H. NEUMANN.

APPARATUS FOR GENERATING HOT COMPRESSED GAS.

APPLICATION FILED DEC. 12, 1905.

928,324.

Patented July 20, 1909.

2 SHEETS—SHEET 1.

FIG. I.

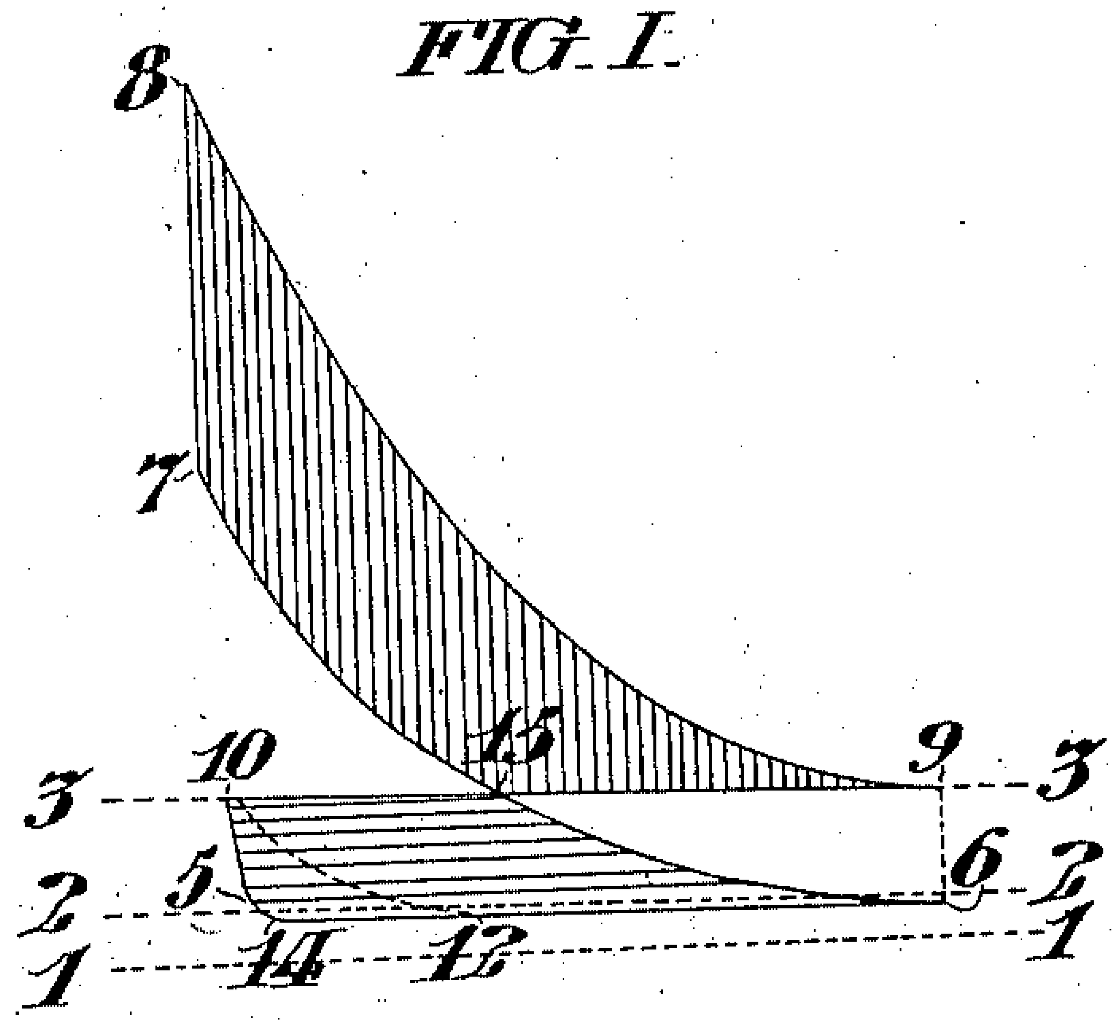


FIG. II.

