H. J. PODLEŠÁK.

MIXTURE PRODUCING AND SPEED GOVERNING DEVICE FOR GAS ENGINES.

APPLICATION FILED AUG. 10, 1907. RENEWED JUNE 22, 1911.

1,014,328. Patented Jan. 9, 1912.

3 SHEETS—SHEET 1.

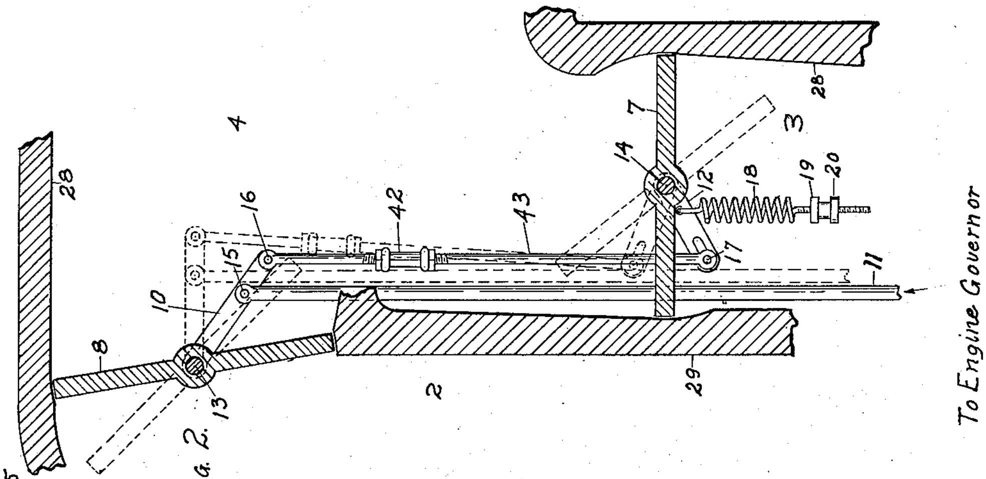

FIG. 2.

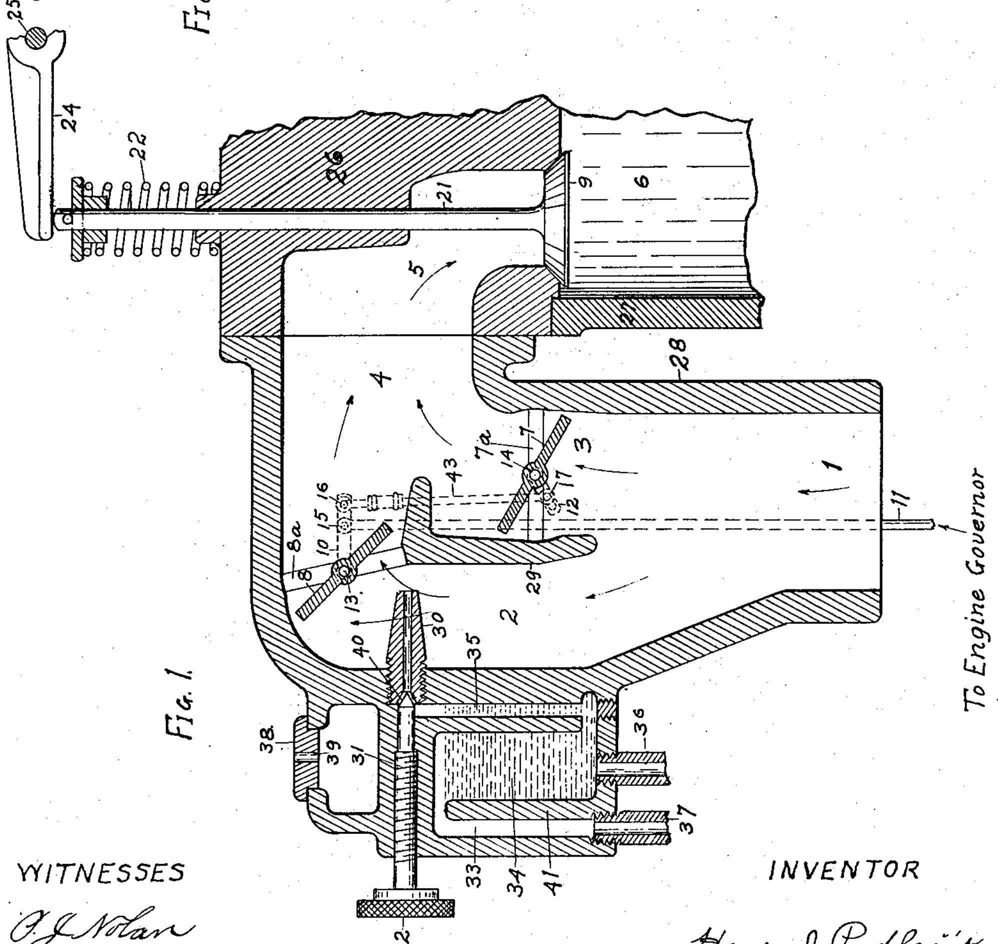

FIG. 1.

WITNESSES

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FIG. 3.

