No. 730,782. PATENTED JUNE 9, 1903.

E. MORRISON.

MOTIVE POWER APPARATUS.

APPLICATION FILED AUG. 16, 1899.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

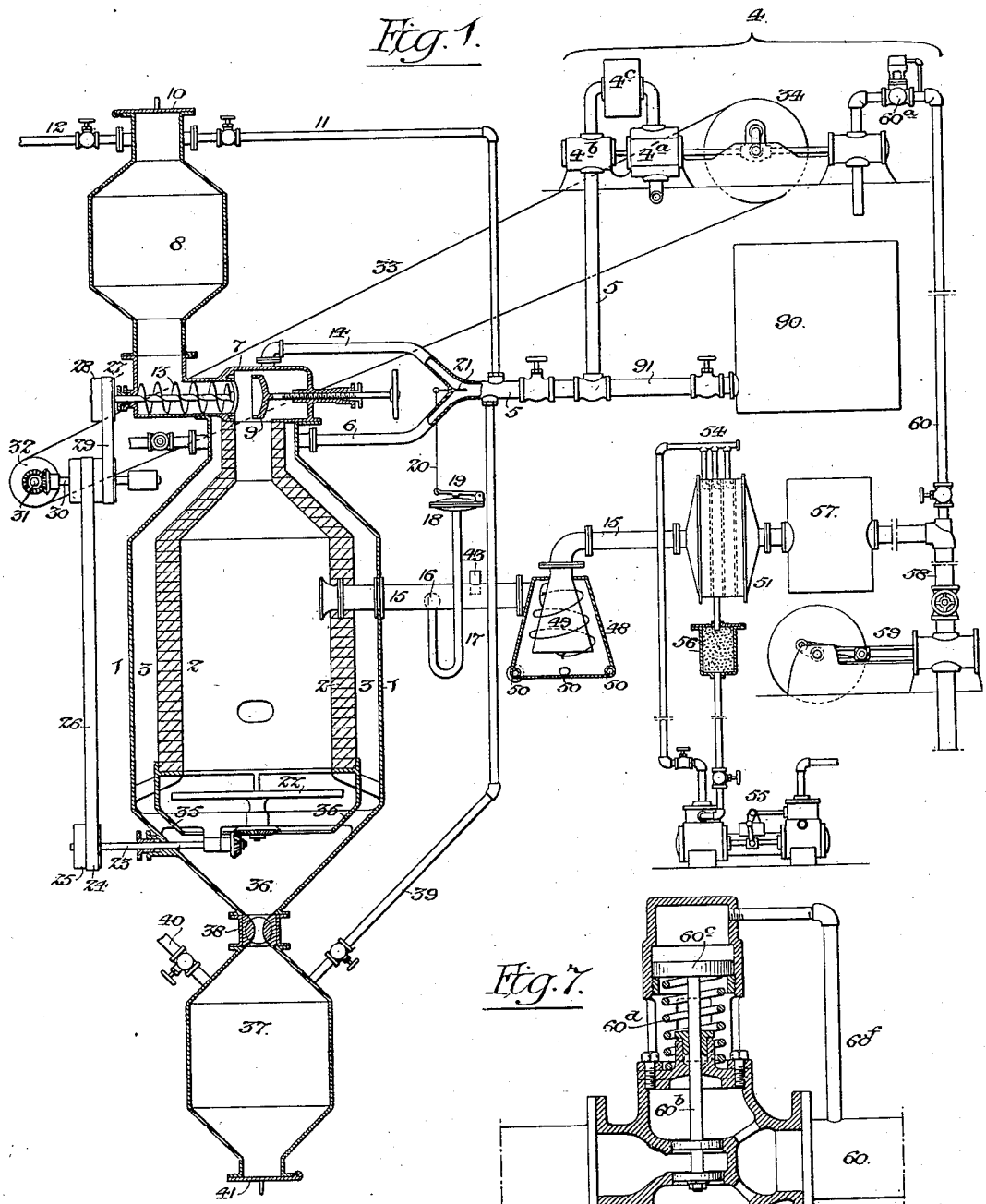
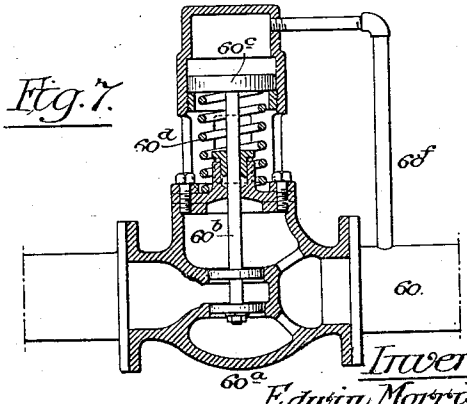


Fig. 7.



Witnesses:-

Frank L. A. Graham

Louis W. Whitehead.

Inventor:

Edwin Morrison.

by his Attorneys:

Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 9.