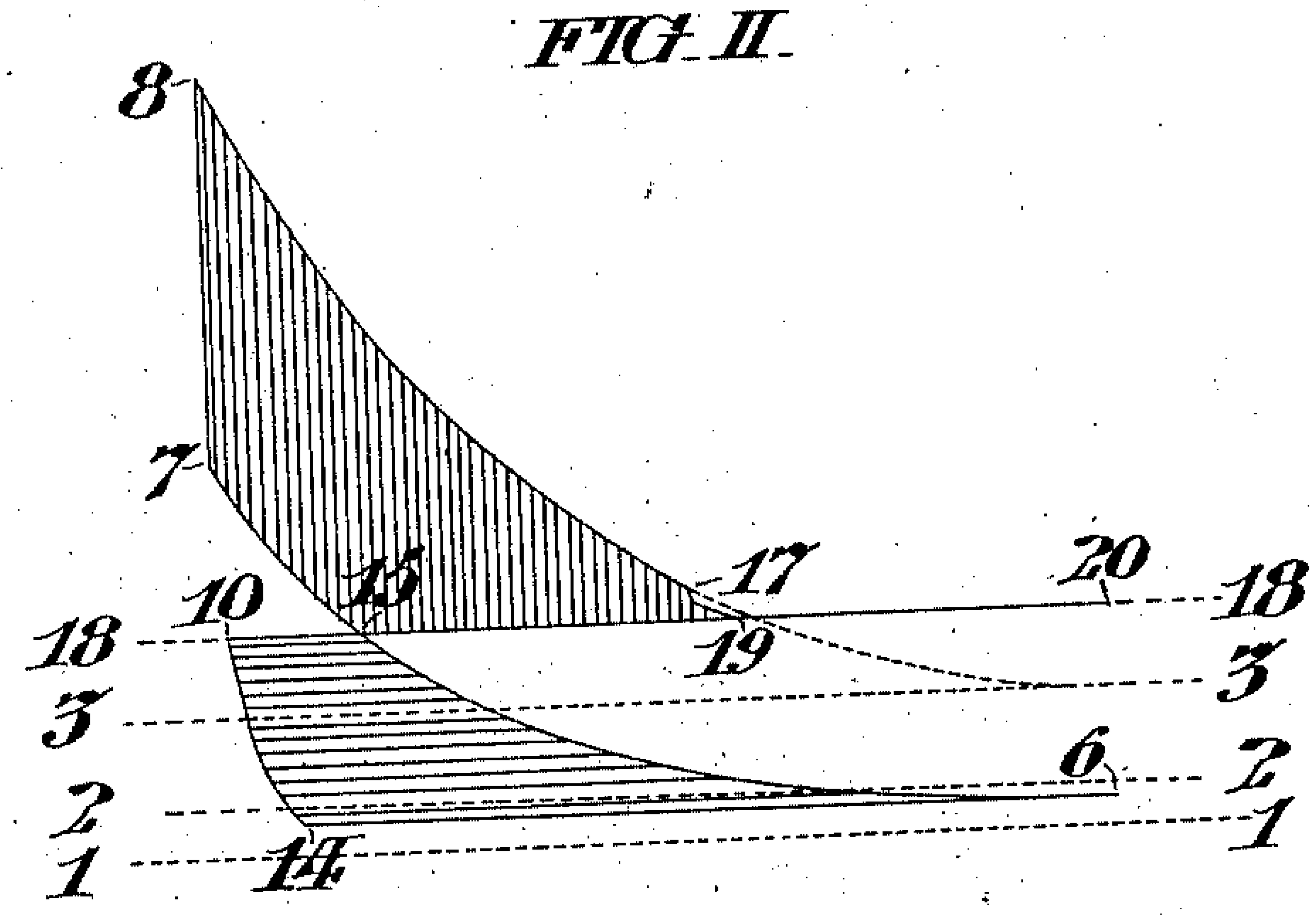