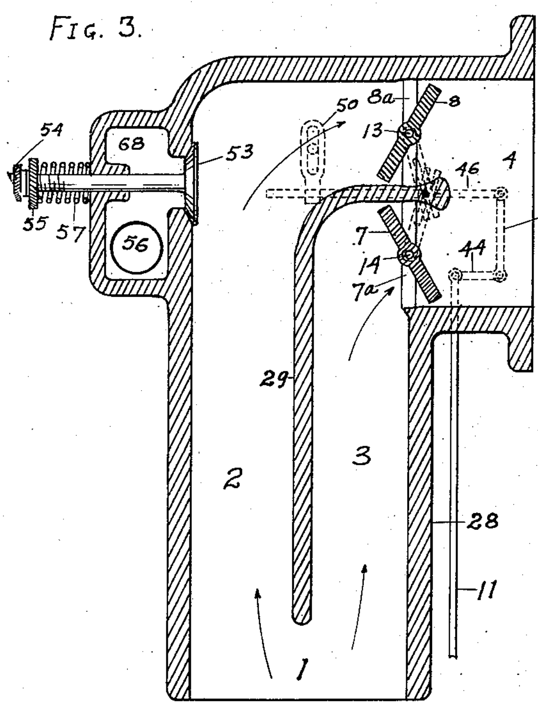


FIG. 4.

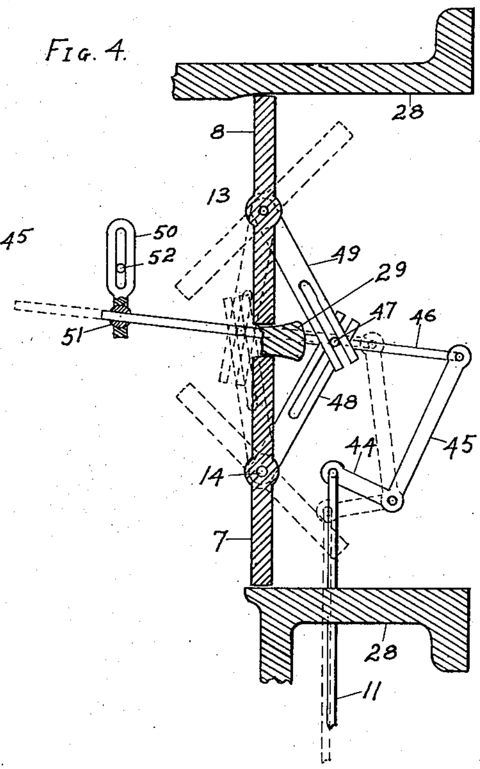
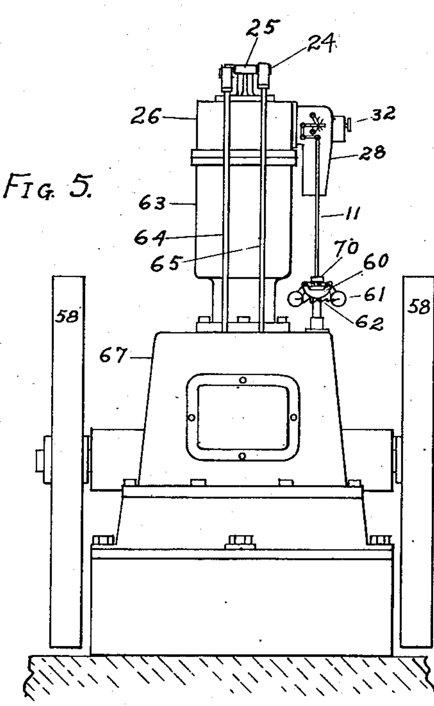


FIG. 5.



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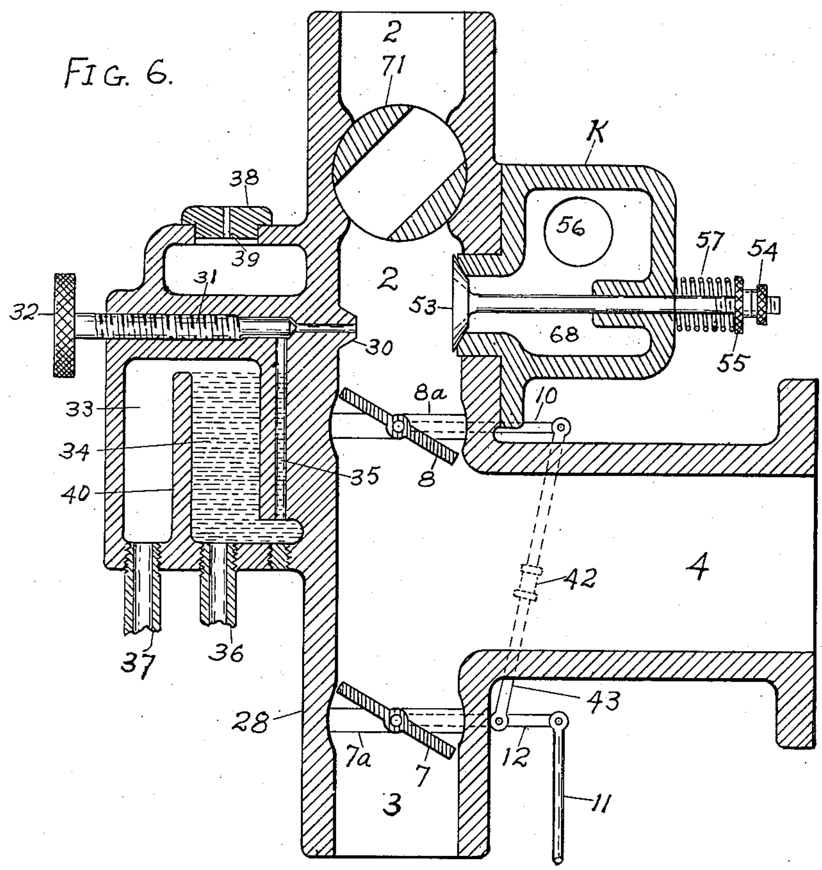
3 SHEETS—SHEET 3.

FIG. 6.



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MIXTURE-PRODUCING AND SPEED-GOVERNING DEVICE FOR GAS-ENGINES.

