June 19, 1962 H. EILER 3,040,181

MIXTURE CONTROL FOR INTERNAL COMBUSTION ENGINE

Filed Jan. 23, 1961

FIG. 1

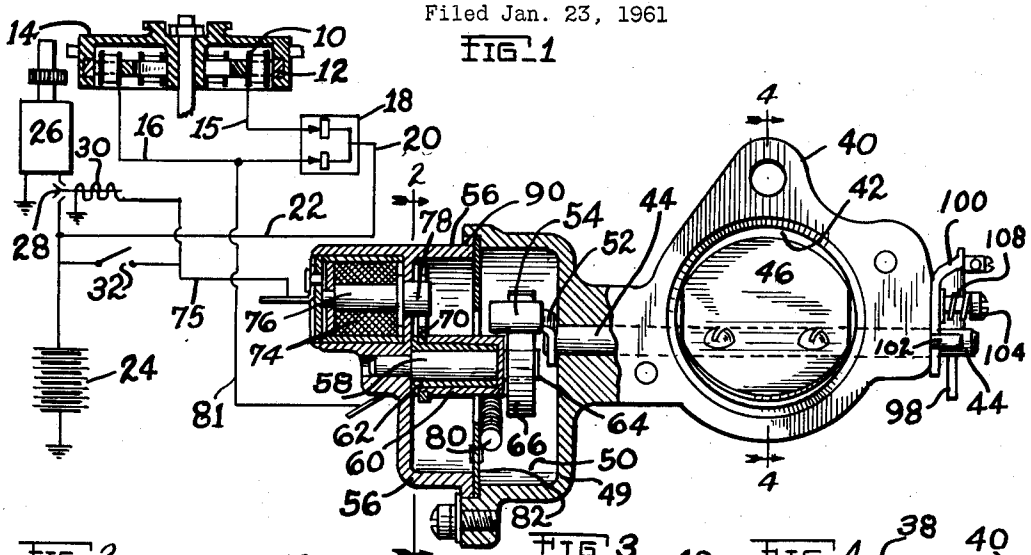


FIG. 2

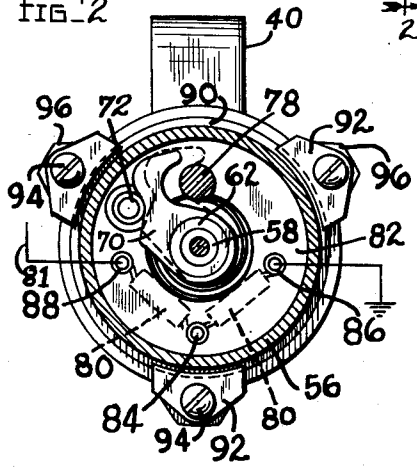


FIG. 3

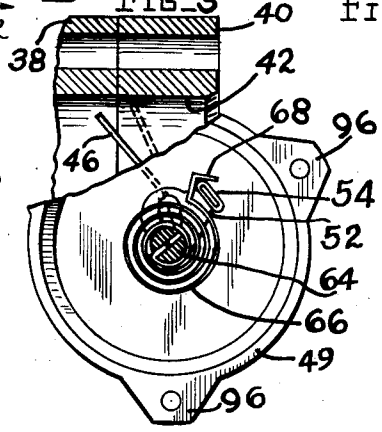


FIG. 4

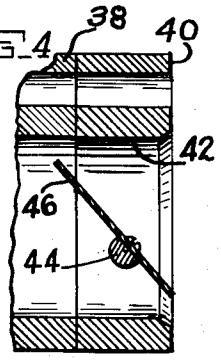


FIG. 5

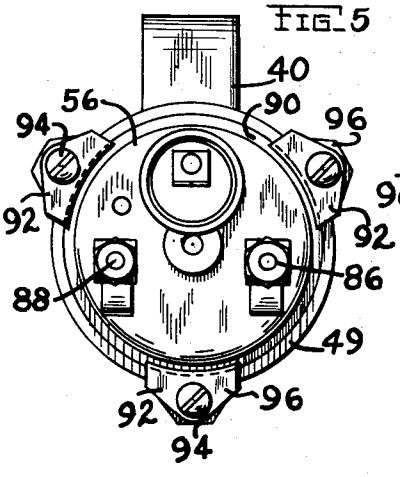
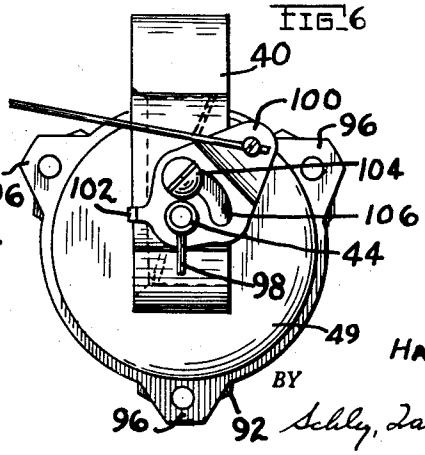


FIG. 6



INVENTOR.
HAROLD EILER
BY
Schley, Dask & Jenkins
ATTORNEYS.

United States Patent Office 3,040,181 Patented June 19, 1962

3,040,181

MIXTURE CONTROL FOR INTERNAL COMBUSTION ENGINE

Harold Eiler, Lapel, Ind., assignor to The Pierce Governor Company, Inc., Anderson, Ind., a corporation of Indiana

Filed Jan. 23, 1961, Ser. No. 84,444
14 Claims. (Cl. 290—40)

This invention relates to a mixture control for an internal combustion engine, in the nature of an automatic choke, and the combination thereof with an electrical system for the engine including a battery which is utilized as a power source to increase choking action during engine starting, and including also a battery-charging generator, especially an A.C. generator which charges the battery through a rectifier, which generator is utilized as a power source to regulate choking action during engine operation.

It is an object of the invention to provide a mixture control in the nature of a choke which is independent of both the cooling system and the exhaust system of the engine with which it is associated. It is a particular object of the invention to provide a mixture control or automatic choke especially adapted for use with 2-cycle outboard engines which are air-cooled or cooled by a non-recirculating fresh water system. It is a further object of the invention to provide a mixture control which provides a variable choking action which is regulated to parallel the choking needs of the engine during operation under its own power and which also provides increased choking action during starting of the engine. It is a further object of the invention to regulate the choke in response to the running output of an A.C. generator or alternator, in combination with means responsive to D.C. battery power to increase choking during starting.

