

[54] **AUTOMATIC CHOKE SYSTEM**

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123/180 R

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[58] Field of Search **123/108, 119 F, 179 G,**
123/180 R

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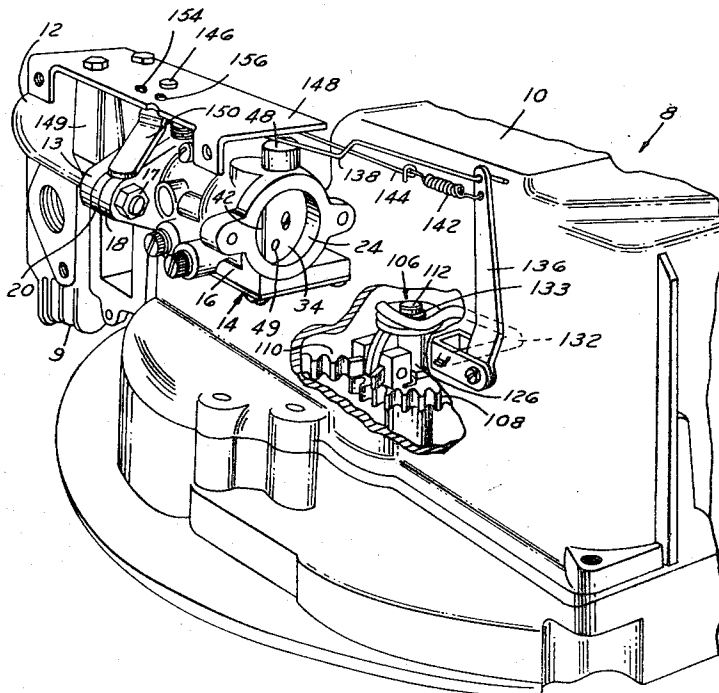
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[57] **ABSTRACT**

An automatic choke system for the carburetor of an internal combustion engine featuring a resilient member located within the air-fuel mixture conduit of the carburetor and operable through a lost-motion connection with the throttle to selectively position the choke in ac-

cordance with the position of the throttle over a selected range of movement thereof. During a last increment of movement of the throttle toward full open position, the resilient member yieldably urges the choke towards its choking position. As the engine starts, with the throttle in full open position and the choke in choking position, the resilient member permits the choke to flutter in response to engine suction thereby preventing overchoking as the engine accelerates. A conventional engine governor becomes operable above a selected speed to increasingly move the throttle away from its open position. As the throttle leaves the open position, the resilient yieldable member is backed off from its yieldable engagement with the choke so that the choke can be biased by its spring and air pressure away from the choking position so that automatic choking is provided only during engine starting. Thereafter, the choke is fully open and the throttle is modulated by the governor. A second governor is integrated with the first governor to restrict the movement of the first governor when the engine encounters a heavy load which significantly reduces engine speed. This restriction similarly restricts throttle movement so that the throttle cannot operate the choke via the resilient member. The second governor is automatically reset by stopping the engine and then setting the engine operating control to a combined "start-run" position so that automatic choking is always provided when the engine is being restarted.