1,014,328. Specification of Letters Patent. Patented Jan. 9, 1912.

Application filed August 10, 1907, Serial No. 388,040. Renewed June 22, 1911. Serial No. 634,831.

To all whom it may concern:

Be it known that I, Henry Joseph Podlešák, a citizen of the United States, residing in the city of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Mixture-Producing and Speed-Governing Devices for Gas-Engines, of which the following is a specification.

My invention relates to said internal-combustion engines, or, briefly gas engines, generally, and specifically to those devices that are employed to produce, through the aid of the engine's suction, the explosive mixture charges for the engines and simultaneously regulate the speed of the engine by the throttling method, that is, by controlling the quantity of the explosive mixture for the successive charges. These devices regulate the engine's speed by varying the quantity of the explosive mixture per charge; when the quantity of mixture per charge is varied, the resultant compression is varied and hence also the mean effective pressure, acting during the working stroke, is varied; the turning force is thus varied, proportionate to the power required of the engine. The devices of this character are commonly known as throttling governors, or regulators, though sometimes also as the volume-governor. The throttling valves, or mechanisms, in these governors are preferably operated by hand when a variable speed is desired, but when the speed of the engine is to be maintained uniform, the said valves are operated by a governor driven by the engine.

The object of this invention is to provide means whereby the proportions of fuel and air comprising the mixture are varied when the quantity, and hence compression, is varied, the variations in the proportions of fuel and air for the charge being in such relation as to obtain a mixture that is most suitable for the degree of compression simultaneously obtained. It is well-known to those familiar with the operation of gas engines, that, to obtain best results and economy in operation, the mixtures employed must be comparatively richer in fuel when low compression is obtained, or employed, than when the higher compressions are obtained, or employed.

The object of my invention is to produce explosive mixtures in which the fuel constituent of the mixture is automatically varied, and in such relation to the degree of pressure to which the mixture is compressed, as to obtain the best results and economy in operating gas engines. By thus varying the proportional composition of explosive mixture, I overcome the difficulties, such as back firing, sooting up of the engine's valves, the igniter, etc., met with in the present devices, in which the proportions of fuel and air, comprising the mixture, remain unchanged throughout the range of controlling the quantity of mixture fed.

With the present devices when it is desired to vary the proportions of fuel and air, either the valve controlling the fuel supply, or the one, if provided, controlling the air supply, is readjusted by hand, or, both are at the same time readjusted. Now, if these adjustments are such that a proper mixture is obtained when the engine is operating under heavy load, a comparatively high compression being then obtained, that mixture will be too lean, in fuel, for the reduced compression, obtained when the load on the engine is diminished; under these latter conditions, the mixture will burn slowly, produce back firing or explosions in the mixing chamber of the device and much disturb the proper operation of the device and hence of the engine; furthermore, such mixture is ignited with great difficulty; whenever, during operation of a gas engine, this back firing appears, the engine attendant readjusts the valves so as to obtain a richer mixture, such as will be most suitable for the reduced compression. But this last adjustment of the valves will give too rich a mixture when the load is again increased; too rich mixture produces not only soot, which clogs the engine valves, igniter, etc., but also loss of power, waste of fuel and difficulty in ignition. I overcome these difficulties and attain other advantages, which will hereinafter appear, by constructions illustrated in the preferred forms in the accompanying drawings, wherein:

Figure 1 is a sectional elevation through one form of my device and through a portion of a cylinder head of a gas engine, a portion of whose combustion chamber is also and similarly shown; as shown the device is arranged to use liquid hydrocarbon fuels. Fig. 2 is a detached detail of Fig. 1 showing the throttling valves and the mechanism for operating these in enlarged scale. Fig. 3 is a sectional elevation of another form of my device, as shown the device is arranged to use gaseous fuels. Fig. 4 is a detached detail, enlarged, showing the throttling valves and the operating mechanism. Fig. 5 is an end elevation of a stationary gas engine provided with my device, the throttling valves of which are operated by the engine's governor. Fig. 6 is a sectional elevation of my device as arranged to use liquid fuels and gaseous fuels alternately, or simultaneously, as may be desired.

In Fig. 1, 26 is a cylinder head, containing the mixture inlet passage 5, and the inlet valve 9, which is held normally closed by spring 22, and suitably opened by valve lever 24; the cylinder head 26 is attached to the engine cylinder 27, directly over the combustion chamber 6. Attached to the cylinder head is a casing 28, having an air inlet passage 1, this passage dividing into two air passages, 2 and 3, which communicate with mixture outlet passage 4 through valve-controlled ports 8^a and 7^a, respectively; these ports are formed by ridges raised in the side walls of the air passages or conduits, making it easier to fit in the valves. In the port 7^a is a double-winged valve 7, rigidly secured to a pivotal shaft 14, the bearings for this shaft being formed in the side walls of the conduit; the shaft is extended outside the casing to carry an arm 12, fixedly attached to the shaft; likewise, in port 8^a is a double-winged valve 8, rigidly mounted on pivotal shaft 13, which extends through the casing and carries an arm 10, fixedly attached to the shaft. These valves 7 and 8 control the area of effective aperture through their respective ports and by rotating the valves, by means of their shafts and arms, into different positions, (as shown in Fig. 2) different sized effective apertures through the ports may be obtained, ranging from the largest opening to a complete closing, which is shown in Fig. 2 in full lines; the dotted lines show the valves in partly open position. It will be observed that the arms 10 and 12 are pivotally linked together by a connection rod 43, (Fig. 2) and that thus the two throttling valves 7 and 8, will move simultaneously; this rod 43 is pivotally attached to arm 10 at 16, and to arm 12 at 17. The rod 43 is constructed so that the distance between the pivot centers 16 and 17 can be varied, by changing the length of the rod through means of the turnbuckle 42; the purpose of this adjustment is to facilitate obtaining any desired angular relation of one valve to the other with respect to their closing position; for example, it may be desirable, on account of condition of fuel, etc., to have the valve 7 close somewhat earlier than the valve 8 closes; to obtain this condition, the rod 43 would be adjusted to be somewhat longer than would be necessary for the condition where both valves were to close simultaneously. A further adjustment is provided for the purpose of obtaining relatively faster, or slower, rate of movement of valve 7, in correlation with the rate of movement of valve 8; this adjustment is provided for by slotting the end of arm 12, where the pivot 17 is engaged; by securing this pivot 17 at different positions in the slot, different effective lengths of the arm, operating the valve 7, are obtained; it will be apparent that when the effective arm on valve 7 is changed and the effective arm on valve 8 remains the same, the relative rate of movement of the two valves will be changed.

