July 26, 1966 T. M. BALL ETAL 3,262,683

AUTOMATIC CHOKE

Filed Aug. 2, 1963 2 Sheets-Sheet 1

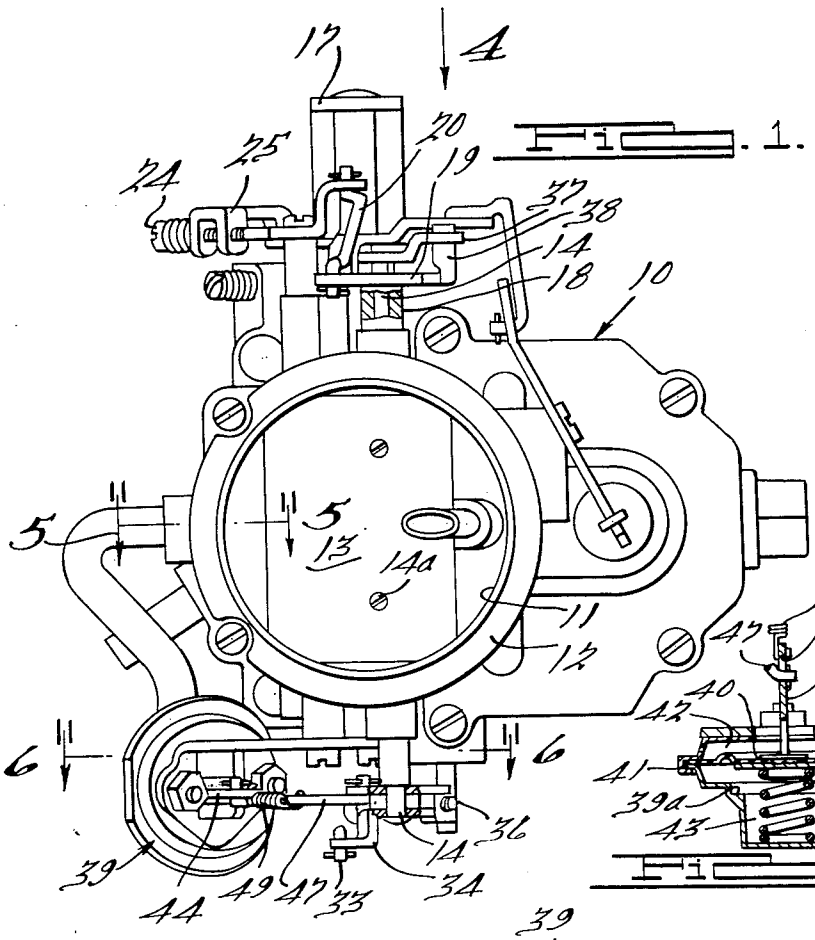
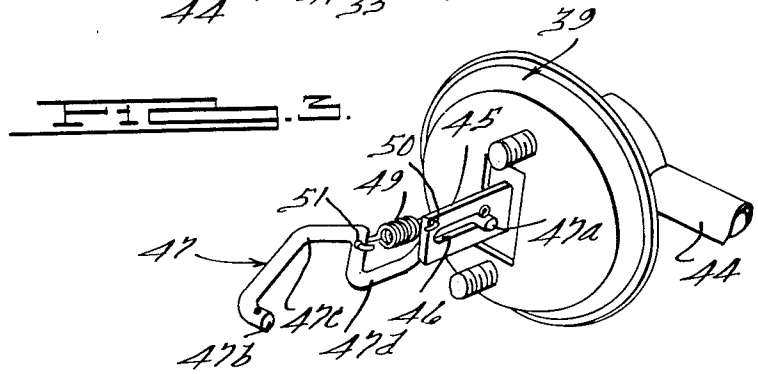


FIG. 1.

FIG. 3.



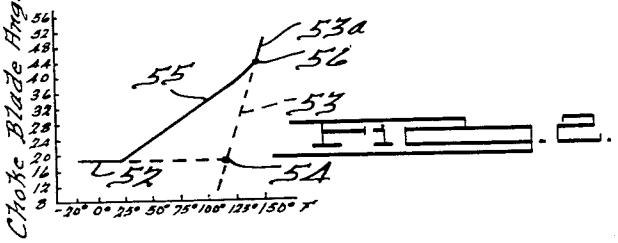


FIG. 2.

