Jan. 13, 1942. A. G. H. VANDERPOEL ET AL 2,269,496

ENGINE DECELERATION CONTROL

Filed Nov. 19, 1940 2 Sheets-Sheet 1

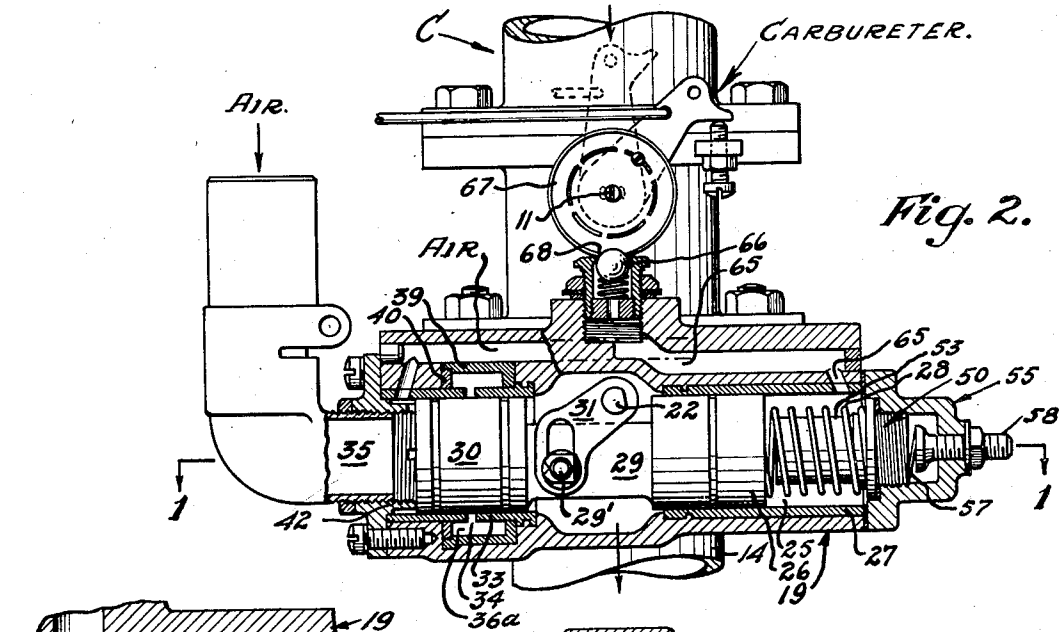


Fig. 2.

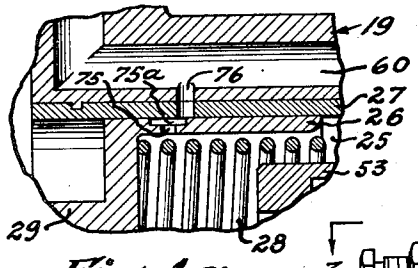


Fig. 1a.

Fig. 1.

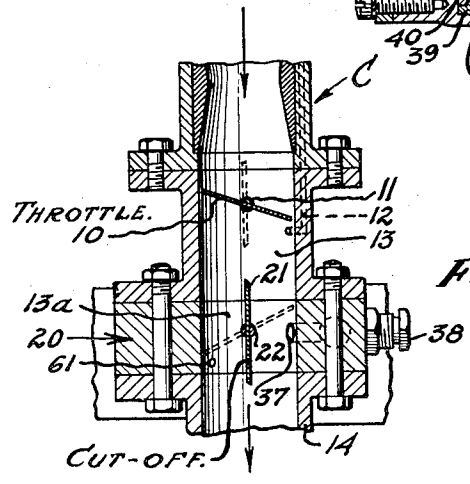


Fig. 3.

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ENGINE DECELERATION CONTROL

Filed Nov. 19, 1940 2 Sheets-Sheet 2

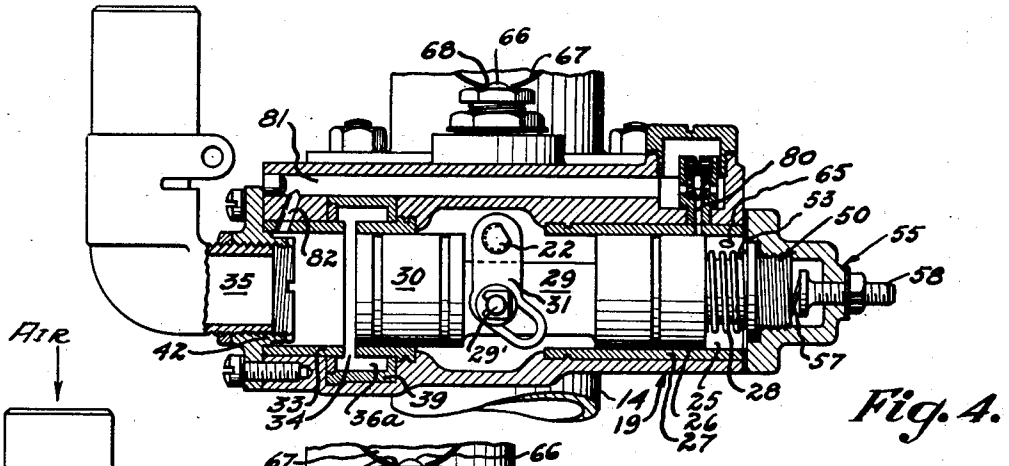


Fig. 4.