The purpose of the above adjustment, namely, to secure earlier closing of one valve than of the other, or, to secure relatively faster movement of one valve than of the other, or, to secure both conditions simultaneously, is to facilitate obtaining any desired variation of relative degree of vacuum, hence draft, in the air conduits 2 and 3, during the suction stroke of the engine. The object is to gradually obtain a relatively higher degree of vacuum in the air conduit 2 (into which the fuel is charged or fed) than in the air conduit 3 as the throttling valves are moved toward closing position and are thus reducing the quantity of mixture, and hence reducing the compression; by so increasing the degree of vacuum, or suction, in conduit 2, proportionately more fuel is drawn in for the mixture as the compression is reduced, the above adjustments being so made that the variations in proportion of fuel and air are in such correlation with the degree of compression, at any moment obtained, that the mixture obtained is the most suitable one for the compression simultaneously obtained. It will be understood by those familiar with operating gas engines, that by means of these above adjustments, together with a suitable initial adjustment of fuel supply, the suitable and desirable variations in the proportions of fuel and air, in the mixtures, will be obtained automatically, and for almost any range in variation of speed, or of load.

Referring now again to Fig. 1, 30 is a spraying nozzle, positioned in air conduit 2, and extending into the casing wall where it communicates with a fuel inlet passage 35, through a valve-controlled port 40; the fuel inlet passage communicates with a liquid fuel reservoir 34, to which the fuel is supplied through pipe 36, any surplus of fuel overflowing the bridge-wall 41, into conduit 33 and from there through a pipe 37, the liquid fuel in the reservoir 34 is thus kept at a constant level, or head. The part or valve seat 40 is controlled by a needle valve 31, this being adjustable so that different size free openings through port 40 may be obtained to accommodate different conditions of fuel, atmosphere, etc. The arrangement just described is one of a liquid fuel feeder, for gasolene engines, now in quite general use. I prefer to use this fuel feeder as it gives very satisfactory service; however, any form of liquid fuel feeder in which the feeding operation is dependent, more or less, on the engine's suction can be used in combination in my device.

The operation of the fuel feeding device before described, in combination with my device, is this: The engine being in motion, a partial vacuum is created by its piston during the suction stroke; the moment the inlet valve 9 is opened, this partial vacuum is extended into the conduits 4, 2 and 3, and 1, and a quantity of air will be drawn in through these conduits; when there is partial vacuum in conduit 2, and the needle valve 31 is open, the liquid fuel will be drawn up (or rather pushed up by the atmospheric pressure acting on the liquid in 34, forcing it up through 35, 40 and 30) into the preliminary mixture conduit 2, through nozzle 30; the quantity of fuel so drawn up will depend upon the duration of the suction, the degree of vacuum created, and the size of free opening in port 40, the level, or head, of the liquid remaining constant; the liquid so fed is vaporized and commingles with the air rushing through the conduit 2 forming a comparatively rich preliminary mixture which is diluted in the conduit or mixing chamber 4 by air, admitted through conduit 3, to such degree as to form a proper explosive mixture for the charge.

The operation of my mixture-producing and speed-regulating device, shown in Fig. 1, is best explained in connection with a stationary gas engine whose speed is to be maintained uniform, in which case the throttling valves 7 and 8 are operated by the engine's governor, through suitable connections, as shown in Fig. 5, for example. The connection for operating the throttling valves by the governor is effected through rod 11, one of whose ends is pivotally secured to arm 10 at 15, and the other end suitably connected to the governor mechanism, whereby the rod 11 may be given reciprocating movement as the speed of the engine, and hence of the governor, tends to vary; as the speed varies the governor balls 61 are caused to fly into different positions, thus imparting a reciprocating movement to a loose sleeve 70, to which the rod 11 is suitably connected. The adjustments of the connections between the governor and the throttling valves is such that the valves are open to such extent as to admit a full charge before the engine attains the desired speed; the action of the governor upon rod 11 is such that a variation of small percentage of the engine's speed will suffice to give sufficient movement, to the rod 11, to operate the valves to throttle or vary the quantity of mixture from the largest to the smallest requisite, according to the load.

