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AUTOMATIC CHOKE FOR SMALL ENGINES

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Fig. 1.

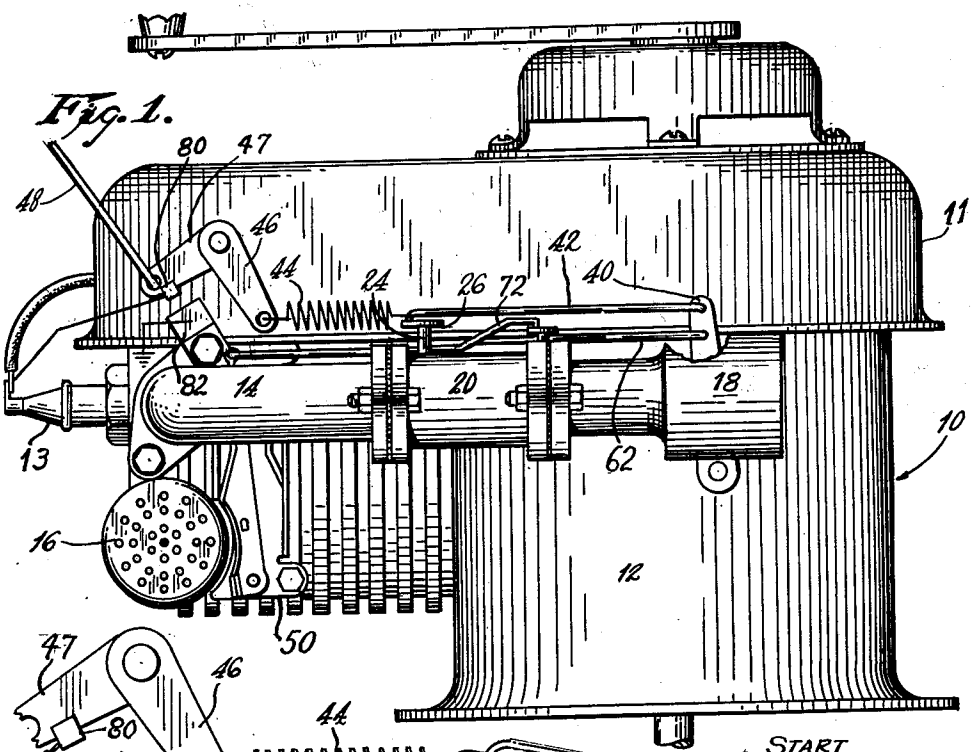


Fig. 2.

