No. 768,807. PATENTED AUG. 30, 1904.

E. KÖRTING.

GAS MIXING DEVICE FOR GAS ENGINES.

APPLICATION FILED JAN. 5, 1904.

NO MODEL.

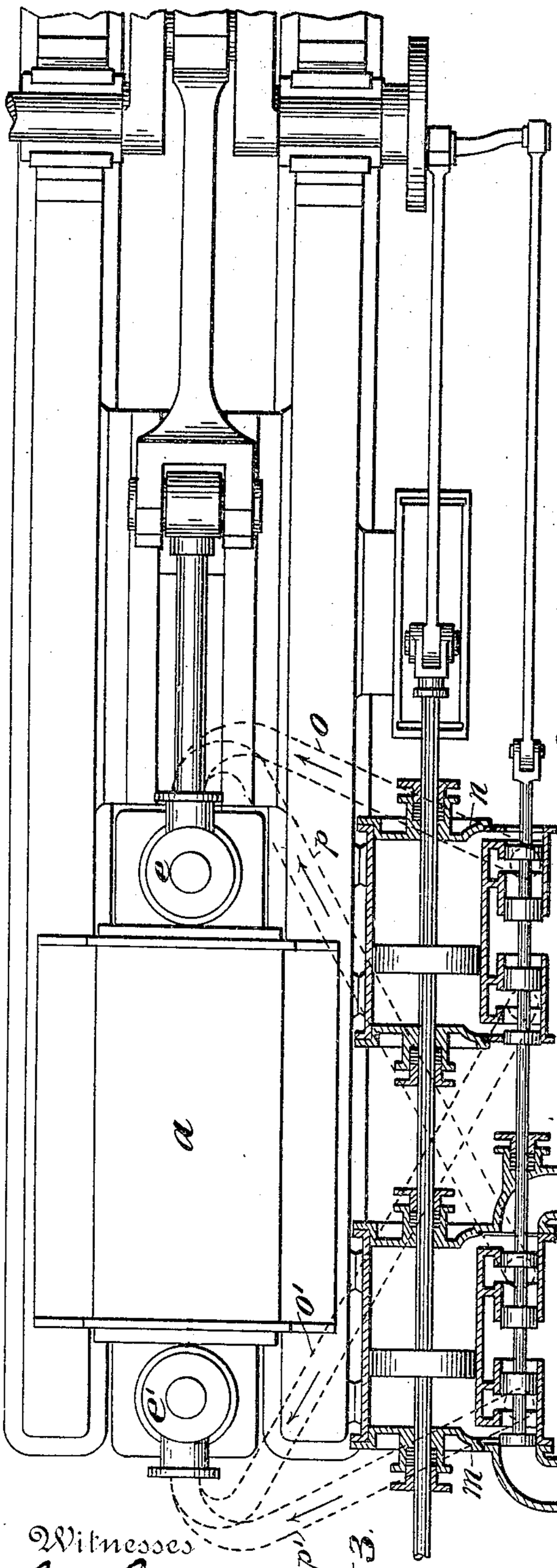


Fig. 3.

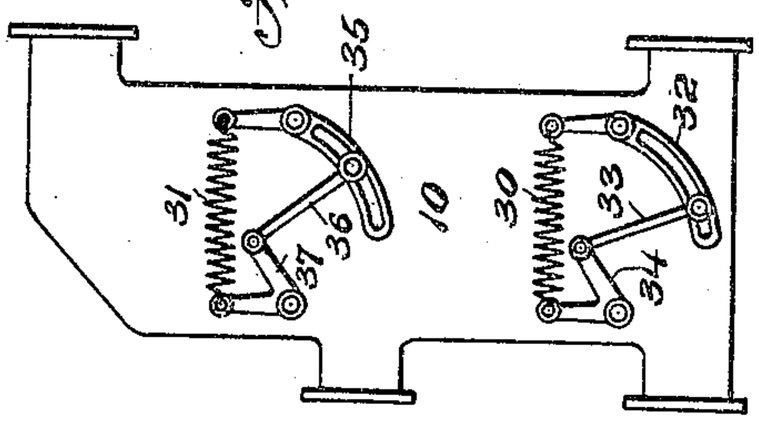


Fig. 2.

