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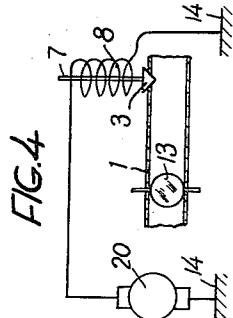
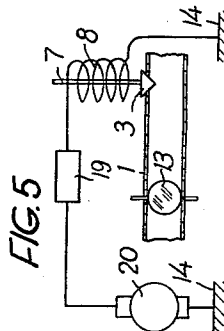
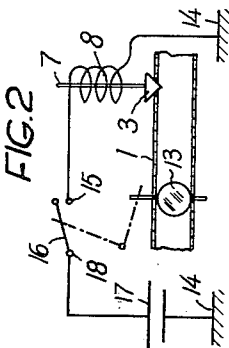
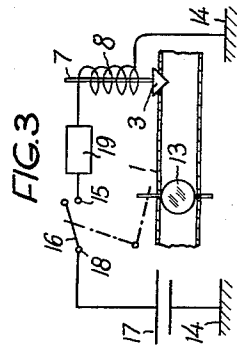
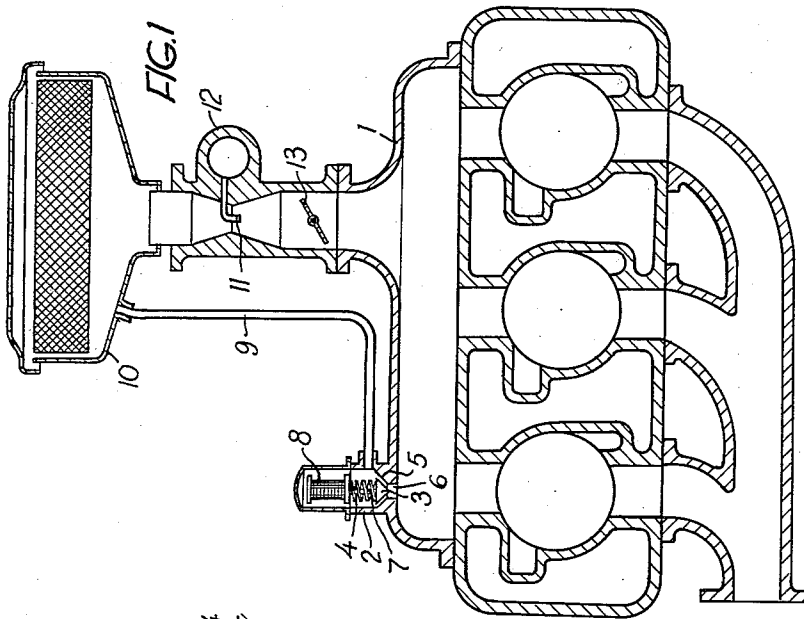
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3,043,286

METHOD AND MEANS FOR THE EQUALIZATION OF THE IDLING OPERATION
OF A MULTIPLE CYLINDER 2-STROKE CYCLE INTERNAL COMBUSTION
ENGINE, PREFERABLY A CARBURETOR ENGINE