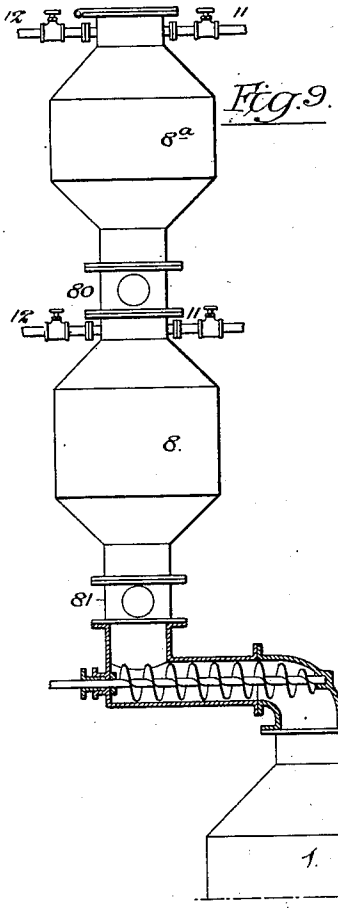


Fig. 10.

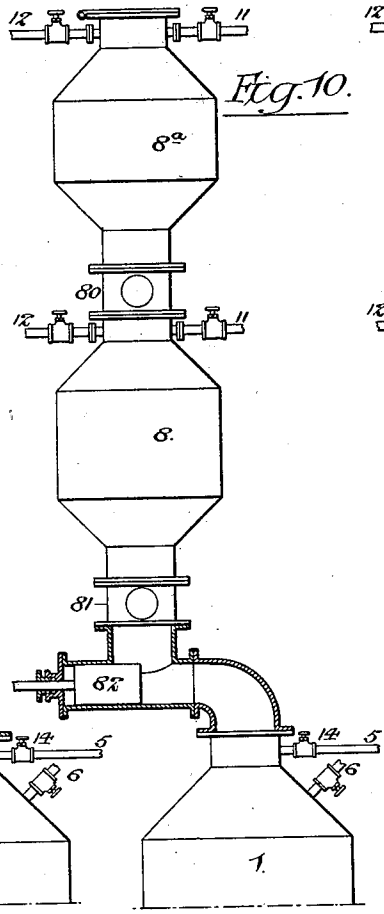


Fig. 11.

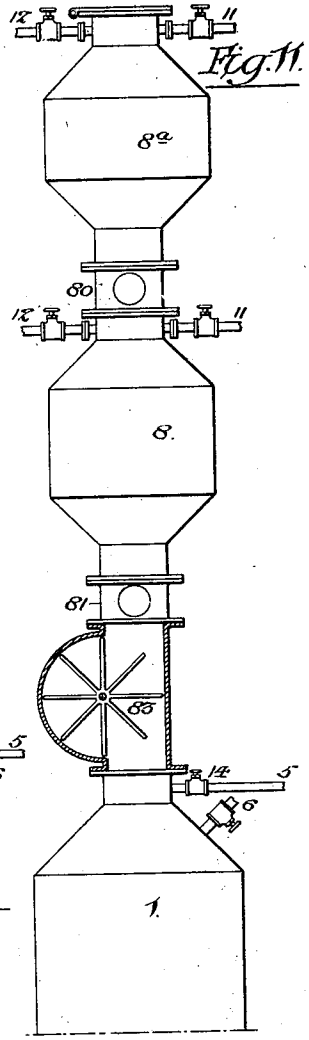


Fig. 5.

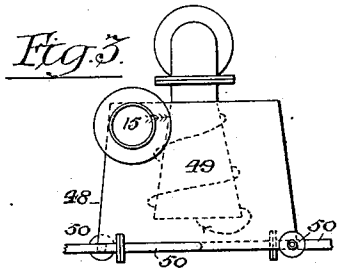


Fig. 4.

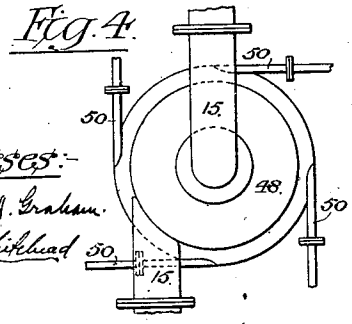
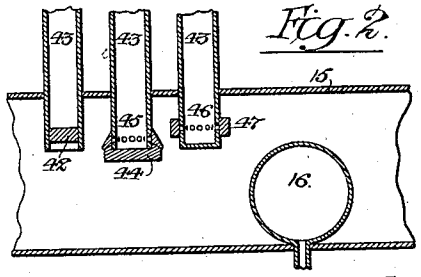


Fig. 2.



Witnesses:-

Frank L. A. Graham.

Louis M. F. Whitehead

Inventor:

Edwin Morrison.

by his Attorneys:-

Howson & Howson

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NO MODEL. 4 SHEETS—SHEET 3.