25 Claims, 9 Drawing Figures

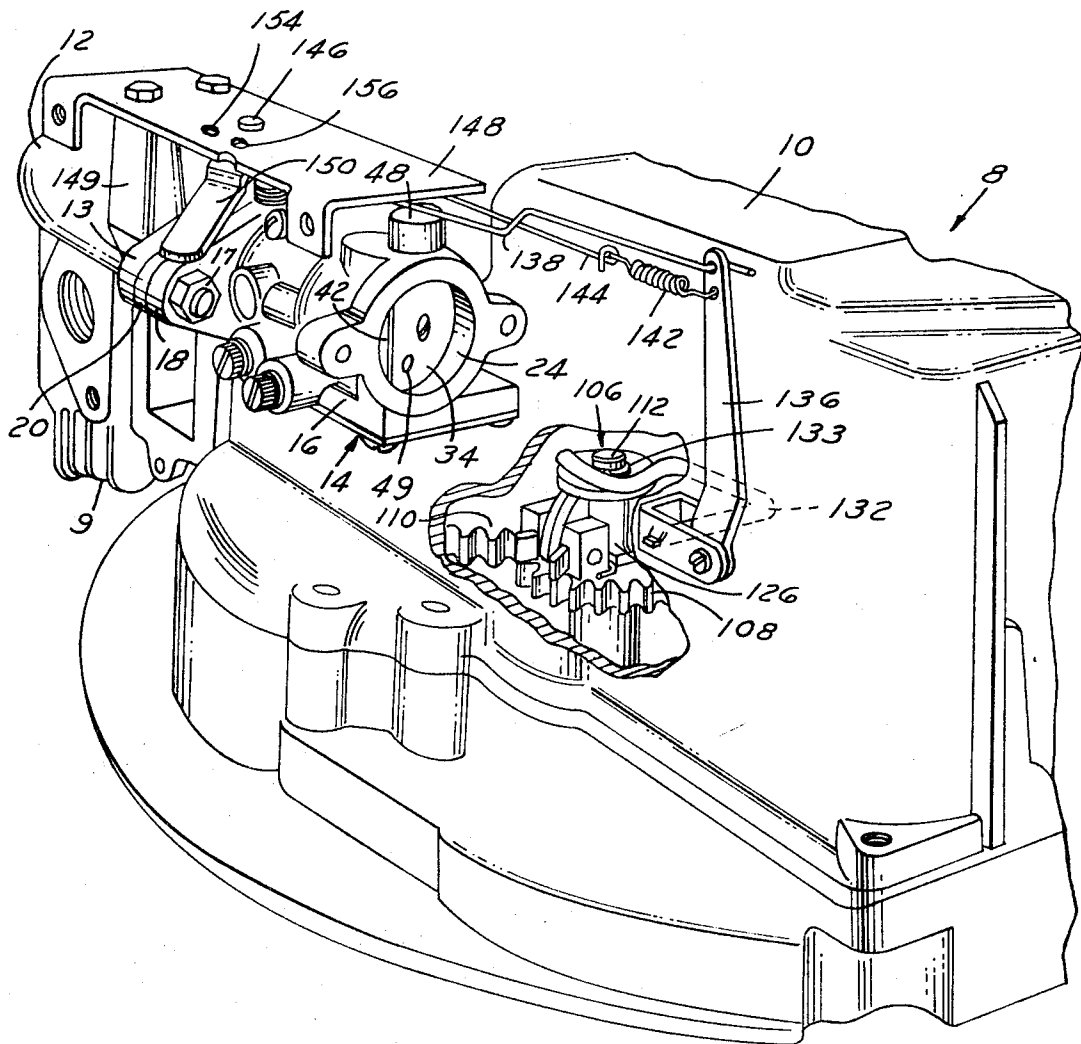


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FIG. 1



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FIG. 2

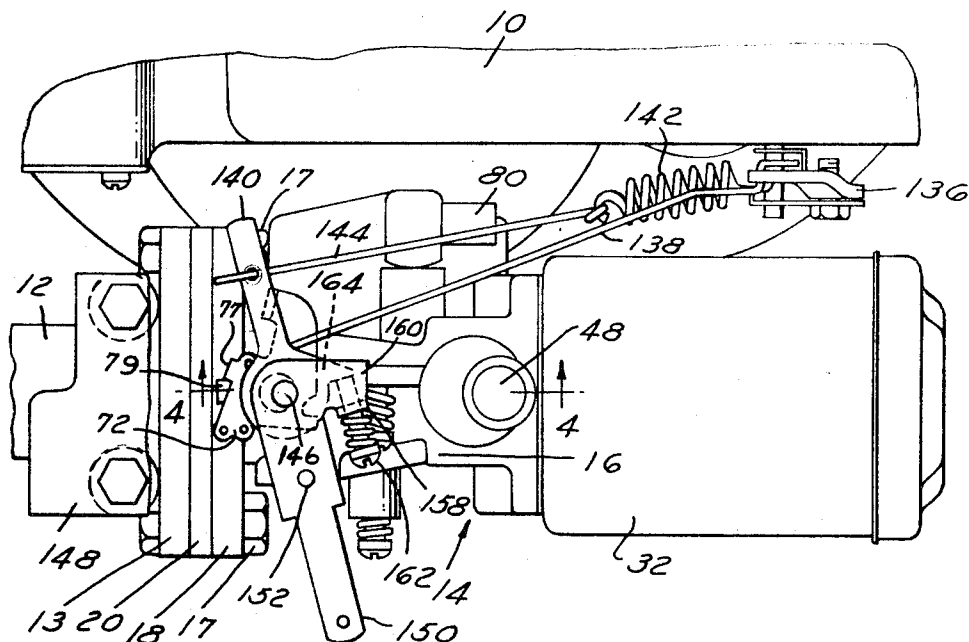
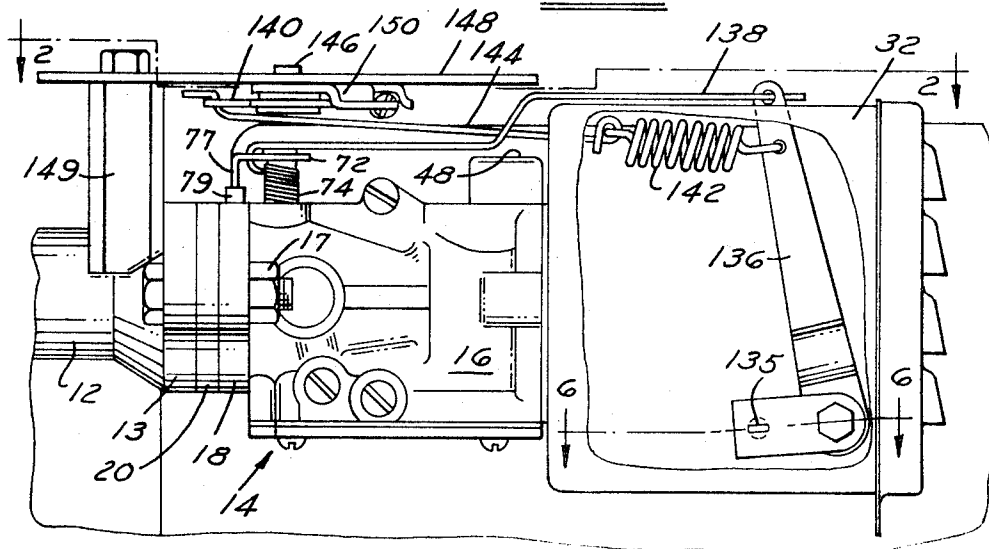


FIG. 3



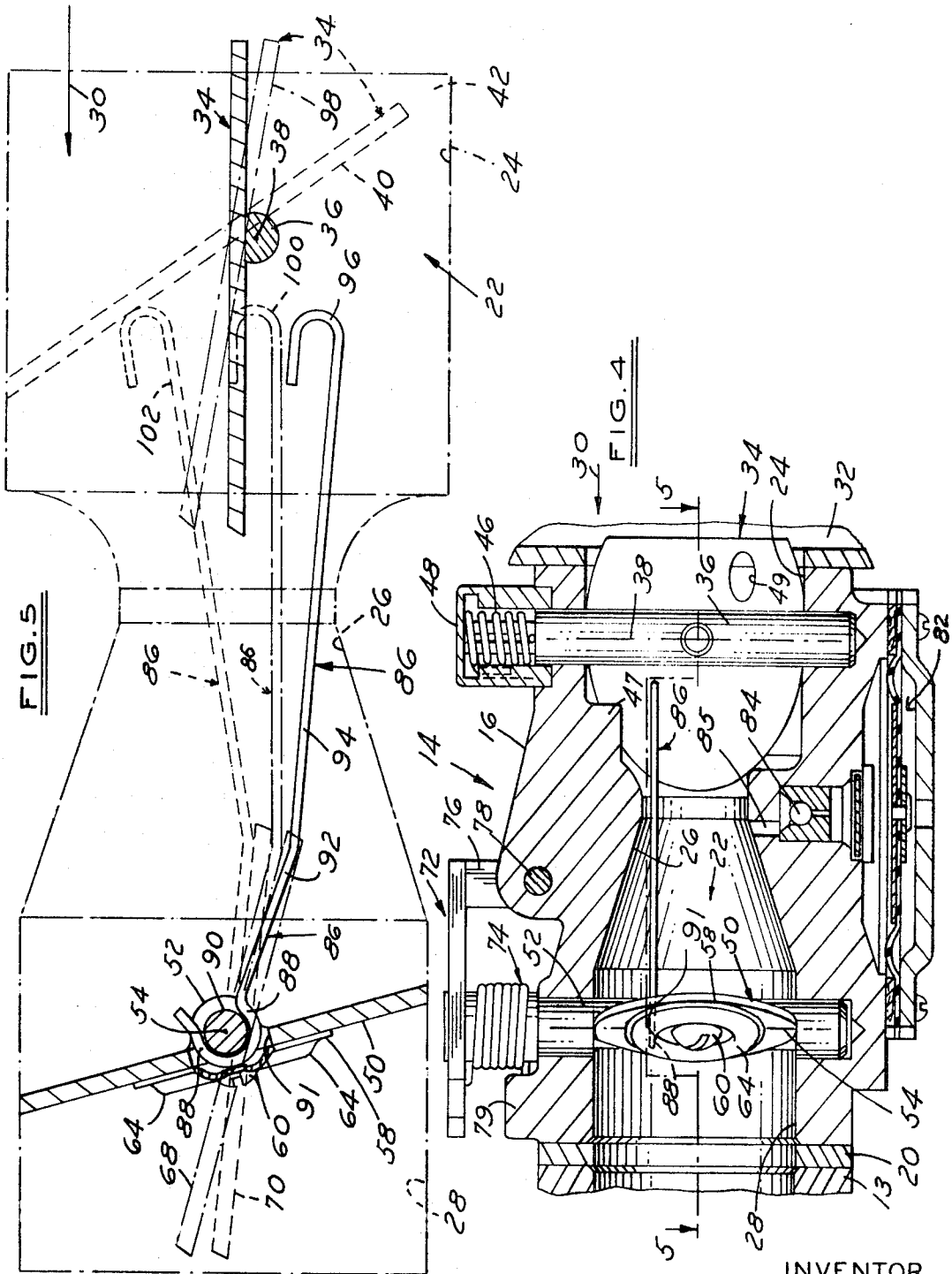
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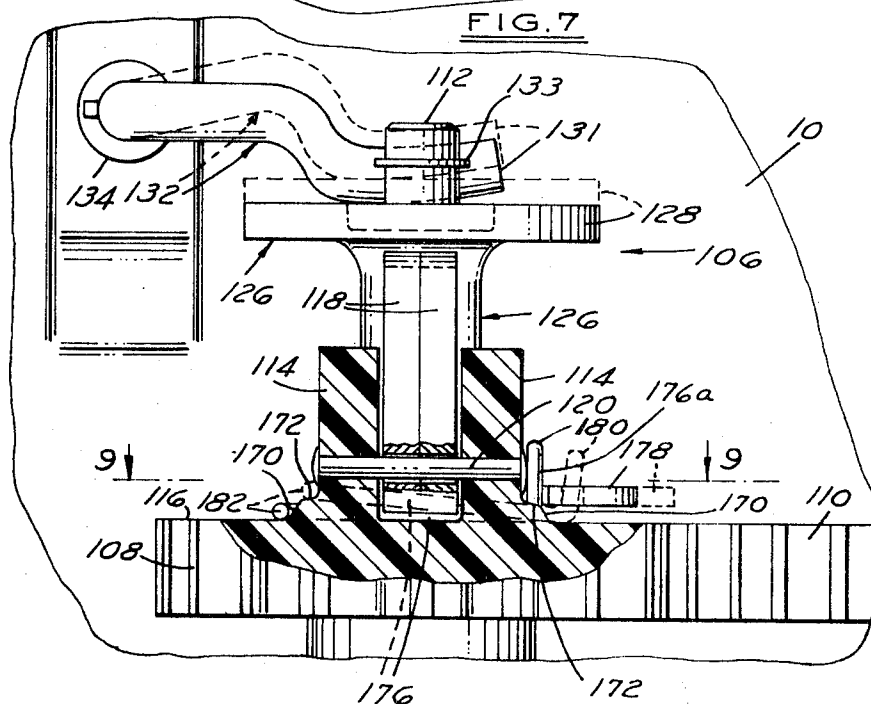
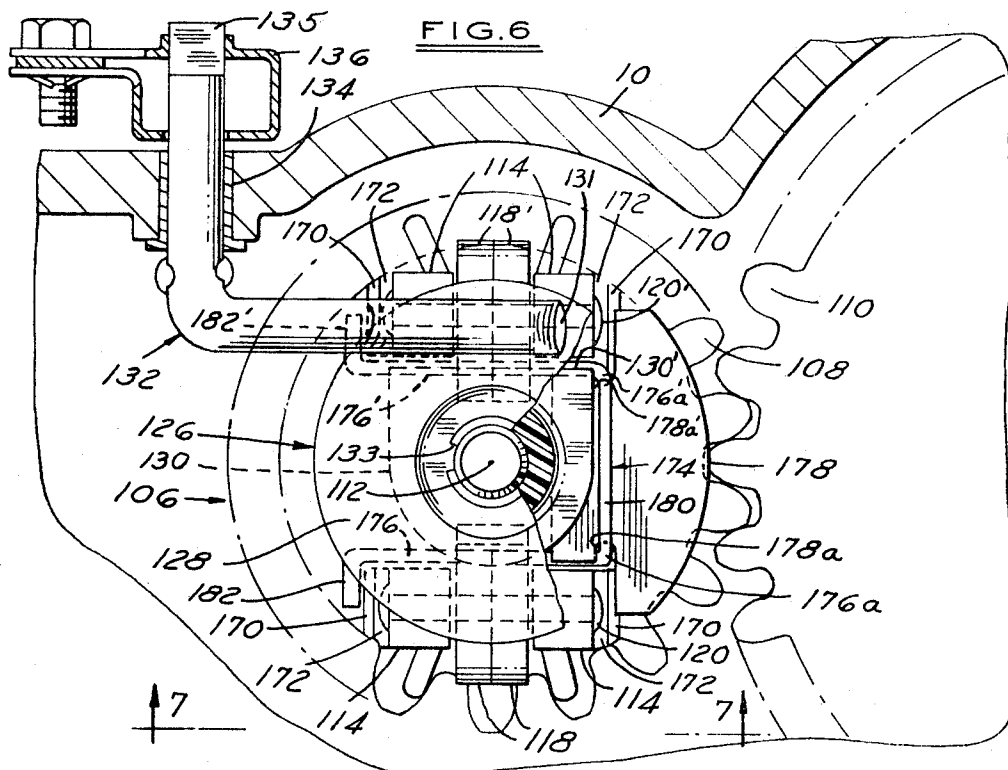