Filed Sept. 16, 1958

4 Sheets-Sheet 1



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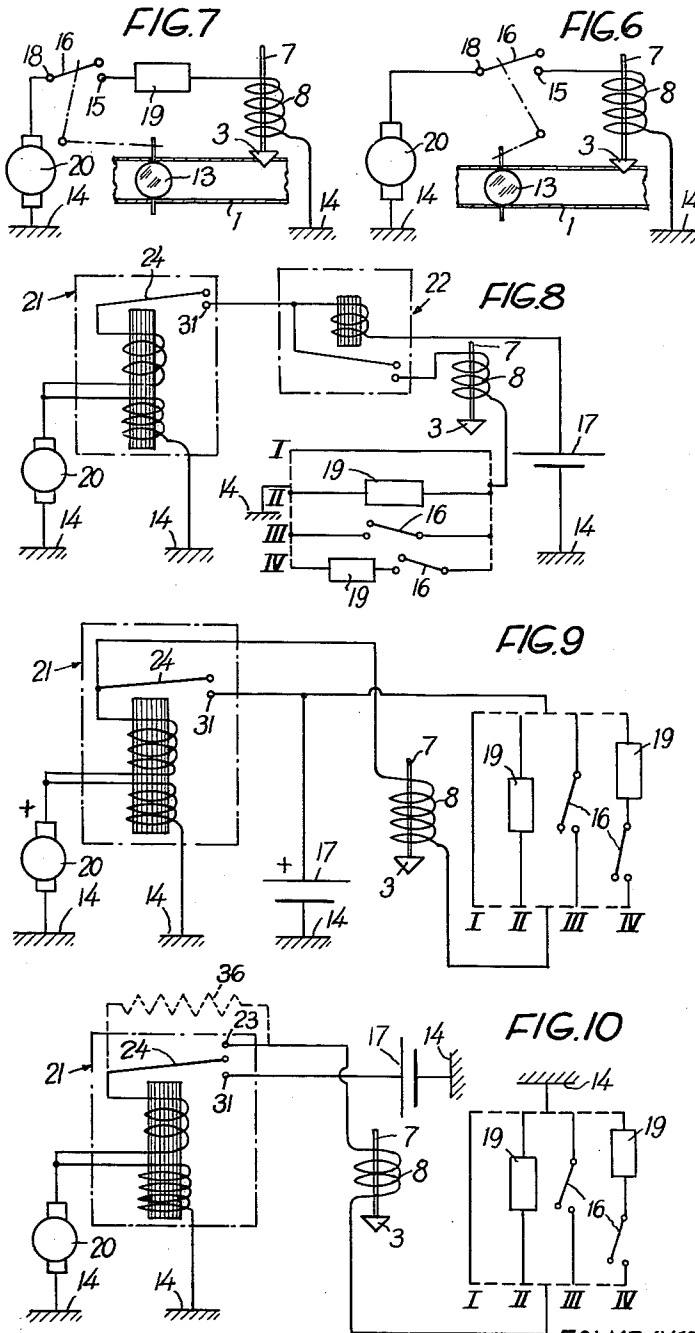
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

FIG. 11

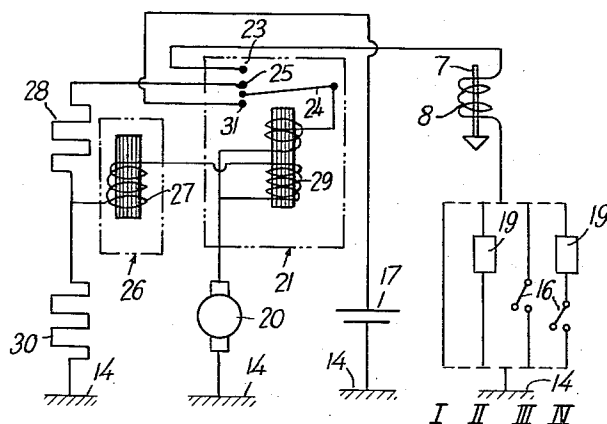
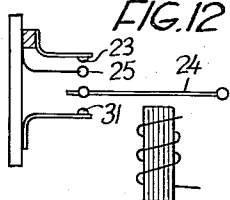