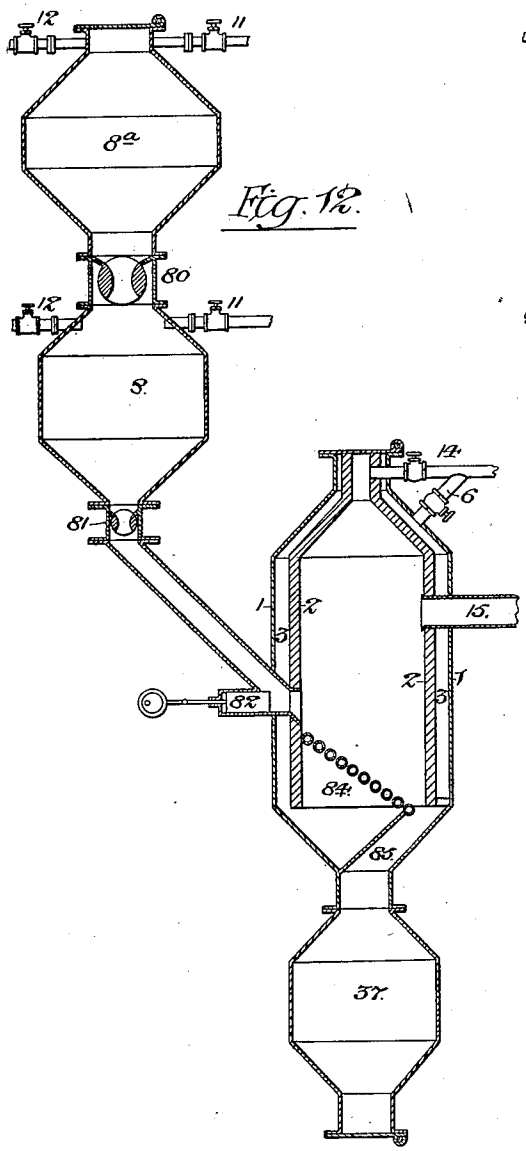

Fig. 12.

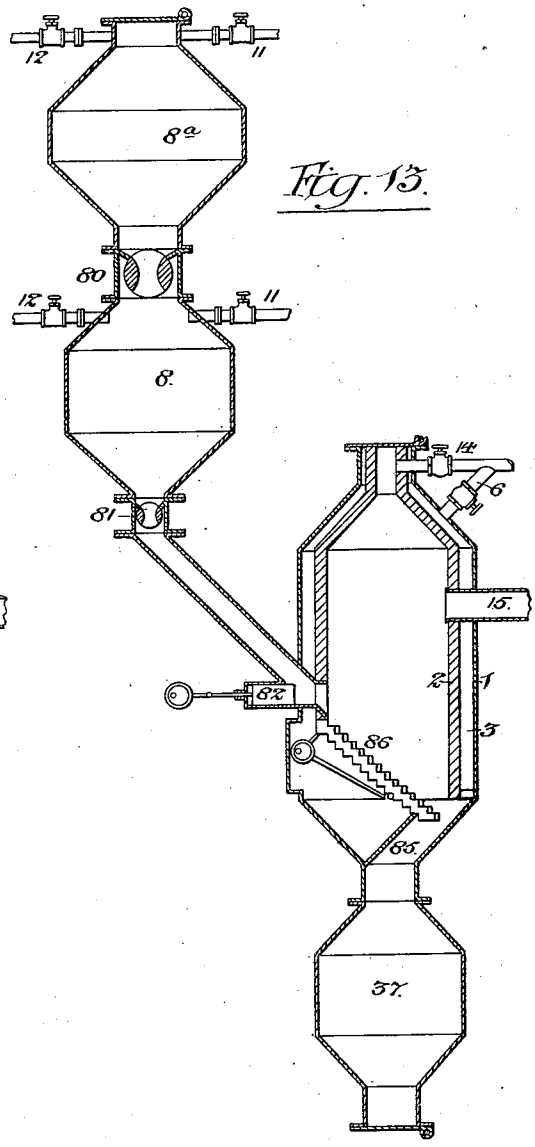

Fig. 13.

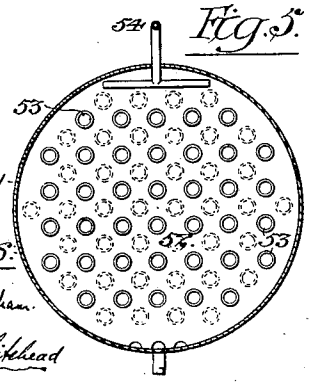

Fig. 5.

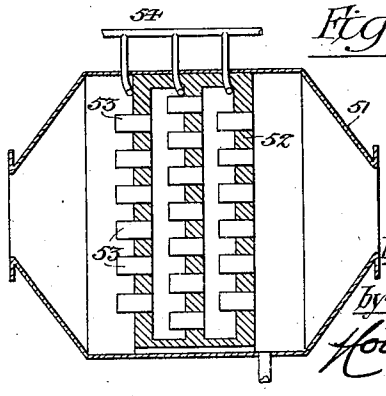

Fig. 6.

Witnesses:
Frank L. A. Graham.
Louis M. Whitehead

Inventor:
Edwin Morrison.
by his Attorneys
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,782. PATENTED JUNE 9, 1903.

E. MORRISON

MOTIVE POWER APPARATUS.

APPLICATION FILED AUG. 16, 1899.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 8.