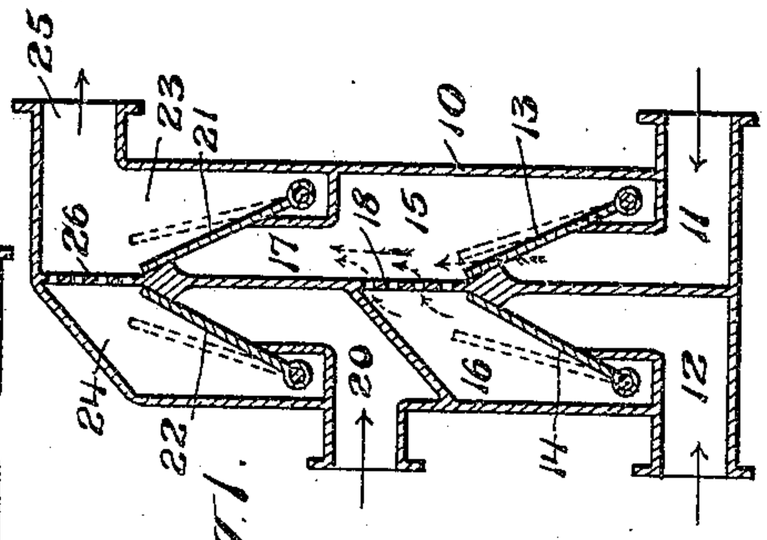
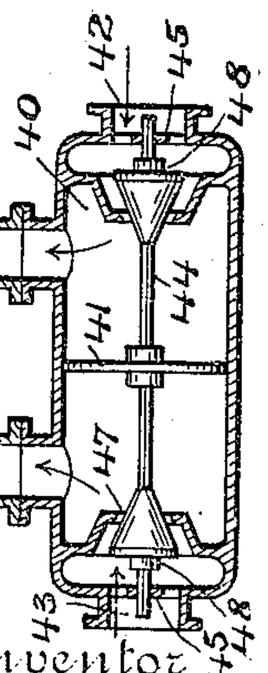


Fig. 1.



Witnesses
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No. 768,807. Patented August 30, 1904.

UNITED STATES PATENT OFFICE.

ERNST KÖRTING, OF HANOVER, GERMANY.

GAS-MIXING DEVICE FOR GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 768,807, dated August 30, 1904.

Application filed January 5, 1904. Serial No. 187,763. (No model.)

To all whom it may concern:

Be it known that I, ERNST KÖRTING, a subject of the Emperor of Germany, residing at Hanover, in the Kingdom of Prussia and Empire of Germany, have invented certain new and useful Improvements in Gas-Mixing Devices for Gas-Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to means for supplying gas-engines with an explosive gaseous mixture of a constant thermic efficiency with the use of power-gases of varying calorific values.

The power-gas usually used for operating gas-engines is the manufactured or producer gas, which has a comparatively low calorific value. It is often desirable, however, to make use of a gas of comparatively high calorific value, such as natural gas, which has a value of about nine hundred heat units per cubic foot. The value of ordinary producer-gas is about one hundred and fifty heat units per cubic foot. Such gases of high calorific value when mixed with a combustion-supporting gas, such as air, to form an explosive mixture produce a mixture of such character that the danger of preignition is so increased as to necessitate the engine being constructed and proportioned to operate with a lower compression than is desirable and than is provided for when power-gas of a lower calorific value is used. Such high calorific value gases also require a different proportion of air for forming the explosive mixture, and this necessitates a difference in the construction of the devices for supplying the explosive mixture to the engine-cylinder. Especially is this so in the case of engines such as the two-cycle engine described in my United States Patent No. 746,342, dated December 8, 1903, in which the power-gas and air are supplied by separate pumps.

The object of my present invention is to enable natural gases or other power-gases of high calorific value to be used without danger of preignition, while permitting the engine to be operated with the same high compression that is used with producer-gas and the same feeding means for supplying the explosive mixture to the engine-cylinder as is used for power-gas of low calorific value. To this end I employ an engine constructed for using a gas of low calorific value and provide means for mixing with the combustible or power gas a neutral gas in proportion to produce a mixture having the calorific value of the gas for which the engine is constructed. The proportionate amount of air required to be mixed with such mixture of reduced calorific value will be the same as the amount which would be required to be mixed with a gas originally of the same low calorific value, and the same means may thus be employed for supplying such gas and air to the engine-cylinder as would be employed for supplying any power-gas of the same calorific value and air to the engine-cylinder. As the amount of gas to be supplied to the engine-cylinder varies according to the load on the engine, means are provided for supplying varying volumes of the high calorific value power-gas and the neutral gas in constant proportions, and to provide for the use of power-gases of varying calorific values provision is made varying the proportions in which the neutral gas is mixed with the power-gas to form the gas of reduced calorific value. Any suitable neutral gas which has the property of diluting the power-gas and diminishing its property of self-ignition may be employed. Preferably, however, I make use of the exhaust-gases from the engine-cylinder for this purpose.