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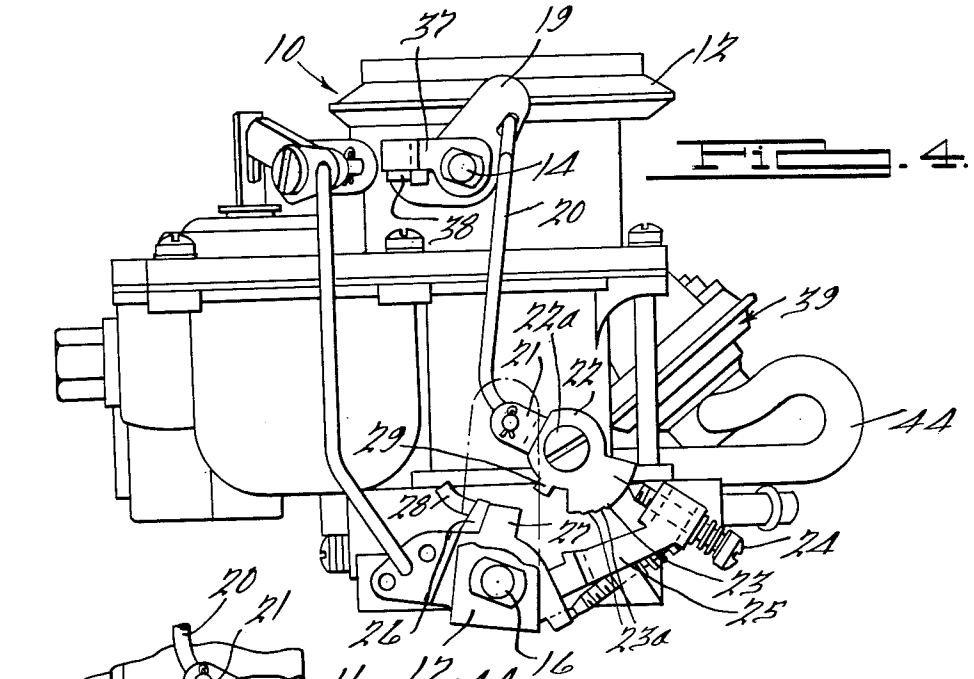


Fig. 4.

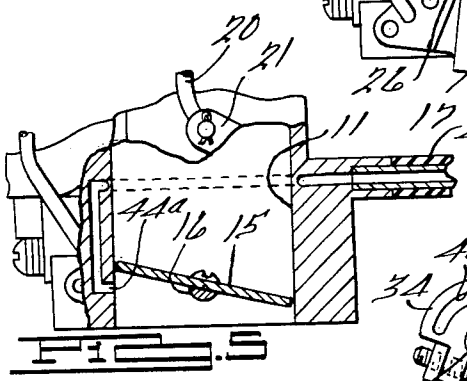


Fig. 5.

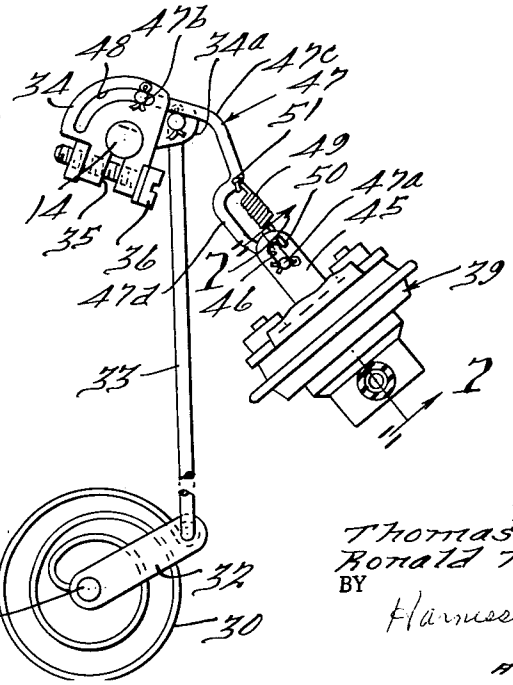


Fig. 6.

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AUTOMATIC CHOKE

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12 Claims. (Cl. 261—39)

This invention relates to improvements in the automatic choke for the carburetor of an internal combustion engine, and in particular to improved means for modulating the temperature and vacuum actuated means which automatically controls the choke during periods of cold idling and engine warmup.

An object of the invention is to provide a low friction choke control which can be readily adjusted to approximately any desired relationship between engine temperature and the extent of choke opening during all operating conditions of the engine including idling and road load operation.