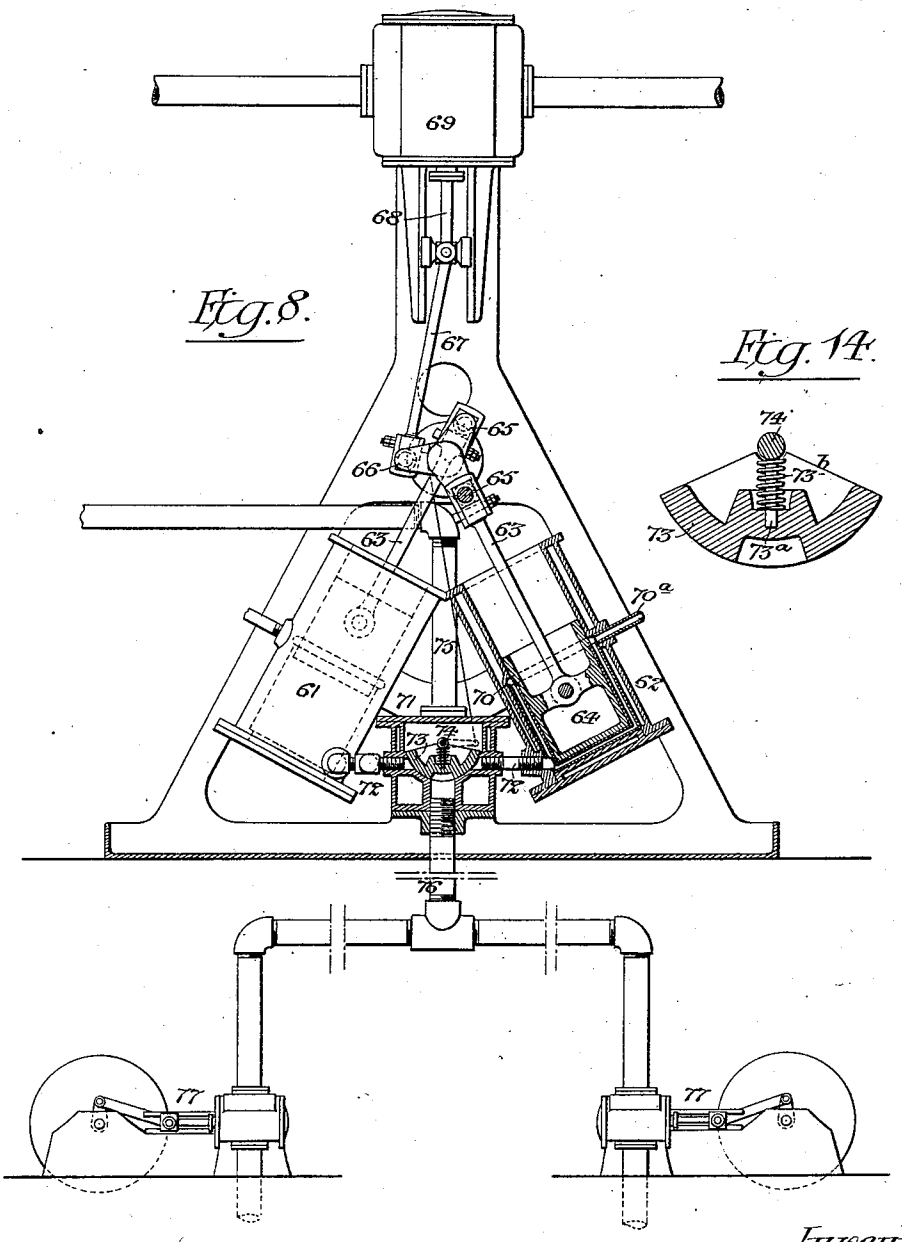

Fig. 14.

Witnesses:-
Louis M. Hohlfeld.
Frank L. A. Graham.

Inventor.
Edwin Morrison.
by his Attorneys:-
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 730,782. Patented June 9, 1903.

UNITED STATES PATENT OFFICE.

EDWIN MORRISON, OF PHILADELPHIA, PENNSYLVANIA.

MOTIVE-POWER APPARATUS.

SPECIFICATION forming part of Letters Patent No. 730,782, dated June 9, 1903.

Application filed August 16, 1899. Serial No. 727,412. (No model.)

To all whom it may concern:

Be it known that I, EDWIN MORRISON, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented certain Improvements in Motive-Power Apparatus, of which the following is a specification.

My invention consists of a motive-power apparatus comprising a heat-generator in which air under pressure to maintain combustion passes through a mass of ignited fuel supported upon a grate, the heated gases being kept under continued pressure and by preference furnishing motive power to operate both a compressor to keep up the supply of compressed air and an engine or engines for other work. Suitable regulators, safety appliances, and gas-cleaners are also employed in order to maintain the apparatus at all times in proper operative condition.

The special features of construction and combinations of parts constituting my invention are fully set forth and specifically claimed hereinafter.