In accordance with the invention, the air inflow passage to the carburetor of the internal combustion engine is provided with an unbalanced choke valve which tends to open in response to air inflow. At normal ambient temperature, say 75° F., the choke valve is biased to partially-closed position by a temperature responsive element such as a helically wound bimetallic spring. Such element is rotatably mounted, as on a rockshaft, which valve-reaction normally urges in a choke-decreasing direction against a stop. A solenoid energized from the battery rotates the rockshaft in a choke-increasing direction during starting, and such rotation acts through the thermal element to move the choke valve in a closing direction. The arrangement is such that at normal starting temperature the choke valve will be substantially closed when the solenoid is actuated. The solenoid is desirably energized concurrently with the engine starter so that the choke is moved to full choking position during starting, and is released to a partially open position when the engine starts and the starter is de-energized.

The bimetalic spring is housed in a heater housing which contains an electric resistance heating element connected to be heated by running output of the generator. In the preferred case of an altenator or A.C. generator which charges the battery through a rectifier, the heater is connected ahead of the rectifier so that it receives generator output but is isolated from the battery by the one-way valving action of the rectifier. The output of the alternator will of course vary with engine speed of the engine, and this will control the heater output and the temperature of the bimetallic spring. The bimetallic spring is such that as its temperature rises it relaxes in a choke-decreasing direction, and progressively allows the choke valve to open under the influence of air flow into the carburetor. As the result, the choking action during engine operation will be varied in response to generator output, and in parallel with engine needs.

The choke mechanism may be provided with a manually operable actuating lever which overrides the automatic control.

Other objects and features of the invention will appear from the following description of a preferred embodiment of the invention.