Another object is to provide such a device which is responsive to engine intake manifold pressure yet which is insensitive to operational variations in such pressure.

Other and more specific objects are to provide such a device cooperable with an unbalanced butterfly type choke blade and with a thermostatic choke control means, which latter yieldingly urges the choke blade closed with increasing force as the engine temperature decreases. A diaphragm type pressure responsive means having one side of its diaphragm in communication with the inlet manifold or fuel-air induction passage of the carburetor downstream of the throttle valve is provided with an actuating link secured to the diaphragm to shift therewith. The other side of the diaphragm is in communication with atmospheric pressure, so that during operation of the engine at idling or low load conditions, the diaphragm and link will shift to a limit of movement referred to herein as an actuated position.

A movement limiting slot provided in the actuating link extends parallel to the direction of movement of the diaphragm and link to the actuated position and contains one end of a second link having its other end connected to a crank arm of the choke blade shaft to open the choke blade in accordance with movement of the diaphragm toward the actuated position. The movement limiting slot is dimensioned so that upon movement of the diaphragm and first named link to the actuated position when the engine is cold and opening of the choke blade is resisted by the temperature responsive means, said one end of the second link will bottom against one end of the slot and be pulled to open the choke blade at least to a minimum cold idling or kick position.

In order to increase the choke opening as increasing engine temperature relaxes the temperature responsive force urging the choke blade to its closed position, a modulating coil spring is connected under tension between the first and second links to urge said one end of the second link in a choke opening movement until said one end bottoms against the other end of the movement limiting slot. By suitably determining the tension in the coil spring, the length of the movement limiting slot, and the closing force exerted by the temperature responsive means, any desired relationship between the extent of the choke opening and engine temperature can be approximated.

In the above regard, the two links are arranged substantially in linear alignment with each other and with the movement limiting slot which extends perpendicularly to the diaphragm. The coil spring is also stretched with its axis in alignment with the slot. By this arrangement, frictional interaction is minimized, especially any

scissors-type frictional engagement or bearing load which would otherwise hinder the usefulness of the device in consequence of the comparatively small actuating forces involved.

The size of the diaphragm is determined in accordance with the choke closing force of the temperature responsive means to shift the diaphragm and first link to the actuated position whenever the manifold pressure downstream of the throttle valve falls a predetermined amount below the manifold pressure which normally exists during engine cranking. This latter condition is essential in order to prevent pulsating opening of the choke blade during cranking. After the engine is started, the manifold pressure will be at a minimum during idling and will cause the diaphragm to snap immediately to the actuated position in opposition to the temperature responsive means regardless of the engine temperature. As the engine load increases toward wide open throttle conditions, the manifold pressure will rise so that the manifold vacuum alone may not be sufficient to hold the choke open to the kick position. By this time, however, the increased air flow in the induction passage impinging on the unbalanced choke blade will add sufficient choke opening force to overcome the temperature responsive means and maintain the choke open at least to the kick position. Thus once the engine starts, the choke will remain open at least to the kick position, regardless of the ambient temperature.

The spring modulation described enables elimination of the piston type pressure responsive choke actuator and the substitution of the more economical and trouble free diaphragm type actuator. Heretofore this piston type actuator, which was subject to severe frictional problems and tended to become gummed by the residue of fuel vapors was required because it was susceptible of staged porting, whereby various choke positions could be readily obtained with different conditions of engine load and temperature. Such conditions are now readily obtained by the spring modulated diaphragm type choke actuating device described herein.

Another object is to form the second link of comparatively heavy rigid wire stock and to provide an open loop or U-shaped bend therein preferably at a location between its attachment with the crank arm and modulating spring, where such a spring is employed. By suitably increasing or decreasing the opening of the loop, the extent of choke opening at the kick position can be readily adjusted. Thus means are readily provided for accommodating the numerous tolerances in the linkage and for effecting a final preferred setting for the choke blade at the kick position.

The structure described including the U-shaped bend in the wire link is desirable to provide simple means for adjusting the extent of choke opening at the kick position if some other arrangement of the modulating spring is employed, or even if no modulating spring is employed.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

FIGURE 1 is a plan view of a carburetor embodying the present invention.

FIGURE 2 is a graph showing the relationship between the choke blade angle and temperature during engine idling conditions.

FIGURE 3 is an isometric view of the vacuum actuated device and connecting linkage embodying the present invention.