In the accompanying drawings, Figure 1 is a general view of apparatus embodying my invention. Fig. 2 is an enlarged view of portion of the discharge-pipe of the retort, showing various forms of fusible safety-plugs. Figs. 3 and 4 are a side elevation and a plan view, respectively, of the centrifugal separator used with my device. Figs. 5 and 6 are an end elevation, partly in section, and a longitudinal vertical sectional view, respectively, of the baffle-plate separator. Fig. 7 is a vertical sectional view of the automatic regulating-valve for controlling the supply of motive fluid to the compressor-engine. Fig. 8 is a view illustrating the preferable method of utilizing the motive fluid in accordance with my invention. Figs. 9, 10, and 11 are views illustrating different forms of fuel-feeders. Figs. 12 and 13 are views illustrating different forms of generators which may be used in carrying out my invention; and Fig. 14 is a sectional view, on an enlarged scale, of part of the engine shown in Fig. 8.

Referring first to Fig. 1, it will be observed that the heat-generator or retort consists of an outer casing 1, preferably of sheet metal and containing a lining structure 2, of fire-brick or other refractory material, between which and the casing 1 intervenes an air-space 3, so that said casing will not be unduly heated.

The casing 1 should have sufficient strength to withstand any pressure to which it is likely to be subjected in the operation of the apparatus, the space 3 communicating with an air-compressor 4 through a pipe 5 and branch 6. I prefer to use a compressor having two or more cylinders, so that the air is compressed by successive steps or stages, and I also prefer in order to obtain the greatest amount of energy in the cycle of operation resulting from the working of the apparatus to cool the air during compression. This may be effected by water-jacketing the primary and secondary compressing-cylinders 4^a and 4^b, or either of them, and also by the use of an appropriate cooler 4^c, through which the partially-compressed air passes in flowing from the cylinder 4^a to the cylinder 4^b, or in cases where there is more than a two-stage compression the air may be cooled between every two of the stages.

Above the heat-generator or retort is a feed-box 7, which is in communication with a fuel-reservoir 8, a valve 9 serving to cut off communication between the interior of the retort and the fuel-reservoir when necessary—as, for instance, when a fresh supply of fuel is being introduced into said reservoir.

The reservoir 8 has at the top a valve or door 10, which should be constructed so as to close hermetically and can be opened in order to introduce fuel into the reservoir, a valved branch 11, leading from the pipe 5, serving to introduce air under pressure into the reservoir 8, as is necessary before the valve 9 is opened, since in this case the same pressure must be maintained in the reservoir as in the retort.

The use of a special valve for admitting air under pressure into the fuel-reservoir is preferable to using the valve 9 for the purpose, as in the latter event the air would have to force its way through any fuel remaining in the reservoir or contained in the feeder below the same.

When the valve 9 has been closed, the valve in the pipe 11 may also be closed and the valve in a discharge-pipe 12 opened, so as to permit the air under pressure to escape from the fuel-reservoir 8 preparatory to opening

the top valve 10 when a fresh supply of fuel is to be introduced into the reservoir.

In the structure shown in Fig. 1 a feed-screw 13 is employed for conveying the fuel from the lower portion of the reservoir 8 into the upper end of the retort when the valve 9 is open, said valve being adapted to close the end of the tube in which the feed-screw is contained. Other forms of valve and feed mechanism may, however, be used, as will be explained hereinafter.

Air from the compressor 4 is introduced into the upper portion of the retort through a branch 14 of the pipe 5, this air passing through the feed-box, so as to protect from the heat the fuel-feeder and valve and also serving to lower the temperature of the gases of combustion, as may be desired. A mixture of these gases and of the air under pressure escapes from the retort through the pipe 15, and in order to properly regulate the temperature of the escaping mixture I place in said pipe a vessel 16, containing air or other fluid which will be readily expanded by heat. This vessel communicates through a pipe 17 with a damper-regulator 18 of ordinary construction, said damper-regulator acting through a lever 19 and connecting-rod 20 upon the arm of a damper 21, located at the point where the branches 6 and 14 join the pipe 5.

As shown in Fig. 1, the damper occupies a mid-position, equal volumes of air being directed from the pipe 5 to the upper and lower portions of the retort.

In case the temperature of the gases exceeds a predetermined limit the expansion of the air or other fluid in the vessel 16 will cause such operation of the damper-regulator 18 as will throw the damper 21 downward, and thus partially obstruct the entrance to the branch 6, at the same time providing for a freer flow of air into the branch 14, thereby restricting the supply of air to maintain combustion and increasing the supply of air for admixture with the products of combustion to lower their temperature. If the temperature of the products of combustion falls below the predetermined limit, reverse action will take place.

The damper may be placed in either of the branch pipes instead of at their junction with the main 5, although the latter construction is preferred. The device constitutes a thermostatic heat-regulator, and, if desired, a solid expansion-rod may take the place of the fluid-expansion device.

At the bottom of the retort is a grate 22, that form of grate which I prefer to use being a revolving grate operated by gearing from a shaft 23, which extends through a suitable stuffing-box to the outside of the retort-casing and is there provided with fast and loose pulleys 24 and 25 for the reception of a suitable driving-belt 26. The feed-screw 13 also has fast and loose pulleys 27 and 28 for receiving a driving-belt 29, and both feed-screw and grate are intended to be driven in unison with the air-compressor, so that the supply of fuel and the discharge of ashes will always bear a certain relation to each other and to the supply of air furnished by the compressor. This result is attained in the present instance by driving the belts 26 and 29 by means of a drum or pulleys on a shaft 30, which is geared to another shaft 31, having a pulley 32 driven by a belt 33 from a pulley or fly-wheel 34, forming part of the compressor 4.