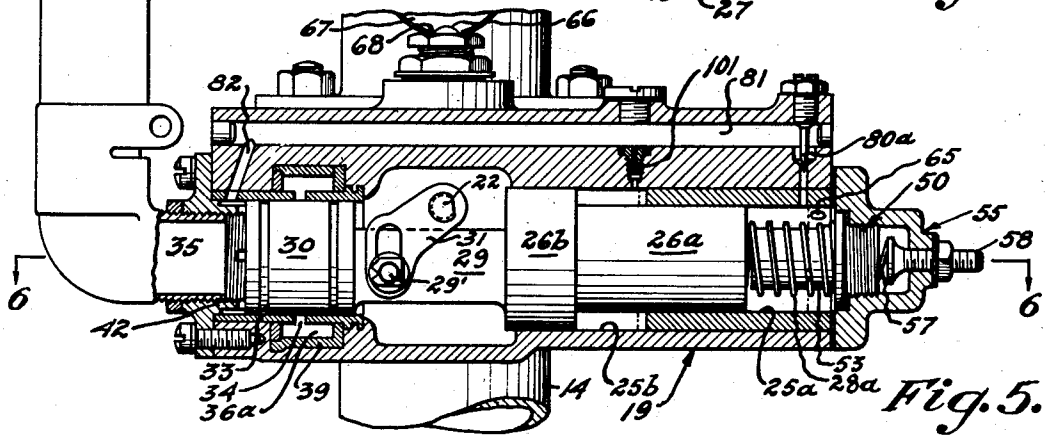


Fig. 5.

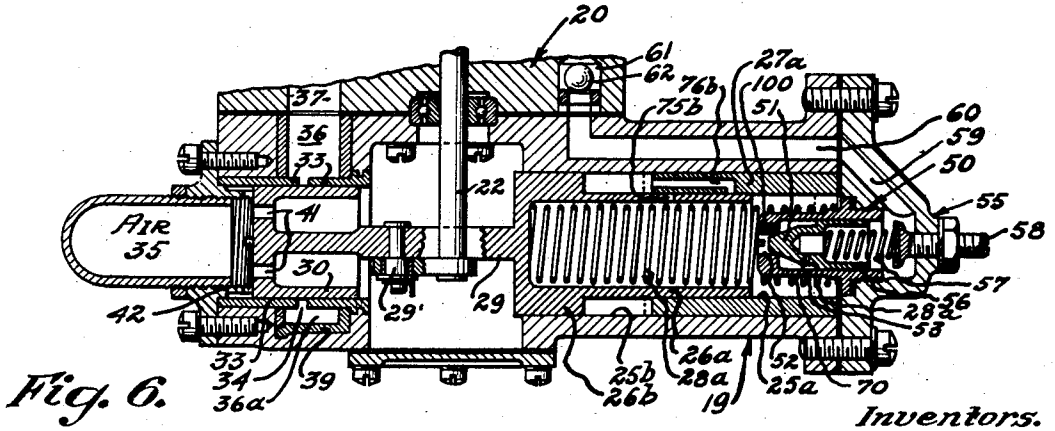


Fig. 6.

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ENGINE DECELERATION CONTROL

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14 Claims. (Cl. 137—153)

This invention relates to devices for controlling the admission of fuel to internal combustion engines, and more particularly to devices known as deceleration controls. The invention comprises certain improvements upon deceleration controls of the general type disclosed in the previous patents of Albert G. H. Vanderpoel and Karl W. S. Ostling, and in the following description the improvements will be described in connection with, but without limitation to, the type of deceleration control device which is shown for instance in prior Patent 2,129,609, dated September 6, 1938, Albert G. H. Vanderpoel.