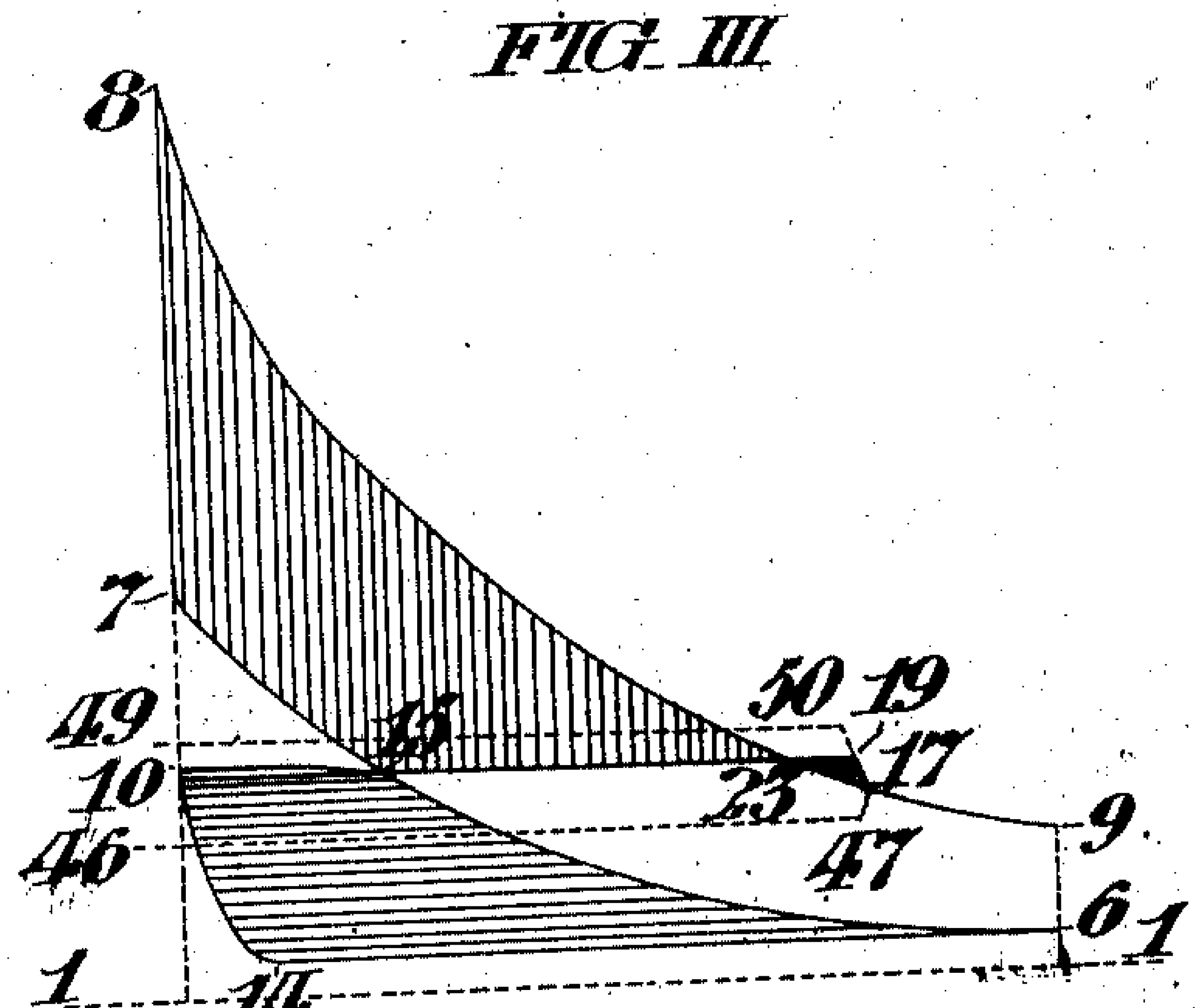


