Feb. 1, 1949. E. L. HALL 2,460,693

SEQUENCE CONTROL MECHANISM

Filed May 13, 1947 2 Sheets-Sheet 1

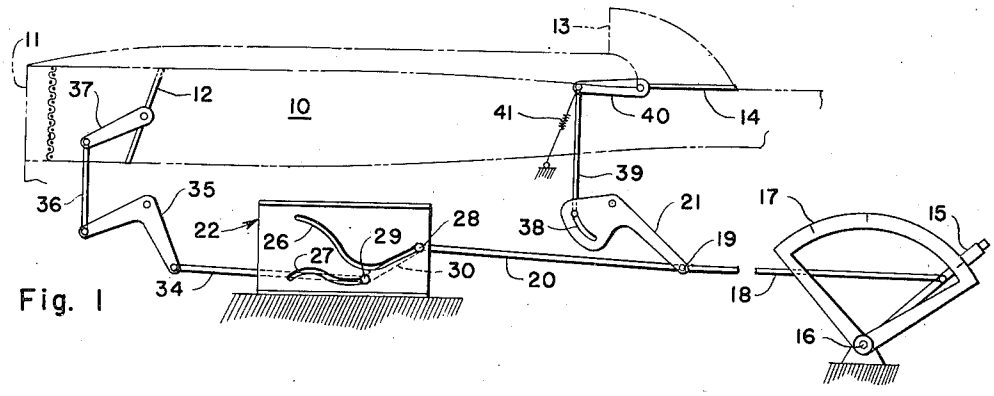

Fig. 1

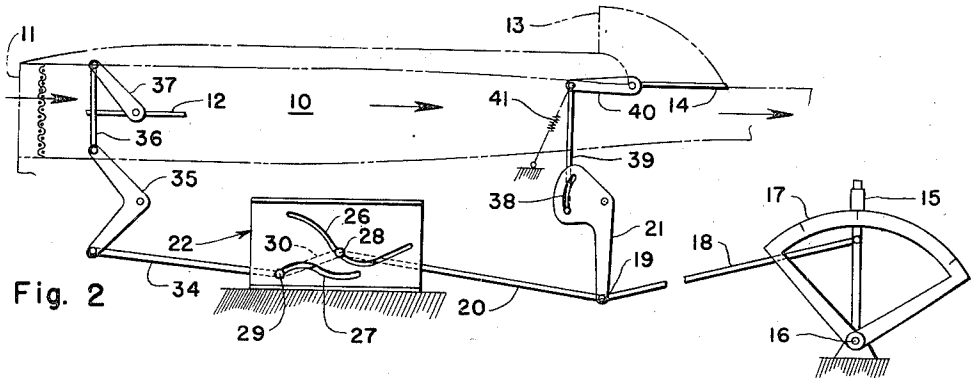

Fig. 2

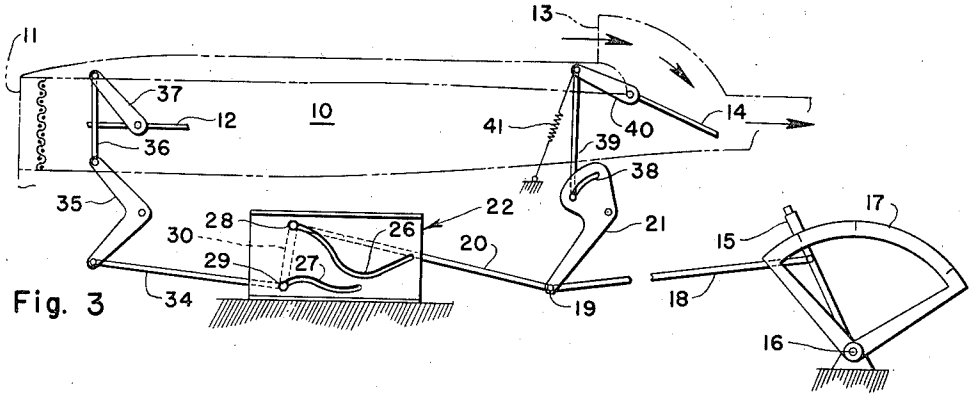

Fig. 3

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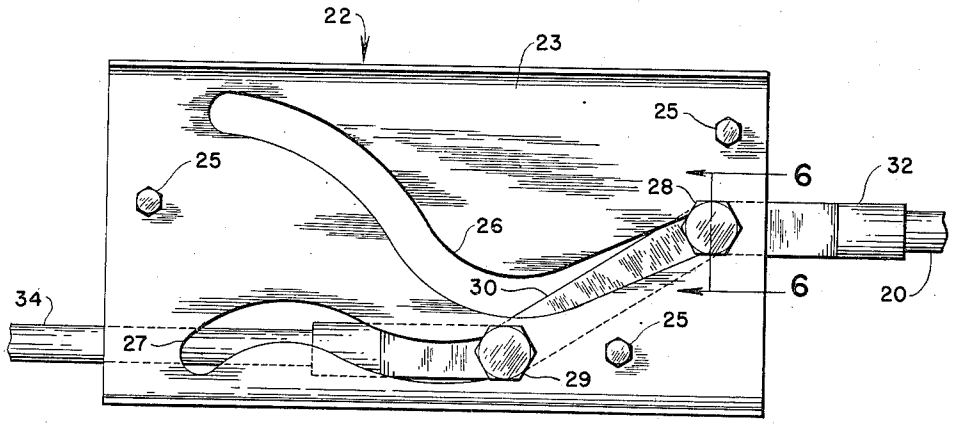

Fig. 4

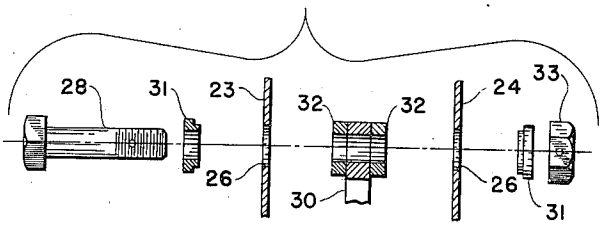

Fig. 6

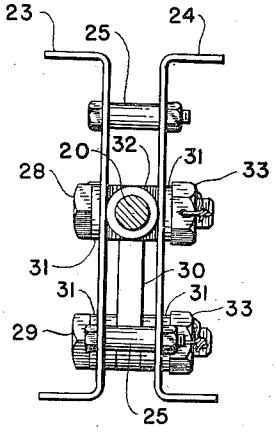

Fig. 5

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UNITED STATES PATENT OFFICE

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SEQUENCE CONTROL MECHANISM

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8 Claims. (Cl. 74—471)

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The present invention relates generally to control means and more particularly to improved arrangements and mechanisms for the selectively controlled operation of a plurality of devices in a predetermined sequence by a single control means.

It is frequently desirable that several related devices or instrumentalities be operated selectively at different times in a prearranged sequence and in which the setting of one or more of the devices may be overridden. In such instances it is also advantageous, particularly in the operation of aircraft, that the mechanism for accomplishing these operations be made as simple and foolproof as possible, that it preferably be operated by a single manual control means and that it be automatic and irreversible in its action in order to prevent disturbance of the positions to which the several devices have been set. The present invention relates to improvements in such overriding and sequence mechanism by which the selective and sequential operation of a plurality of movable members having a definite interrelationship, is simply and expeditiously accomplished by an improved means. This invention is particularly adapted to those installation, such as in the cold air intake system for a carburetor, where it is desirable to provide an intake gate or valve which is normally opened by the initial movement