The air is directed from the space 3, surrounding the refractory lining 2 of the retort, around and under an annular guard-plate 35, which extends some distance below the grate 22, and it is preferable to permit the ashes to accumulate upon the grate to such an extent that the bed of ashes thus formed will protect the grate from the heat, the incoming supply of air to maintain combustion passing through this accumulated mass of ashes, and thereby serving to cool the latter and also itself becoming heated while passing upwardly through the mass.

Below the ash-pit 36 is an ash-receiver 37, communicating with said ash-pit through a valved neck 38, this ash-receiver being supplied with air under pressure from the pipe 5 through the valved branch 39 and being also provided with a valved escape-pipe 40 and with a hermetically-closing discharge door or valve 41 at the bottom. When, therefore, it is desired to discharge the ashes, the valves in the neck 38 and pipe 39 are normally opened and ashes pass from the ash-pit into the receiver, and when a sufficient quantity of ashes has accumulated in the latter the valves in the neck 38 and pipe 39 are closed and the valve in the discharge-pipe 40 is opened, so as to permit the opening of the valve or door 41 and the removal of the ashes, the door 41 and the valve in the pipe 40 being then closed and the valves in the pipe 39 and neck 38 opened.

In order to provide for an escape of the heated and compressed gases from the pipe 15 in case the temperature of said gases should rise above a predetermined point, I employ in connection with said pipe one or more outlets normally closed by fusible plugs, but providing an escape for the heated and compressed gas when the temperature of the same rises to such a point that the plug or the solder securing the plug is melted. Three of such devices are shown in Fig. 2, the first consisting simply of a plug 42, inserted in the discharge-pipe 43 and properly secured therein by fusible solder or the plug itself being composed of such fusible solder. Another form of plug 44 surrounds the end of the discharge-pipe 43 and is held in position thereon by solder engaging with openings 45, formed in the pipe, and in still another form the pipe 43 is closed at the inner end, but has openings 46, which are surrounded by a fusible ring 47 or a ring secured by fusible solder, the melting of which clears the openings 45

and permits the heated gas under pressure to flow into and escape from the pipe 43.

In order to provide for the separation of solid matters from the gas before the latter is used as a motive-power agent, I pass the gas through separators, the first of these being a centrifugal separator, as shown in detail in Figs. 3 and 4. This separator has a casing 48 in the form of a frustum of a cone, with the upper portion of which the pipe 15 communicates tangentially, as shown in Fig. 4, so that as the gas enters the separator it is given a whirling motion, which by reason of centrifugal force throws the solid particles against the wall of the casing, the gas escaping through a central conical discharge-funnel 49 and the fine particles retaining the gyrating motion given to them and escaping through tangential outlet-pipes 50 at the base of the casing 48.

From the centrifugal separator the gas passes through a dash-plate separator, which is shown in detail in Figs. 5 and 6. This separator consists of a cylindrical casing 51 with conical ends and having a series of internal partitions 52, each with a number of short projecting tubes 53, these tubes being staggered or offset in respect to each other—that is to say, the tubes of the central partition being in line with the spaces between the tubes of the outer partitions, as shown in Fig. 5. Down the front face of each partition-plate 52 a stream of water or other fluid is caused to flow when very fine particles are to be arrested, this water being projected onto the faces of the plates from the branches of a manifold pipe 54, located above the separator and receiving its supply of liquid from a pump 55, to which the liquid is returned from the separator after passing through a suitable filter 56, whereby the solid particles are removed therefrom. The gas in passing through the separator 51 is therefore brought into contact successively with the baffle-plates contained therein, and solid particles are projected against the faces of these baffle-plates and are caught by the stream of liquid flowing down the same, so as to be carried to the lower portion of the separator, from which they escape through a suitable pipe leading to the filter 56. From the baffle or dash plate separator 51 the gas passes into a subsiding chamber 57, and its flow is by this time arrested to such an extent that solid particles which have not been separated from the gas by the previous separators are now caused to drop by gravity to the bottom of the subsiding vessel 57, so that the gas will issue from the latter in a properly clean and purified condition. The order of succession of the separators 48 and 51 may be changed, if desired.

Part of the escaping gas may flow through a valved pipe 58 directly to the motive-power engine 59, another portion of the gas flowing through a pipe 60 to the power-cylinder of the compressor 4.

The supply of air to the generator or retort may be regulated so as to maintain a uniform pressure of motive-power gas in the discharge-pipe 15 of said generator by using an automatic valve 60^a in the pipe which supplies the motive-power gas to the power-cylinder of the compressor, rise of pressure in the gas-pipe above the predetermined limit causing the valve to close or partially close, so as to arrest or retard the operation of the compressor until the gas-pressure falls to the necessary extent. One form of such valve is shown in Fig. 7, the valve having a stem 60^b attached to piston 60^c, contained in a cylinder above the valve-chest and acted upon in one direction by a spring 60^d and in the other direction by the motive fluid derived from the pipe 60 through a branch 60^f.