By my invention I am enabled to operate the same engine with power-gases of widely-varying calorific values—as, for example, natural gas or poor producer-gas.

A full understanding of the invention can best be given by a detailed description of preferred constructions embodying the same, and such a description will now be given in connection with the accompanying drawings, in which—

Figure 1 is a sectional view of a construction for supplying the explosive mixture to an engine of that class in which the mixture is drawn into the engine-cylinder or combustion-chamber by the action of the engine-pis-

ton as in the ordinary four-cycle gas-engine. Fig. 2 is an elevation of the construction shown in Fig. 1. Fig. 3 is a plan view, partly in section, illustrating the application of the invention to a two-cycle engine such as described in my said United States Patent No. 746,342.

Referring to the drawings, and first to Figs. 1 and 2, these figures show a mixing apparatus consisting of a casing 10, having inlet-passages 11 and 12 controlled and normally closed by valves 13 and 14. One of said inlet-passages, as 11, is for the power-gas and is adapted to be connected with the gas-supply, and the other of said inlet-passages, as 12, is for the neutral gas and is adapted to be connected to the neutral-gas supply. The valves 13 and 14 are preferably self-acting check-valves, which may be of any suitable form, the form shown being well adapted for the purpose, and said valves open to chambers 15 and 16, which communicate with each other and with a passage 17, leading, preferably, from the chamber 15. The communication between the chambers 15 and 16 is preferably through a partition provided with a number of openings, as shown at 18, so that the two gases will be thoroughly mixed as they pass through the passage 17. The combustion-supporting gas, as air, is admitted through an inlet-passage 20. The passage 20 and the gas-passage 17 are controlled and normally closed by means of valves 21 and 22, these valves 21 and 22 opening to chambers 23 and 24, which are in communication with each other and with an outlet-passage 25, from which the explosive gaseous mixture is drawn into the combustion-chamber of the engine. The valves 21 and 22 are preferably self-acting check-valves and may be of the same construction as valves 13 and 14, and the communication between the chambers 23 and 24 is preferably through a perforated partition 26, similar to the partition 18. The valves of each pair 13 14 and 21 22, respectively, are preferably held yieldingly in their normally closed position by means of springs 30 and 31, respectively, as shown in Fig. 2, and means are provided whereby the valves of each pair are constrained to move together in such manner that one valve of each pair cannot move without the other and the amount of opening movement of one valve of each pair will always bear a certain relation to the amount of opening movement of the other valve of each pair. Any suitable means may be provided for securing this result. As shown, the shaft of the valve 13 is provided with an arm 32, which is connected by a link 33 with an arm 34 on the shaft of the valve 14, and similarly the shaft of the valve 21 carries an arm 35, which is connected by a link 36 with an arm 37 on the shaft of the valve 22. The arm 32 is formed so as to permit the point of connection of the link 33 therewith to be adjusted toward or from the valve-shaft for changing the ratio of the amount of movement of the valves 13 and 14, and similarly the arm 35 is formed so as to provide for adjusting the point of connection therewith of the link 36 toward or from the valve-shaft for changing the ratio of the amount of movement of the valves 21 and 22.

In operation the suction of the engine will cause the valves to open, as indicated by dotted lines in Fig. 1, and the power-gas and the neutral gas will be drawn past the valves 13 and 14, respectively, and the mixture of reduced calorific value thus formed will be drawn from the passage 17 past the valve 21 to mix with the air drawn past the valve 22 to form the explosive gaseous mixture, which passes through the passage 25 to the combustion-chamber of the engine. The valve-openings are of such relative size and the valves of each pair are constrained to move together with such ratio of movement that the volume of neutral gas passing the valve 14 will bear the proper proportion to the volume of power-gas passing the valve 13 to form a mixture of the desired calorific value and that the volume of air passing the valve 22 will bear the proper proportion to the volume of gas passing the valve 21 to form the desired explosive mixture. The power-gas, the neutral gas, and the air will thus be supplied in constant proportions, though the volume of the mixture drawn through the passage 25 is varied as required to meet the running conditions of the engine, the apparatus thus supplying the several gases in constant proportions for varying volumes.