FIG. 12



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4 Sheets-Sheet 4

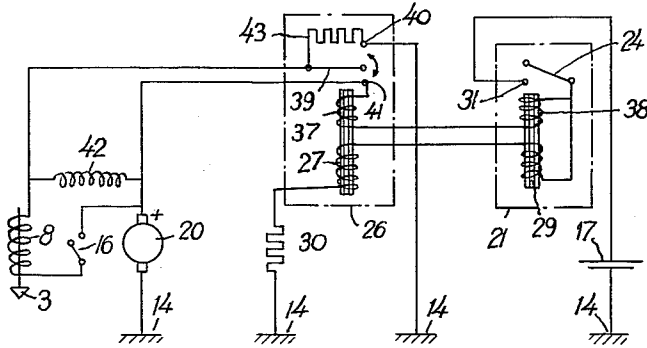


FIG. 18

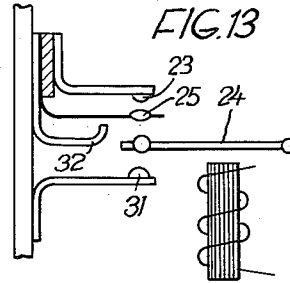


FIG. 13

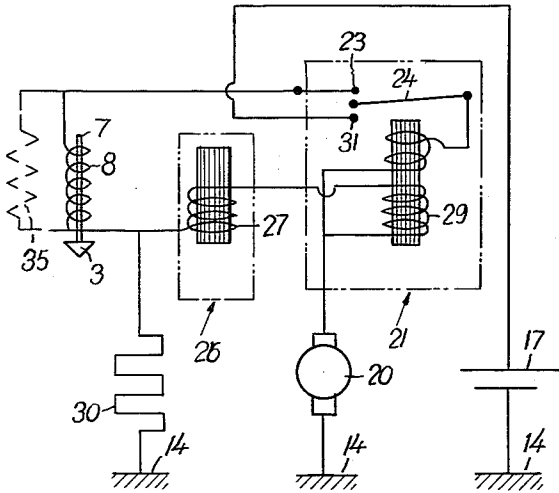


FIG. 17

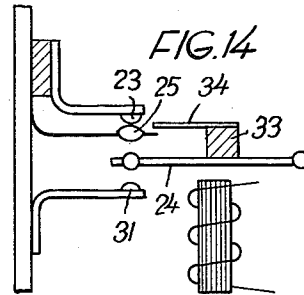


FIG. 14

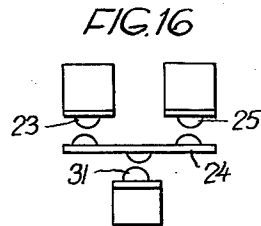


FIG. 16

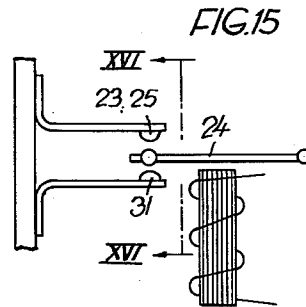


FIG. 15

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METHOD AND MEANS FOR THE EQUALIZATION OF THE IDLING OPERATION OF A MULTIPLE CYLINDER 2-STROKE CYCLE INTERNAL COMBUSTION ENGINE, PREFERABLY A CARBURETOR ENGINE

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Claims priority, application Sweden Sept. 18, 1957

8 Claims. (Cl. 123-124)

As is well known, the idling operation of a 2-stroke carburetor internal combustion engine is very irregular on account of the incomplete scavenging of the cylinders at the low speeds involved, whereby the fuel-air mixture will be so contaminated with combusted gases that ignition cannot take place in every revolution, inasmuch as a certain cylinder may perform a number of working strokes without the occurrence of any ignition.

It is well known that it is impossible to achieve a fully even distribution of the fuel in the air entering the different cylinders of an engine where one carburetor is feeding several cylinders. The designer has no other choice than to choose the best possible compromise. When choosing this compromise the distribution at idling conditions is generally neglected which can be done without any obvious disadvantages. This invention is mainly based upon this fact.

The present invention has for its object to obviate this drawback of multiple cylinder 2-stroke carburetor internal combustion engines, wherein additional air is supplied through one or more openings into the induction system of the engine. This object is attained according to the invention by supplying the cylinder or cylinders which in the idling operation receive too much fuel with such a quantity of additional air that a readily combustible gas-air mixture is obtained and that the cylinder or cylinders which in the idling operation receive too little fuel are supplied with such a quantity of additional air that a non-combustible gas-air mixture is obtained. The cylinders thus rendered inoperative then bring about a rather considerable braking effect by reason of the great pump losses caused through the comparatively large gas quantities passing through the crank casing to the cylinders. Accordingly the cylinder or cylinders that have received an ideal mixture through the additional air are permitted to operate at a load which is so high that they will ignite regularly on account of said circumstances. The idling operation of the engine may thus become just as regular as that of a 4-stroke internal combustion engine.

In certain internal combustion engines, the practical solution may be as simple as that suitable ports are provided in the induction passages of the engine preferably provided with suitable filters, for instance connected to the normal external air filters of the engine. In this connection the requisite additional air quantities are understood to be so small as to be entirely without any import, as soon as the supply of the fuel and air is increased by an increased throttle opening. Throttling, for instance by means of a throttle plate having sharp-edged apertures or a long and narrow pipe conduit may also be utilized to restrict the air quantity.