The starting of a gas engine provided with my throttling governor is done in any of the usual ways, and the cyclic operations of inhaling the charge, compressing, igniting and expanding, and exhausting, are also the usual. The difference in action of my device as compared with the similar present devices, is in automatically varying the proportional composition of the mixture with the variations in degree of compression, the variations in degree of compression being effected by the throttling valves, these varying the quantity of mixture per charge. It will be noted, from a reference to Fig. 1, that the stream of air, inhaled during the suction stroke through the device, is divided, a part passing through conduit 2 and another part through conduit 3; now when the throttling valves are in such position, of opening as to permit a full charge, the greatest quantity of mixture to be inhaled by the engine, the needle valve, or fuel valve, 31, is adjusted to permit a proper quantity of fuel to be drawn in, by the degree of vacuum then in conduit 2, to form a mixture most suitable for the compression then obtained; if now the speed of the engine tends to rise above the normal, the governor operates the valves 7 and 8 to constrict or reduce the area of free aperture through their respective ports; by this reduction of free aperture in the air passages the quantity of air that it is possible to pass through in a given time, as the duration of suction stroke at or near normal speed of engine, is reduced; the resulting compression is lowered, and also the degree of suction in conduits 2 and 3 is lowered, and hence also the quantity of fuel drawn in is lessened; in my device the lessening of the quantity of fuel is not in uniform proportion with the lessening of the quantity of air as it is in the present devices; by the action of the throttling valves 7 and 8, of my device, (which action, of simultaneously disproportionately varying the free apertures through ports 7^a and 8^a to obtain relatively higher degree of vacuum in conduit 2 as the free apertures are being reduced and vice versa, has been herein explained) such relation of the degree of vacuum in conduits 2 and 3 is obtained that proportionately more fuel will be drawn in as the quantity of air for the charge, and hence the compression, is reduced. Again, should now the speed of the engine tend to fall below the normal, the governor will so operate the valves as to increase the free apertures through their ports, thus increase the quantity of the air charge, and hence, also the compression, but now the proportion of fuel will be decreased. Thus the proportional composition of the mixture will be varied when the compression is varied, and in such degree as to obtain the best results and economy in operation; the requisite degree in the variation of the proportions of fuel and air is attained by making suitable adjustment of rod 43, in length and in the position of point 17 in the slot of arm 12, as already explained.

In Fig. 2 a spring 18 is shown; one end of this spring is secured to arm 12, the other passing through a lug 19, suitably cast on or fastened to, the outside of the casing, and having a nut 20, which rests against the lug 19, for adjusting its tension; the primary function of this spring is to keep the slack, or lost motion, in the connections between the valves and the governor always taken up in the same direction, to secure uniform action of the valves when the rod 11 is moved back and forth, to thus secure closer regulation of speed. As shown, this spring 18 will, by its tension, tend to close the valves, thus acting against the governor-ball springs 62, (Fig. 5) and with the centrifugal force of the governor balls. If the spring 18 were so placed that its action would tend to open the valves, the primary function would still be obtained, though the tension on the governor-ball springs 62 would have to be reduced, to obtain same speed on engine as before, since now the spring 18 would act against the centrifugal force of the governor balls, which force is also acted against by springs 62. It will also be apparent that the speed of the engine can be changed, to some extent, by varying the tension on the spring 18, and that this can be done while the engine is in motion. The initial adjustments to obtain the desired speed are made in the adjustments provided for in the governor and its connections to the valves.

In Fig. 3 is shown a modification employing different valve actuating mechanism, which is more clearly shown in Fig. 4. Here the valves 7 and 8 derive their movement through their respective arms 48 and 49, which are slotted to receive a pin 47, in rod 46; this rod receives movement of the governor rod 11 through bell-crank lever 44—45; one end of the rod 46 is pivoted in arm 45, the other end is carried in ball 51, being adapted to slide in this ball 51 which is loosely carried in a socket formed in a support piece 50; this support piece is so slotted as to be adjustable, up and down; bolt 52 serves to secure the piece 50 in any desired position. It will be noted that by lowering the slotted piece 50, a lowering of the pin 47, in the rod 46, will be effected and thus the effective length of the slotted arms 48 and 49 will be changed, that of arm 48 being shortened while that of arm 49 is lengthened; the relative speeds of rotative movement of valves 7 and 8 will be changed, the valve 7 being moved relatively faster, in either direction, than valve 8 when the rod 46 is moved to and fro. Thus the same conditions will obtain as will obtain by moving pivot 17 into different positions in the slot of arm 12 of the device shown in Figs. 1 and 2; it will be noted that in the modification shown in Figs. 3 and 4 this adjustment can readily be made while the engine is in motion. The adjustment of the relative angular advance of one valve with respect to that of the other is here effected in the fastening of the slotted arms to their shafts, and may be by means of set screws, or by means of a supplemental arm rigidly secured to one of the shafts, preferably shaft 14, and adapted to pivotally carry the slotted arm and some suitable means to secure these arms, the supplemental and the slotted, together in the desired position of adjustment; this last arrangement may also be made so that the adjustment may be made while the engine is in motion. It will be seen that same adjustments, correspondingly, in the valve actions of the form shown in Fig. 3 can be made as in the form of the device shown in Fig. 1; the same conditions of relative degree of suction in air conduits 2 and 3 are thus obtained in both forms.