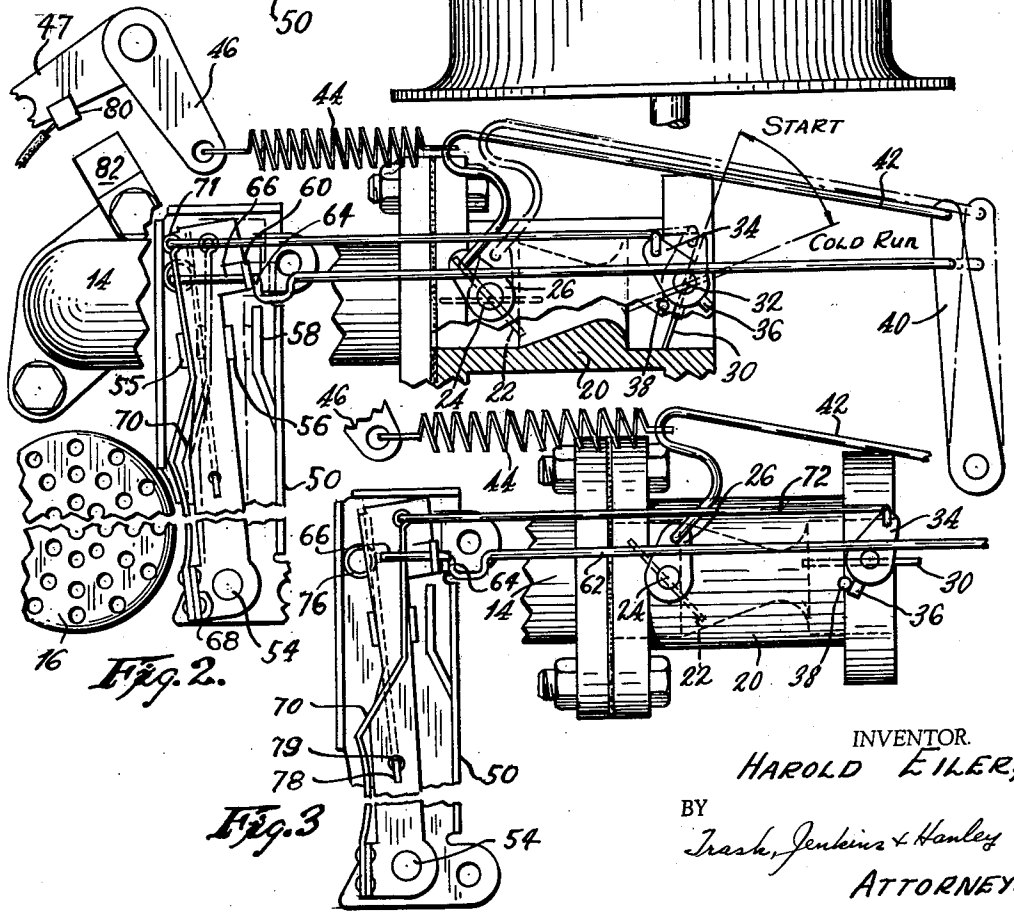


Fig. 3

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AUTOMATIC CHOKE FOR SMALL ENGINES

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This invention relates to an automatic choke for small internal combustion engines, and is especially applicable to governor-controlled four-cycle engines but may also be applied to two-cycle engines.

It is the principal object of the invention to provide a simple and inexpensive but reliable and effective automatic choke for a governor-controlled small internal combustion engine.

The engines to which my invention particularly applies include single- and plural-cylinder engines of the type having a carburetor throttle valve which is urged toward closed position by the control arm or other speed-responsive element of a centrifugal governor, in response to increasing speed of the engine, and is biased toward open position either by a manually-variable or a fixed spring or other biasing means. The carburetor, ahead of the throttle, has a normally-open choke valve, which may be a valve which is biased to open position, but conveniently is an unbalanced choke valve which tends to move to open position in response to carburetor intake air flow.

In accordance with the invention, the choke valve is connected for movement toward closed or choking position with movement of the throttle toward open position, and by the same bias which moves the throttle toward open position, and such connection is through a linkage which includes a lost-motion connection and temperature-responsive means which, in response to engine heat, changes the effective length of the linkage in a choke-reducing direction. In a preferred embodiment, the temperature-responsive assembly includes a rigid lever arm and an interconnected temperature-responsive spring lever arm having limited temperature-responsive movement relative to the rigid lever. One of such lever arms is connected to be actuated with the throttle valve and the other is connected to actuate the choke valve, and one of the arms may form part of a lost-motion connection arranged to transmit movement in a choke-closing direction and to allow free relative movement in the opposite direction. The temperature-responsive lever arm is exposed to the heat of the engine, as by being mounted adjacent the exhaust pipe or muffler of the engine, and is arranged to relax in response to temperature rise, in a direction to reduce the transmitted choke-closing movement and force in response to the temperature rise.