In most casts, however, measures will have to be taken for an automatic closure of the additional air ports, when the engine is not running at idle. The reason may be that the carburetor of the engine is fitted with a cold starting device, which does not function, if air is supplied otherwise than through the carburetor. In some engines additional air also may disturb the normal operation of the engine at speeds and loads other than those

2

prevailing in idling operation. Such an automatic closure of the additional air ports may either be effected so as to be controlled by the speed of the engine, or to be controlled by the gas throttle lever or both by the speed of the engine and by the position of the gas throttle lever. The control may be effected electrically, mechanically, with the aid of a negative pressure from the induction system of the engine, or in some other suitable manner.

The invention will be described herein in connection with the accompanying drawings, which illustrate various forms of embodiment of the invention, wherein FIG. 1 is a diagrammatic representation of a horizontal section through a 3-cylinder 2-stroke internal combustion engine provided with an electro-magnetically operated additional air valve, FIG. 2 shows an additional air valve and a switch, connected to a battery, FIG. 3 shows a thermo-switch connected into the circuit according to FIG. 2, FIG. 4 shows the additional air valve switched in over a generator, FIG. 5 shows a thermo-switch connected into the line circuit according to FIG. 4, FIG. 6 shows a switch connected into the line circuit according to FIG. 4 and FIG. 7 shows both a contact breaker and a thermo-switch connected into the circuit between the solenoid of the additional air valve and the generator. FIG. 8 shows the use of a cut out relay and an auxiliary relay for the additional air valve with various alternative constructions for the connection of the solenoid, FIG. 9 shows another connection of the solenoid with different alternative constructions, FIG. 10 shows the use of an additional contact in the cut out relay, FIG. 11 shows the use of an additional third contact, FIGS. 12-16 show on a larger scale various constructions of the third contact according to FIG. 11, FIG. 17 shows an embodiment, wherein the solenoid of the valve replaces an additional shunt resistance occurring in FIG. 11, and FIG. 18 shows an embodiment, wherein the solenoid of the valve is connected in parallel to the field winding of the generator. The same details have the same reference characters in the various figures.

Arranged on the intake manifold 1 of the 3-cylinder two-stroke carburetor engine shown in FIG. 1 is an electromagnetic additional air valve 2 provided with a valve body 3, which is kept seated under normal conditions by a return spring 4 against a seat 5 surrounding an opening in the wall of the intake manifold 1. It is assumed, for purposes of illustration, that the left hand cylinder as shown in FIG. 1 is that firing irregularly at idling speeds, and the additional air valve 2 is shown as positioned adjacent this cylinder. Thus the extra air supply port is offset, with respect to the normal intake from the carburetor. Control of the additional air valve is electrical. The valve body 3 is connected to an armature 7 extending through a solenoid 8, which is adapted, when connected to a source of current, to raise the valve body 3 from the seat 5 against the action of the spring 4. The valve 2 is connected to the external air, for instance through a pipe 9 connected to the induction filter 10, said pipe being adapted to lead additional air past the gas throttle lever. 11 designates the discharge tube from the carburetor channel 12, and 13 denotes the butterfly throttle valve.

In the arrangement shown in FIG. 2, the solenoid 8 of the additional air valve is connected at one end thereof to ground 14 and is connected at the other end thereof to the one pole 15 of a switch 16, which is mechanically coupled to the gas throttle lever, as shown diagrammatically in the drawing. The source of current is constituted by a battery 17, one pole of which is connected to ground 14, and the other pole of which is connected to the second pole 18 of the switch. The switch 16 and the butterfly valve 13 are interconnected, so that the switch 16 will be closed when the butterfly valve 13 is shifted to the position of idling operation or substantially to such position, where-

3

in the circuit from the battery 17 is closed at the same time through the solenoid 8 of the additional air valve, so that the valve body 3 is raised.