FIGURE 4 is a side elevational view taken in the direction of the arrow 4 of FIGURE 1.

FIGURE 5 is a fragmentary sectional view taken in

the direction of the arrows along the line 5—5 of FIGURE 1.

FIGURE 6 is a view showing the relationship between the thermostat and vacuum pressure operated device and the choke shaft, taken in the direction of the arrows substantially along the line 6—6 of FIGURE 1.

FIGURE 7 is a sectional view taken substantially in the direction of the arrows along the line 7—7 of FIGURE 6.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings a particular embodiment of the present invention is illustrated by way of example in a carburetor **10** having a vertical induction conduit **11** which opens upwardly to receive combustion supporting air. Fuel is admixed with the air in the carburetor in accordance with conventional practice and discharged at the lower or throttle end.

The upper end of the carburetor provides the usual air horn ring **12** for attachment with an air filter. Slightly below the ring **12** is a horizontally extending unbalenced choke blade or valve **13** secured by screws **14***a* to a choke shaft **14** journalled in the body of the carburetor **10** at opposite sides of the induction conduit or passage **11**. As illustrated in FIGURES 1 and 4, the shaft **14** is offset slightly from the diameter of the passage **11**, so that a major portion of the choke blade **13** will be leftward of the shaft **14** in FIGURE 1. In consequence, the unbalanced choke blade **13** is susceptible of being blown to an open position by the air flow through the passage **11** when the engine is under load or cruising conditions. Referring to FIGURE 5, the throttle valve **15** is mounted on a pivotal shaft **16** journalled in the carburetor body at opposite sides of the passage **11** and is actuated by a manually operated throttle lever **17** to control the fuel-air flow in the passage **11** to the engine.

A bushing **18** is pivotally mounted on an extension of choke shaft **14** and is secured to thermostatically controlled crank arm **19** for pivoting as a unit therewith. A connecting link **20** is pivotally connected at its upper and lower ends respectively to crank arm **19** and to the swinging arm **21** of a fast idle cam lever **22** having an arcuate cam surface **23** concentric with the axis of a pivot stud **22***a* on which the lever **22** is pivoted. Extending clockwise from the cam surface **23** in FIGURE 4 is a series of radially inwardly stepped arcuate cam surfaces **23***a*. An adjustable cam follower screw **24** extends radially toward the cam surfaces **23** and **23***a* to ride therealong upon pivoting of the cam lever **22** and is supported by a swinging arm **25** pivoted on an extension of throttle shaft **16**. Integral with the lever **25** is a stop portion **26** which engages a mating stop **27** integral with the throttle lever **17**. Thus upon counter-clockwise or closing movement of throttle lever **17**, its stop **27** will engage stop **26** to swing the latter and lever **25** counter-clockwise. Then if the engine is operating below a predetermined temperature, follower **24** will engage the appropriate surface of the cam portions **23**, **23***a* to limit closing of the throttle blade **15** at a corresponding fast idle position.

Also integral with throttle lever **17** is an unloader lever **28** engageable upon clockwise or opening movement of throttle valve **15** in FIGURE 4 with a mating lever **29** of fast idle cam **22** so as to swing the latter counter-clockwise and thereby swing crank arm **19** and choke blade **13** downwardly to an open position (to open choke valve **13** as described below) to facilitate the exhaustion of unburned fuel from the passage **11** and engine cylinder in accordance with customary practice.

A bi-metalic thermostat or temperature responsive spring **30** is suitably located in juxaposition with a portion of the engine to sense the temperature thereof and is secured at one end to a stud **31** carried by the engine. A crank arm **32** pivots on stud **31** and is secured at its outer swinging end to the lower end of a connecting link **33**. The upper end of link **33** is pivotally connected to an arm **34***a* of a U-shaped lever **34** suitably secured to an extension of choke shaft **14** to pivot therewith. In the present instance the lever **34** is provided with a slot **35** extending radially toward shaft **14** and is tightly clamped to the latter by means of a screw **36** which draws opposite sides of slot **35** toward each other. Keyed to an extension of choke shaft **14** outwardly of crank arm **19** is a choke actuating lever **37** which overlies in FIGURE 4 the clockwise edge of a stop **38** integral with arm **19**. Thus upon clockwise swinging of arm **19** in FIGURE 4, stop **38** will engage lever **37** and swing the latter and choke blade **13** clockwise to an open position.