The arrangement is such that when the engine is cold and being cranked, the governor is ineffective and the throttle bias moves the throttle valve to open position and the choke valve to closed or full-choke position. When the engine starts under its own power, the governor, opposing the throttle bias, moves the throttle to a partially closed position to govern the speed for the engine. Such movement actuates the connecting linkage to move the choke valve to a partially open position at which the temperature-responsive spring resiliently prevents full opening of the unbalanced choke valve under the influence of intake flow. As the engine heats up, its heat raises the temperature of the temperature-responsive spring, and such spring relaxes to permit full opening of the choke valve. Preferably, the response of the temperature-responsive spring to the normal operating heat of the engine, and the limits of its action, are such that at normal operating temperatures, the effective length of the linkage and the lost motion therein permit the throttle to

be moved through its full range of open to closed movement without transmitting any choke-closing movement to the choke valve. If desired, however, the action of the temperature-responsive spring may be limited by a suitable stop so that at full open position of the throttle, a limited amount of choking action will occur even when the engine is hot.

The accompanying drawing illustrates my invention.

In such drawing:

FIG. 1 is a side elevation of a single-cylinder internal combustion engine equipped with my automatic choke;

FIG. 2 is a diagrammatic elevational view, which may be considered similar to that of FIG. 1 but with certain of the parts, including the carburetor and its overlying linkage, rotated through 90 degrees to show in elevation in the same plane with the governor lever and the temperature-responsive assembly;

FIG. 3 is a fragmental view similar to FIG. 2 but showing the parts in hot-running position.

The engine **10** shown in FIG. 1 is a single-cylinder air-cooled engine having a crank case **12**, a blower shroud **11**, an intake manifold **14**, and an exhaust muffler **16**. A carburetor **20** is mounted between the intake manifold **14** and an air cleaner **18**. The carburetor **20** is of a common venturi type and has a throttle valve **22** carried by a throttle shaft **24** having an operating arm **26**. The inlet of the carburetor contains a choke valve **30** mounted on an eccentric choke shaft **32** which has an operating arm **34**. Such arm **34** carries a stop finger **36** positioned to engage a stop pin **38** when the choke valve is in fully open position. The eccentric positioning of the choke shaft **32** makes the choke valve **30** an unbalanced valve which tends to move toward open position in response to carburetor intake flow.

The engine **10** contains a governor of the centrifugal or fly-ball type, which moves a lever **40** to the right or clockwise in response to increasing speed of the engine **10**. This governor lever **40** is connected by a link **42** to the throttle actuating arm **26**, and the link **42** is engaged with a biasing spring **44** anchored to a lever **46** manually operable by a control wire **48** and adapted to be rotated clockwise to increase the tension of the spring **44**. Manual adjustment of the lever **46** to vary spring tension opposing the speed-responsive movement of the governor lever **40** will vary the governed speed of the engine. If the engine tends to overrun such governed speed, the governor lever **40** will be moved clockwise against the bias of the spring **40** to move the throttle **22** toward closed positon, while if the speed of the engine falls below the desired speed, the governor will permit the governor lever **40** to be pulled to the left by the biasing spring **44** and this will have the effect of opening the throttle **22** to increase the speed of the engine.

The choke operating mechanism comprises a bracket **50** mounted on the side of the engine cylinder in a position to lie adjacent the muffler **16** and including a rear wall and forwardly projecting side walls to shield the mechanism from the cooling air discharged across the cylinder of the engine from the engine shroud **11**. Within the bracket **50**, a rigid lever **52** is mounted on a pivot pin **54** and extends upward therefrom past the muffler **16**. At an intermediate point, the lever **52** carries a pair of opposed ears **55** and **56** for limiting the relative movement of the temperature-responsive spring lever described below. A stop member **58** is formed on the bracket **50** in position to be engaged by the finger **56** on the lever **52** to limit the clockwise movement of the lever **52**. Near its upper end, the lever **52** carries a forwardly bent finger **60** having a hole therein to slidably receive the end **66** of an actuating link **62**, and forming an abutment for thrust engagement from the right by a shoulder **64** formed by an offset in the link **62**. The opposite end of the link **62** is offset and en-

gaged in pivotal engagement with the governor lever 40. The free end 66 of the link 62 extends through the aperture in the finger 60 for a considerable distance, and permits a substantial amount of movement of the shoulder 64 to the right away from the finger 60 without disengagement of the link 62 from the finger 60.