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FIG. 8

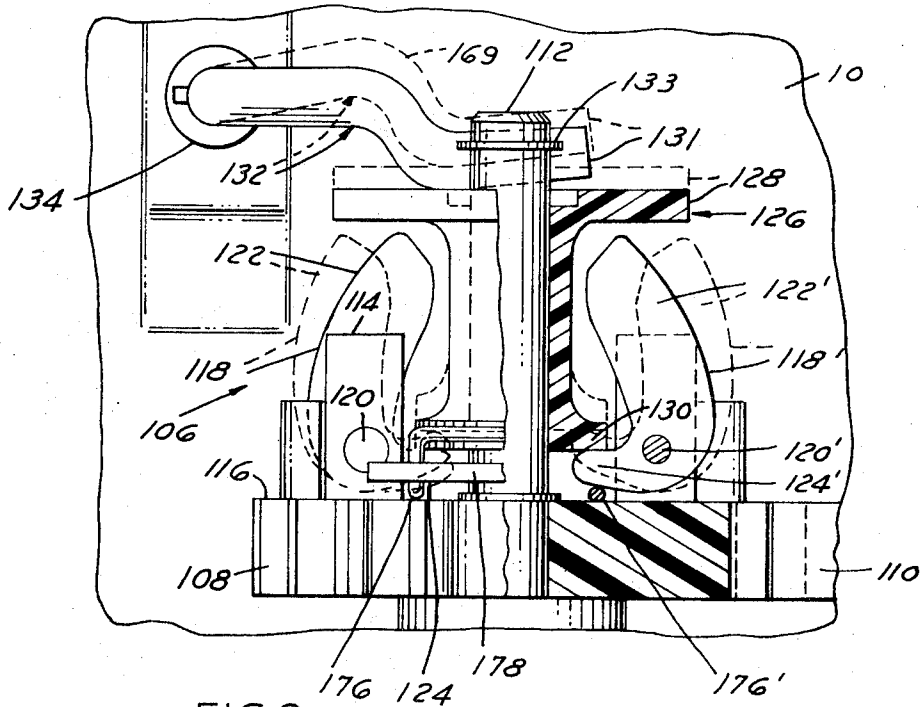
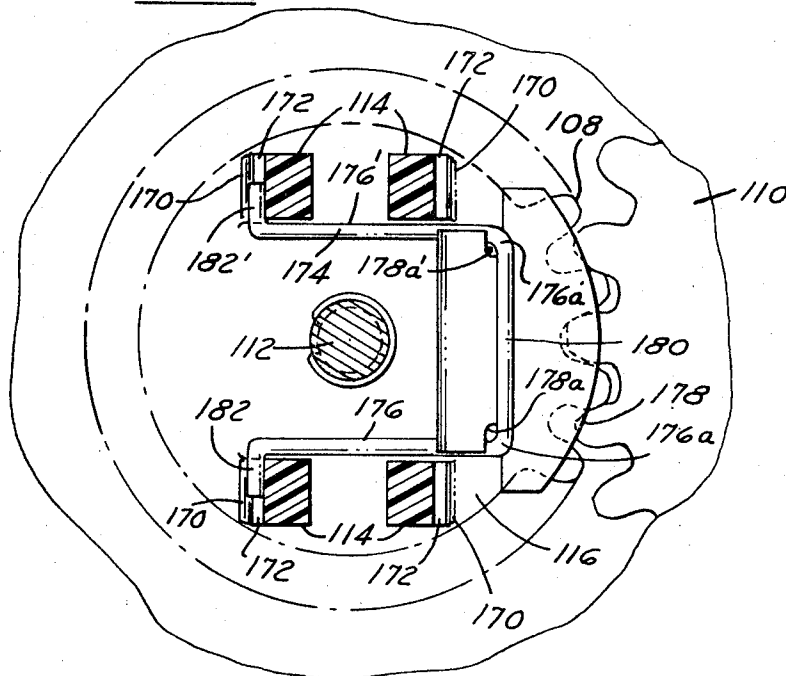


FIG. 9



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AUTOMATIC CHOKE SYSTEM

This invention relates to carburetors for internal combustion engines and particularly to an automatic choke control system for a carburetor.