Deceleration controls of the general type shown in the previous patents, including the type shown in said patent particularly referred to, are operated under cooperative control of intake manifold depression and throttle position, in such a manner as substantially to completely cut off fuel feed to the engine whenever the throttle is closed to idling position and the engine is turning over at a speed greater than that of normal idling. In the particular patent referred to, the design which is here used as the basis of disclosure of our present improvements includes a cut-off valve which is located in the fuel passage at the engine side of the ordinary control throttle. That cut-off valve, normally open, is moved to a closed position by a suction piston, and application of manifold depression to that piston is controlled by a depression-operated pilot valve. The depression operated pilot valve is adjustably set so that it will open and remain open whenever the manifold depression exceeds that of normal idling, which occurs for instance whenever the throttle is closed and the engine is being driven by its own momentum or by that of an automobile or other mechanism. The pilot valve, when open, applies manifold depression to the valve closing piston to close the cut-off valve. If, during the period when the cut-off valve is so closed, the control throttle is not opened, the cut-off valve is held closed by the action of the pilot valve and operating piston until the engine speed and the manifold depression fall to normal idling, when the cut-off valve opens and the engine proceeds to operate at normal idling or under other normal conditions. If, however, the throttle is opened during the period of abnormal manifold depression and cut-off valve closure, the action of opening the throttle immediately relieves the suction applied to the valve operating piston, causing the cut-off valve immediately to open and allowing the engine to proceed in normal operation in accordance with the opening of the control throttle.

In devices of the general type, and in the devices of said particular patent, a valvular means is employed for admitting a controlled amount of scavenging air to the intake manifold whenever the fuel feed is cut off. Admission of that air causes a relative lowering of the manifold depression, and under some circumstances of operation the lowering of the depression may cause the pilot valve to close, shut off the application of suction to the valve operating piston, causing the cut-off valve to momentarily open; and a fluttering action of the valve and its operating mechanism may, under some circumstances, ensue. It is one of the major objects of the present invention to provide arrangements for more positive and definite actuation of the cut-off valve under conditions capable of definite control and for preventing the possibility of such fluttering action; and in those connections to provide a deceleration control which may be adjustably set to go into action (cut off the fuel feed) at one manifold depression value, and go out of action (open the fuel feed for normal operation) at another manifold depression value. There are further objects, such for instance as a general improvement of such deceleration control mechanisms and improvement in speed, certainty and reliability of action, all of which, together with other objects and accomplishments, will best appear from the following detailed description of preferred and illustrative present embodiment of the invention. For the purpose of description reference is had to the accompanying drawings in which:

Fig. 1 is a horizontal section of one form of our improved deceleration control, the section being taken on line 1—1 on Fig. 2;

Fig. 1a is an enlargement of certain portions shown in Fig. 1 but showing the parts in the relative position occupied as the valve operating piston approaches its position to close the cut-off valve;

Fig. 2 is a vertical section taken on line 2—2 of Fig. 1, with parts shown in elevation and with other parts shown in broken away section for purposes of clear illustration;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a section similar to that of Fig. 2, but taken entirely on section line 2—2 of Fig. 1 and showing the parts in the positions assumed when the cut-off valve is closed;

Fig. 5 is a vertical section similar in aspect

to that of Fig. 2 but showing a modified embodiment of the invention, and

Fig. 6 is a horizontal section taken as indicated by line 6—6 on Fig. 5.

The parts of the illustrated mechanisms which are similar to those shown in said Patent 2,129,609, will be described only insofar as is necessary to describe their functions. For further details of such mechanisms reference may be had to said patent. In Figs. 2 and 3 the lower part of any standard down-draft carburetion is shown at C and its usual control throttle is indicated at 10 mounted on throttle shaft 11. The typical idling by-pass is shown at 12, discharging into the suction passage 13 at a point on the engine side of the throttle when the throttle is closed. A portion of the engine intake manifold is shown at 14; the direction of flow of fuel mixture through the suction passage is indicated by the arrows. As at present designed, the mechanism is intended to be applied as an attachment to existing engine systems, and it therefore includes a block 20 which has a suction passage 13a forming a part of the suction passage 13 which leads from the carburetion to the intake manifold. This block 20 contains within it the cut-off valve 21 mounted on shaft 22, and also contains certain passages which will be described. The main cylinder 25 for the cut-off valve operating piston 26 is, in the present design, contained in another casting 19 which is secured by any suitable means to block 20, and that casting also contains other operating parts and other passages, which will be described. Cylinder 25 is preferably formed directly in a cylinder liner 27, and piston 26 is urged toward the left in Figs. 1 and 2, in a valve opening direction, by the piston operating spring 28. The piston has an extension or piston rod 29 carrying a pin 29' which cooperates with a slotted crank arm 31 on valve shaft 22 in such manner as to open valve 21 when the piston is in the position shown in Figs. 1 and 2 and to close valve 21 to the dotted line position of Fig. 3 when the piston 26 is in the position shown in Fig. 4. Manifold depression is applied to the piston to move it to the position of Fig. 4 and close the cut-off valve, through the agency of the pilot valve 50 which will be later described. When the piston and cut-off valve are so moved, the cylindric air valve 30, attached to the left-hand end of piston extension 29, is moved in its cylinder liner 33 to a position to uncover the air slot 34, to admit air from an air intake 35 into a passage 36, 37 which leads through casting 19 and block 20 to the main suction passage 13a at a point on the manifold side of cut-off valve 21 when that valve is closed. Adjustable screw 38 provides means for controlling the effective capacity of passage 37 and thereby controlling the amount of scavenging air which is admitted to the engine manifold when valve 21 is closed. The operation of this air admission valve is generally similar to that of the corresponding air admission valve in Patent 2,129,609. The passage 36, which includes an annular part 36a surrounding the cylinder liner 33, is lined with suitable metal liners as shown at 39 and 40, and the cylinder liner 33 is made in two spaced parts to provide the slot 34 which cooperates with the left-hand end of piston 30 for valvular control of the air admission. The end of cylinder 30 is perforated as shown at 41 to admit air to the chamber at the right hand end of the piston, to put normal air pressure on that end of piston 30 and also on the left-hand end of valve operating piston 26. A bushing 42 which fits into the end of air valve cylinder 33 forms a limiting stop for the movement of both piston 30 and piston 26 towards the left, stopping the movement with valve 21 in the position shown in full lines in Fig. 2.