The lower end of the lever 52 carries a forwardly extending flange 68 to which is secured a temperature-responsive spring lever arm 70. This extends upward from the flange 68 in spaced conforming relation to the exhaust muffler 16, and thence upward between the stop fingers 55 and 56, to a point above the level of the finger 60 on the fixed lever 52. The upper end of the arm 70 is formed into an eye 71 which receives the transversely bent end portion of a link 72 whose opposite end is pivotly engaged in an aperture in the choke actuating arm 34. When the spring arm 70 is cold, it is flexed to the left, as shown in full lines in FIG. 2, and lies against the stop 55 at a maximum distance from the finger 60 of the rigid lever 52. As the arm 70 is heated by heat radiated from the exhaust muffler 16, it flexes to the right relative to the rigid arm 52, to the position shown in dotted lines in FIG. 2. At normal operating temperature of the engine, such spring lever arm 70 will be flexed still further rightward to a stop position against the stop finger 56, as shown in FIG. 3, at a minimum distance from the finger 60.

The lever assembly 52—70 is desirably lightly biased to the right or clockwise about its mounting pivot 54. To this end, a light formed spring 76 is mounted on the bracket 50 and has its offset end 78 engaged in a hole 79 in the rigid lever arm 52 at a point intermediate its length. This light biasing spring 76 tends to move the lever assembly in a direction, that is , clockwise, which drives the link 72 to move the choke valve 30 toward open position, but the biasing action is primarily to overcome the effect of gravity on the mechanism and preferably has but a minor effect on the operation of the choke.

If desired, the manual operation of the lever 46 may be employed to control the ignition of the engine. To this end, the actuating arm 47 for the lever 46 may be provided with an insulated grounding contact 80 connected by a wire to the spark plug 13 of the engine, and positioned to engage a grounded contact 82 when the actuating arm 47 is rotated counter clockwise to the limit of its motion.

Operation is as follows: It is assumed that the engine 10 is cold and that the temperature-responsive spring arm 70 of the choke mechanism is also cold so that it lies at its leftward position against the stop finger 55 of the rigid lever 52, as shown in full lines in FIG. 2. In the stopped condition of the engine, it may be assumed that the actuating arm 47 of the lever 46 is at its extreme counterclockwise position so that the spark plug 13 is grounded by engagement of the contact 80 with the grounded contact 82.

If, now, the control wire 48 is manually pulled in a direction to rotate the lever 46—47 clockwise, this disengages the grounding contact 80 from the grounded contact 82, and stretches the biasing spring 44 to a degree determined by the setting of the manual control. The spring 44 will pull the link 42 to its extreme leftward position, as shown in full lines in FIG. 2. While the engine is stopped or being cranked, the spring bias will be unopposed by the governor of the engine, and the governor lever 40 will be pulled leftward to its full line position shown in FIG. 2. The throttle valve 22 will then be fully open. This leftward movement of the governor lever 40 will thrust the choke actuating link 62 to the left, and its shoulder 64 will push against the finger 60 on the fixed lever 52, to move the lever assembly leftward to the position shown in full lines in FIG. 2. Since the temperature-responsive lever arm 70 is cold and flexed leftward, it will pull the link 72 to the left and move the throttle arm 34 counterclockwise, in a choke-increasing direction, to its limit of movement, where the choke valve 30 will lie in full-choke or closed position, as shown in full lines in FIG. 2.

In this choke-producing action, it will be noted that the link 62 is actuated with the throttle valve, since both are connected to the same governor lever 40, and that the choke valve closing movement is transmitted through the linkage made up of the link 62, the lever assembly 52—70, and the link 72. The effective length of the linkage will depend on the position of the eye 71 of the temperature-responsive arm 70 relative to the fixed finger 60 of the fixed lever arm 52. Under the cold conditions described, the eye 71 and finger 60 will have their maximum spacing and the linkage will have an effective length to produce a maximum choking action. It is also to be noted that the linkage connection of the link 62 with the finger 60 is a lost-motion connection arranged to transmit motion and force in the direction to close the choke valve and to prevent its opening, but to permit lost motion in the opposite direction.