The automatic choke system of the present invention is well suited for carburetors of the type frequently used with small engines such as in a power mower. Such carburetors are typically of a relatively simple construction which includes a throttle valve and a choke valve. The throttle valve controls the amount of air-fuel mixture which is supplied to the engine and as a result, the engine speed. The choke valve is usually operated to its choking position only during engine start-up to reduce the air intake into the carburetor and thus enrich the air-fuel mixture so that the engine may be easily started. In a manually operated choke, the operator must observe the engine start-up and must adjust the choke valve after the engine has started. Hitherto, automatic choke arrangements have been provided wherein choke positioning is automatically established by a speed-responsive mechanism such as an engine governor and an appropriate linkage connecting the governor and the carburetor. However, such prior art arrangements have generally been too complex and costly for small engine use, and too easily prone to malfunction from the dirt and abuse such engines often encounter.

Accordingly, it is an object of the invention to provide a speed-responsive automatic choke control system for a carburetor which is of relatively simple and economical construction.

Another object is the provision of an engine governor which prevents operation of an automatic carburetor choke when the engine speed falls below a selected speed.

It is also an object of the invention to provide a system of the above character including a resilient choke positioning member which is contained entirely within the carburetor air-fuel mixture conduit and hence protected from dust and dirt contamination by an air filter which encloses the carburetor air intake.

A further object of the invention is to provide a speed-responsive choke control system wherein setting of the operating control to a combined "start-run" position positions the throttle to full open position and the choke to full choking position to provide proper choking of the carburetor for engine start-up and which after the engine has accelerated to a selected speed automatically prevents choking of the carburetor when the engine encounters a load which drops its speed into the speed range for which automatic choking is provided during engine starting.

Other objects, features and advantages of the present invention will become apparent from the following detailed description and drawings in which:

FIG. 1 is a fragmentary perspective view of a vertical shaft, single cylinder lawnmower engine having the improved automatic choke control system of the present invention embodied therein, portions being broken away and the system being shown with the throttle control in the single "start-run" position and the engine not running.

FIG. 2 is a top plan view of the control system of FIG. 1 as taken along line 2—2 in FIG. 3.

FIG. 3 is a front elevational view of the control system of FIG. 2 having a portion broken away.

FIG. 4 is an enlarged vertical sectional view taken along line 4—4 in FIG. 2, but with the throttle control disconnected so that the throttle is in the throttling position.

FIG. 5 is an enlarged horizontal sectional view taken along line 5—5 in FIG. 4 showing selected operating positions of the throttle-choke control of the present invention.

FIG. 6 is an enlarged horizontal sectional view of the centrifugal, speed-responsive governor mechanism of the control system taken along line 6—6 in FIG. 3 rotated 180° and having a portion broken away.

FIG. 7 is a side elevational view taken along line 7—7 in FIG. 6 and having portions broken away.

FIG. 8 is a view taken in the same direction as the view of FIG. 7 but having the governor gear rotated 90° clockwise from the position shown in FIG. 7.

FIG. 9 is a horizontal sectional view taken along line 9—9 in FIG. 7.

Referring in more detail to the drawings, FIGS. 1 through 5 show a portion of an engine 8 which has a cylinder block 9, a crankcase 10 and an intake manifold 12 having a carburetor mounting flange 13. By way of illustration and not by way of limitation, engine 8 as shown herein is a single cylinder, air cooled, vertical crankshaft engine of the type adapted for mounting on the deck of a rotary lawnmower. A carburetor 14 having a carburetor body 16 is attached to manifold 12 by a pair of fasteners 17 which secure a flange 18 at the outlet end of body 16 to flange 13. A gasket 20 seals the connection between flanges 13 and 18. As shown in FIG. 4, an air-fuel mixture conduit 22 extends through body 16. Conduit 22 includes an air intake opening 24 at the nearer end of body 16 as viewed in FIG. 1, a venturi portion 26 and a discharge outlet 28 at the other end of body 16. In the illustrated embodiment, carburetor 14 is oriented in a horizontal position so that the direction of fluid flow as indicated by arrow 30 (FIGS. 4 and 5) through conduit 22 is horizontal. The air intake opening 24 is covered by a conventional air filter 32 (FIGS. 2 and 3).

Carburetor 14 further includes a choke plate 34 positioned within conduit 22 adjacent intake opening 24. Choke plate 34 is fastened to a choke shaft 36 which is notched within conduit 22 (FIG. 5) to receive plate 34 and support the same for movement about a vertical axis 38. Plate 34 is a truncated ellipse having an unbalanced mounting of shaft 36; i.e., its center of mass is to the left of axis 38 as viewed in FIG. 5 so that induction air pressure tends to pivot the plate counterclockwise to the solid line "full open" position thereof shown in FIG. 5. In this full open position, choke plate 34 is substantially parallel to the direction of air flow into carburetor 14, and the truncated edge protrudes only slightly beyond air intake opening so as not to interfere with air filter 32. With choke plate 34 in the closed position shown by broken lines 40 in FIG. 5, the elliptically-contoured edge abuts the wall of conduit 22 and the truncated edge cooperates with the wall to define a restricted opening 42 (FIGS. 1 and 5) to restrict air intake into carburetor 14. Intake air is also drawn through a small relief hole 49 in plate 34 adjacent the truncated edge when choke plate 34 is in the closed position. The size of hole 49 may be varied to suit different engine requirements. A small torsion spring 46 at one end of shaft 36 biases shaft 36 so that plate 34 is urged toward its open position by this spring as well as

by air pressure. Movement of plate 34 beyond this position is prevented by a stop 47 within conduit 22 (FIG. 4). Spring 46 is covered by a cap 48 to shield that end of shaft 36 from contamination.

A throttle plate 50 is positioned within conduit 22 adjacent discharge outlet 28. Throttle plate 50 is attached to a throttle shaft 52 which supports plate 50 for movement about a vertical axis 54. The attachment of plate 50 to shaft 52 is made by a circular washer 58 which engages the downstream surface of plate 50. A screw 60 is passed centrally through washer 58 and a clearance hole (not shown) in plate 50 and is threaded into shaft 52. Washer 58 includes an annular bead 64 whose purpose will be later described. Throttle plate 50 is elliptically shaped so that when in the full throttling or closed position as illustrated in solid lines in FIG. 5, the peripheral edge thereof abuts the wall of conduit 22. Throttle plate 50 is rotatable counter-clockwise as viewed in FIG. 5 from its "stop" (full throttling) position to an intermediate position 68 (dot-dash lines) and finally to an open position 70 (dash lines) by rotating a throttle lever 72 (FIG. 4) connected to the exposed end of shaft 52. A torsion spring 74 biases shaft 52 clockwise as viewed in FIG. 5 to urge throttle plate 50 toward its closed position and to urge a vertical tab 76 on lever 72 into abutment with the end of an idle adjustment screw 78 which is threaded into body 16. Movement of throttle plate 50 counter-clockwise as viewed in FIG. 5 beyond its open position is prevented by the abutment of a second tab 77 on lever 72 with a stop 79 on flange 18 (FIGS. 2 and 3).