FIG. III



WITNESSES:

Clifton C. Hallowell

John C. Bergner

INVENTOR:

HANS NEUMANN,

by Paige, Paul & Fraley

Attys.

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2 SHEETS—SHEET 2.

FIG. IV.

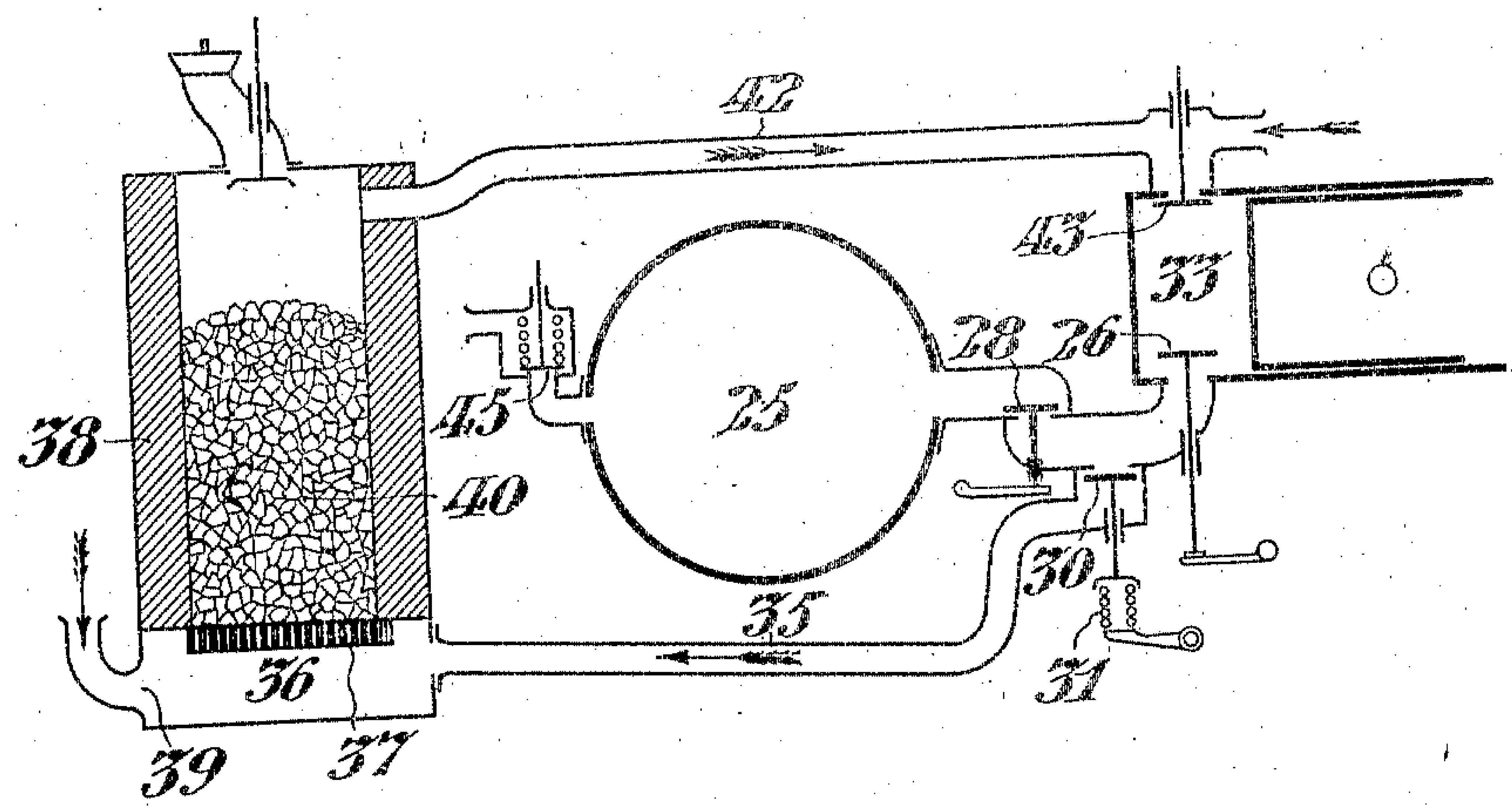
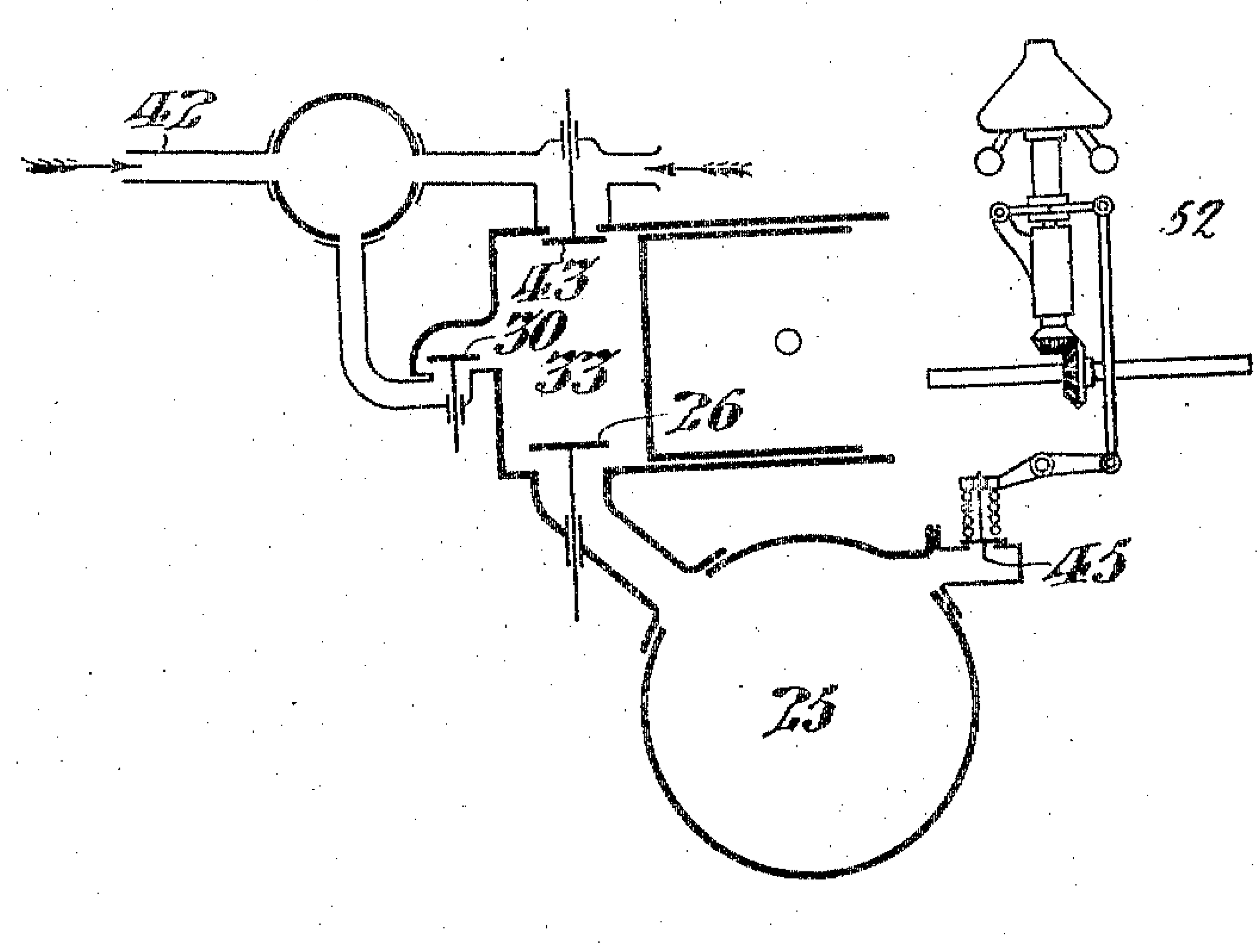


FIG. V.