When power-gases of different calorific values are used, the proportionate amount of exhaust-gas which is mixed with the power-gas must be varied to produce a mixture of the desired calorific value. With the construction shown this result is readily obtained by shifting the point of connection of the link 33 with the arm 32, thereby changing the ratio of the opening movements of the valves 13 and 14. It will be seen that the apparatus is thus self-adjusting for varying loads or speeds of the engine and may be adjusted at will for using power-gases of varying calorific values or for changing the composition of the mixture supplied to the engine, as desired.

Fig. 3 shows the application of the invention to a two-cycle engine such as shown and described in my United States Patent No. 746,342. In such engine the air and gas are supplied to the working cylinder *a* of the engine by separate air and gas pumps, the air being supplied by an air-pump *n* through pipes *o* and *o'* and the gas being supplied by a gas-pump *m* through pipes *p* and *p'*, the pipes *o* and *p* leading to the admission-valve *e* at one end of the working cylinder and the pipes *o'* and *p'* leading to the admission-valve *e'* at the other end of the working cylinder. As explained in my said patent, the ratio of the piston area of the air and gas

pumps is equal, or nearly so, to that of the quantities of air and gas to be supplied to the engine-cylinder, and the gas-pump is provided with means whereby the piston does not commence to compress the gas in the pump-cylinder until it has made a portion of its stroke and until after the piston of the air-pump has commenced to compress the air in its cylinder. Such arrangement is for the purpose of causing the air-pump to first force air alone into the engine-cylinder and then to cause both pumps to act together to force air and gas into the engine-cylinder in proportions corresponding to their piston areas. One way described in said patent of securing such delayed compression of the gas in the gas-pump is by throttling the gas-inlet to the pump. The quantity of the gaseous mixture delivered to the working cylinder may be varied without varying the proportions of air and gas in the mixture by throttling the gas-inlet to a greater or less degree. For this purpose the gas-inlet is shown as provided with a throttle-valve *r*, and this throttle-valve may be connected to the engine-governor, so that the quantity of mixture supplied to the working cylinder will be automatically controlled, according to the load on the engine. For further description of this engine I refer to the specification and drawings of my said United States Patent No. 746,342. It is evident that as the air and gas pumps of this construction supply the air and gas to the engine admission-valve in fixed proportions the relative size of such pumps must be varied, according to the calorific value of the power-gas supplied to the gas-pump, since a power-gas of high calorific value requires a greater proportion of air to form the proper explosive mixture than does a gas of lower calorific value. By my invention I am enabled to use the same air and gas supply pumps when operating with power-gases of different calorific values by providing the engine with pumps of the proper size for a gas of low calorific value and providing means for mixing with the power-gas as it is supplied to the gas-pump a neutral gas, such means being constructed to supply the two gases in constant proportion for varying volumes as required by the pump. The means shown in Fig. 3 for mixing neutral gas with the power-gas is similar to the means shown in Figs. 1 and 2 for mixing such gases and will be understood from the description already given of the construction shown in Figs. 1 and 2. In operation the suction of the gas-pump *m* will cause the valves 13 and 14 to open and the power-gas and the neutral gas will pass the valves in proper proportions to form a mixture of the desired calorific value. Such gas of reduced calorific value will be forced by the gas-pump through the pipes *p* and *p'*, and such gas and air from the air-pump *n* will be mixed in certain proportions to form the explosive mixture. The valves 13 and 14 being constrained to move together and according to a certain ratio of movement, the power-gas and the neutral gas will be supplied to the gas-pump always in constant proportions, though the volume of the mixture passed through the pump is varied by the position of the throttle-valve *r* to meet the requirements of the engine. The power-gas, the neutral gas, and the air will thus with this construction also as supplied to the engine be mixed in constant proportions for varying volumes. As the amount of gas passing either of the valves 13, 14, 21, and 22 for any given opening of the valve depends on the pressure at which the gas is supplied to the valve, each valve should be proportioned and adjusted with regard to the pressure at which the gas is supplied thereto, and the pressure at which the gas is supplied to the valve should be uniform, or for any variation in pressure of the gas supplied to one of the valves of each pair there should be a corresponding variation of the gas supplied to the other valve of such pair. Any suitable pressure-regulating means may be provided for regulating the pressure at which the gas is supplied to the several valves. The valves of each pair are conveniently constructed to operate with gas supplied at the same pressure. In Fig. 3 there is shown a preferred form of a pressure-regulating means which is also a pressure-equalizing means, the valves 13 and 14 being constructed to operate with gas supplied at the same pressure. In the construction shown the gas-inlets 11 and 12 are connected to opposite ends of an equalizing-chamber 40, which is divided into two compartments by a piston 41, one of said compartments having an inlet 42 for the power-gas and the other of said compartments having an inlet 43 for the exhaust-gas. The piston 41 is fitted to move easily in the chamber 40 and is carried by a rod 44, arranged to move in guides 45 at either end of the chamber-casing. The piston-rod 44 is arranged to actuate two valves which control the openings of the inlets 42 and 43 to the chamber 40. Such valves are preferably cone-valves, carried by the piston-rod, as shown, and adapted to coöperate with valve-openings 46 and 47, respectively, and are placed on the piston-rod, so that when the piston is in its central position both valve-openings will be partly open. Suitable stops, as 48, are preferably provided to prevent the total closing of either valve-opening. In operation, as will be readily understood, any difference in pressure on the two sides of the piston 41 will cause the piston to move so as to move the valves to decrease the admission of gas to the end of the equalizing-chamber at which the pressure was greater and to increase the admission of gas to the other end of the equalizing-chamber.