In the arrangement according to FIG. 3, a thermo-switch 19 is also incorporated into the circuit, said switch preventing closure of the circuit through the solenoid 8 of the additional air valve, if the temperature of the engine falls below a certain value. The reason of the incorporation of the thermoswitch 19 may be that certain carburetors are fitted with cold starting devices, that do not function, if air penetrates into the induction system by abnormal ways, and that certain engines refuse, when cold, to run at idle in the manner distinguished by the invention. The thermoswitch 19 may also be replaced by a circuit breaker which is operated by the choke control lever.

In the arrangement according to FIG. 4, the solenoid 8 of the additional air valve is connected directly to the generator 20 driven by the motor. Thus the valve 3 cannot be opened, before a certain speed of the engine has been reached. This is advantageous in consideration of choke starting devices, and if for some reason or another the engine would be pressed down to a very low speed (below normal idle speeds) inasmuch as the valve is then caused to close and the engine operates again as a normal two-stroke internal combustion engine on all of the cylinders. The arrangement according to FIG. 5 is identical to the arrangement according to FIG. 4, save for the fact that a thermo-switch 19 has been incorporated into the circuit. This thermo-switch 19 may frequently be omitted, even if the engine refuses to operate at idle on additional air when the engine is cold. The speed of the engine adjusts itself automatically for a speed immediately below that at which the valve 3 opens during the warm-up period of the engine. After it has become warm, the speed at idling operation rises above the opening speed of the valve 3.

The arrangement according to FIG. 6 is identical to the arrangement according to FIG. 4, save for the fact that a throttle switch 16 has been incorporated into the circuit. A throttle switch is necessary in engines, where the additional air disturbs the normal functions of the engine.

The arrangement according to FIG. 7 is identical to the arrangement according to FIG. 4, save for the fact that both a gas throttle switch 16 and a thermo-switch 19 have been incorporated for reasons explained in connection with the description of the arrangements according to FIGS. 5 and 6.

In the arrangement according to FIG. 8, an auxiliary relay 22 is incorporated into the circuit between a cut out relay 21 and the battery 17, said auxiliary relay admitting current from the battery 17 to the solenoid 8 of the additional air valve, when the engine (and thus the generator 20) operates on speeds so low that the cut out relay 21 is still disconnected. As soon as the engine (and the generator 20) has come above that speed at which the cut out relay 21 is disconnected, the auxiliary relay 22 breaks the circuit of the additional air valve. With respect to the four connecting alternatives from the solenoid 8 of the additional air valve to ground 14, as shown in the drawing, the following instances might be mentioned:

(I) the solenoid 8 is connected directly to ground 14. Such arrangement may be used in engines, which in a cold condition may both start and operate idle on additional air, but where the additional air disturbs the normal function of the engines at higher engine speeds;

(II) a thermo-switch 19 is connected into the circuit. Such an arrangement must be used in engines that cannot start nor operate at idle on additional air, when the engine is cold;

(III) a switch 16 is connected into the circuit. Such an arrangement may be utilized in engines permitting of starting and operating, even if the engine is cold, but where the additional air disturbs the normal operating features of the engine;

4

(IV) both a thermo-switch 19 and a circuit breaker 16 are connected into the circuit. The incorporation both of a thermo-switch 19 and of a gas throttle switch 16 permits the system to be used in engines, where additional air is undesirable when the engine is cold, and where additional air also disturbs normal operating features.

In the arrangement according to FIG. 9, the solenoid 8 of the additional air valve is connected in the same manner as the charging control lamp in normal auto-electric installations, that is to say over the cut out relay 21, between the plus-pole of the generator 20 and the plus-pole of the battery 17. When the engine is standing still, practically the whole of the battery voltage acts upon the solenoid 8 of the additional air valve by reason of the small ohmic resistance of the generator. When the generator 20 commences to rotate, it will yield an increased opposed electromotive force at an increased number of revolutions, which electromotive force successively weakens the current through the solenoid 8 of the additional air valve. When the connecting number of revolutions of the generator 20 is reached, the contacts of the cut out relay are closed, whereby the solenoid 8 of the additional air valve is short-circuited. Depending on the nature of the solenoid 8 of the additional air valve, the iron core 7, the return spring 4, and so forth, it will thus be possible with an increasing speed to cause the valve to close at a predetermined speed lying between that speed of the engine when the generator commences to yield a voltage and some speed near the connecting speed. The different connecting alternatives I-IV are employed in the same manner as in the arrangement according to FIG. 8.