of a control member and a second auxiliary gate which is operable through the second stage of the movement of the control member without further movement of the first gate. A further arrangement is that which utilizes a normally open cold air intake door which is closed through the initial movement and a secondary door (such as is frequently provided in aircraft to draw air through a filter or from within the cowling to offset icing conditions) opened by the further movement of the control member.

It is accordingly a major object of the present invention to provide an improved operating system and mechanism by which a plurality of instrumentalities may be selectively controlled in a desired sequence by a single control member. It is a further object to provide an improved overriding and sequence mechanism of a unitary construction which is adapted to be readily connected to a control system having the present requirements. It is also an object to provide a simple and foolproof means for operating automatically, and in the proper sequence, a plurality of members by means of a single manual control. Another object of the invention resides in the provision of a unitary overriding and sequence mechanism which is automatically and positively locked in certain of its positions to provide irreversibility of the connected operating mechanism and the devices which are operated thereby.

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It is a further object to provide an overriding and sequence mechanism of the type described provided with guide slots having improved contours by which back pressure on the mechanism cannot effect a displacement of any of its parts. It is also an object to provide a unitary mechanism of the type described which can be readily installed and connected to the respective devices to be operated with a positive action and in a predetermined sequence. A further object resides in the provision of an improved arrangement in the application of the present overriding and sequence mechanism to the air intake system of an engine carburetor.