The fuel distribution arrangement of carburetor 14 is entirely conventional and includes an inlet nipple 80 (FIG. 2) which is connected by means (not shown) to a fuel supply. Nipple 80 communicates with an inlet valve (not shown) controlled by a regulating diaphragm or float valve system 82 to admit fuel to the diaphragm or float chamber which in turn supplies fuel to high and low speed metering needle valves (not shown) which in turn regulate the passage of fuel into conduit 22 via back check 84 and main nozzle 85, and via idle jets or ports (not shown).

Referring again to FIGS. 4 and 5, a resilient member, such as a spring wireform 86, is situated within conduit 22. Wireform 86 comprises a hooked downstream end portion 88, a first segment 92 extending away from hook 88 at a small acute angle relative to the longitudinal axis of conduit 22, a second segment 94 continuing from the upstream end of segment 92 at a lesser acute angle and a partially looped portion 96 at the upstream end of segment 94. As shown in FIG. 4, the described portions of wireform 86 are coplanar in a horizontal plane. Wireform 86 is offset with respect to the axis of conduit 22 to facilitate the assembly thereof into carburetor 14. Hook 88 of wireform 86 partially encircles a grooved portion 90 of shaft 52, and a portion of hook 88 projects through a rectangularly shaped clearance hole 91 in plate 50. Hook 88 is retained for pivotal movement about axis 54 by washer 58, which also seals hole 91, the portion of hook 88 which projects through hole 91 being retained within a portion of the annular bead 64 in washer 58. Segment 92 is positioned for lost-motion engagement with the upstream surface of the leading half of throttle plate 50 when the latter is rotated counter-clockwise about 55° from its closed position as viewed in FIG. 5. Once throttle plate 50 engages segment 92, continued counter-clockwise rotation

thereof rotates wireform 86 counter-clockwise about axis 54 to bring end portion 96 thereof into sliding abutment with the downstream surface of the trailing half of choke plate 34 at a point spaced from its axis of rotation towards throttle plate 50. Further counter-clockwise rotation of throttle plate 50 now causes wireform 86 to rotate choke plate 34 in the clockwise direction with loop 96 wiping along the downstream surface of plate 34. With throttle plate 50 in an intermediate, almost full open position as at 68, wireform 86 and choke plate 34 assume the positions indicated at 100 and 98 respectively in FIG. 5. When throttle plate 50 has been moved to its full open position 70, choke plate 34 will have been moved to its choking position 40, wireform 86 now being positioned as indicated at 102. In this latter "start-run" position of the choke and throttle, segment 94 forms a yieldable resilient connection which, while tending to maintain plate 34 in the choking position, is sufficiently resilient to permit plate 34 to flutter partially open during starting of the engine as air is drawn into carburetor 14 by engine suction.

Hence, with the lost-motion arrangement just described, as throttle plate 50 is rotated over its last increment of movement toward its full open position, an increment of approximately 10° to 15°, wireform 86 automatically moves choke plate 34 through its full range of angular travel from its open to choking position. It is to be noted that the 10° to 15° increment of throttle travel utilized for actuating the choke is that portion of throttle travel when it is substantially parallel to air flow through conduit 22. Hence, movement of the throttle through such increment has a de minimis restricting effect on such air flow. Therefore, once plate 50 has moved counterclockwise to position 68, it is essentially open to permit maximum flow of the air-fuel mixture past the throttle plate, and further counterclockwise travel to position 70 would not materially increase such flow.

Referring now to FIGS. 1 and 6 through 9, an engine speed-responsive governor mechanism 106 is situated within crankcase 10. Governor 106 includes a first governor which is of conventional construction for regulating engine speed. In addition, a second governor is integrated with the first governor to prevent the automatic choke system from choking the carburetor when the engine is lugged down by a heavy load. The conventional governor is first described and comprises a governor gear 108 which may be driven by any speed-responsive engine member, such as the engine cam shaft timing gear 110. In the illustrated embodiment, gear 108 is journaled on a vertical post 112 projecting from the bottom wall of crankcase 10. Gear 108 has four integral upright posts 114 projecting from the upper face 116 of gear 108 at a fixed radius from the axis of post 112 in a rectangular array. Two identical pairs of flyweights 118 and 118' are respectively pivoted on pins 120 and 120', one flyweight pair being disposed between each of the two sets of posts 114 which are more closely spaced to each other. As can be seen in FIG. 8, flyweights 118 and 118' comprise somewhat L-shaped members having massive bodies 122 and 122' extending uprightly of pins 120 and 120' and less massive toes 124 and 124' projecting radially inwardly of pins 120 and 120'. When gear 108 is stationary, the toes of flyweights 118 and 118' are spring biased downwardly to the position illustrated in solid lines in FIG. 8 as will soon become apparent. In the solid line posi-

tion, toes 124 and 124' rest on side segments or legs 176 and 176' respectively of a U-shaped stop wire or lockout rod 174 which will be later described in connection with the second governor. In this position, side segments 176 and 176' lie flat on face 116 of gear 108 and define the farthest limit of the downward movement of toes 124 and 124'. As gear 108 is rotated, the centrifugal force acting on bodies 122 and 122' swings them radially outward of the axis of gear 108 once the downward spring bias is overcome, thereby pivoting flyweights 118 and 118' on pins 120 and 120' to raise toes 124 and 124'. The upward movement of toes 124 and 124' increases with increasing gear speed as the governor spring increasingly yields to the build-up in centrifugal forces.

A spool 126 (FIG. 8) is axially slidable on post 112. Spool 126 includes a large diameter circular flange 128 at its upper end, and a smaller flange 130 at its lower end which rests on toes 124 and 124' of flyweights 118 and 118' and has a straight edge 130' facing the upper two posts 114 in FIG. 6 which keys spool 126 for rotation with gear 108. The inner free end 131 of a curved governor rod 132 slidably engages the upper surface of flange 128, rod 132 being pivoted in and extending through crankcase 10 via a bushing 134. Hence, as toes 124 and 124' move upwardly, they force spool 126 upwardly, causing flange 128 to push end 131 upwardly to thereby rotate rod 132 counterclockwise as viewed in FIG. 8. A retaining ring 133 on post 112 limits upward movement of spool 126.

Referring to FIGS. 1, 2, 3 and 6, the exterior portion 135 of governor rod 132 which extends outside of crankcase 10 is fixedly attached to a governor lever 136. The upper portion of lever 136 is connected to throttle lever 72 by a rigid throttle link 138 and to a control lever 140 (FIG. 2) by means of a governor spring 142 and a governor link 144. Control lever 140 is pivoted as at 146 on a mounting plate 148 (FIGS. 1 and 3) which is fixedly attached to a support 149 on manifold 12. A bellcrank control handle 150 is pivoted about pivot 146 and is vertically captured between lever 140 and plate 148. Handle 150 is rotatable in the clockwise direction from the "start-run" position illustrated in FIG. 2 to an intermediate engine "idle" position and finally to a far clockwise engine "stop" position. Handle 150 includes a detent 152 (FIG. 2) which may engage either of two holes 154 and 156 (FIG. 1) in plate 148. Engagement of detent 152 with hole 154 establishes engine "idle" position; engagement of detent 152 with hole 156, engine "start-run" position. When handle 150 is moved to engine "stop" position, the primary winding of the ignition coil (not shown) is shorted out to prevent further engine firing as is conventional. A turned-down tab 158 is supported on a radial projection 160 of handle 150. An adjustment screw 162 is threaded into tab 158 to abut a radial projection 164 on lever 140. Engagement of the threaded end of screw 162 with projection 160 prevents spring 142 from rotating lever 140 in the clockwise direction beyond the position established by handle 150. Screw 162 thus may be adjusted to slightly vary the tension in spring 142 with handle 150 in the "start-run" position and hence the governed speed of the engine.