In the arrangement according to FIG. 10, an additional contact 23 is incorporated into the cut out relay 21. The solenoid 8 of the additional air valve will thus be fed directly from the generator 20, until the connecting speed is reached, when the armature 24 of the cut out relay 21 is switched over, in order that the generator shall supply its current to the battery 17 and the other current consumers. The different connecting alternatives I-IV are used in the same manner as in the arrangement according to FIG. 8. The arrangement according to FIG. 10 has a number of considerable advantages over the arrangement previously set forth, inter alia the advantage that the additional air valve is closed under all circumstances, if the generator operates at a higher speed than at the connecting speed which is very essential for maintaining sufficient lubrication in traveling downhill with closed throttle valve for vehicle engines, where the transmission is devoid of free wheeling.

FIG. 10 also shows an improvement of the connection, which consists in that a resistance 36 is connected over the movable contact 24 of the cut out relay and its additional contact 23. Hereby the following function will be obtained. When the relay contact 24 reaches the additional contact 23 at a reduction of the speed, the additional air valve 3 opens. Hereby the speed of the engine increases for a moment. The connection with the solenoid 8 is then interrupted, and the additional air valve would close again, if the solenoid did not receive a small current through the resistance 36, which current is sufficient to retain the additional air valve already opened. The speed of the engine may thus increase without any disadvantage, to an arbitrary value, without the additional air valve closing again. As soon as the throttle switch disconnects, which it does at the slightest opening of the throttle, the additional air valve will of course close, however, independently of the condition of the cut out relay.

The arrangement according to FIG. 11 practically equals the arrangement according to FIG. 10, but an additional contact 25 is incorporated therein into the cut out relay 21. The generator 20 is shown here as being fitted with a voltage regulator 26, of which only

5

the iron core with the voltage winding 27 is shown, the latter of which is connected between the normal series resistance 30 and the voltage winding 29 of the cut out relay 21. Connected at the joining point between this series resistance 30 and the voltage winding 27 of the voltage regulator 26 is one end of a resistance 28, the other end of which is connected to the third additional contact 25 of the cut out relay 21. The two fixed contacts 31 and 23 of the cut out relay 21 are, as in FIG. 10, connected to one pole of the battery 17 as well as to one end of the solenoid 8 of the additional air valve. The additional contact 25 is inserted resiliently between the normal movable contact 24 of the cut out relay and the fixed contact 23, which is connected to the solenoid 8 of the additional air valve. At speeds below the connecting speed, the resilient contacts 24, 25 and the fixed contact 23 are in touch with each other. FIGS. 12-16 show various forms of embodiment of the contacts of the cut out relay. FIG. 13 shows a holder 32 serving as a support for the resilient contact 24 to ensure the stability thereof. The arrangement according to FIG. 13 has the advantage that, should the contact 25 and the contact 24 be sticking when the connecting speed is reached, the contact 24 is prevented from coming into touch with the contact 31, unless the sticking contacts 24 and 25 be forced apart. Hereby connection to the electrical system is prevented, while the contacts 24 and 25 are connected to one another, which would be dangerous, inasmuch as the voltage regulator 26 is then adjusted for a much higher voltage than that endured by the electrical system. FIG. 14 shows an arrangement, where the contact 25 bears in its unactuated condition on the contact 23, and which, when connection is established, is brought along by means of a carrier 34 secured on the movable contact 24 by means of an insulation 33. Alternatively, the contact 25 may in its unactuated condition be at a certain distance from the contact 23. This arrangement has the advantage that, should the contacts 23 and 25 stick, the mutual contacting of the contacts 24 and 31 is prevented, unless at the reaching of the connecting speed said sticking is forced apart, which is important, inasmuch as the voltage regulator 26, when contact is established between the contacts 23 and 25, is adjusted for a lower voltage value than normal, which prevents the normal functioning of the generator in supplying the battery and other consumers with current. The arrangements of FIGS. 13 and 14 may be combined to advantage. In FIGS. 15 and 16, which show the same arrangement in different planes, the movable contact 24 is constructed as a double contact, and the two contacts 23 and 25 are secured side by side, whereby breaking between the contact 24 on the one hand and the contacts 23 and 25 on the other hand is effected at the same time. The arrangement according to FIG. 11 functions so that in addition to current being transmitted through the solenoid 8 of the additional air valve at speeds below the connecting number of revolutions, current will also be transmitted through the resistance 28, which reduces the voltage drop both over the voltage winding 29 of the cut out relay 21 and the voltage winding 27 in the voltage regulator 26. This reduction of the voltage drop brings about hysteresis between that speed of the generator at which connecting takes place at an increasing generator speed and that generator speed at which disconnection takes place at decelerating generator speeds, in a manner such that the disconnecting speed remains unactuated, whereas the connecting speed may be augmented to rather an arbitrary value by a suitable selection of the resistance 28. This is of importance for the reason that many engines, when the additional air valve opens at low speed race up momentarily because of combustion of the frequently rather considerable fuel quantities collected in induction passages and crank cases at the deceleration of the engine from high speeds with a closed gas throttle valve.