In operation of the device described thus far, the crank arm **19** and fast idle cam **22** are weighted to swing the latter counter-clockwise to a choke open or warm idle position. When the engine is cold, thermostatic spring **30** operates to swing arm **32** counter-clockwise in FIGURE 6 and thereby to swing lever **34** and choke blade **13** counter-clockwise to the closed position with increasing force as the temperature decreases. Conversely, as the temperature operating on spring **30** increases, the counter-clockwise closing force on choke blade **13** decreases. As choke blade **13** and shaft **14** are pivoted counter-clockwise to the cold position by thermostatic spring **30**, actuating lever **37** keyed to choke shaft **14** will swing into contact with stop **38** and cause counter-clockwise swinging of pivot arm **19**, thereby to elevate link **20** and swing the fast idle cam **22** clockwise to its cold position illustrated in FIGURE 4.

In order to open choke blade **13** to a predetermined position when the engine is idling, a vacuum actuated device is provided comprising a sheet metal housing **39**, FIGURE 7, containing a flexible diaphragm **40** securely clamped around its peripheral edge **41** to partition housing **39** into a first chamber **42** open to the atmosphere and a second or vacuum chamber **43** connected by means of conduit **44** with induction passage **11** at port **44***a* downstream of the throttle valve **15**, FIGURE 5.

A link or plunger **45** is suitably secured centrally to diaphragm **40** and extends upward and leftward therefrom, FIGURE 6. The left or outer end of plunger **45** is provided with a lost motion slot **46** within which rides one end **47***a* of a connecting link **47**. The opposite end **47***b* of link **47** extends parallel to end **47***a* and rides in an arcuate slot **48** in lever **34** concentric with choke shaft **14**. Thus during operation of the engine under load, the unbalanced choke blade **13** is free to swing clockwise to its fully open position independently of the position of link **47**. When the choke blade **13** is closed, the link end **47***b* will be at the most clockwise edge of slot **48**, FIGURE 6, so that upon vacuum operation of links **45** and **47** as described below, lever **34** and choke blade **13** will be swung clockwise against the force of thermostatic spring **30** to a predetermined partially opened position.

In order to modulate the opening of the choke blade **13**, a spring **49** is connected at one end **50** with the left end of link **45** and is connected at its opposite end at **51** with link **47**. In this regard, the link **47** loops at **47***d* around spring **49** in FIGURE 6 so that the modulating spring **49** is feasibly arranged in substantially linear alignment with link ends **47***a* and **47***b*.

By the arrangement shown, modulating spring **49** urges and **47***a* against the inner end of movement limiting slot **46** proximate housing **39**, FIGURE 6. When the engine is being cranked in a cold condition and choke blade **13** is closed, the low pressure downstream of throttle valve **15** will be nominal and will be insufficient to actuate diaphragm **40** against the tension of spring **49**. Also in

order to prevent movement of diaphragm **40** from its inactive position shown in FIGURE 7 during cranking, biasing spring **40***a* is preferably provided between diaphragm **40** and the base of chamber **43**. Accordingly pulsating opening movement of the choke blade **13** is avoided during the cranking operation. As soon as the engine is idling however, the low pressure downstream of throttle **15** will be at a maximum and will be transmitted to chamber **43** to urge diaphragm **40** rightward or downward in FIGURE 7 and to pull link **45** inwardly of housing **39**. If the engine temperature is sufficiently cold, the force of thermostatic spring **30** urging the choke valve closed will be sufficient to maintain the latter closed against the tension of spring **49** as the latter is stretched upon the aforesaid inward movement of link **45**. Accordingly link end **47***a* will ride to the top or outer end of slot **46** upon inward movement of link **45**. When the outer end of slot **46** engages link end **47***a*, link **47** will be pulled downward in FIGURE 6 upon the continued rightward movement of diaphragm **40**.

The limit of movement of diaphragm **40** known as the "kick" position is determined by abutment between the base of diaphragm **40** and a shoulder **39***a* of housing **39**. At the kick position, link **47** will have pivoted link **34** and choke blade **13** to a predetermined open position regardless of the engine temperature. Thereafter, as the engine temperature progressively increases, modulating spring **49** will urge link **47** downwardly or inwardly in FIGURE 6, thereby to progressively open choke valve **13** by swinging lever **34** clockwise until link end **47***a* bottoms against the inner end of slot **46**.