With handle 150 in either the "stop" or "idle" position, spring 142 is relaxed. When handle 150 is rotated counterclockwise from "idle" to "start-run," link 144 stretches spring 142 which tends to rotate governor

lever 136 counterclockwise as viewed in FIG. 3. This in turn maintains rod 132 in contact with flange 128 of spool 126. With the engine stopped, the counterclockwise limit of rotation of lever 136 is established by the downward limit of travel of spool 126 as illustrated in solid lines in FIGS. 7 and 8. With governor lever 136 in this position, throttle plate 50 is held in the full open position via throttle link 138. In turn, wire 86 positions choke plate 34 to the choking position. As the engine starts, flyweights 118 and 118' tend to pivot outwardly in response to centrifugal force produced by the acceleration of gear 108. However, pivotal movement of flyweights 118 and 118' is prevented by the downward governor spring force acting through spool 126 on toes 124 and 124'. When the speed of gear 108 is sufficiently great to produce a centrifugal force on flyweights 118 and 118', whose reaction at toes 124, 124' produces an upward force which exceeds the downward governor spring force, flyweights 118, 118' begin to lift spool 126. For example, in the illustrated arrangement, this occurs at approximately 3,000 rpm. As engine speed increases beyond 3,000 rpm, the increasing centrifugal force pivots flyweights 118 and 118', thereby raising toes 124 and 124' to lift spool 126. Governor lever 136 is thus rotated clockwise to move throttle plate 50 away from its open position, allowing wire 86 to move with it which in turn permits choke plate 34 to be increasingly moved by spring 46 and air pressure toward its open position. The engine continues to accelerate until the movement of throttle plate 50 toward closed position provides just enough air-fuel mixture to maintain engine operation at governed speed. Except for stop wire 174, the engine governor structure described thus far is conventional and well-understood in the art.

Referring again to FIGS. 1 and 6 through 9, the conventional governor structure has superimposed thereon a second governor which is operable to prevent choke 34 from being moved toward choking position once the engine is running above a selected speed. A ramp 170 and a slightly inclined shelf 172 are formed as a fillet at the junction of one side of each post 114 and upper face 116 of gear 108 as can be seen in FIGS. 6, 7 and 9. As previously noted, rod 174 rests on upper face 116 when the engine is not running (FIG. 6), legs 176 and 176' of wire 174 extending parallel to pins 120 and 120' and underlying toes 124 and 124' of flyweights 118 and 118' as previously noted. A flyweight 178 is attached to the upturned bight segment 180 of wire 174 by having the upturned inner ends 176a and 176a' pass through notches 178a and 178a' in the side edges of flyweight 178 so that bight 180 overlies flyweight 178, whereas the horizontally extending portions of legs 176 and 176' underlie the side edges of flyweight 178. The out-turned ends 182 and 182' of wire 174 are in juxtaposition to the left-hand ramps 170 as viewed in FIGS. 6 and 7. (The right-hand ramps 170, which are not used in the illustrated embodiment, permit wire 174 and flyweight 178 to be mounted in a position which is rotated 180° from that illustrated for ease of assembly.)

To illustrate the operation of the second governor, it is assumed for the moment that flyweights 118 and 118' are pivoted outwardly by centrifugal force by rotation of gear 108. The centrifugal force acting on flyweight 178 tends to pull wire 174 radially outwardly. The mass of flyweight 178 is sufficiently large and the slopes of ramps 170 sufficiently small such that out-

turned ends 182 and 182' of wire 174 move up ramps 170 and onto shelves 172. Further radial movement of wire 174 is prevented by abutment of ends 182 and 182' with their respective posts 114, and therefore legs 176, 176' assume the inclined positions illustrated by broken lines in FIG. 7. As will soon be seen, the inclined positions of legs 176, 176' provide raised stops to prevent movement of flyweights 118, 118' through their last increment of pivotal movement toward their solid line positions shown in FIG. 8.

The operative relationship of this second governor with the first governor will now be more apparent. As gear 108 rotates, flyweights 118, 118' and 178 all tend to move radially outwardly. As was pointed out, the centrifugal force of flyweights 118, 118', as reacted at toes 124, 124' counteracts the governor spring force and tends to raise spool 126. The centrifugal force of flyweight 178 produces an upward force on legs 176, 176' (via the camming action of ramps 170) which is sufficient to maintain contact thereof with the underside of toes 124, 124', but which in the illustrated embodiment makes essentially no contribution to overcoming the downward governor spring bias. Hence, the movement of wire 174 to its inclined position is constrained by the movement of flyweights 118, 118'. Therefore, only after the engine has accelerated to the speed at which the upward force on spool 126 (caused by the centrifugal force acting on flyweights 118, 118') counteracts the downward force produced by governor spring 142 (i.e., approximately 3,000 rpm) do toes 124, 124' begin lifting spool 126. By the time the engine has accelerated to 3,000 rpm, ends 182, 182' of wire 174 will have moved up ramps 170 as far as toes 124, 124' will permit. As the engine speed increases further, the lifting of the toes allows wire 174 to move to its raised position with ends 182, 182' resting on shelves 172. The positions of the governor components are illustrated by the broken lines in FIGS. 7 and 8. A further increase in speed pivots flyweights 118, 118' further outwardly, thereby causing toes 124, 124' to lift off legs 176, 176'. However, due to the axial orientation of the side surface of post 114, no axial component is developed by the centrifugal force acting on flyweight 178, and hence legs 176, 176' are not raised any further on posts 114. With the engine unloaded, governed running speed is a few hundred rpm higher than the speed at which wire 174 comes to its inclined position (for example 3,600 rpm).

When the engine encounters a heavy load sufficient to drop its speed to say 2,800 rpm, and with the throttle control still set in its "start-run" position, the reduced centrifugal force of flyweights 118, 118' results in a net downward force on spool 126 which would be sufficient to move the spool to its lowermost position shown in solid lines in FIGS. 7 and 8. However, such downward movement of spool 126 is foreshortened because the inclined (raised) position of wire 174 blocks the last increment of downward movement of toes 124, 124'. Thus, under these conditions, governor lever 136 moves throttle plate 50 to the open position 68 (FIG. 5) so that increased air-fuel mixture can be supplied to the engine to develop more power to meet the increased load, but movement to the full open position 70 (which could cause choke plate 34 to close) is prevented. Therefore, when the engine is lugged down, choking is always prevented (unless, of course, the load is so great that the engine stalls).

When the engine is stopped by moving handle 150 to "stop" position, spring 142 is again relaxed. As a result, there is no downward force on spool 126 and hence as the engine comes to rest, wire 174 remains in its raised position. However, when handle 150 is moved to "start-run" position for restarting the engine, spring 142 stretches to urge spool 126 downwardly. The inclinations of shelves 172 are large enough that this downward force as applied to legs 176, 176' via toes 124, 124' cams ends 182, 182' off shelves 172 and down ramps 170 so that legs 176, 176' are forced flat against face 116 of gear 108 (as illustrated in FIG. 6). This camming action is great enough to overcome any oil film or contamination on ramps 170 and shelves 172 which might hinder the sliding action of ends 182, 182' thereon. On the other extreme, the inclination of shelves 172 must be small enough to frictionally maintain wire 174 in the inclined, blocking position despite increasing governor spring force when the engine speed drops to some minimum speed, for example 500 rpm. Thus, when the engine stalls with handle 150 in "start-run" position, the governor spring force is sufficient to cause toes 124, 124' to cam flat against face 116 as the engine comes to a stop. In the illustrated arrangement, ramps 170 are inclined 50° to the horizontal (40° relative to the axis of rotation of weight 178) and shelves 172 slope in the same direction as ramps 170 but at only 10° inclination to the horizontal (80° relative to the axis of rotation of weight 178).