The pilot or control valve, designated generally by numeral 50, has substantially the same initial functions in causing the cut-off valve to close as the corresponding diaphragm-operated control valve in Patent 2,129,609; but the opening action of the cut-off valve is different, as will be explained. And in our improved design pilot valve 50 is preferably of a piston-operated type. The valve proper 51 is conical and seats in a valve seat opening 52 in the end of a valve cylinder 53 that is mounted in a valve cover and cylinder head casting 55. Valve cylinder 53 may be threaded and flanged into casting 55 as shown, and projects longitudinally into piston cylinder 25 surrounded by spring 28. Piston 26 is hollow so that, when moved to the right, it may pass over spring 28 and valve cylinder 53, as indicated in Fig. 4. The arrangement is one which makes for compactness which is especially desirable in some installations where space is restricted.

An enlarged hollow valve piston 56 is formed integrally with valve 51 and reciprocates in valve cylinder 53. A valve spring 57 tends to keep valve 51 seated, the spring pressure being adjustable through the adjusting screw 58. Depression is applied to the outside end of valve piston 56 through passage 59 which communicates with passage 60 in casting 19. Passage 60 in turn communicates with passage 61 in block 20, and passage 61 communicates with the main suction passage 13a at a point which is at the manifold side of cut-off valve 21 when that valve is closed, see Fig. 3. The manifold depression passages just referred to contain a check valve 62 here shown as located in passage 61 in block 20, the office of this valve being to prevent backfire pressures in the manifold reaching and possibly injuring the pilot valve structure or other parts of the device. It will be understood that in all normal operations of the device the check valve remains open as illustrated in Fig. 1; only such large pressure differences as occur in backfiring will close it.

A depression relief pasasge 65 (see Fig. 2) communicates with the right-hand end of main cylinder 25 at a point beyond the piston travel to the right. Passage 65 has its atmospheric end controlled by the spring pressed ball valve 66 which opens to atmosphere by being moved downwardly. Throttle shaft 11 carries an adjustably settable disc 67 which has a peripheral notch 68 that allows valve 66 to move up the closed position when throttle 10 is in its closed position, that is, the position of throttle 10 for idling operation of the engine. This arrangement is substantially the same as that described more fully in Patent 2,129,609, being such that whenever throttle 10 is opened beyond its idling position valve 66 is depressed, allowing atmospheric entry to passage 65 and to piston cylinder 25. Thus, as soon as the control throttle is opened past idling any application of depression to piston 26 will not draw the piston back and close cut-off valve 21; or if actuating depression has previously been applied to piston 26 to close cut-off valve 21 when the throttle is in idling position, subsequent opening of the throttle will immediately relieve the depression and allow piston 25 and cut-off valve 21 to be returned to normal position by spring 28.

With the exception of differences and improve-

ments which have been pointed out, the device and its functions as so far described are substantially the same as the corresponding parts and functions disclosed in Patent 2,129,609. The further functions, and remaining improvements and their functions will now be best understood in a description of the functions of the whole device.

Assuming the control throttle to be closed to idling position, pilot valve spring **57** is set so that the normal idling depression in the engine manifold will not open pilot valve **51**. However, spring **57** is set at such spring pressure that some predetermined and desirable manifold depression greater than normal idling depression will draw valve piston **56** back and move pilot valve **51** off its seat. For illustration, we may assume that the valve spring is set for a depression of twenty-two inches of mercury. Immediately valve **51** opens, manifold depression is admitted to the main piston cylinder **25** via passage **70** through the wall of hollow valve **51** and via valve seat passage **52**. The main cylinder spring **28** is chosen or set to exert such a spring pressure on main piston **26** that the depression value which will open pilot valve **51** will always move piston **26** to the right to its position of Fig. 4 in which cut-off valve **21** is closed. In fact, spring **28** is so chosen that a lesser depression will move it toward the right and keep it in the position of Fig. 4. How much less that smaller piston operating depression may be is a matter of choice and adjustment, as will be pointed out later; but in our improved design and its consequent functioning, spring **28** is always chosen to correspond to a lesser depression value than is valve spring **57**, for reasons which will appear.