The form of my device shown in Fig. 3 is shown adapted to use gaseous fuels. The gas is suitably supplied through a pipe (not shown) having a regulating and cut off valve, and communicating with chamber 68 through port 56; this gas chamber 68 communicates with air conduit 2 through a port controlled by a valve 53. This valve 53 normally closes the port, the valve being held against its seat in the port by a spring 57; the tension of this spring is preferably so adjusted, by means of knurled nuts 54 and 55, that the pressure of gas supply, acting to open the valve, is just barely counterbalanced when there is no partial vacuum in conduit 2; thus adjusted, it will permit valve to readily open, to permit feeding of gas, as soon as a partial vacuum is created, in conduit 2, during the suction stroke. Thus adjusted, the valve 53 will operate as a check valve, on the gas, and also as a pressure regulator to a certain extent. Where the gaseous fuel is supplied by a suction gas producer, the valve 53 serves to prevent air from rushing into the gas pipe, after the completion of suction stroke, there being a partial vacuum in such gas producer plant during operation. Where the gas supply is under pressure and an effective pressure reducing and regulating device is employed, the valve 53 may be dispensed with, to simplify the construction; however, it is advantageous to include this valve in my device, even where the gas pressure regulating device employed is capable of reducing the gas pressure to that of atmosphere. The mixture producing operations of the modification in Fig. 3 are similar to those in the form shown in Fig. 1; the relative degree of vacuum in conduits 2 and 3 is varied in the same manner, being relatively increased in port 2, to draw in or inhale, proportionately more fuel, when the quantity of the charge, and hence the compression, is decreased. Thus it will be apparent that the liquid fuel feeder shown in Fig. 1 can be substituted for the gaseous fuel feeder shown in Fig. 2, and vice versa. Also, that the fuel feeders need not be cast integral with the device, but that these can be made separable and interchangeable.

Fig. 5 shows a stationary single cylinder gas engine, having my mixture-producing and speed-regulating device attached to it. As here shown, the form of the device is that shown in Fig. 3, but having a liquid fuel feeder, to use such fuels as alcohol, gasolene, benzol, distillate, etc. 26 is the cylinder head in which are the exhaust and the inlet valves; these valves are operated in the usual way, by cams, on a cam shaft, within crank chamber 67 and driven from the crank shaft 59, through means of valve rods 64 and 65 and suitable valve levers. The igniter and its mechanism may be of any desired form. The governor 60, suitably driven from the crank shaft, actuates the rod 11 through suitable connections, causing this rod to move up or down as the speed varies. The rod 11 by its movements operates the throttling valve mechanisms in such manner as to obtain the valve actions, before described, namely, to control the quantity of each successive charge of mixture varying the quantity in such relation to the load as to maintain a uniform speed, and to control the proportions of fuel and air comprising the mixture for the successive charges, varying the proportion in such relation to the quantity in the charge as to obtain uniform and most economical operation of the gas engine.

In Fig. 6 is shown a modification of my device arranged to use liquid fuels and gaseous fuels, either simultaneously or interchangeably. The liquid fuel feeder shown is similar to the one employed in the form of my device shown in Fig. 1, and the gaseous fuel feeder is similar to the one shown in Fig. 3, except that it is built in a separate casing K, which is suitably secured to the main casing 28. In the preliminary mixture conduit 2 is a plug valve 71, by means of which the air supply to this conduit may be regulated, which it may be desirable to do in cases where the fuels used interchangeably differ considerably in their respective heat values, as for instance, alcohol used interchangeably with producer gas.

Although I show my device attached to a single cylinder gas engine, it is obvious that the device can readily, by means of a suitable manifold, be attached to engines having two or more cylinders. Also, that instead of the double-winged throttling valves, which I prefer on account of their simplicity and their inherent balancing when under the air pressure, other forms of valves, such as the mushroom or puppet valves, piston valves, slide valves, etc., may be employed, if desired. It is understood that the throttling valves should preferably be so designed and arranged that their action is not affected much by the action of the variable suction. Such details as these, however, are matters of design for any particular adaption and for manufacture, and may be varied and made to suit different conditions. For example, it may be desired to adapt my device to use liquid fuels and gaseous fuels interchangeably, or even simultaneously; this condition would be met by suitably proportioning the various conduits, ports, and parts in my device and suitably equipping it with two, or more, fuel feeders, all to feed fuel into conduit 2, as shown in Fig. 6. This air conduit could be divided into two conduits, if desired, and a throttling valve placed in each division.

When the fuels that are to be used interchangeably differ much in their respective heat values, as, for instance, alcohol used interchangeably with blast furnace gas, or producer gas, some means of regulating the air supply should be provided, for instance, a plug valve, preferably in the conduit 2, or in at least one of them if more than one are used, and ahead the fuel supply port, as in Fig. 6, for example, so that the air supply can be throttled and reduced, to compensate for the necessary extra large quantity of lean fuel (blast furnace gas, etc.) when this is to be used, and to again increase the supply of air when the richer fuel is to be used. Those familiar with the art understand that when the lean gases, such as producer gas, are used, the explosive mixture comprises about equal quantities of the gas and air, while when richer fuels, such as natural gas or alcohol vapor, the relative quantities are in the neighborhood of one of fuel to nine of air; hence the necessity of regulating the air supply when such fuels are to be used interchangeably and the engine desired to deliver its greatest power. In suction gas producer plants, the heat value of producer gas is apt to vary during operation, the heat value being higher just after charging in fresh coal; hence it is also desirable to be able to regulate the air supply while this fuel is being used; of course, the gas supply could here be regulated by a valve to compensate for the variations in heat value of the gas, but it is obvious that then the charges will be relatively smaller than when the air supply is regulated. However, such arrangements of parts in my structure as will be most suitable for any particular condition, or conditions, and the many advantages of my device, will readily occur to those familiar with the art.

What I claim as my invention, and desire to secure by Letters-Patent, is:

1. A mixture-producing and speed-governing device for gas engines, comprising, in combination, plurality of air conduits each communicating with air supply, a port in each said air conduit, a valve in each said port and adapted to vary the free opening therethrough, means for actuating the valves to vary the said openings simultaneously and disproportionately, a fuel inlet port controlled by an adjustable valve and adapted to feed fuel into one of said air conduits, means for supplying fuel at constant pressure to the fuel inlet port, means to supply air, and an outlet conduit, in communication with the air conduits, for the mixture of fuel and air, substantially as set forth.