6

Arrangements that do not comprise the modification with the additional contact 25 and the resistance 28 will therefore have idling speeds oscillating up and down in several spells during the opening and the closure of the additional air valve, before the surplus fuel has had time to become combusted. By a suitably chosen hysteresis between the connecting and disconnecting speeds the engine may be permitted, after the additional air valve has been opened, to race up for a moment, without the valve being shut again. The surplus fuel is then consumed in a moment at a certain increase of the speed of the engine. After that, the engine speed drops to normal idling operation with additional air.

In the arrangement according to FIG. 17, the resistance 28 of the voltage winding 27 of the voltage regulator has been replaced by the solenoid 8 of the additional air valve. To enable adjustment of the resistance to a suitable value, a resistance 35 may be connected in parallel to the winding, as is shown by dash lines. Consequently, no additional contact 25 is called for in this circuit, such as is used in the circuit according to FIG. 11.

In the arrangement according to FIG. 18, the generator is provided with a voltage and current regulator 26 having a current winding 37, one end of which being connected between the current winding 38 of the cut out relay 21 and the plus-pole of the generator. The regulator is provided with a movable contact 39 which vibrates between two fixed contacts 40 and 41. The field winding 42 of the generator 20 is connected between the plus-pole of the generator and the movable contact 39 of the regulator. The plus-pole of the generator is also connected to the fixed contact 41, to which the other end of the current winding 37 of the regulator 26 is connected. The regulator is provided with a regulator resistor 30, the one end of which being grounded and the other end of which being connected to one end of the voltage winding 27 of the regulator, and with a regulator resistor 43 which is connected between the movable contact 39 and the fixed contact 40 of the regulator, the fixed contact 40 also being grounded. In this known electric regulator system the solenoid 8 of the additional air valve together with a switch 16 closed by means of the gas pedal under idling speeds is connected in parallel to the field winding 42 of the generator. By this system it is possible by adequate adjusting of the spring and magnetic air gap of the additional air valve to cause the additional air valve to open during the decreasing of the high speeds of the engine and at closed throttle valve. By also adjusting the air gap at open additional air valve, it is possible, as stated above, to keep the additional air valve open down to such speeds where there is a risk of the engine stopping if additional air is supplied, e.g. if the engine is very cold or the like. Besides the simple design the present system has the advantage of the idling system being usable at speeds higher than the connecting speed of the generator.

The invention is not limited to the embodiments described above and shown in the drawings, but may be varied in its construction and details within the scope of the invention. Thus the additional air valve need not be arranged directly on the intake manifold but may have an arbitrary position and be connected to the intake manifold by means of a pipe conduit. There may be more than one additional air valve on the intake manifold, should more than one air port be found to be necessary. The valve may also be located sideways, separated from the intake manifold and have its outlet conduit connected at a suitable point on the intake manifold.