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UNITED STATES PATENT OFFICE.

HANS NEUMANN, OF BERG GLADBACH, GERMANY.

APPARATUS FOR GENERATING HOT COMPRESSED GAS

No. 928,324. Specification of Letters Patent. Patented July 20, 1909.

Application filed December 12, 1905. Serial No. 291,501.

To all whom it may concern:

Be it known that I, HANS NEUMANN, of Berg Gladbach, Germany, have invented certain new and useful Improvements in Apparatus for Generating Hot Compressed Gases, whereof the following is a specification, reference being had to the accompanying drawings.

This invention may be advantageously employed first to render available the expansion work which hot compressed gases are capable of delivering, for instance, for the purpose of operating compressed air tools, or for lifting liquids, etc., and second, to utilize the chemical properties of such gases where the chemical re-action to be utilized takes place more efficiently at a pressure higher than that of the atmosphere.

In the form of my invention hereinafter described an internal combustion engine, viz: a four cycle gas engine, is provided with means whereby the engine piston discharges the hot exhaust gases into a reservoir which is under more than atmospheric pressure, and, in order to obtain a practically useful efficiency the products of combustion remaining in said engine toward the end of the discharge stroke are permitted to escape into the atmosphere or into a space which is under essentially lower pressure than that of the exhaust gases in said reservoir.

My invention comprehends the various novel features of construction and arrangement hereinafter more definitely specified.

In the drawings, Figure I, is a diagram of a four cycle engine working in accordance with this invention in its simplest form. Fig. II, is a diagram of a four cycle engine working in accordance with this invention where the gases are pumped into the reservoir at a pressure higher than at the end of the expansion stroke. Fig. III, is a diagram of a four cycle engine working in accordance with this invention, in a manner somewhat different from that indicated in Fig. II, but with the same final effect of maintaining a higher pressure in the reservoir, than that of the end pressure of the expanding gases. Fig. IV, is a diagrammatic view showing the typical elements of apparatus embodying my invention. Fig. V, shows a modified form of apparatus embodying my invention.

Referring to Fig. I, 1—1, represents the zero line, 2—2 the atmosphere line, and 3—3 the line of pressure which corresponds to the end pressure of the expansion stroke. Therefore, 5—6 represents the suction stroke, 6—7 the compression stroke, and 7—8—9 the working stroke. The discharge line 9—10 is the result of permitting the gases to be pumped into a reservoir by the action of the engine piston during its back stroke, and the opening of the exhaust valve at the point 9, the pressure maintained in the reservoir being the same as that in the cylinder at 9. The exhaust valve is then closed at 10. Without any special arrangement, the compressed gases remaining in the clearance space would have to expand to atmospheric pressure (approximately as shown by the dotted line 10—12) and the new charge would enter only during the period indicated at 12—6. Consequently, not only would the work done by the engine be less than would be attained with the normal suction stroke 5—6, but the volume of the compressed spent gases would be diminished to such an extent as to render the process practically valueless.

In order to increase the efficiency of the engine and the volume of the spent gases, I provide a vent from the engine cylinder to the atmosphere (or to a space under essentially lower pressure than that in the engine cylinder) at the point 10, after closing the connection between the engine cylinder and the reservoir. Consequently, the pressure will fall according to line 10—14, so that the new charge will be admitted to the cylinder during the period 14—6.

In Fig. I, the work of the engine without the pumping action is represented by the area 6—7—8—9 and the pump work by the area 6—9—10—14. The resulting indicated work of the engine corresponding to the difference between these two areas or, deducting the overlapping areas, to the difference between 15—7—8—9 and 15—6—14—10.

Referring to Fig. II which illustrates a case where the gases are pumped in the reservoir at a pressure higher than that at the end of the expansion stroke, the exhaust valve is opened at 17; immediately the pressure indicated by the line 18 is established in the reservoir (at point 19) and maintained during the latter part of the forward stroke 19—20 of the piston and the entire back stroke 20—10. The volumetric work of the pumping action corresponds to the line 19—10 and the resulting work of the engine is represented by the difference between the areas 15—7—8—17—19 and 15—6—14—10.