When the engine starts to run under its own power, its governor will force the the governor lever 40 to the right against the bias of the spring 44, as to the dotted line position shown in FIG. 2, at which the speed-responsive force exerted by the lever 40 exactly opposes the bias being exerted by the spring 44. This position will determine governed speed of the engine, and any variation from such speed will be overcome by the conventional operation of the governor. The movement of the governor lever 40 to its running position also moves the link 62 to the right a limited distance. This allows the choke actuating lever assembly 52—70 to rock to the right under the unbalance bias of the choke valve 30, and permits the choke valve 30 to move to a partially open position, such as the "cold-run" position shown in dotted lines in FIG. 2. Any tendency of the engine to falter will result in a reduction in its speed and a consequent movement of the governor lever 40 to the left, in a direction which tends to open the throttle valve 22 and close the choke valve 30.

As the engine continues to run, its exhaust muffler 16 radiates heat to the adjacent temperature-responsive spring arm 70, and as the temperature of that arm rises, the arm flexes to the right, as indicated in dotted lines in FIG. 2. This carries the eye 71 toward the finger 60 to change the effective length of the linkage in a choke-reducing direction. As the arm 70 flexes to the right relative to the finger 60, this allows the link 72 to move to the right and allows the choke valve 30 to move from its cold-run position shown in FIG. 2 toward its fully open position, in which it is stopped by engagement of the stop finger 36 with the stop pin 38.

This open-choke condition is desirably reached before the temperature-responsive arm 70 of the choke linkage mechanism has reached its maximum temperature. As the arm 70 gets hotter and tends to flex further rightward relative to the rigid arm 52, its upper end will be stopped by reaction from the stop pin 38 through the arm 36 and link 72. Further flexing of the arm 70 will be permitted, however, by the lost-motion connection between the link 62 and the rigid lever 52, and such lever will freely rock to the left, against the light biasing force of the spring 76. This will move the lever 52 away from its stop 58, and will move its finger 60 along the free end 66 of the link 62 and away from the shoulder 64 on that link 62. This will further change the effective length of the linkage, and will introduce sufficient lost motion therein to permit the governor lever 40 to move freely through its normal throttle governing movements without transmitting any movement to the lever assembly 52—70 or to the choke valve 30, and such choke valve 30 will remain in fully open position as shown in FIG. 3.

When the engine is to be stopped, the manual control

wire 48 is moved downward, to move the lever 46—47 in a counter clockwise direction. This reduces the tension in the spring 44 and allows the throttle valve 22 to move toward closed position, and carries the grounding contact 80 against the grounded contact 82 to short out the ignition of the engine.

If manual variation of the governed speed of the engine 10 is not desired, the lever 46 can be anchored in a fixed position to maintain a fixed bias in the spring 44, and the engine can be turned on or shut off by independently controlling the grounding contact 80.

With a fixed bias exerted by the spring 44, when the engine stops, the governor will exert no force on the governor lever 40 and such lever 40 will be pulled to its extreme leftward position as shown in full lines in FIG. 2. This will be the same position in which the corresponding parts are held when the lever 46 is moved to running position, as described above, and the engine will be conditioned ready to start whenever the ignition system is ungrounded.

I claim as my invention:

1. Automatic choke mechanism for an internal combusion engine having

a carburetor throttle valve, a choke valve, means biasing the throttle valve toward an open start position, and a governor including an element responsive to engine speed and connected to move the throttle valve, in opposition to said biasing means, to a partially-closed running position for governing the speed of the engine,

said choke mechanism comprising

linkage means actuated with the throttle valve and connected for actuating the choke valve toward closed position as the throttle valve is moved toward open position,

said linkage means including temperature-responsive means for varying the effective length of the linkage means in response to heat from the engine,

said temperature-responsive means having a cold condition in which it renders said linkage effective to move the choke valve to full-choke position when the throttle valve is moved to start position and to hold the choke valve in partial-choke position when the throttle valve is moved to running position,

said temperature-responsive means being operative, in response to heat from the engine, to progressively change the effective length of the linkage means in a direction to reduce the choking action produced,

said linkage means also including a lost-motion connection operative to transmit motion in a choke-closing direction and permitting lost motion in the opposite direction,

the response of said temperature-responsive means to engine heat at normal operating temperature being sufficient to change the effective length of the linkage means to one which permits the choke valve to remain in non-choking position at all running positions of the throttle valve.