It will be understood that an equalizing device, such as shown in Fig. 3, may be pro-

vided for the valves 13 and 14 and also for the valves 21 and 22, if desired, of the apparatus of Figs. 1 and 2.

It will be understood that the invention is not to be limited to the exact constructions and arrangements of parts as shown in the drawings for the purpose of illustrating the invention and to which the foregoing description has been largely confined, but that the invention includes changes and modifications thereof within the claims.

What is claimed is—

1. The combination of means for mixing a neutral gas with a combustible gas in certain proportions to obtain a combustible gas of desired calorific value, and means for mixing a combustion-supporting gas with such combustible gas of reduced calorific value in proportions to form an explosive mixture, substantially as described.

2. The combination of means for supplying a combustible gas and a neutral gas in certain proportions to form a combustible gas of desired calorific value and for maintaining the proportions of the gases constant for varying volumes supplied, and means for mixing a combustion-supporting gas with such combustible gas of reduced calorific value in proportions to form an explosive gaseous mixture, substantially as described.

3. The combination of means for supplying a combustible gas and a neutral gas in certain proportions to form a combustible gas of desired calorific value, means for varying the proportions in which such gases are supplied, and means for mixing a combustion-supporting gas with such combustible gas of reduced calorific value to form an explosive gaseous mixture, substantially as described.

4. The combination of means for supplying a combustible gas and a neutral gas in certain proportions to form a combustible gas of desired calorific value and for maintaining the proportions of such gases constant for varying volumes supplied, means for varying the proportions in which such gases are supplied, and means for mixing a combustion-supporting gas with such combustible gas of reduced calorific value to form an explosive gaseous mixture, substantially as described.

5. The combination with means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, and means for controlling the passage of said gases through said passages to cause them to pass in certain proportions and for maintaining said proportions constant for varying volumes supplied, substantially as described.

6. The combination with means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, means for controlling the passage of said gases through said passages to cause them to pass in certain proportions and for maintaining said proportions constant for varying volumes supplied, and means for adjusting said controlling means for varying the proportions in which said gases pass through said passages, substantially as described.

7. The combination with means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, said passages leading to a common outlet through which the combustible gas is supplied to said mixing means, check-valves in said passages, and means for constraining said check-valves to move together with a certain ratio of movement, substantially as described.

8. The combination with means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, said passages leading to a common outlet through which the combustible gas is supplied to said mixing means, check-valves in said passages, means for constraining said check-valves to move together with a certain ratio of movement, and means for changing the ratio of movement of said check-valves, substantially as described.

9. The combination with means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, said passages leading to a common outlet through which the combustible gas is supplied to said mixing means, check-valves in said passages, means for constraining said check-valves to move together with a certain ratio of movement, and pressure-regulating means for controlling the pressure at which said gases are supplied to said passages, substantially as described.

10. The combination of means for mixing a combustible gas and a combustion-supporting gas in proportions to form an explosive mixture; of means for supplying the combustible gas to said mixing means comprising a passage for a combustible gas of high calorific value, and a passage for a neutral gas, said passages leading to a common outlet through which the combustible gas is supplied to said mixing

means, check-valves in said passages, means for constraining said check-valves to move together with a certain ratio of movement, and pressure-equalizing means for causing the combustible gas of high calorific value and the neutral gas to be supplied to said passages at equal pressures, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

ERNST KÖRTING.

Witnesses:
T. F. KEHOE,
A. L. KENT.