Fig. III. indicates an arrangement different from that indicated in Fig. II, but with the same final effect of maintaining a higher pressure in the reservoir than that of the end pressure of the expanding gases. In this case, the exhaust valve opens during the back stroke of the piston at the point 17, and the expansion line continues first to point 9, and with the resulting compression line 9—17 which overlaps if no heat is transmitted. Immediately after the opening of the exhaust valve a pressure is established in the reservoir indicated by the line 18, beginning at point 19, and the gases are discharged during the period indicated by the line 19—10. The work of the engine corresponds to the difference between the area 15—7—8—23 on one hand and the areas 15—6—14—10 plus 23—19—17 on the other hand.

Referring to Fig. IV, the reservoir 25, for receiving the compressed gases, is connected to the exhaust valve 26, of a four cycle engine, by means of a check valve 28, (loaded as lightly as possible), the space between said valves 26, and 28, contains the check valve 30, which opens toward the atmosphere and which is retained on its seat by the spring 31, as long as said exhaust valve 26, is open. Said arrangement is such that as soon as the exhaust valve 26, begins to close, (at the point 10, in the diagrams aforesaid) the spring 31, of the check valve 30, is released to allow said valve to open. As soon as the pressure in the space between the valves 26, and 28, falls below that in the reservoir 25, the valve 28, is forced upon its seat, and the pressure in the engine chamber 33, and in the space between said valves 26, and 28, can escape through the valve 30. Thereupon, the exhaust 26, closes entirely, and the suction stroke of the engine can begin. However, when the pressure in the engine chamber 33, after combustion and partial expansion equals the pressure in the reservoir 25, the check valve 30, must be forced upon its seat before the exhaust valve 26, is opened. In order to diminish the pressure required to open the exhaust valve 26, I find it advantageous to open the check valve 28, after or during the closing movement of the valve 30, so that the pressure from the reservoir 25, acts upon the under side of said exhaust valve. The valves 26, and 28, and 30, can be operated singly, in pairs, or all at the same time, or said valves may be combined in a single structure, such as a rotary slide valve. It may be noted that it is advisable to have the space between said valves 26, and 28, as small as possible, to avoid loss of efficiency. The check valve 30, may open to the atmosphere, so that the escaping gases are entirely removed from the working cycle, or, they may be mixed with the succeeding charge for the engine, or, if the combustible gas for the engine is furnished by a producer, the spent gases may be advantageously conducted to said producer. As a matter of fact, it is necessary to employ the highest possible compression and explosive pressures, to attain the greatest advantages from the invention, and I find that the danger of premature ignition is avoided and higher compression is possible, if the spent gases are mixed with a charge containing easily inflammable gases. The advantages of admitting the spent gases to a gas producer is that a larger percentage of carbonic oxid and less hydrogen is contained in the gas than produced, and such producer gas may be advantageously employed by the present invention because carbonic oxid will stand higher compression than hydrogen without causing premature ignition.