Other forms and advantages of the present invention will occur to those skilled in the art after a reading of this description taken together with the accompanying drawings, forming a part hereof, in which:

Fig. 1 is a diagrammatic view of a preferred form of the present overriding and sequence mechanism as applied to the control gates of a carburetor air intake system showing both gates in the closed position;

Fig. 2 is a similar view of the mechanism of Fig. 1, with the main gate opened;

Fig. 3 is a similar view of the mechanism shown in Figs. 1 and 2, with both the main and auxiliary gates opened;

Fig. 4 is an enlarged side elevational view of the unitary overriding and sequence mechanism;

Fig. 5 is an end elevational view of the mechanism of Fig. 4; and

Fig. 6 is an exploded view of one of the sliding pins shown in the mechanism of Figs. 4 and 5, as taken at 6—6 in Fig. 4.

Referring now to Figs. 1, 2 and 3, the numeral 10 indicates the fresh air intake duct such as may be used in conjunction with the carburetor of an aircraft engine. The duct 10 is provided with a screened main air intake or inlet 11 which preferably faces forwardly in the direction in which the aircraft travels, in order to be addresed to the airstream. The main inlet portion of the duct is controlled by a main gate or butterfly valve 12 suitably mounted upon the adjacent structure for pivotation about its mid-portion.

To the rear of the duct 10, there is preferably provided an auxiliary or emergency intake 13 which is controlled by the pivotally mounted gate

or flap valve 14. In this duct installation it is possible to provide an air intake gate 12 which can be opened by the initial movement of a control member 15 in the cockpit of the airplane, and the further auxiliary air intake gate 14 which is operable through the second stage of the movement of the same control member 15 in the airplane cockpit. It will be understood, however, that the improved overriding and the sequence mechanism of the present invention, while particularly adapted to the operation of the air intake gates shown, is equally applicable to the operation of other devices.

The control lever 15 is pivotally mounted in the cockpit of the aircraft convenient to the operator or pilot for rotation about the axis of the pivot 16, and for movement along the control segment or quadrant 17, fixedly supported from the aircraft structure. To the control lever 15, there is pivotally connected a push-pull operating rod 18, which is pivotally attached at its other terminal 19 to an arm of a lost motion lever 21 pivotally mounted upon the aircraft structure. A further push-pull rod 20 is connected to the pivot 19 connecting the rod 18 with the arm of the lever 21, and the opposite terminal of the push-pull rod 20 is connected to the overriding and sequence mechanism unit 22.

Referring now more particularly to the details of the overriding and sequence mechanism shown in Figs. 4, 5 and 6, this unit is preferably comprised of a pair of spaced channel elements 23 and 24, in a back-to-back relationship with a plurality of spacing bolts and washers 25 attached to the separated webs of the respective channel sections. The webs of the channels 23 and 24 are each provided with upper curved cam guide slots 26 and lower guide slots 27 of somewhat shorter length. It will be noted that the upper and longer slots 26 start appreciably to the right or prior to the beginning of the lower slot 27, with a relatively straight inclined portion beginning slightly above the mid-height of the channels and sloping downwardly generally toward the middle of the lower slots. The remaining portions of each of the upper and lower slots are substantially similar in curvature, but vary in their general direction. Each of the remaining corresponding portions of the slots may be said to be sinusoidal, or of S-shape in curvature, with the upper slots 26 slightly flatter or straighter than the lower slots 27. The lower slots extend generally in a horizontal direction, or parallel to the longitudinal axis of the channel supports, starting to curve slightly downwardly from the beginning position of the pin at the right hand ends of the slots, swinging upwardly past their mid-portions and then downwardly again toward their terminal positions at the opposite ends.

The push-pull operating rod 20 is provided with an apertured and bifurcated clevis terminal 32 through which the pin bolt 28 is adapted to be passed. The diameter of the pin bolt 28 is such that the shouldered washers 31 are adapted to fit freely thereupon and to have their shouldered portions engaged within the upper slots 26 in the channels 23 and 24. The washers 31 are rotatable upon the pin 28 and engage the channels 23 and 24 from the outside, while the clevis terminal 32 of the operating push-pull rod 20 is arranged to slidingly fit freely between the webs of the channels. The pin bolt 28 is suitably threaded to receive the nut 33 which backs up the washer 31 on the far side of the mechanism and this nut is suitably wired through apertures

in the nut and the bolt to lock the same securely together. The clevis terminal 32 is adapted to embrace the bar link 30 which is apertured at its upper and lower terminals to receive the pin bolt assemblies 28 and 29, respectively. The lower pin bolt 29 is similarly arranged to slide within the cam slots 27 and is similarly attached to a like clevis terminal mounted upon the end of the push-pull rod 34. It will accordingly be noted that pressure exerted upon the rod 20 toward the overriding mechanism 22 will cause the pin 28 to move downwardly and forwardly within the initial portion of the cam slots 26, and the link 30 will serve to maintain the spacing between the centers of the pin bolts 28 and 29 by causing the latter to move forwardly in a generally horizontal direction, moving the rod 34 in the same direction.