The accompanying drawing illustrates my invention In such drawing:

FIG. 1 is an elevation, with parts shown in section, of an automatic choke embodying my invention, in combination with an electrical diagram showing the relationship of the automatic choke and its parts to the electrical system of an internal combustion engine with which it is associated;

FIG. 2 is a section taken on the line 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 2, showing in end elevation the housing containing the bimetallic spring, with the housing cover and its supported parts removed but with bimetallic spring shown in end elevation;

FIG. 4 is a section taken on the line 4—4 of FIG. 1;

FIG. 5 is an end elevation taken from the left-hand end of FIG. 1;

FIG. 6 is an end elevation taken from the right-hand end of FIG. 1.

As indicated in FIG. 1, the choke mechanism there shown is especially adapted for use with an internal combustion engine having an electrical system in which an A.C. generator or alternator charges the battery through a rectifier. The electrical system shown diagrammatically in FIG. 1 may be considered to be that of an outboard engine. A series of alternator coils **10** are energized by a magnet **12** carried in the flywheel **14** of the engine. The output from such alternator is carried by a pair of wires **15** and **16** to a rectifier **18** having a D.C. output terminal **20** connected by a wire **22** to the battery **24** of the system. The system may include other conventional elements, such as a voltage regulator not shown. A starter motor **26** is connected to the battery **24** through a relay switch **28** actuated by a coil **30** connected to the battery through a starter switch **32**. The A.C. output of the alternator is converted by the rectifier to D.C. current to charge the battery **24** during running operation of the engine.

The choke mechanism shown in the drawing comprises the body **40** adapted to be mounted against the intake end of a carburetor **38** and defining an air inflow passage **42** to the carburetor. A choke shaft **44** is rotatably mounted in the body **40** on an axis extending transversely across the passage **42** and offset from its center, and such shaft carries a choke valve **46** which in closed position will substantially choke off the passage **42**. The left-hand end of the choke shaft **44** extends into a heater chamber **50** formed by walls **49** on the body **40**, and there carries a choke-actuating crank finger **52**, which is desirably covered by a wear sleeve **54**. The chamber **50** extends into and is closed bl a hollow cover **56** which carries a fixed central mounting pin **58**. A rockshaft sleeve **60** is mounted on such pin **58** by means of a sleeve bearing **62** and carries at its end a slotted stud shaft **64** in which is mounted a helical bimetal spring **66**. The outer end of this helical spring **66** is turned outward to form a hook **68** which engages the crank finger **52** on the choke shaft **44**. The opposite end of the sleeve **60** carries a control arm **70** which normally lies rotated counterclockwise against a stop **72** fixed in the rear wall of the cover **56**.

The outer end of the cover **56** forms a housing containing a D.C. solenoid **74** having a core **76** whose forward end **78** extends through the end wall of the cover **56** into the chamber **50**. Such forward end **78** is angularly spaced from the stop **72** and lies in the path of the operating arm **70** for the rockshaft **60** and its bimetal spring **66**, and such lever **70** is arcuately notched to em-

brace the core-end **78**. The relationship is such that the arm **70** forms the armature for the solenoid. Accordingly, when the solenoid is energized, the core **78** attracts the armature lever **70** and rotates such lever **70** clockwise away from its stop **72**, to the position shown in dotted lines in FIG. 2. This rotates the sleeve **60** and its bimetallic spring **66** in a clockwise direction in FIGS. 2 and 3, and the spring, in turn, rotates the choke valve clockwise to the closed position shown in dotted lines in FIG. 3. The solenoid **74** is connected by a wire **75** to the starter relay circuit controlled by the switch **32**, so that such solenoid **74** is energized concurrently with the starter **26**.

A pair of resistance elements forming heater coils **80** are mounted on an annular disc **82** received between the wall **49** of the chamber **50** and the cover **56**. The two heater coils **80** are interconnected by a mounting eyelet **84** and their outer ends are connected to terminal posts **86** and **88** mounted through the end wall of the cover **56**. As indicated in FIGS. 1 and 2, the heater coils **80** are arranged in series and are connected by a wire **81** directly to one wire **16** of the A.C. output leads from the alternator **10—12**, so that such heater elements are energized directly by the alternator output at all times when, but only when, the engine is running at A.C. generating speed. The coils are isolated from the battery **24** by the rectifier **18**.

