by lever **35**, this movement of the locking element **25** releases the plunger **21** of the decompression valve **14** so that the plunger is moved inwardly by its spring **23** to press the ball **22** against the valve seat **17** and thereby close the decompression port **12**.

When the decompression valve is held open by the lever **35** during starting of the engine, a portion of the fuel-air charge is released through the decompression port **12** and discharge port **19** during a portion of each compression stroke. The exhaust port **19** of the decompression valve **14** may, if desired, be connected to the crank case of the engine so as to return the discharge fuel-air charge to the crank case. Alternatively, the discharge port **19** may be connected to the exhaust system of the engine. However, in practice it has been found that the amount of fuel-air mixture discharged through the decompression port during starting of the engine is so

small that it can be discharged directly to the atmosphere without any objectionable effects.

The ball **22** which constitutes the valve member of the decompression valve **14** is self-centering and is also free to rotate—when not being pressed by the plunger **21**. Presumably by reason of such rotatability of the ball, the valve has been found to be self-cleaning so as to assure gas tight closure of the decompression port at all times when the valve **14** is closed. Objectionable leakage of gas from the cylinder is thereby avoided.

While it has been found in practice that gas pressure inside the cylinder is sufficient to unseat the ball **22** when the plunger **21** is withdrawn by the lever **35**, means can be provided if desired for positively withdrawing the ball from its seat when the plunger **21** is moved outwardly. Such an arrangement is illustrated by way of example in FIG. 5 in which the plunger **21** is shown provided at its inner end with portions **40** which extend past the mid-point of the ball and are restricted so as to cage the ball while leaving it free to rotate and free to move laterally sufficiently to be self-centering.

Another form of the decompression valve is illustrated in FIG. 6. A valve plunger **41** corresponding to the plunger **21** illustrated in FIGS. 1 to 5 is divided into two portions namely, an outer portion **41a** and an inner portion **41b** which constitutes a valve member. The outer portion **41a** is provided with an opening **42** to receive the arm **35a** of the lever **35** and with a transverse groove to receive a spring **23**. The inner portion **41b** of the plunger is rotatable relative to the outer portion **41a**. Hence, although the outer portion is held against rotation by the lever arm **35a** and spring **23**, the inner portion **41b** is free to rotate. The two portions of plunger **41** are shown rotatably connected with one another by a reduced portion **43** on the inner end of the outer plunger portion **41a** fitting sufficiently freely in a corresponding recess provided in the outer end of the inner plunger portion **41b** to permit free rotation. The inner plunger portion **41b** has a reduced portion **44** of smaller diameter than the inner diameter of the bore **18** of the valve housing. At its inner end, the inner plunger portion **41b** has a frusto-conical portion **45** adapted to seat on the valve seat **17** and a tip portion **46** adapted to project into the decompression port **12** to keep it clear of carbon or other deposits. It has been found that by reason of the rotatability of the inner plunger portion **41b** constituting a valve member, the valve is self-adjusting and self-cleaning so as to maintain a fluid tight seal when the valve is in closed position.

While preferred embodiments of the invention have been illustrated by way of example in the drawings and have been herein particularly described, it will be understood that the invention is not thereby limited to the particular examples shown.

What we claim is:

1. Control means for an internal combustion engine having a cylinder and a hand grip, said control means comprising a decompression port in said cylinder, a normally closed compression relief valve closing said port, an engine fuel control member associated with said hand grip and operable to control the supply of fuel to said engine, locking means for releasably locking said fuel control member in selected position for starting said engine, said locking means being movable between a locking position and a released position and means connecting said locking means with said valve to hold said valve in open position when said locking means is in locking position.

2. Control means according to claim **1**, in which said compression relief valve comprises a valve seat, a ball-shaped valve member adapted to seat on said seat and spring pressed means normally pressing said valve member on its seat.

3. Control means according to claim **2**, in which said spring pressed means comprises a longitudinally slidable plunger and spring means pressing said plunger toward said valve member.

4. Control means according to claim **3**, in which said valve member comprises a ball rotatably secured to an end of said plunger.

5. Control means according to claim **1**, in which said locking means comprises a movable plunger and spring means urging said plunger toward released position, said plunger and fuel control member having cooperating latch means for holding said plunger in locking position, said latch means being releasable by movement of said fuel control member in a direction to increase engine speed.

6. Control means according to claim **1**, in which said compression release valve comprises a valve seat, a rotatable valve member adapted to seat on said seat and spring pressed means normally pressing said valve member onto its seat.

7. Control means according to claim **1**, in which said compression release valve comprises a valve seat, a valve housing having a bore aligned with said seat and a plunger longitudinally movable in said bore, said plunger comprising an outer non-rotating portion and an inner rotatable portion having a valve surface adapted to seat on said seat.

[8. Unitary control means for an internal combustion engine having a cylinder with a side wall and a head and a piston reciprocable in said cylinder, said control means comprising a manually operable starting control member which controls a starting function of the engine and is movable between a starting position for starting the engine and a running position when the engine has been started and is running, a decompression port located in the side wall of the cylinder and spaced from the head of the cylinder a distance equal to about 15% to 25% of the stroke of the piston, a normally closed compression relief valve for closing said port, and means connecting said starting control member with said valve to hold said valve in open position when said starting control member is in starting position.**]**

9. Control means according to claim **[8]** *11*, in which said compression relief valve comprises an annular valve seat surrounding said port, a rotatable self-centering valve member seating on said seat to close said port and movable outwardly from said seat to open said port and *in which said first biasing means comprises* spring means biasing said valve member to closed position.

10. Control means according to claim **9**, in which said valve member has a portion adapted to project into said decompression port to keep it clear of engine deposits.

11. In a hand held power tool comprising an internal combustion engine having a cylinder with a side wall and a head and a piston reciprocable in said cylinder, and provided with a hand grip, unitary control means comprising a decompression port located in the side wall of the cylinder and spaced from the head of the cylinder a distance equal to about 15% to 25% of the stroke of the piston, a movable compression relief valve for closing said port, first biasing means for biasing said valve to closed position, a manually operable fuel control member associated with said hand grip and operable to control the supply of fuel to the engine and thereby control engine speed, second biasing means for biasing said fuel control member to a position in which only sufficient fuel is supplied to the engine for it to run at idling speed, locking means for releasably holding said fuel control member in a selected position for starting said engine, said locking means being movable between a locking position in which said locking means hold said fuel control member in engine-starting position and a released position in which said fuel control member is released by said locking means, and means connecting said locking means with said compression relief valve to hold said valve in open position when said locking means is in locking position and to release said compression relief valve for positioning it

t closed position by said first biasing means when said ocking means is in released position.

12. Control means according to claim 11, in which said onnecting means comprises lever means providing a me-hanical advantage whereby the movement of said locking leans between released and locking position is greater lan the movement of said valve between closed and open osition.

13. Control means according to claim 11, in which said ocking means comprises a movable locking member and pring means biasing said locking member toward said eleased position, said locking member and said fuel con-ol member having interengaging portions for releasably etaining said locking member in locking position when uid fuel control member is in engine-starting position, uid portions being disengaged by movement of said fuel ontrol member in a direction to increase engine speed to elease said locking member for movement to released osition by said spring means.

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