Pilot valve **51** having opened, it will only remain open and continue to apply manifold depression to piston **26**, as long as the manifold depression remains as high as, or higher than, the manifold depression for which valve spring **57** is set to open. If, after the pilot valve opens and piston **26** is moved toward the right the manifold depression decreases for any reason below the depression for which valve spring **57** is set, valve **51** will immediately close and cease to apply depression to main piston **26**. In the device of Patent 2,129,609 the main cylinder was equipped with an open bleed which, upon closure of the pilot valve, acted to relieve the depression on the main piston to allow it to open the cut-off valve. Thus a relatively slight decrease in manifold depression after the pilot valve closed might cause relief of the depression in cylinder **25** to allow piston **26** and the cut-off valve **21** to return to or toward normal position.

Such a decrease in manifold depression value immediately after the opening of pilot valve **51** at the pressure for which it is set, may be caused by the opening of the air valve at the air slot **34** when the air valve piston **30** reaches its right-hand position shown in Fig. 4. It will be understood of course that when the cut-off valve finally closes substantially tightly, that tight closure will in itself have the effect of raising the manifold depression above that for which the pilot valve is set to open; and then scavenging air can be admitted in such restricted quantity as not to lower the depression to a pilot-valve-closing value. But if more air than that restricted quantity is admitted, or if the air valve begins to open before the cut-off valve is finally closed, the pilot valve may temporarily close and the action become uncertain of fluttering. Certain of our present improvements are directed toward eliminating all uncertainty of action. In so doing, we provide that the depression value which will hold the main piston and cut-off valve in closed position is independent of the depression value which operates the pilot valve.

When the valve operating piston **26** approaches its limiting position toward the right, a port **75** which extends through the skirt of hollow piston **26** comes initially into register with a port **76** just before the left-hand end of air valve **30** begins to open air slot **34**. A typical position of piston **26** and its port **75**, just before the air inlet valve begins to open, is shown in the fragmentary enlarged Fig. 1*a*. Port **75** has at its outer end, at the outer surface of piston **26**, an enlargement or counter-bore **75***a* which enables port **75** to register with port **76** as piston **26** approaches its most retracted position, and also enables port **75** to keep registry with port **76** when piston **26** passes to its final limiting position and when the air inlet valve is fully opened as shown in Fig. 4. Port **76** communicates with the manifold depression passage **60**.

When manifold depression is applied to piston **26** by the operation of pilot valve **51** and piston **26** is drawn back, manifold depression is applied directly to piston **26** from passage **60** as soon as port **75***a* begins to register with port **76**. Thus, before the air inlet valve begins to open, manifold depression is applied to piston **26** independently of pilot valve **51**, and the subsequent closure of pilot valve **51** due to any cause, or specifically due to the lowering of the manifold depression by the immediate opening of the air inlet valve, will not then cause or allow piston **26** to move toward the left. On the contrary, piston **26** having once reached the relative position shown in Fig. 1*a*, the directly applied manifold depression will then cause the piston to move on to its limiting position in which cut-off valve **21** is fully closed, and the air valve is fully opened, regardless of whether pilot valve **51** at that time is opened or closed.

The adjustable bleed **80** for main cylinder **25** is positioned so that piston **26** just effectively covers it when the piston reaches its final valve-closing position, see Fig. 4. In this position of the parts, with bleed **80** closed (and assuming the throttle controlled valve **66** not to be opened) the only condition which will cause piston **26** to return to the left and the cut-off valve to open, is the decrease of manifold depression to the value for which piston spring **28** is chosen or set.

Piston operating spring **28** may be so chosen or set as to have a compression strength corresponding to any chosen depression pressure on piston **26** less than the depression pressure at which pilot valve **51** opens under the adjusted pressure of spring **57**. Thus, pressure of the spring **28** may be chosen to correspond to a depression value considerably less than that to which valve spring **57** corresponds; and in that case piston **26** will not move toward the left to open cut-off valve **21** until the manifold depression falls to a value considerably less than the manifold depression at which the operation of pilot valve **51** has caused piston **26** initially to move toward the right. As an illustration, the depression value of spring **28** may be as low as ten inches of mercury. The widely adjustable difference between the values of those two depressions—the depression which initially causes

the pilot valve to open, and the depression which will keep piston 26 toward the right when once moved to that position—affords ample leeway for a desirable adjustment of several operating factors of the device. It affords ample leeway for adjustment of the amount of scavenging air admitted, and it also affords ample leeway for adjustment of the abnormal depression which initially actuates pilot valve 51. That initially actuating abnormal depression may thus be chosen to be either just slightly above normal idling depression, or considerably above normal idling depression. And the air inlet adjustment screw 38 may be adjusted through a comparatively wide range to admit either a comparatively small amount of scavenging air or a comparatively large amount of scavenging. And under all of these adjustable and variable conditions of operation, spring 28 may be set or chosen so that piston 26 will not move toward the left as engine speed and manifold depression fall, to automatically open cut-off valve 21, until the engine speed and manifold depression have fallen even below the normal idling, if such things are so desired.