It will be noted that the cover **56** for the heater chamber **50** carries the bimetal spring **66** and its entire operating mechanism, including the rockshaft **60—64** which supports the bimetal spring and the arm **70** which determines the angular position of such parts. To provide for adjusting the action of the choke, the cover **56** is desirably mounted in a manner which permits adjustment of its angular position relative to the choke body **40**. To this end, the open end of the cover **56** carries an outward extending flange **90** rotatably engaged in the open end of the chamber wall **49** and retained by three clips **92** held by screws **94** taking into three ears **96** on the wall **49**.

The opposite end of the choke body may carry a manual actuating mechanism as shown in FIGS. 1 and 6. The choke shaft **44** extends outward beyond the end of the body **40** and is provided with a depending pin **98**. An actuating lever **100** is loosely mounted on the choke shaft **44** and carries a crank finger **102** which normally lies well beyond the normal range of movement of the pin **98** during the automatic operation of the choke. A screw **104** mounted through an arcuate slot **106** into the end face of the body **40** serves to limit the angular movement of the lever **100**. A spring **108** surrounding the screw **106** bears against the lever **100** to retain it in manually adjusted position.

Operation of the choke shown in the drawing is as follows:

In such drawing, the parts are shown in the positions they occupy with the engine at rest with the choke mechanism at atmospheric temperature of say 75° F. Under these conditions, choke-valve reaction to air inflow tends to move the parts in choke-decreasing direction, which is counter-clockwise in FIGS. 2, 3, and 4. The armature lever **70** lies counter-clockwise against the stop **72**, and the bimetal spring **66** resiliently holds the choke valve **46** against opening beyond the partially open position shown in FIGS. 3 and 4. When the engine starter is energized, by manual closing of the starter switch **32** to energize the starter relay switch **28**, the closing of the starter switch **32** also energizes the solenoid **74**. This pulls the armature lever **70** clockwise to the dotted line position shown in FIG. 2, against the core **78** of the solenoid, and the lever **70** rotates the rockshaft **60—64** and the bimetal spring **66** clockwise, to move the choke valve **46** to its fully closed position as indicated in dotted lines in FIG. 3. This produces increased choking action necessary for starting under the assumed conditions. When the engine starts under its own power and the starter switch **32** is opened, this de-energizes the solenoid **74** and allows the armature lever **70** to move counter-clockwise in FIG. 2 to its retracted position against the stop **72**. This allows the bimetal spring **66** to rotate counterclockwise back to its position shown in full lines in FIG. 3, and permits the choke valve **46** to move to partially open position. Under running conditions, air inflow through the choke passage **42** tends to open the unbalanced choke valve **46** beyond the partially open position shown, and such further opening is yieldingly opposed by the bimetal spring **66**.

It is characteristic of the conventional alternator or A.C. generator **10—12** that it produces some A.C. output even at idling speeds, and such output is applied across the heater elements **80**. At such idling speeds, the engine and its induction system heat up rather slowly, and correspondingly, the alternator output is relatively low and acts to heat the heater elements **80** to only a low temperature. Part or even most of the low heat output will be dissipated to the choke and carburetor bodies, and the bimetal spring **66** will be only slowly heated. At higher operating speeds, both the alternator output and the consequent heat output of the heater elements **80** will be greater, and the bimetal spring will receive more heat. As the bimetal spring **66** is heated, either slowly or rapidly, it relaxes and winds upon itself to carry its hooked end **68** counter-clockwise in FIG. 3, and this allows the choke valve **46** to move progressively toward fully open position. The rate of bimetal spring response can of course be varied by selecting different spring characteristics, in accordance with known design practices.

The choke body **40** is mounted against the inlet end of the carburetor **38**, in heat transfer relation therewith, and both the carburetor and the choke mechanism will normally be enclosed within a motor housing. Accordingly, the temperature of the choke body and of the bimetallic spring **66** enclosed within its heater chamber **50** will in part depend both upon the temperature of the induction system and upon the general temperature condition of the engine and the engine compartment.