In Fig. IV, which shows a typical embodiment of my invention, in connection with a gas producer, the exhaust pipe 35, opens into the chamber 36, below the grate 37, of the producer 38, so that the exhaust gases are mixed with the air entering said chamber 36, by the port 39, in said chamber, before traversing the body of fuel 40, in said producer 38. The valve 30, which relieves the pressure in the compression chamber 33, may be so arranged as to open directly into the latter, in which case, the check valve 28, may be omitted, and the loss of pressure in the space between the valves 26, and 28, which occurs at each opening of the valve 30, be thereby obviated. Such an arrangement is shown in Fig. V, which also shows means to introduce the spent gases into the gas intake pipe 42, leading to the engine. It is also feasible to locate the valve 30, within the inlet valve 43, so that the latter separates the valve 30, from the engine chamber 33. This has the advantage over the arrangement shown in Fig. V, of reducing the number of valves opening into the interior of the engine chamber 33. The check valve 45, is weighted so as to regulate the pressure in the reservoir 25, it being understood that a decrease in said weight lowers the pressure line in the indicator card of the engine, as shown by line 46—47, in Fig. III. If, however, the weight of said valve 45, is increased, the pressure line rises as indicated by the line 49—50, in Fig. III, and the resulting work of the engine varies accordingly. Therefore, if it is desired to utilize the whole power of the engine for generating the largest possible quantity of spent gases, at the highest possible pressure, the governor 52 of the engine may be connected with the check valve 45, as shown in Fig. V in such a manner that during an increase of the engine speed above the normal, the weight upon the valve 45, is increased, thereby increasing the pump work and the resulting work done by the engine, and thereby regulating the speed of the engine. Similar regulation of the engine may be effected if it does other work besides that of pumping the gases, for instance, the operation of any kind of machinery. In such a case the governor would so regulate that all of the surplus power developed by the engine beyond that required at any time by the machinery would be utilized for pumping.

It is to be understood that I do not desire to limit myself to the precise details of construction and arrangement herein set forth, as various modifications may be made therein, without departing from the essential features of my invention.

I claim:—

1. The combination with an internal combustion engine; of a reservoir; means arranged to deliver the waste gases from the engine into said reservoir at a pressure higher than the atmosphere, and to permit the compressed gases remaining in the combustion chamber to escape at lower pressure before a new charge is admitted; and, a pressure regulating valve communicating with said reservoir arranged in operative relation with the engine governor, whereby the pressure in the reservoir is increased as the engine speed increases, substantially as set forth.

2. The combination with an internal combustion engine; of a reservoir; a conduit connecting the exhaust port of the piston chamber of said engine with said reservoir; a branch conduit connecting the exhaust port of said engine with the atmosphere; and valves arranged to control said conduits independently, comprising means arranged to positively open one of said valves and to close the other, substantially as set forth.

3. The combination with an internal combustion engine; of a reservoir; a conduit connecting the exhaust port of the piston chamber of said engine with said reservoir; a branch conduit connecting the exhaust port of said engine with the atmosphere; valves arranged to control said conduits independently, comprising means arranged to positively open one of said valves and to close the other; and, a pressure regulating valve in operative relation with said reservoir and independent of the other valves aforesaid, substantially as set forth.

4. The combination with an internal combustion engine; of a gas producer; a conduit leading from said gas producer to the inlet port of said engine; a second conduit leading from the exhaust port of said engine to said gas producer; a reservoir connected with said exhaust conduit; a check valve arranged to admit fluid from said exhaust conduit to said reservoir and prevent return of the same; and a valve in said exhaust conduit, comprising means to normally prevent the passage of fluid from said exhaust port to said gas producer, substantially as set forth.

5. The combination with an internal combustion engine; of a reservoir; a conduit connecting said reservoir with the exhaust port of the engine; a valve controlling said exhaust port; a separate valve controlling the admission of waste gases from said conduit to said reservoir; and a relief valve between said engine exhaust valve and said reservoir valve controlling the emission of the waste gases to a region of lower pressure than in said reservoir.

6. The combination with an internal combustion engine; of a reservoir; a valve arranged to admit the waste gases from the engine into said reservoir at a pressure higher than the atmosphere; a valve arranged to permit the waste gases to escape from the engine combustion chamber toward the end of the discharge stroke at a lower pressure; and means arranged to positively actuate said valves.

7. The combination with an internal combustion engine; of a reservoir; means arranged to deliver the waste gases from the engine into said reservoir at a pressure higher than the atmosphere; a pressure regulating valve operatively connected with said reservoir; and means arranged to automatically vary the pressure determined by said regulating valve.

In testimony whereof, I have hereunto signed my name at Cologne, Germany, this 28th day of November 1905.

HANS NEUMANN.

Witnesses:
Bessie F. Dunlap,
Louis Vandorn.