An illustration may make the functioning more clear. Assuming that the normal idling depression is in any particular case 18" to 20" of mercury, pilot valve spring 57 may be set so that the pilot valve will open at a depression enough higher than that of normal idling so that the device does not go into action until the engine is turning over at a speed definitely above normal idling. Assuming further that it is desired to admit sufficient scavenging air to the manifold that the manifold depression at normal idling speed would then be say ten inches, or becomes say twelve inches at the engine speed at which the pilot has opened. Piston spring 28 may be set or chosen to correspond to a manifold depression of substantially ten inches. The device will then operate to open pilot valve 51 and move piston 26 to close cut-off valve 21, whenever the control throttle is closed and manifold depression reaches the abnormal value for which valve spring 57 is set. When piston 26 approaches its right-hand position the full abnormal depression is applied to it independently of the pilot valve, and before the air valve opens, to move the piston on to final position. When the air valve opens the manifold depression drops to say twelve inches, and the pilot valve closes. The depression in cylinder 25 then also goes down to twelve inches; but piston 26 remains in its right hand position with the cut-off valve closed until the engine speed drops to normal idling and the depression is at ten inches. When the depression reaches that normal idling equivalent, spring 25 immediately starts the piston toward the left. Before the air valve closes and before piston port 75 has moved out of register with depression port 76, piston 26 uncovers bleeder port 80 to admit atmosphere to cylinder 25 so that the piston may then continue its movement to the left. Bleeder port 80 is adjusted to admit sufficient air to bleed the depression in 25 down to a point below that at which the piston moves toward the left, even if momentarily the air valve at 34 closes before the port registration at 75, 76 closes. And once the depression ports 75, 76 pass out of register then piston 26 moves quickly to the left, opening the cut-off valve.

All the actions are positive, rapid, and capable of being accurately controlled. When the manifold depression reaches the chosen abnormal value, the pilot valve 50 opens immediately and positively, causing positive and quick closure of the cut-off valve. Any desired amount of scavenging air may be admitted, but the cut-off valve will not again open until either the throttle valve is opened or the engine speed falls to that chosen, say normal idling. And when either of those conditions occur the cut-off valve then opens quickly and positively.

Adjustable bleeder 80 preferably communicates with atmosphere via a passage 81 which connects at 82 with the air inlet 35. This air inlet is equipped for application of or connection to air conditioning devices.

Figs. 5 and 6 show a modified form similar in the main to the form first described and acting in a similar manner. The block 20 in Fig. 6 is the same as in Figs. 1 to 3 and has the same passages. The air inlet valve assembly and the pilot valve assembly are the same, and the same numerals are applied. The connection of piston rod 29 to cut-off valve shaft 22 is the same; and the throttle shaft operates valve 66 in the manner before described to admit air through passage 65 to the main cylinder.

The main piston is in trunk form, its smaller part 26*a* reciprocating in cylinder liner 27*a*, while its larger part 26*b* works in cylinder 25*b*. Spring 28*a* moves the piston to the left to open the cut-off valve. A permanent calibrated bleeder orifice 100 extends through the seat 52 of pilot valve 51 to apply manifold depression restrictedly and constantly to the smaller cylinder 25*a*, when valve 51 is closed. An adjustable air bleed 80*a*, corresponding to bleed 80 of Fig. 4, connects the air passage 81 with cylinder 25*a* at a point where the bleed is just effectively covered by piston 26*a* when at the extreme right with the cut-off valve 21 closed. Another calibrated bleed orifice 101 connects air passage 81 with the larger cylinder 25*b* at a point where the larger piston 26*b* will just effectively cover it when at the extreme right. The smaller piston 26*a* is hollow and has a port 75*b* through its wall. This port 75*b* is closed by the wall of the smaller cylinder 25*a* except as the piston is approaching or is in its extreme right hand position, when port 75*b* registers with a passage 76*b* which leads through the cylinder wall to the interior of the larger cylinder 25*b*. With the parts in the positions shown in Figs. 5 and 6, adjustable bleed 80*a* prevents piston movement by the depression applied through the bleed 100.