This push-pull rod 34 is pivotally connected at its forward terminal to the lower arm of the bell crank 35 which is pivotally mounted upon the aircraft structure. The upper arm of the bell crank 35 is pivotally connected directly to the vertical link 36, which in turn is pivotally connected to the outer terminal of the operating lever 37 for the main control gate 12. Unlike the lost motion lever 21 for the auxiliary gate 14, the bell crank 35 does not have a lost motion slot corresponding to the slot 38 in the lever 21, but the link 36 is directly pivoted thereto. The main control gate 12 is accordingly adapted to be rotated through somewhat less than a right angle as the lower pin 29 moves from the rear position shown in Fig. 1 to the forward position shown in Fig. 2; and as the upper pin bolt 28 is continued to the end of the slots 26, the link 30 is rotated about the axis of the lower pin 29, which remains in the same position and accordingly no further rotational movement is translated to the main control gate 12 during this half of the forward movement of the lever 15.

The lost motion lever 21 pivotally connected at 19 to the push-pull rods 18 and 20 is pivotally mounted for rotation upon the aircraft structure and is provided in its upper portion with the lost motion slot 38 arcuately formed with respect to the lever pivot. A link 39 having a pin portion at its lower terminal engageable with the lost motion slot 38 is pivotally connected at its upper terminal to the outer extremity of a further lever 40. This lever 40 is connected to the pivot for the auxiliary control gate 14 in such manner that its rotation, by vertical movement of the link 39, causes similar movement of the auxiliary gate 14. The outer extremity of the lever arm 40 has connected to it a tension spring 41, which is anchored to fixed structure at its opposite terminal, and continually urges the lever 40 and the attached gate 14 into the closed position of the auxiliary intake 13.

The operation of the overriding and sequence mechanism of the present invention is as follows. Referring again to Fig. 1, it will be noted that both the main inlet 11 and the auxiliary inlet 13 are closed by the control gates 12 and 14, respectively. For this condition of the air intake inlets, the control lever 15 is in its rearmost position with respect to the quadrant 17. Assuming now that it is desired to open the main control gate 12 without movement of the auxiliary gate 14, the control lever 15 is moved forwardly about the axis of pivot 16, moving the push-pull rods 18 and 20 in the same forward direction. During this angular movement of the lever 15, the lost motion lever 21 is correspondingly rotated due to its pivotal connection 19 with the push-pull rod 18.

Inasmuch, however, as the pivotal connection of the link 39 in the operating mechanism for the auxiliary control gate 14 is free to move through the lost motion slot 38 in the lever 21, no corresponding movement is imparted to the link 39, the lever 40 or the auxiliary gate 14, by this forward movement of the control lever 15.

This initial forward movement of the push-pull rod 20 causes the attached pin 28 to move to the mid-portion of the upper cam slots 26 as shown in Fig. 2, and through the medium of the link 30 the lower pin 29 is caused to move forward to the end of the lower slots 27. In doing so, however, it imparts similar forward movement to the rod 34, causing corresponding rotation of the bell crank 35, and through the link 36 imparts rotation to the lever 37. This causes the main control gate 12 to be rotated into its fully opened position as shown in Fig. 2. During this portion of the travel of the pin bolts 28 and 29, the interconnecting link 30 moves forward, without appreciable change in the angle of its forward and downward slope from the pin 28 to the pin 29. This angle is slightly steeper than the initial portion of the upper slots 26 through which the pin 28 is moved forward during the early part of this portion of its movement. The quadrant 17 may be suitably marked to indicate the extent to which the main gate 12 has been opened. In this position the mechanism is irreversible and rearward forces upon the rod would not disturb the position of the pins 28 and 29 due to the wedging effect of the upper slots 26.