I prefer to use the highly-compressed gas in the first instance in the engine of the compressor, so that it is subjected to expansion and partial cooling therein and then to convey it to the motive-power engine or engines in which it is to be used for the performance of other work. The compressor-engine may also perform useful work other than the operation of the compressor, if desired. The form of engine which I prefer for this purpose is that shown in Fig. 8, on reference to which it will be observed that there are two power-cylinders 61 and 62, so inclined in respect to each other that the rods 63 of their pistons 64 will operate cranks 65, set at an angle of one hundred and twenty degrees in respect to each other, a third crank 66, at an angle of one hundred and twenty degrees, to the cranks 65 being connected by a rod 67 to the piston-rod 68 of the air-compressing cylinder 69. In the present instance the engines are single-acting engines with hollow or trunk pistons, the lower portions of each cylinder being of slightly-greater diameter than the upper portion, and being, if desired, lined with any suitable heat-resisting material, a facing of similar material being applied, if desired, to the lower portion or each piston. The enlarged bore of each cylinder terminates at the upper end in a groove 70, which is in communication with an air-supply pipe 70^a, so that air may be introduced into the lower portion of each cylinder for cooling purposes as desired. The heated gas under pressure is supplied to the lower end of each cylinder from a central valve box or chest 71, which communicates with each cylinder through a short pipe 72 or in the case of a double-acting engine may communicate with opposite ends of the cylinder. The valve-chest 71 contains a rocking valve 73, which is operated by an arm 73^a on a rock-shaft 74, the latter receiving its rocking motion from a crank or eccentric on the main shaft, a spring 73^b being interposed between the valve and the rock-shaft 74, as shown in Fig. 14 and the tendency of this spring being to keep the valve always properly seated and to automatically compensate for wear. The heated gas under pres-

sure is supplied to the valve-chest through a pipe 75 and discharged therefrom through a pipe 76, which conveys it to one or more motive-power engines—such, for instance, as represented at 77 in Fig. 8. The valve 73 is practically an ordinary D-valve, having a curved instead of a flat acting face and is intended to act like such ordinary D-valve—that is to say, to admit motive fluid to the cylinder 61 past one edge of the valve, while the other cylinder 62 is exhausting to the pipe 76 through the central chamber in the face of the valve, and then to admit motive fluid to the cylinder 62 past the opposite edge of the valve, while the cylinder 61 is exhausting through the central chamber. As shown in the drawings, the valve 73 occupies a mid-position; but when moved therefrom in one direction it admits the hot gas under pressure to the cylinder 62 and permits of the exhaust of the gas from the cylinder 61 into the pipe 76, rocking of the valve in the opposite direction permitting the hot gas under pressure to flow into the cylinder 61 and exhausting it from the cylinder 62. It will be noted that the valve-chest 71 is disconnected from the cylinders 61 and 62 except through the medium of the pipes 72. Hence the high degree of heat attained by the valve-chest is not communicated to the cylinders, and the objections which would arise from such high temperature in the cylinders are obviated. The walls of the cylinders and valve-chest may be hollow, as shown, in order to provide for the use of an air-jacket for lowering their temperature, the air thus heated being employed at some other point in the operation of the apparatus where its heat is of use.

When but a single fuel-reservoir is employed in connection with the gas-generating apparatus, as shown in Fig. 1, the feed of fuel to the retort must be arrested when a fresh supply of fuel is being introduced into the reservoir; but in order to provide for a continuous operation of the retort it is only necessary to employ duplex fuel-reservoirs located one above the other, as shown, for instance, at 8 and 8^a in Figs. 9, 10, and 11. These fuel-reservoirs are connected by suitable valved necks 80, the valve in the neck being closed when the upper chamber 8^a is being filled and after the closing of the valve or lid at the top of said upper chamber being then opened, so as to permit the fuel to pass into the lower chamber 8. A valved branch 81 is interposed between the lower feed-chamber and the feeding device, and this valve may be closed during the limited period that the valve in the neck 80 is opened in order to permit of the passage of fuel from the upper to the lower chamber. It is preferable to provide both the upper and lower fuel-chambers with a valved air-pressure-supply pipe 11 and a like discharge-pipe 12, as shown in connection with the single fuel-chambers of Fig. 1 and for the same purpose.

Various forms of fuel-feeding devices may also be employed, preference being given to the endless screw 13, as shown in Figs. 1 and 9, although a reciprocating pusher, such as shown at 82 in Fig. 10, or a rotating feed-wheel, such as shown at 83 in Fig. 11, are available for the purpose.

While I prefer also to employ a rotating horizontal grate in connection with the gas generator or retort, other forms of grate may be used—for instance, a grate composed of hollow bars 84, disposed so as to form an inclined fuel-supporting bed, as shown in Fig. 12, and adapted to rotate so as to feed the fuel from the upper to the lower end of said bed, the ashes being delivered into an inclined chute 85, by which they are directed to the ash-receiving chamber 37.