The pilot valve 50 operates as before described. When it opens the abnormal manifold depression is applied to piston 26*a* and moves the piston to the right, spring 28*a* being of such strength and bleed 80*a* being so adjusted that piston movement takes place. As the piston approaches its limit of travel and before the air valve at 34 begins to open, port 75*b* begins to register with passage 76*b*, and the depression is then applied to the larger piston 26*b* as well as to the smaller 26*a*. With this larger piston area exposed, the piston goes on through its stroke toward the right to fully close the cut-off valve tightly, even though the air valve at 34 has opened and the pilot valve has closed. During piston travel to the right bleed 101 allows the air behind piston 26*b* to escape until port 75*b* registers with passage 76*b*.

With the pistons at the right and the cut-off valve closed, both bleeds 80*a* and 101 are closed by the pistons. The parts are now held in that

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position by the manifold depression acting through the calibrated orifice **100** and through ports **75***b* and **76***b*, against the action of spring **28***a*. That spring is set or chosen to have the same depression value as is spring **28** in the form first described; so that, as the manifold depression falls to the idling equivalent the spring will start the piston toward the left. The bleeder orifices at **80***a* and **101** are immediately uncovered to relieve the depression rapidly in both cylinders **25***a* and **25***b*, and the piston continues rapid movement to its normal position shown in the drawings.

The action is much the same as in Figs. 1 to 4. When the piston approaches its position in which the cut-off valve is closed, in Fig. 1 the manifold depression is applied to the piston independently of the pilot valve before the air valve opens and the pilot closes; and in Fig. 6 the depression is applied to the whole piston area, under the same conditions, by the orifice **100** and the ports **75***b* and **76***b*. In both forms the atmospheric bleed (**80** in Fig. 2, and **80***a*, **101** in Fig. 5) is closed at the end of piston travel. so that the piston and cut-off valve are then held in position by the manifold depression opposed only by the piston spring. And in both forms the return of the piston and cut-off valves to normal depends for its inception only on the strength of the piston spring, and once commenced is insured of completion and accelerated by cutting off the application of the depression (in Fig. 1 cutting off the depression from the whole piston, in Fig. 6 from the larger piston area) and by opening the atmospheric bleeds.

In another view of the characteristics of the design shown in Figs. 5 and 6, and comparison with that shown in Figs. 1 to 4, the small piston **26***a* may be considered as a part of the pilot mechanism, or as the pilot for the larger piston. For instance, the piston spring **28***a* may be chosen or set at such strength relative to the area of small piston **26***a* that only the chosen abnormally high manifold depression will start the piston toward the right. Upon approaching its limiting position, the small piston acts as a valve with ports **75***b*, **76***b*, to admit the depression to the larger piston. Depending then on the chosen total area of the whole piston to the area of the smaller, the depression acting on the whole piston will hold the parts in their limiting position until the depression has fallen to a value below that which has caused the initial actuation.

In either of the forms described, it is preferable that the air valve at **34** open near the end of the piston stroke as the cut-off valve is near closing, so that the abnormally high depression, unmodified by air admission, is applied to the piston during the major portion of its stroke. This promotes quick and positive action in closing the cut-off valve. However, the air valve can open at an earlier point in the piston stroke. In any case, the valvular means which admits depression directly to the piston (ports **75**, **76** in Fig. 1; ports **75***b*, **76***b* in Fig. 6) will always come into register before the air valve opens. They may come into register some distance in advance of the air valve opening. Preferably however they register just before the air valve opens, so that on the return stroke they go out of register and cut the depression off from the cylinder early in the stroke, thus promoting quick and positive opening of the cut-off valve.

We have preferred, in our improvements, to utilize an air valve of the definitely mechanically operated type, to insure positive action and timing relative to the co-operating actions. However an automatic air valve of the type and functioning such as shown in the Ostling Patent 2,186,989, or Vanderpoel and Ostling, 2,152,226, may be used, within the scope of our present invention. Such automatic valves may be set to be opened by the depression increase caused by cut-off valve closure, and will therefore maintain the same general sequence of operation that has been described for the mechanically operated air valve.

It will be understood that the main purpose in placing the cut-off valve **21** in a position between the carbureter and the engine manifold is to control both the main fuel jet and, mainly, the idling by-pass of the usual form of carbureter. Depending on the form of carbureter the cut-off valve may be placed in any position in the suction passage or where it will control the fuel passage or passages to cut them off completely.

When we refer to pistons for operating the cut-off valve and the pilot, it will of course be understood that any other of the well known and equivalent forms of pressure operated elements may be used instead, such as a diaphragm or Sylphon.

We claim:

1. In a deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises valvular means actuated by virtue of piston travel to apply suction passage depression directly to the piston, independently of the pilot valve, as the piston approaches and reaches its position in which the cut-off valve is closed.

2. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder and a port in the piston, adapted to register as the piston approaches and reaches its position of cut-off valve closure, to apply suction passage depression directly to the piston independently of the pilot valve.

3. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direc-

tion, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises valvular means actuated by virtue of piston travel to apply suction passage depression directly to the piston, independently of the pilot valve, as the piston approaches and reaches its position in which the cut-off valve is closed, and a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure.

4. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abornal value higher than that of normal idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder and a port in the piston, adapted to register as the piston approaches and reaches its position of cut-off valve closure, to apply suction passage depression directly to the piston independently of the pilot valve, and a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure.

5. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises valvular means actuated by virtue of piston travel to apply suction passage depression directly to the piston, independently of the pilot valve, as the piston approaches and reaches its position in which the cut-off valve is closed, and the yielding means which actuates the piston in a valve opening direction exerting such force as to return the piston to valve opening position only when the applied depression falls to a value substantially lower than that at which the pilot valve opens against the action of its yielding closing means.

6. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder and a port in the piston, adapted to register as the piston approaches and reaches its position of cut-off valve closure, to apply suction passage depression directly to the piston independently of the pilot valve, a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure, and the yielding means which actuates the piston in a valve opening direction exerting such force as to return the piston to valve opening position only when the applied depression falls to a value substantially lower than that at which the pilot valve opens against the action of its yielding closing means.

7. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises valvular means, actuated by virtue of piston travel in its direction to close the cut-off valve, to apply suction passage depression directly to the piston, independently of the pilot valve, at a point in the piston movement prior to the opening of the air valve.

8. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder, and a port in the piston communicating with the cylinder interior, adapted to register at a point in the piston travel prior to the opening of the air valve and remaining in register throughout the cut-off valve closing stroke of the piston.

9. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage

depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises valvular means, actuated by virtue of piston travel in its direction to close the cut-off valve, to apply suction passage depression directly to the piston, independently of the pilot valve, at a point in the piston movement prior to the opening of the air valve, and a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure.

10. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder, and a port in the piston communicating with the cylinder interior, adapted to register at a point in the piston travel prior to the opening of the air valve and remaining in register throughout the cut-off valve closing stroke of the piston, and a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure.

11. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises valvular means, actuated by virtue of piston travel in its direction to close the cut-off valve, to apply suction passage depression directly to the piston, independently of the pilot valve, at a point in the piston movement prior to the opening of the air valve, and the yielding means which actuates the piston in a valve opening direction exerting such force as to return the piston to valve opening position only when the applied depression falls to a value substantially lower than that at which the pilot valve opens against the action of its yielding closing means.

12. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by opposite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises a stationary depression communicating port in the wall of the piston cylinder, and a port in the piston communicating with the cylinder interior, adapted to register at a point in the piston travel prior to the opening of the air valve and remaining in register throughout the cut-off valve closing stroke of the piston, a restricted air admission port leading into the cylinder and closed by the piston substantially only when the latter is in its position of cut-off valve closure, and the yielding means which actuates the piston in a valve opening direction exerting such force as to return the piston to valve opening position only when the applied depression falls to a value substantially lower than that at which the pilot valve opens against the action of its yielding closing means.

13. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve except when the depression reaches an abnormal value higher than that of normal idling; the improvement which comprises valvular means actuated by virtue of piston travel to apply suction passage depression directly to the piston, independently of the pilot valve, as the piston approaches and reaches its position in which the cut-off valve is closed; the improvement which comprises a cylinder and piston of trunk form with two parts of relatively larger and smaller diameters, the pilot valve acting to apply the depression to the smaller cylinder part, a restricted depression passage applying the depression constantly to the smaller cylinder part, restricted air admission ports leading into each cylinder part and adapted to be closed by the respective piston parts as the latter approach their position in which the cut-off valve is closed, and valvular ports in the piston and the cylinder wall adapted to register and communicate depression from the smaller to the larger cylinder part as the piston approaches and reaches its cut-off valve closing position.

14. In deceleration controls for internal combustion engines, which have a cut-off valve in a fuel intake suction passage of the engine, a cylinder and a piston therein adapted to be actuated in one direction by suction passage depression to close the cut-off valve, yielding means actuating the piston in a valve opening direction, an air valve communicating with the suction passage at the engine side of the cut-off valve and opened by the piston during its movement closing the cut-off valve and closed by op-

posite piston movement, a pilot valve actuatable by suction passage depression to open and apply depression to the piston, and yielding means acting to close the pilot valve whenever the depression is below an abnormal value higher than that of normal engine idling; the improvement which comprises a cylinder and piston of trunk form with two parts of relatively larger and smaller diameters, the pilot valve acting to apply the depression to the smaller cylinder part, a restricted depression passage applying the depression constantly to the smaller cylindrical part, restricted air admission ports leading into each cylinder part and adapted to be closed by the respective piston parts as the latter approach their position in which the cut-off valve is closed, and valvular ports in the piston and the cylinder wall adapted to register and communicate depression from the smaller to the larger cylinder part at a point in the piston movement prior to the opening of the air valve.

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