It is to be noted in the above regard that the modulated opening of choke valve **13** in response to spring **49** is insensitive to variations in the vacuum pressure downstream of the throttle valve **15**. During cranking, the vacuum force downstream of throttle valve **15** will be insufficient to actuate the diaphragm **40**. At lower pressures, the diaphragm **40** will move to its limiting or kick position. Thus when the engine is idling and the vacuum force is at a maximum, the diaphragm **40** will be moved to the kick position. Thereafter as the engine load increases and the vacuum force downstream of the throttle decreases, the increased air flow in the induction conduit **11** will be effective to blow the unbalanced choke blade **13** beyond the kick position and eventually to the fully open position at high engine loads.

Referring to FIGURE 2, the horizontal line **52** represents the extent of opening of the choke blade angle at the kick position. In one type of engine, this angle of opening is approximately 19 degrees. If it were not for the modulating spring **49**, the thermostatic spring **30** would hold choke blade **13** at the kick position during engine idling until the thermostatic spring relaxed sufficiently with increasing temperature to enable further opening. The thermostatic spring **30** is necessarily comparatively strong in order to maintain the choke closed during engine cranking.

The angle of choke opening that would be permitted by the thermostatic spring **30** with increasing temperature is indicated by dotted line **53** which intersects line **52** at **54**. If the thermostatic spring **30** only were used, it would be necessary for the engine to warm to well over 100° F. before the choke blade would open beyond the kick position.

By virtue of the modulating spring **49**, this spring can be adapted to enable continued opening of the choke blade beyond the kick position at a temperature of approximately 24° F. The relationship between the choke blade opening and temperature resulting from modulating spring **49** is indicated by line **55** in FIGURE 2. This line intersects line **53** at point **56**, which indicates the point whereat link end **47***a* bottoms against the inner end of slot **46**, FIGURE 6. Thereafter continued opening of the choke blade **13** will be determined by thermostatic spring **30** as indicated by line **53***a* comprising an extension of line **53** in FIGURE 2.

In order to facilitate adjustment of the initial tension in spring **49**, link **47** is formed from comparatively heavy wire stock and is provided with elbow bends **47***c* and **47***d*. By opening or closing the one or the other of the loops formed by the elbow bends **47***c* and **47***d*, either the initial tension of spring **49** is adjusted or the position of end **47***b* is adjusted in slot **48** to accommodate the stack-up of tolerances in the various operating linkages, thereby to provide ready means for calibrating the carburetor for any predetermined desired operating condition. Also by virtue of the alignment of the axis of coil spring **49** with the ends **47***a* and **47***b* of link **47**, no side loading between these ends and the sides of slots **46** and **48** will result. Ideally, the ends **47***a* and **47***b* would not move transversely of their respective slots even if links **45** and **34** were removed. Accordingly, frictional resistance in the coupling is minimized.

We claim:

1. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging said choke valve to a closed position with progressively increasing force in response to progressively decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being shiftable to an actuated position in response to said pressure during predetermined operation of said engine, means for opening said choke valve to a predetermined position in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, and means for yieldingly urging additional opening of said choke valve in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including resilient means operatively connecting said pressure responsive means and connecting means.

2. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging said choke valve with increasing force to a closed position with decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being shiftable to an actuated position when said pressure is at a predetermined pressure below the pressure that exists in said passage during cranking of said engine, means for opening said choke valve to a predetermined position in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, and means for yieldingly urging additional opening of said choke valve in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including resilient means operatively connecting said pressure responsive means and connecting means.

3. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging closing of said choke valve with increasing force upon decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being shiftable to an actuated position in response to said pressure during predetermined operation of said engine, means for opening said choke valve to a predetermined position in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connect-

ing said pressure responsive means and choke valve, and means for yieldingly urging additional opening of said choke valve in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including resilient means operatively connecting said pressure responsive means and connecting means, said pressure responsive means having a first link shiftable substantially linearly in one direction upon shifting of said pressure responsive means to said actuated position, said first link having a movement limiting slot extending therein substantially parallel to said direction and terminating oppositely from said direction at one end, said connecting means including a second link having a portion movable in said movement limiting slot and engageable with said one end to be shifted in said one direction upon movement of said pressure responsive means to said actuated position, said resilient means interconnecting said first and second links and being aligned with said slot to urge said second link substantially linearly in said one direction.