Let us now assume that the volume of air being taken through the main entrance 11 of the duct, with the main control gate 12 in its fully opened position, is insufficient for the requirements of the carburetor or engine due possibly to the mouth of the duct being clogged with ice, or for other reasons, and it is desired that this volume of air be augmented by flow through the auxiliary entrance 13, as controlled by the auxiliary gate 14. This may be accomplished by further forward movement of the hand lever 15 about its pivot 16 by which corresponding movement is transmitted to the push-pull rod 18 which rotates the lever 21 about its pivot. Since the end of the link 39 has already reached the end of the lost motion slot 38, as indicated in Fig. 2, the rotation of the lever 21 is now positively transmitted without any lost motion to the link 39 and the lever 40, and the auxiliary control gate 14 is caused to be opened against the opposition of the tension spring 41. During this movement of the lever 15 and corresponding rotation of the levers 21 and 40 and the gate 14, the push-pull rod 20 causes continued forward and upward movement of the pin bolt 28 along the guide tracks 26. As the guide tracks 26 and 27 extend forwardly, they diverge in direction to such an extent that when the upper pin 28 reaches the end of the upper slots the link 30 has been rotated from its relatively flat, inclined attitude of Fig. 2, to its substantially vertical attitude shown in Fig. 3. Inasmuch as the lower pin bolt 29 had already reached the forward end of the slots 27, as shown in Fig. 2, when the main gate 12 reached its fully opened position, no further movement is transmitted to the operating mechanism of the main gate 12 and the overriding mechanism 22 accordingly serves as a lost motion device for the main control gate during this latter portion of the operating cycle.

It will also be noted that in the condition of the mechanism 22 as shown in Fig. 3, any disturbing forces applied to the main control gate 12 are arrested by the rigidly locked condition of the pin bolt 29 and the irreversibility of the mechanism 22, as when rearward forces are thus transmitted to it by the push-pull rod 34. When, however, it is desired to again close the auxiliary control gate 14, the hand lever 15 may be moved rearwardly to the indicated point at which the position of the mechanism as shown in Fig. 2 is again obtained and the auxiliary gate 14 closed under the influence of the spring 41, while the main gate 12 remains open. If it is again desired to close the main gate 12 as well, the hand lever is moved rearwardly to its limiting position on the quadrant 17 during which movement the lost motion slot 38 prevents transmission of rotative forces to the auxiliary gate 14. This correspondingly permits rotation of the lever 21 while continuing the rearward translatory or bodily movement of the link 30, with the pins 28 and 29, and concurrent rotation and closing of the main control gate 12.

It will accordingly be noted that in opening the main gate 12, during which the link 30 is translated forwardly with a bodily movement without any appreciable degree of rotation, the overriding or lost motion feature is provided by the slot 38 in the lever 21 to prevent application of moving forces to the auxiliary gate 14. In the course of the last half of the further forward movement, however, during which the main gate 12 remains in its opened position and opening forces are applied only to the auxiliary gate 14 the overriding or lost motion feature is provided by the divergence in the guide slots 26 and 27 and the ability of the link 30 to rotate about the pin bolt 29, without transmitting further forward movement to the push-pull rod 34 and the operating mechanism for the main gate 12.

While the operating mechanism comprising the present invention has been shown and described as applied to the main and auxiliary inlets for a carburetor air system, it will be understood that it will equally be adapted for use with other devices which are required to be operated in accordance with a prescribed sequence. It will be obvious that the control means 15 may be eliminated under certain circumstances and the end of the rod 18 grasped and used as a simple manual push-pull control. The devices actuated also may be other than the rotative type and can be other instrumentalities than valves or gates. Other forms and modifications of the present invention, both with respect to its general arrangement and the details of its respective parts, which will occur to those skilled in the art after reading the present description, are all intended to come within the scope and spirit of this invention as more particularly defined in the appended claims.

I claim:

1. A combined lost motion and sequence device comprising a supporting member, a first long curved guide slot associated with said supporting member, a shorter second curved guide slot associated with said member spaced from and diverging with respect to said first guide slot, a control member having a terminal guided for movement within said first guide slot, an operating member having a terminal guided for movement within said second guide slot, and link means interconnecting the said terminals of said control and operating members, the curvature and relationship of said guide slots arranged in such manner as to positively transmit forces from said control to said operating member dur-

ing an initial portion only of said guided terminal movement and for the remaining portion of said guided terminal movement said control forces are overridden by rotation of said link means and said forces are not transmitted to said operating members.