The operative relationship between governor 106 and carburetor 14 can now be clearly understood. With the engine stopped and handle 150 set to "start-run" position, the tension of governor spring 142 biases governor lever 136 to its counterclockwise limit as viewed in FIG. 3. Wire 174 is forced flat against face 116 of gear 108. Lever 136 in turn, via link 138, positions throttle plate 50 in its full open position 70 (FIG. 5). Wireform 86 is therefore swung to actuate choke plate 34 to its choking position 40. As the engine is cranked, air is drawn through filter 32 into conduit 22 of carburetor 14 in proportion to engine suction. Wireform 86 is sufficiently stiff to hold choke plate 34 in choking position at normal cranking speeds, but is sufficiently resilient to permit choke plate 34 to flutter in response to the increased engine suction developed once the engine fires and begins to run under its own power. This fluttering tendency is enhanced by the offset position of plate 34 relative to axis 38, the bias of spring 46 and the pivotal unbalance of plate 34 about axis 38 due to its shape. The fluttering of choke plate 34 thus helps to quickly lean down the mixture as the engine begins to accelerate under its own power to thereby prevent overchoking of the engine.

Throttle plate 50 is maintained in the full open position until the centrifugal force on flyweights 118, 118' begins lifting spool 126 (engine speed of approximately 3,000 rpm as previously noted). As flyweights 118 move governor lever 136 clockwise as viewed in FIG. 3, link 138 rotates throttle 50 toward its closed position, thereby reducing the flow rate of fuel mixture into the engine. The pivotal movement of throttle 50 in the clockwise direction of FIG. 5 permits wireform 86 to back off from its yieldable engagement with choke plate 34 so that choke plate 34 is increasingly opened by its bias spring 46. At the speed which produces lifting of toes 124, 124', sufficient centrifugal force is exerted on weight 178 to move wire ends 182, 182' up

ramps 170 and onto shelves 172 as soon as such movement is permitted by the first upward increment of movement of toes 124, 124' equal to about the diameter of wire ends 182, 182'.

As the engine continues to accelerate, toes 124, 124' of flyweights 118, 118' lift off wire 176 since it remains in its inclined raised position with ends 182, 182' thereof resting on shelves 172. When the unloaded governed running speed of the engine has been attained (for example, 3,600 rpm), throttle plate 50 has been rotated approximately 75 percent of the distance toward its closed position and is therefore only approximately 25 percent open. Due to wire 176 being in its raised position, choke plate 34 can no longer be operatively influenced by wireform 86 and hence remains fully open.

When the intended work load is applied to the engine, its speed drops and hence governor 106 opens throttle plate 50 so that increased fuel mixture is supplied to the engine to supply the power demanded by the load. For engine speeds between 3,600 rpm and 3,000 rpm, governor 106 modulates throttle plate 50 accordingly between its 25 percent open position and normal open position 68. When engine speed drops say below 3,050 rpm, the inclined legs 176, 176' of wire 174 prevent flyweights 118, 118' from assuming the positions they would otherwise have at this reduced engine speed, and consequently, throttle plate 50 cannot be opened beyond its normal open position 68. By restricting the movement of throttle plate 50 in this way, it is impossible for wireform 86 to operate choke plate 34 toward its choking position so long as the engine is running. Therefore, it can be seen that even when the engine is heavily loaded, choking of carburetor 14 is always prevented.

From the foregoing description, it will now be apparent that the present invention provides an improved speed-responsive automatic choke control system which automatically chokes the engine in varying degree for engine operation up to a selected speed, but which prevents choking when the engine speed falls below the selected speed so that engine operation may be continued even when lugged down by heavy loads.

It should be noted that once control handle 150 is set to the single "start-run" position, the engine may be started and operated without changing the setting of handle 150. It should also be pointed out that when handle 150 is moved to the "idle" position, governor spring 142 has no effect on the position of throttle 50, and hence "idle" speed is ungoverned.

As the automatic choke is solely speed responsive, it is particularly suited for lawnmower applications where engine operation is normally limited to a range of warmer temperatures such as 40° to 110° F. The choke is preferably calibrated not to flood the engine under hot engine restart and/or hot ambient conditions, which normally entails some compromise relative to the cold engine startability in cooler ambient conditions. The internal mounting of wireform 86 places it in an environment protected from dirt by air filter 32, adding to the improved reliability of the system. Since wireform 86, washer seal 58, flyweight 178 and stop wire 174 are the only additional parts required to convert a standard engine to an automatically choked engine, manufacturing costs are kept to minimum.

While the invention has been described in its preferred form, it should be understood that various modi-

fications can be made to the illustrated arrangement. For example, the invention may be practiced with a float-type carburetor. Also, the governor may be modified to operate at speed ranges other than those described and the manner in which these changes may be made will be apparent to those skilled in the art from the foregoing disclosure. Therefore, it is to be understood that the invention has been explained by way of illustration and not by way of limitation.

I claim:

1. In an automatic choke control system for a carburetor for use with an engine, said carburetor being of the type having a carburetor body, a carburetor air-fuel mixture conduit extending through the body, choke means within said conduit and supported for movement on said body between open and choking positions and throttle means within said conduit downstream of said choke means and supported for movement on said body between full open and throttling positions, the combination comprising speed governing means responsive to engine speed for modulating the position of said throttle means in accordance with engine speed and choke positioning means disposed within said conduit for selectively positioning the choke means in relation to the position of the throttle means, said choke positioning means operatively connecting said throttle means with said choke means such that a last increment of movement of said throttle means during movement from the throttling to the full open position thereof moves said choke means from its open to its choking position, said means responsive to engine speed comprising a dual governor mechanism having first speed responsive means for exerting primary control over positioning of said throttle means between said throttling and full open positions thereof and second speed responsive means operable to restrict the operating range of said first speed responsive means to all but said last increment of movement of said throttle means when said engine is running above a given speed.

2. The choke control system of claim 1 wherein said choke positioning means comprises a resilient member having a yieldable engagement with said choke means so as to yieldably allow opening movement of said choke means induced by and in proportion to engine intake suction at engine start-up.

3. The choke control system of claim 2 wherein said member comprises a first portion engageable with said throttle means during movement thereof through said last increment of movement thereof and a second portion connected to said first portion and engageable with said choke means for moving the latter from the open to the choking position when said first portion is moved by said throttle means.

4. The choke control system of claim 3 wherein said throttle means is rotatably supported on said body and said choke means comprises a choke plate supported for rotation on said body about an axis generally parallel to the axis of rotation of said throttle means for movement between said open and choking positions, and wherein said second portion of said member engages said choke plate on the side thereof closer to said throttle means to thereby rotate said choke plate from said open to choking positions thereof, said second portion having a wiping engagement with said choke plate during movement of the latter.

5. The choke control system of claim 1 further including spring means yieldably biasing the choke

means toward the open position and being overridable by said choke positioning means.

6. The choke control system of claim 1 wherein said throttle means is supported on said body for rotation between said open and throttling positions and said choke positioning means comprises a first portion spaced from said throttle means when the latter is in its throttling position and engageable with said throttle means when the latter is rotated to traverse said last increment of movement thereof, and a second portion connected to said first portion and engageable with said choke means for moving said choke means from the open to the choking position thereof in response to said movement of the throttle means in said last increment to its open position.

7. The choke control system of claim 6 wherein said choke positioning means includes a third portion connected to said first portion remote from said second portion, said third portion being pivotally mounted on said throttle means for rotation about the rotational axis of said throttle means.

8. The control system of claim 4 wherein said choke positioning means comprises a single piece of spring wire having one end hooked to said throttle means to form a lost motion pivotal connection with said throttle means and being curved at its opposite free end for said wiping engagement with said choke plate.