What I claim is:

1. A multiple cylinder two-stroke internal combustion engine comprising an intake manifold positioned to give uneven distribution of fuel between the engine cylinders at idling speeds whereby certain cylinders fire unevenly or not at all due to insufficient fuel supply and certain cylinders fire unevenly or not at all due to overrich mix-

ture, said intake manifold having at least one extra air supply port therein offset with relation to the normal intake from the carburetor of said engine to a position adjacent cylinders firing irregularly or not at all at idling speeds due to insufficient fuel supply and remote from cylinders firing irregularly or not at all at idling speeds due to overrich mixture, a valve positioned to control the extra air supply port in said intake manifold, means operatively associated with said valve for opening it only at idling speeds, and means for automatically operating said valve opening means only at idling speeds, whereby cylinders firing unevenly or not at all at idling speeds due to overrich mixture are given the proper amount of extra air to create a readily combustible mixture and cylinders firing irregularly or not at all at idling speeds due to insufficient fuel supply are given such an amount of extra air as to create non-combustible mixture, this extra air, apart from creating non-combustible mixture increasing the pumping losses in the non-firing cylinders, thus increasing the braking power on the cylinders given the readily combustible mixture.

2. A multiple cylinder two-stroke internal combustion engine comprising an intake manifold positioned to give uneven distribution of fuel between the engine cylinders at idling speeds whereby certain cylinders fire unevenly or not at all due to insufficient fuel supply and certain cylinders fire unevenly or not at all due to overrich mixture, said intake manifold having at least one extra air supply port therein offset with relation to the normal intake from the carburetor of said engine to a position adjacent cylinders firing irregularly or not at all at idling speeds due to insufficient fuel supply and remote from cylinders firing irregularly or not at all at idling speeds due to overrich mixture, a valve positioned to control the extra air supply port in said intake manifold, said valve being adapted normally to close the port, a solenoid operatively associated with said valve for opening it and means responsive to the speed of the engine for energizing said solenoid only at idling speeds, whereby cylinders firing unevenly or not at all at idling speeds due to overrich mixture are given the proper amount of extra air to create a readily combustible mixture and cylinders firing irregularly or not at all at idling speeds due to insufficient fuel supply are given such an amount of extra air as to create non-combustible mixture, this extra air apart from creating non-combustible mixture increasing the pumping losses in the non-firing cylinders, thus increasing the braking power on the cylinders given the readily combustible mixture.

3. An internal combustion engine as set forth in claim 2, wherein said means for energizing said solenoid comprises a generator driven by the engine, a battery connected to said generator chargeable thereby, a cut out relay inserted between said generator and said battery for disconnecting said generator and said battery upon low generator voltage, and an additional fixed contact being provided in the cut out relay cooperating with the normal movable contact, one winding end of the solenoid being connected to said additional fixed contact and its other winding end being connected to ground, said movable contact of the cut out relay being adapted to make con-

tact with said additional fixed contact of the cut out relay, until the connecting number of revolutions of the generator has been reached.

4. An internal combustion engine as set forth in claim 3 wherein a resistance is connected over the movable contact of the cut out relay and its additional fixed contact.

5. An internal combustion engine as set forth in claim 2 wherein said means for energizing said solenoid comprises a generator driven by the engine, a battery connected to said generator chargeable thereby, and a cut out relay inserted between said generator and said battery for disconnecting said generator and said battery upon low generator voltage, said solenoid being connected between the cut out relay and the plus pole of the battery, said solenoid being short-circuited when the connection speed of the generator has been reached.

6. An internal combustion engine as set forth in claim 2 wherein said means for energizing said solenoid comprises a generator driven by the engine, a battery connected to said generator chargeable thereby, a cut out relay inserted between said generator and said battery for disconnecting said generator and said battery upon low generator voltage, and an auxiliary relay being inserted between the cut out relay and the battery to connect the battery to the solenoid when the cut out relay is disconnected.

7. An internal combustion engine as set forth in claim 2 wherein said means for energizing said solenoid comprises a generator driven by the engine, a battery connected to said generator chargeable thereby, a cut out relay inserted between said generator and said battery for disconnecting said generator and said battery upon low generator voltage, and a voltage regulator to control the generator voltage, said solenoid being connected between the voltage winding of the voltage regulator and an additional fixed contact in the cut out relay.

8. An internal combustion engine as set forth in claim 2 wherein said means for energizing said solenoid comprises a generator driven by the engine, a battery connected to said generator chargeable thereby, a cut out relay inserted between said generator and said battery for disconnecting said generator and said battery upon low generator voltage, and a combined voltage and current regulator to control the generator output, said solenoid being connected in parallel to the field winding of the generator.

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