2. Unitary means for controlling the overriding and sequence of operation of two controlled devices comprising a pair of non-parallel curved guides of different lengths, guided elements arranged for movement along said guides, a link interconnecting said guided elements, and operating mechanism for individually connecting said devices with said respective guided elements, the curvature and relationship of said guides arranged in such manner that control forces applied to a first of said guided elements causes movement thereof which is positively transmitted to said second guided element through an initial portion only of the movement of said first guided element and for the remaining portion of said movement said forces are overridden by rotation of said link and are not transmitted to said guided element.

3. Unitary overriding and sequence control mechanism comprising a pair of non-parallel curved guides of different lengths divergingly disposed, a guided element movable along the longer of said guides, a second guided element movable along the second said guide, means linking said guided elements, the curvature and relationship of said guides arranged for applying control forces to said first guided element for positive transmission through said linking means to said second guided element during the initial portion only of the movement of said first guided element, and further movement of said first guided element imparting rotation to said linking means about the guided portion of said second guided element, the curvature of said guides also being arranged in such manner as to prevent reversely directed forces applied to said second guided element from imparting movement through said mechanism to said first guided element.

4. An overriding and sequence mechanism for use in an operating system comprising a plate member, curved guide means associated with said plate member, said guide means having at least two non-parallel diverging portions of different lengths, link means having its terminals adapted for guided movements within said respective guide portions, actuating means connected to one of said terminals for the controlled movement of said link means and both its terminals along said respective guide portions, and operating means connected to the second said terminal, the curvature and relationship of said guide means arranged in such manner that said operating means are caused to be moved in conjunction with said actuating means through the initial portion only of the movement thereof and due to overriding rotation of said link means remain fixed through a remaining portion of the movement of said actuating means.

5. Unitary overriding and sequence mechanism for regulating the movement of a pair of devices connected to a single control means comprising operating mechanism extending from the control means to a first of said devices, said operating mechanism including a lost motion means, further operating mechanism interconnecting said first operating mechanism with the second device, said further operating mechanism including a lost motion means, and overriding means associated with said first operating mechanism for the operation of said first device upon initial movement of said control means during which operation the second said lost motion means prevents operation of said second device, and further movement of said control means causes overriding and implementation of the first said lost motion means to prevent further movement of said first device while the second said lost motion means is thereby made ineffective and said second device is operated by said further movement of the control means.

6. Mechnism for use in an operating system comprising a unitary overriding and sequence mechanism including a slotted supporting element, a relatively long curved slot in said supporting element, a relatively shorter curved slot in said supporting element divergingly disposed with respect to said first slot, link means having one terminal adapted for guided movement within the first of said slots and its other terminal guided for movement within the other said slot, actuating means connected to one of said link terminals, operating means connected to the other said link terminal, the curvature and relationship of said slots arranged in such manner that for an initial portion of the movement of said actuating and link means said actuating movement is transmitted from said actuating means to said operating means and for the remaining portion of said movement said forces are overridden by rotation of said link means and are not transmitted to said operating means.

7. Overriding and sequence mechanism for regulating the movement of the main and auxiliary gates of a carburetor air intake system connected to a single control means comprising operating mechanism extending from the control means to the main intake gate of the system, said operating mechanism including a lost motion means, further operating mechanism interconnecting said first operating mechanism with the auxiliary intake gate of said system, said further operating mechanism including a further lost motion means, and overriding means including a pair of curved divergingly disposed guide slots associated with said first operating mechanism for the operation of said main intake gate upon initial movement by said control means during which operation the second said lost motion means prevents the operation of said auxiliary intake gate, and further movement of said control means causes overriding and implementation of the first said lost motion means to prevent further movement of said main intake gate while the second said lost motion means is thereby made effective and said auxiliary intake gate is operated by said further movement of the control means.

8. Means for controlling the overriding and sequential operation of the main and auxiliary intake gates of a carburetor air supply system comprising a pair of non-parallel guides, divergingly disposed curved guided elements arranged for movement along said guides, a link interconnecting said guided elements, and operating mechanism for individually connecting said main and auxiliary intake gates with said respective guided elements, the curvature and relationship of said guides arranged in such manner that control forces applied to a first of said guided elements causes movement thereof which is positively transmitted to said second guided element through an initial portion only of the movement of said first guided element and causes the concurrent application of control forces to the oper-

ating mechanisms for both said main and auxiliary intake gates, the relationship of said guides further being such that continued movement of said first guided element imparts overriding rotation to said link and the application of control forces to the operating mechanism for said auxiliary intake gate only.

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