9. The choke system of claim 1 further including a single throttle and choke control linkage for adjusting said throttle means via said governor mechanism to thereby govern the speed of the engine, said linkage having a combined run-choke setting in which said throttle means is positioned in said full open position when said engine is at rest and in which said choke means is conditioned to be moved into said choking position by said linkage when said engine drops below said given speed.

10. The choke control system of claim 2 further including air filtering means positioned upstream of the carburetor air intake and operable to filter all the air drawn into said carburetor mixture conduit whereby said resilient member is protected from contamination by particles having a size greater than the size of particles which may be passed through said air filtering means.

11. In an automatic choke control system for a carburetor for use with an engine, said carburetor being of the type having a carburetor body, an air-fuel mixture conduit extending through the body, choke means within said conduit supported for movement on said body between open and choking positions and throttle means within said passage downstream of said choke plate means and supported for movement on said body between open and throttling positions, the combination comprising first governor means responsive to engine speed for modulating the position of said throttle means, choke positioning means operatively connecting said throttle means with said choke means such that movement of said throttle means to the open position from a position intermediate the open and throttling positions moves the choke means from its open to its choking position, and second governor means responsive to operation of said engine for preventing said throttle means from moving from its intermediate to its open position when the engine speed is reduced below a selected speed to thereby likewise prevent movement of the choke means from its open to its choking position

tion when engine speed drops below said selected speed.

12. The choke control system of claim 11 wherein said second governor means comprises flyweight means radially movable relative to a fixed axis, means for rotating said flyweight means about said axis in relation to engine speed such that said flyweight means is radially displaced a given increment when the engine is accelerated from rest to said selected speed and lockout means operatively connected with said flyweight means and disposable to block the path of travel of a moving portion of said first governor means in response to said radial increment of movement so that when the engine slows down below said selected speed the throttle is prevented from moving from the intermediate position to the open position.

13. The choke control system of claim 11 wherein said second governor means includes lockout means responsive to engine speed greater than said selected speed for blocking the path of travel of a moving portion of said first governor means when the engine slows down below said selected speed whereby said throttle means is prevented from moving from its intermediate to its open position and likewise said choke means from its open to its choking position.

14. The choke control system of claim 12 further including cam means operatively engageable with said lockout means for causing the latter to move in the direction of said axis as it moves radially outwardly as said given increment is traversed.

15. The choke control system of claim 11 wherein said first governor means comprises flyweight means, means supporting said flyweight means for radial movement relative to a fixed axis, means for rotating said support means in accordance with engine speed about said axis whereby said flyweight means moves radially outwardly and means operatively connecting said flyweight means with said throttle so as to correlate the throttle position with the position of said flyweight means, said second governor means comprising means for disrupting the movement of said flyweight means to thereby prevent movement of said throttle beyond its intermediate toward its open position when the engine speed is reduced to said selected speed.

16. The choke control system of claim 15 wherein said support means comprises a surface rotatable about said fixed axis, said flyweight means having a portion movable toward and away from said surface in response to radial movement in opposite directions of another portion of said flyweight means, said second governor means comprising a lockout member rotatable about said fixed axis in unison with said surface and radially movable over a given radial increment when the engine is accelerated from rest to said selected speed, said lockout member comprising a stop portion spaced between said surface and said flyweight means, and cam means engageable with said lockout member in response to radial movement thereof for causing the distance between said stop portion of said member and said surface to change such that said stop portion of said lockout member is disposed to shorten the path of movement of said flyweight means toward said surface to thereby effect said disruption of its movement.

17. The choke control system of claim 16 wherein said cam means constrains said lockout member such that said stop portion thereof assumes a position in-

clined relative to said surface when said surface is rotated.

18. The choke control system of claim 15 further including means for biasing said flyweight means towards a rest position.

19. In an automatic choke control system for a carburetor for use with an engine, said carburetor being of the type having a carburetor body, a carburetor air-fuel mixture conduit extending through the body, choke means within said conduit and supported for movement on said body between open and choking positions and throttle means within said conduit downstream of said choke means and supported for movement on said body between full open and throttling positions, the combination comprising speed governing means responsive to engine speed for modulating the position of said throttle means in accordance with engine speed and choke positioning means disposed within said conduit for selectively positioning the choke means in relation to the position of the throttle means, said choke positioning means operatively connecting said throttle means with said choke means such that a last increment of movement of said throttle means during movement from the throttling to the full open position thereof moves said choke means from its open to its choking position, said throttle means being supported on said body for rotation between said open and throttling positions and said choke positioning means comprises a first portion spaced from said throttle means when the latter is in its throttling position and engageable with said throttle means when the latter is rotated to traverse said last increment of movement thereof, and a second portion connected to said first portion and engageable with said choke means for moving said choke means from the open to the choking position thereof in response to said movement of the throttle means in said last increment to its open position, said choke positioning means including a third portion connected to said first portion remote from said second portion, said third portion being pivotally mounted on said throttle means for rotation about the rotational axis of said throttle means.

20. The choke control system of claim 19 wherein said means responsive to engine speed comprises a dual governor mechanism having first flyweight means for exerting primary control over positioning of said throttle means between said throttling and full open positions thereof and second flyweight means operable to restrict the operating range of said first flyweight means to all but said last increment of movement of said throttle means when said engine is running above a given speed.

21. The choke control system of claim 20 further including a single throttle and choke control linkage for adjusting said throttle means via said governor mechanism to thereby govern the speed of the engine, said linkage having a combined run-choke setting in which said throttle means is positioned in said full open position when said engine is at rest and in which said choke means is conditioned to be moved into said choking position by said linkage when said engine drops below

said given speed.

22. The choke control system of claim 21 further including air filtering means positioned upstream of the carburetor air intake and operable to filter all the air drawn into said carburetor mixture conduit whereby said choke positioning means is protected from contamination by foreign matter filtered out of said air by said filter.

23. In an automatic choke control system for a carburetor for use with an engine, said carburetor being of the type having a carburetor body, a carburetor air-fuel mixture conduit extending through the body, choke means within said conduit and supported for movement on said body between open and choking positions and throttle means within said conduit downstream of said choke means and supported for movement on said body between full open and throttling positions, the combination comprising speed governing means responsive to engine speed for modulating the position of said throttle means in accordance with engine speed and choke positioning means disposed within said conduit for selectively positioning the choke means in relation to the position of the throttle means, said choke positioning means operatively connecting said throttle means with said choke means such that a last increment of movement of said throttle means during movement from the throttling to the full open position thereof moves said choke means from its open to its choking position, said choke positioning means comprising a resilient member having a yieldable engagement with said choke means so as to yieldably allow opening movement of said choke means induced by and in proportion to engine intake suction at engine start-up, said member comprising a first portion engageable with said throttle means during movement thereof through said last increment of movement thereof and a second portion connected to said first portion and engageable with said choke means for moving the latter from the open to the choking position when said first portion is moved by said throttle means, said throttle means being rotatably supported on said body and said choke means comprising a choke plate supported for rotation on said body for movement between said open and choking positions, and wherein said second portion of said member engages said choke plate on the side thereof closer to said throttle means to thereby rotate said choke plate from said open to choking positions thereof, said second portion having a wiping engagement with said choke plate during movement of the latter.

24. The control system of claim 23 wherein said choke positioning means comprises a single piece of spring wire having one end hooked to said throttle means to form a lost motion pivotal connection with said throttle means and being curved at its opposite free end for said wiping engagement with said choke plate.

25. The choke control system of claim 24 further including a spring means yieldably biasing the choke means toward the open position and being overridable by said choke positioning means.

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