2. A mixture-producing and speed-regulating device for gas engines, comprising, in combination, a casing having two air conduits therein, a valve in each said air conduit and adapted to vary opening therethrough, means to effect simultaneous action of the valves whereby said openings are varied in size, means to obtain variation of opening relatively faster in one of the openings than in the other, a fuel inlet port suitably adapted to feed fuel into one of said air conduits, a fuel supply, an air supply, and an outlet passage for the mixture of fuel and air, substantially as set forth.

3. In a mixture-producing and speed-governing device for gas engines, the combination of an air supply, a fuel supply, plurality of air conduits, an adjustable fuel port adapted to convey fuel from the fuel supply into one of said air conduits, a valve in each air conduit and adapted to vary free aperture therethrough, means for simultaneously operating the valves, means operative to regulate relative rate of movement of the valves, means to adjust correlative positions of the valves, and an outlet passage for the mixture of fuel and air, substantially as set forth.

4. In a mixture-producing and speed-governing device for gas engines, the combination of plurality of air conduits in communication with an air supply, valve-controlled fuel port adapted to convey fuel from a fuel supply to one of the air conduits, an outlet passage adapted to receive the air and fuel mixture from the air conduits and convey same to the inlet port of a gas engine, means operative to vary and control the quantity of mixture passing through the outlet passage and to vary, smultaneously with variations of quantity of mixture, the relative quantities of air passing through each air conduit, and means to operate the said means for varying and controlling the quantity of mixture.

5. In a mixture-producing and speed-controlling device for gas engines, the combination of an air supply, fuel supply, plurality of air conduits, each communicating with the air supply, valve-controlled fuel port communicating the fuel supply with one of the air conduits, an outlet passage in communication with the air conduits, means to reduce the air pressure within the outlet passage and the air conduits to induce a flow of air and fuel therethrough, and operative means for varying and controlling the reduction of the air pressure within the air conduits and the outlet passage and for effecting a relatively disproportionate reduction of air pressure within each of the air conduits.

6. In a mixture-producing and speed-governing device for gas engines, the combination of an air supply, fuel supply, plurality of air conduits communicating with the air supply, valve-controlled fuel port for admitting fuel from the fuel supply to one of the air conduits, mixture outlet passage communicating with the air conduits, and means for controlling the quantity of mixture of fuel and air passing through the outlet passage and for controlling, simultaneously with the controlling the quantity of mixture, the relative quantities of air passing through each air conduit.

7. In a mixture-producing and speed-governing device for gas engines, the combination of an air supply, plurality of air conduits each in communication with the air supply, plurality of fuel supplies each adapted to supply fuel into one of the air conduits through a valve-controlled fuel port, outlet passage adapted to receive the air and the mixture of fuel and air from the air conduits and convey the resultant mixture into the combustion chamber of a gas engine, and operative means for varying and controlling the quantity of mixture of fuel and air passing through the outlet passage and for varying, simultaneously with varying the quantity of mixture, the relative quantities of air passing through each air conduit.

8. In a mixture-producing and speed-governing device for gas engines, the combination of plurality of air conduits communicating with an air supply, plurality of valve-

controlled fuel ports communicating one of the air conduits with fuel supply, outlet passage affording communication between the air conduits and the combustion chamber of a gas engine, a gas engine whose mechanisms are adapted to reduce the air pressure in its combustion chamber, the outlet passage, and the air conduits below the atmospheric pressure and thus inhale charges of mixture of fuel and air, and operative means for varying and controlling the quantity of the mixture for the charges and for effecting, simultaneously with varying the quantity of mixture for the charges, a relatively disproportionate reduction of air pressure in the air conduits.

9. In a mixture-producing and speed-controlling device for gas engines, the combination of a gas engine, a plurality of air conduits each communicating with an air supply, valve-controlled fuel port communicating one of the air conduits with fuel supply, outlet passage affording communication between the air conduits and the inlet port of the engine, means for varying and controlling the quantity of mixture inhaled by the gas engine during the suction stroke and for disproportionately varying the quantity of air passing through each air conduit when the quantity of mixture is varied, a governor driven by the gas engine, and an operative connection between the governor and the means for varying and controlling the quantity of mixture for the charges.

10. The combination of an engine, with a mixture producing and speed governing device therefor, said device comprising means for supplying fuel, means for supplying air to the fuel before the resulting mixture is taken into the engine, and automatically operated means for simultaneously decreasing the volumes of air and fuel in such relation to each other as to produce an enriched resulting mixture and for simultaneously increasing the volumes of air and fuel in such relation to each other as to produce a weakened resulting mixture.

11. The combination of an engine, with a mixture producing and speed governing device therefor, said device comprising means for supplying a preliminary mixture of fuel and air, means for supplying air to the preliminary mixture before the resulting mixture is taken into the engine, and automatically operated means for simultaneously decreasing the volumes of air and preliminary mixture in such relation to each other as to provide an enriched resulting mixture and for simultaneously increasing the volumes of air and preliminary mixture in such relation to each other as to provide a weakened resulting mixture.

12. A mixture producing and speed governing device for engines comprising a mixing chamber, means for supplying a preliminary mixture of fuel and air to the mixing chamber, means for supplying air to the mixing chamber to dilute the preliminary mixture, valves controlling the supplies of preliminary mixture and of air to the mixing chamber, and means for automatically operating the valves simultaneously for enriching while diminishing the volume of the resulting mixture in the mixing chamber or for weakening while increasing the volume of the resulting mixture in the said chamber.

13. A mixture producing and speed governing device for engines comprising a mixing chamber, separate conduits discharging into the mixing chamber and open to the atmosphere, means in one of the conduits for producing a preliminary mixture of fuel and air, mechanically connected swinging valves at the discharge ends of the conduits for controlling the volumes of air and preliminary mixture delivered to the mixing chamber, and means for simultaneously operating the valves.