The position of the choke valve at any particular time will correspondingly depend in part on these temperature conditions, as well as on heat output of the heater **80** controlled by the generator.

When the engine is started under elevated-temperature conditions, the choke valve **46** will initially lie at a more open position than that shown in FIG. 3, because of the elevated temperature of the bimetallic spring **66**. When the starter switch **32** is closed and the solenoid **74** is thereby energized, the choke valve **46** will be moved toward closed position through an angle limited by the throw between the fixed stop **72** and the core **78** of the solenoid. The actual angular movement of the choke valve will ordinarily be greater than that throw, however, for the choke arm **44** is not coaxial with the rockshaft **60—64** but is offset upwardly therefrom, and the length of the lever arm (**52**) on the choke shaft is substantially shorter than the effective lever arm formed on the rockshaft **60—64** by the bimetallic spring **66**. Accordingly, a given rotational movement of the armature lever **70** and the bimetallic **66** will produce a greater angular movement of the choke shaft **44** and the choke valve **46**. Moreover, the difference will vary depending upon the initial position of the choke valve, since when the choke valve is more nearly open, the choke actuating finger **52** will be more nearly in line with the direction of offset between the shaft **44** and **64**.

In general, there will be an interchange of heat between that provided by the heater **80** energized by the A.C. alternator output and that deriving from the engine and its induction system. In general, the action will produce in the bimetal spring temperature conditions which parallel the choking needs of the induction system, with the

result that the choke mechanism will automatically provide the amount of choking required under all conditions.

I claim as my invention:

1. An automatic choke mechanism for an internal combustion engine, comprising a body forming an inflow passage, a choke valve having a normal position in which it partially closes said passage and being adapted to be urged in an opening direction by inflow through said passage, a bimetal spring operatively connected to bias said choke in a closing direction, a rock shaft on which said spring is mounted, said shaft having a normal stop position to which it is urged by opening movement of the choke valve, electromagnetic means for rotating said shaft in a valve-closing direction during starting of the internal combustion engine, and electro-resistance means for heating said bimetal spring during running operation of the engine, said bimetal spring relaxing with heat to decrease its valve-closing bias.

2. An automatic choke mechanism as set forth in claim 1 with the addition that said body forms a heating chamber and said bimetal spring and said electro-resistance means are mounted in spaced relation therein.

3. An automatic choke mechanism for an internal combustion engine, comprising a body forming an inflow passage, a choke valve having a normal position in which it partially closes said passage and being adapted to be urged in an opening direction by inflow through said passage, a bimetal spring operatively connected to bias said choke in a closing direction, a rock shaft on which said spring is mounted, said shaft having a normal stop position to which it is urged by opening movement of the choke valve, electromagnetic means for rotating said shaft through a limited angle in a valve-closing direction during starting of the internal combustion engine, and electro-resistance means for heating said bimetal spring during running operation of the engine, said bimetal spring relaxing with heat to decrease its valve-closing bias.

4. An automatic choke as set forth in claim 3 with the addition that said rock shaft is offset from the axis of rotation of said choke valve, and said choke is connected to said bimetal spring by a choke-actuating lever arm which is shorter than the effective lever arm formed by said spring between the rock shaft and choke-actuating lever arm.

5. An automatic choke mechanism for an internal combustion engine, comprising a body forming an inflow passage, a choke valve mounted on a choke shaft extending across said passage and rotatable in valve-opening and valve-closing directions, an operating crank on said shaft, a bimetal spring engaging said crank in a direction to oppose valve-opening movement of said choke shaft, a rock shaft supporting said spring, stop means supporting said rock shaft against movement beyond a predetermined position in its valve-opening direction of movement, an armature lever on said shaft, electromagnetic means for rotating said lever and rock shaft in a valve-closing direction to increase the choking action of said choke valve, and electro-resistance heating means for heating said bimetal spring to relax the same in a direction to permit valve-opening movement of said choke shaft to decrease the choking action thereof.