2. Automatic choke mechanism as set forth in claim 1, in which said temperature responsive means, at normal engine operating temperature, changes the effective length of said linkage means to one which renders the linkage means inoperative to move the choke valve away from non-choking position when the throttle valve is moved to open start position.

3. Automatic choke mechanism as set forth in claim 1, in which change in the effective length of said linkage means is limited, and with maximum change the linkage means transmits a partial choke-closing movement when the throttle valve is moved to open start position.

4. An automatic choke mechanism as set forth in claim 1 in which said temperature responsive means is positioned to be heated by radiation from the exhaust system of the engine.

5. Automatic choke mechanism for an internal combustion engine having

a throttle, a choke which tends to move to open position, and actuating means for moving the throttle to an open starting position and to a partially-closed running position,

linkage means adapted to be actuated with the throttle and to actuate the choke in a closing direction as the throttle is opened,

said linkage means including a pair of lever arms through which choke-closing motion and force is transmitted,

at least one of said arms being movable relative to the other in response to heat to vary the effective length of the linkage means,

said arms having a normal cold relation in which the linkage means is effective to move the choke to full-choke position when the throttle is moved to open start position, and to position the choke for partial-choking when the throttle is partially closed,

and said heat-responsive arm being operative in response to heat from the engine to progressively change the effective length of the linkage means in a choke-reducing direction.

6. Automatic choke mechanism as defined in claim 5 in which one of said movable arms is a temperature-responsive spring.

7. Automatic choke mechanism as defined in claim 6 in which the other arm is a pivoted rigid arm and the spring arm is mounted thereon.

8. Automatic choke mechanism as defined in claim 5 in which said linkage means comprises a pair of links respectively connected to the free ends of the said lever arms.

9. Automatic choke mechanism as defined in claim 5 in which said linkage means comprises a rod slidably engaged with the free end of one of the lever arms and shoulder means therebetween for transmitting motion in choke-closing direction and permitting lost motion in the opposite direction.

10. Automatic choke mechanism as defined in claim 9 in which said heat-responsive arm responds sufficiently to normal engine heat to cause lost-motion movement between said rod and shoulder means.

11. Automatic choke mechanism as defined in claim 5 with the addition of positive stop means limiting the relative movement between the arms.

12. Automatic choke mechanism for an internal combustion engine having a throttle and a choke, comprising

a pair of interconnected pivotal lever arms,

a first link adapted to be actuated with the throttle and connected to pivotally move one of said arms,

a second link connected to be moved by the other arm and connected to actuate the choke in a closing direction in response to actuation of the first link with throttle opening movement,

one of said connections being a lost-motion connection operative to transmit motion in a choke-closing direction and permitting lost motion in the opposite direction,

one of said arms being movable relative to the other arm in response to engine heat, in a direction to reduce the effectiveness of the arms for transmitting motion from the first link to the second link,

said arms having a cold condition for actuating the choke to full-choke position when the throttle is moved to full open position, and having a hot condition, responsive to normal engine heat, in which the choke is positioned in non-choking position when the throttle is in running position.

13. Automatic choke mechanism as defined in claim 12, with the addition of

positive stop means limiting heat-responsive relative movement of the arms.

14. Automatic choke mechanism as defined in claim 12, in which

one of said arms is a rigid arm pivotally mounted on a fixed axis

and the other arm is a heat-responsive spring mounted on the first arm.

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