14. In a controlling device for internal combustion engines, the combination of a mixing chamber, separate passages leading into the chamber and both open to the atmosphere, means on one of the passages for supplying fuel to the air drawn therethrough, and valves between the inner ends of the passages and the mixing chamber and mechanically connected to swing together to or from open position for simultaneously controlling the air and fuel drawn into the mixing chamber.

15. In a controlling device for internal combustion engines, the combination with the valved inlet port of an engine, of a mixing chamber leading to the port, separate passages communicating with the chamber and open to the atmosphere, means in one passage for admitting fuel thereto to mix with the passing air, a valve controlling each passage, such valves being connected together to simultaneously close or simultaneously open and so related as to cut down the flow through the passages disproportionately for effecting an enriched mixture when the quantity for each charge drawn into the engine is reduced and a weakened mixture when the quantity for each charge is increased, and means for operating the valves.

16. In a controlling device for internal combustion engines, the combination of a mixing chamber, an air supply passage for supplying the main volume of air to the mixing chamber, two fuel supply passages, means for controlling said passage for permitting fuel of different qualities to be used, and means for diluting the fuel from one of the said passages prior to its delivery to the main volume of air to maintain the proper

proportions of fuel and air in the resulting mixture.

17. In a controlling device for engines, the combination of a mixing chamber, an air supplying means for conveying the main volume of air thereto, means for supplying fuel of different qualities, valves for opening or closing the supply of either fuel, means for admitting air with the fuel to produce a preliminary mixture before reaching the mixing chamber, and simultaneously actuated valves for controlling the main supply of air and the supply of the preliminary mixture to the said mixing chamber.

18. In a controlling device for internal combustion engines, the combination of a mixing chamber, an air supply conduit discharging into the mixing chamber, a second conduit discharging into the mixing chamber, separate devices for delivering fuel to the second conduit, a valve for each device for opening or interrupting the supply of fuel, an adjustable valve for admitting air to the second conduit for diluting the fuel and producing a preliminary mixture in such conduit, and valves controlling the volume of the preliminary mixture and volume of air admitted from the conduits to the mixing chamber.

19. In a controlling device for internal combustion engines, the combination of a mixing chamber, an air supply conduit discharging into the mixing chamber, a second conduit discharging into the mixing chamber, separate devices for delivering fuel to the second conduit, a valve for each device for opening or interruping the supply of fuel, an adjustable valve for admitting air to the second conduit for diluting the fuel and producing a preliminary mixture in such conduit, valves controlling the volume of the preliminary mixture and volume of air admitted from the conduits to the mixing chamber, and means for operating the last-mentioned valves for simultaneously decreasing the volumes of air and preliminary mixture in such relation to each other as to produce an enriched mixture in the mixing chamber and for simultaneously increasing the volumes of air and preliminary mixture in such relation to each other as to produce a weakened mixture in the said mixing chamber.

20. In a mixing and controlling device, the combination of an engine, a mixing chamber from which the engine receives its charges, a preliminary mixture conduit, a manually adjustable fuel admitting valve, a manually adjustable air admitting valve, a governor actuated valve controlling the quantity of preliminary mixture supplied to the mixing chamber, and an air supplying means communicating with the mixing chamber for delivering air into the preliminary mixture supplied to said chamber.

21. The combination of an engine, a mixing chamber communicating therewith, a preliminary mixture conduit connected with the said chamber, separate manually controlled valves for admitting fuel of different qualities to the conduit, a manually controlled valve for admitting air to the conduit to dilute the fuel, a governor actuated valve for controlling the quantity of preliminary fuel mixture supplied from the conduit to the mixing chamber, and a governor actuated air supply valve for admitting air to further dilute the mixture in the mixing chamber.

22. The combination of an engine, a mixing chamber communicating therewith, a preliminary mixture conduit connected with the said chamber, separate manually controlled valves for admitting fuel of different qualities to the conduit, a manually controlled valve for admitting air to the conduit to dilute the fuel, a governor actuated valve for controlling the quantity of preliminary fuel mixture supplied from the conduit to the mixing chamber, a governor actuated air supply valve for admitting air to further dilute the mixture in the mixing chamber, and means connecting the valves together for reducing or increasing simultaneously and disproportionately the quantity of preliminary mixture and air to the mixing chamber.

23. A mixing device comprising a pair of air admitting valves, a pair of fuel admitting valves associated with one of the air valves for producing a preliminary mixture of fuel and air, a governor connected with the other air valve, and a preliminary mixture controlling valve connected with the governor actuated air valve.

24. A mixing device comprising a preliminary mixture conduit open at its outer end to the atmosphere, a fuel admitting valve of the self-closing suction type having adjusting means for holding the valve closed, a valve controlled liquid fuel admitting means in the conduit, an adjustable air admitting valve between the outer end of the conduit and the fuel admitting valve, a mixing chamber connected with the conduit, a governor controlled valve in the conduit, and means for supplying air to the mixing chamber to dilute the preliminary mixture delivered thereto from said conduit.

25. In a mixture producing and speed governing device, the combination of a pair of valves, arms thereon, an extensible and contractible connection uniting the arms, means for adjusting the point of union between the connection and one of the arms, and a speed responsive device for operating the valves.

26. In a mixture producing and speed

governing device, the combination of a plurality of valves, means for connecting the valves for simultaneous movement, a speed responsive device including a spring opposed centrifugal element connected with the valves, and a yielding means connected with and tending to hold the valve in a predetermined position and acting with the centrifugal element in one direction and in opposition thereto in the other direction.

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Witnesses:

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