In Fig. 13 I have shown a gas generator or retort provided with an inclined grate 86 of the reciprocating stepped-bar type, whereby constant agitation of the fuel is effected and the ashes are automatically discharged at the lower end of the grate.

In connection with the pipe 5, which leads from the air-compressor to the generator, I prefer to use a storage-chamber, as shown, for instance, at 90 in Fig. 1, this storage-chamber communicating with the pipe 5 through a valved branch 91, so that it may be filled with air under any desired degree of pressure, which may be used to supply the generator when from any cause the operation of the compressor is arrested.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The combination in an apparatus for generating motive-power gas under pressure, of a generating-retort with a fuel-supply chamber provided with means for maintaining pressure therein, a device for feeding fuel from said chamber to the retort, a valve between said retort and the supply-chamber, and means other than the valve for releasing the pressure in the supply-chamber when it is desired to open the same, substantially as described.

2. The combination in an apparatus for generating motive-power gas under pressure, of a generating-retort with a duplex fuel-supply chamber having upper and lower portions with interposed valve connections and separate and independent means for supplying air under pressure to each chamber, substantially as described.

3. The combination in an apparatus for generating motive-power gas under pressure, of a generating-retort with a duplex fuel-supply chamber having upper and lower portions with interposed valved connections, means for supplying air under pressure to each chamber and means other than the valved connections for releasing said pressure, substantially as described.

4. The combination in an apparatus for generating motive-power gas under pressure, of a generating-retort, with a fuel-supply cham-

ber having a valved opening for the introduction of fuel, a valve for closing the communication between said chamber and the retort, means for maintaining pressure in said fuel-chamber, and valved connections for releasing said pressure, substantially as described.

5. In apparatus for generating motive-power gas under pressure, the combination of a generating-retort having a movable grate, means for supplying air under pressure to said retort, and provision for operating the air-supplying device and the grate in unison, substantially as specified.

6. In apparatus for generating motive-power gas under pressure, the combination of the generating-retort, a fuel-feeder therefor, means for supplying air under pressure to the retort to maintain combustion, and provision for operating the fuel-feeder and air-supplying mechanism in unison, substantially as specified.

7. In apparatus for generating gas, the combination of the retort having a movable grate, a fuel-feeder, and means for operating said fuel-feeder and grate in unison, substantially as specified.

8. In apparatus for generating motive-power gas under pressure, the combination of the generating-retort, a fuel-feeding device therefor, a movable grate, means for supplying air under pressure to the retort to maintain combustion, and provision for operating the air-supplying device, the fuel-feeder and the grate in unison, substantially as specified.

9. In an apparatus for generating motive-power gas, the combination of a generating-retort having a grate, said grate being revolubly supported in the lower portion of said retort and projecting beyond the same whereby it maintains a deep bed of ashes in the bottom of said retort, and provision for discharging air under pressure beneath said deep bed of ashes and for causing said air to pass through the ashes and thereby become heated, substantially as described.

10. In apparatus for generating motive-power gas under pressure, the combination of the generating-retort, the ash-hopper, an ash-receiving chamber, and a valved connection between the two, substantially as specified.

11. In apparatus for generating motive-power gas under pressure, the combination of the generating-retort, the ash-pit, an ash-receiver below the same, a valved connection between the two and means for supplying air under pressure to said ash-receiver, substantially as specified.

12. In apparatus for generating motive-power gas under pressure, the combination of the generating-retort, the ash-pit, an ash-receiver below the same, a valved connection between the two, means for supplying air under pressure to said ash-receiver, and means for releasing said pressure, substantially as specified.

13. In apparatus for generating motive-power gas, the combination of the generating-retort, the discharge-pipe thereof, and a separator in said discharge-pipe having perforated baffle-plates with offset perforations, and short projecting tubes in said perforations, substantially as specified.

14. In an apparatus for generating motive-power gas, the combination of a generating-retort, a discharge-pipe, and a separator in said pipe, the said separator being provided with baffle-plates for arresting the passage of solid particles, each of said plates being provided with openings out of line with those of adjacent plates together with means for causing a flow of liquid over the face of said baffle-plates, and parallel with the same, substantially as described.

15. In apparatus for generating motive-power gas, the combination of the generating-retort, the discharge-pipe, and a separator in said pipe having baffle-plates for arresting the passage of solid particles, said baffle-plates having openings with short projecting tubes, and means for causing a flow of liquid over the faces of said baffle-plates, substantially as specified.

16. In an apparatus for generating motive-power gas, the combination of a generating-retort, a gas-discharge pipe, a centrifugal separator in which relatively coarse particles of solid material carried by the gas are deposited, a baffle-plate separator in which fine particles of solid material are removed from the gas and a subsiding-chamber communicating with said pipe, said gas passing through the separators and said chamber successively, substantially as described.

17. The combination in apparatus for generating and using motive-power gas under pressure, of a generating-retort, a compressor for supplying air under pressure thereto, an engine for operating said compressor, a motive-power engine independent of the compressor, and means for conveying the gas under pressure to the compressing-engine and thence to the other motive-power engine, substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWIN MORRISON.

Witnesses:
WILL. A. BARR,
JOS. A. KLEIN.