6. An automatic choke mechanism as set forth in claim 5, in combination with an internal combustion engine having an A.C. generator connected to charge a battery through a rectifier, switch means connected for energizing said electromagnetic means from said battery, and means for energizing said electro-resistance means directly from said generator at a point isolated from said battery by said rectifier.

7. An automatic choke mechanism as set forth in claim 5 with the addition of manual choke-operating means comprising an arm fixed on said choke shaft, a manually operable lever rotatably mounted relative to said choke shaft and having an arm-engaging face, said face normally lying beyond the range of movement of said arm and being movable upon manual rotation of said lever into choke actuating engagement with said arm.

8. An automatic choke mechanism for an internal combustion engine, comprising a choke valve movable between choking and non-choking positions, a choke shaft controlling the position of said valve, a rock shaft in substantially end-to-end relation with said choke shaft, a crank arm on one of said shafts, a bimetal element on the other of said shafts and operatively engaging the crank arm in a direction to oppose choke-decreasing movement of the choke shaft, stop means limiting angular movement of said rock shaft in choke-decreasing direction, and electromagnetic means for rotating said rock shaft in choke-increasing direction, and electro-resistance heater means for heating said bimetal element, said bimetal being constructed and arranged to respond to increased temperature by relaxing in a choke-decreasing direction.

9. An automatic choke mechanism, for an internal combustion engine, comprising a body forming an inflow passage, a choke valve mounted in said passage on a transverse choke shaft, walls on said body forming a chamber into which said choke shaft extends, a rock shaft having an end portion lying in said chamber, a bimetal element on one of said shafts and an arm on the other and interconnecting the same within said chamber to control valve-opening movement of the choke shaft, stop means limiting movement of said rock shaft in a valve-opening direction, means to rotate said rock shaft in a valve-closing direction for increasing the choking action of said choke valve, said bimetal element being operative when heated to relax in a direction to permit valve-opening movement of the choke shaft to decrease the choking action of said choke valve, and electro-resistance means mounted in said chamber for heating said bimetal to cause such relaxing action.

10. An automatic choke mechanism as set forth in claim 9 in which said chamber is closed by a cover removable from said body, and said rock shaft, stop means, and rock shaft rotating means are mounted in said cover.

11. An automatic choke mechanism as set forth in claim 9 in which said chamber is closed by a cover separable from said body at a position intermediate the length of the chamber, and said electro-resistance means is mounted on a mounting plate received between the body and cover.

12. In combination with an internal combustion engine having an electrical system including a battery and an alternator connected to charge the battery through a rectifier, automatic choke means comprising a choke valve movable between choking and non-choking positions, a choke shaft controlling the position of said valve, a bimetal element operatively connected to oppose choke-decreasing movement of said shaft, movable means normally supporting said bimetal element in a predetermined stop position, said bimetal element being constructed and arranged to respond to increased temperature by relaxing in the direction of choke-decreasing movement of said choke shaft, electro-magnetic means connected for energization from said battery to move said movable means and bimetal element in a choke-increasing direction, and electro-resistance heating means connected for energization direct from said alternator ahead of said rectifier for heating said bimetal element to relax the same in choke decreasing direction.

13. The combination set forth in claim 12 with the addition of a switch controlling a starter for said engine, and means connecting said electro-magnetic means for energization concurrently with the starter.

14. In combination with an internal combustion engine having an electrical system including a battery and a charging generator connected to charge the battery through a valve device permitting current flow from the generator to the battery and preventing reverse flow, auto-

matic choke means comprising a choke valve movable between choking and non-choking positions, a choke shaft controlling the position of said valve, a bimetal element operatively connected to oppose choke-decreasing movement of said shaft, movable means normally supporting said bimetal element in a predetermined stop position, said bimetal element being constructed and arranged to respond to increased temperature by relaxing in the direction of choke-decreasing movement of said choke shaft, electromagnetic means connected for energization from

said battery to move said movable means and bimetal element in a choke-increasing direction, and electro-resistance heating means connected for energization direct from said generator ahead of said valve device for heating said bimetal element to relax the same in choke-decreasing directions in response to generator energizing operation of said engine.

No references cited.