4. In the combination according to claim 3, said pressure responsive means including a pressure responsive diaphragm having said first link secured thereto and extending substantially perpendicularly to said slot, and also including a conduit connecting one side of said diaphragm with said passage at a location downstream of said throttle valve.

5. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging said choke valve with increasing force to a closed position; with decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being shiftable to an actuated position in response to said pressure during predetermined operation of said engine, means for opening said choke valve to a predetermined position in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, and means for yieldingly urging additional opening of said choke valve in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including resilient means operatively connecting said pressure responsive means and connecting means, said choke valve comprising an unbalanced butterfly blade adapted to be opened in opposition to said temperature responsive means by the air flow in said passage during operation of said engine at greater than idling speed, said pressure responsive means being cooperable with the air flow in said passage to open said choke valve at least to said predetermined position during operation of said engine at idle and greater speeds.

6. In the combination according to claim 5, said pressure responsive means having a first link shiftable substantially linearly in one direction upon shifting of said pressure responsive means to said actuated position, said first link having a movement limiting slot extending therein substantially parallel to said direction and terminating oppositely from said direction at one end, said connecting means including a second link having a portion movable in said movement limiting slot and engageable with said one end to be shifted in said one direction upon movement of said pressure responsive means to said actuated position, said resilient means interconnecting said first and second links and being aligned with said slot to urge said second link substantially linearly in said one direction.

7. In the combination according to claim 6, said pressure responsive means including a pressure responsive diaphragm having said first link secured thereto and extending substantially perpendicularly to said slot, and also including a conduit connecting one side of said diaphragm with said passage at a location downstream of said throttle valve.

8. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging closing of said choke valve with increasing force upon decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being shiftable to an actuated position in response to said pressure during predetermined operation of said engine, means for opening said choke valve to a predetermined position in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, and means for yieldingly urging additional opening of said choke valve in opposition to said temperature responsive means upon shifting of said pressure responsive means to said actuated position including resilient means operatively connecting said pressure responsive means and connecting means, said pressure responsive means having a first link shiftable substantially linearly in one direction upon shifting of said pressure responsive means to said actuated position, said connecting means including a second link, said connecting means including lost motion means interconnecting said first and second links and including a movement limiting slot in one of said links extending substantially parallel to said direction, said movement limiting means including a portion engageable with an end of said slot to shift said second link in said one direction upon movement of said pressure responsive means to said actuated position, said resilient means interconnecting said first and second links and being aligned with said slot to urge said second link substantially linearly in said one direction.

9. In the combination according to claim 8, said second link comprising comparatively rigid bendable stock having an open loop therein at a location on the choke valve side of the attachment between said second link and said resilient means, said second link being bendable at said loop to adjust the extent of opening of said choke valve at said predetermined position when said pressure responsive means is shifted to said actuated position.

10. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means having a portion operatively connected with said choke valve for moving in unison therewith upon opening of the latter and for yieldingly urging said choke valve with increasing force to a closed position with decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being responsive to said pressure for shifting to an actuated position during predetermined operation of said engine, means for opening said choke valve to a predetermined position in opposition to the force of said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, said connecting means having lost motion means for enabling additional opening of said choke valve independently of said pressure actuated means at said actuated position, and means for yieldingly urging said additional opening in opposition to said temperature responsive means including resilient means connecting said pressure actuated means and connecting means.

11. In a carburetor for an internal combustion engine, an air induction passage, a choke valve and a throttle valve in said passage, temperature responsive means for yieldingly urging said choke valve with increasing force to a closed position with decreasing temperature, pressure responsive means in communication with the pressure in said passage downstream of said throttle valve and being

responsive to said pressure for shifting to an actuated position when said pressure is at a predetermined value below the pressure that exists in said passage during cranking of said engine, means for opening said choke valve to a predetermined position in opposition to the force of said temperature responsive means upon shifting of said pressure responsive means to said actuated position including connecting means operatively connecting said pressure responsive means and choke valve, said connecting means having limited lost motion means for enabling limited movement of said pressure responsive means towards said actuated position independently of said choke valve, and second means for urging opening of said choke valve against the force of said temperature responsive means comprising resilient means operatively connected with said pressure actuated means and choke valve for transmitting to the latter the pressure force urging said limited movement of said pressure actuated means.

12. In the combination according to claim 11, said connecting means including a link of comparatively rigid bendable stock having an open loop therein adjustably deformable to adjust the extent of opening of said choke valve at said predetermined position when said pressure responsive means is at said actuated position.

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