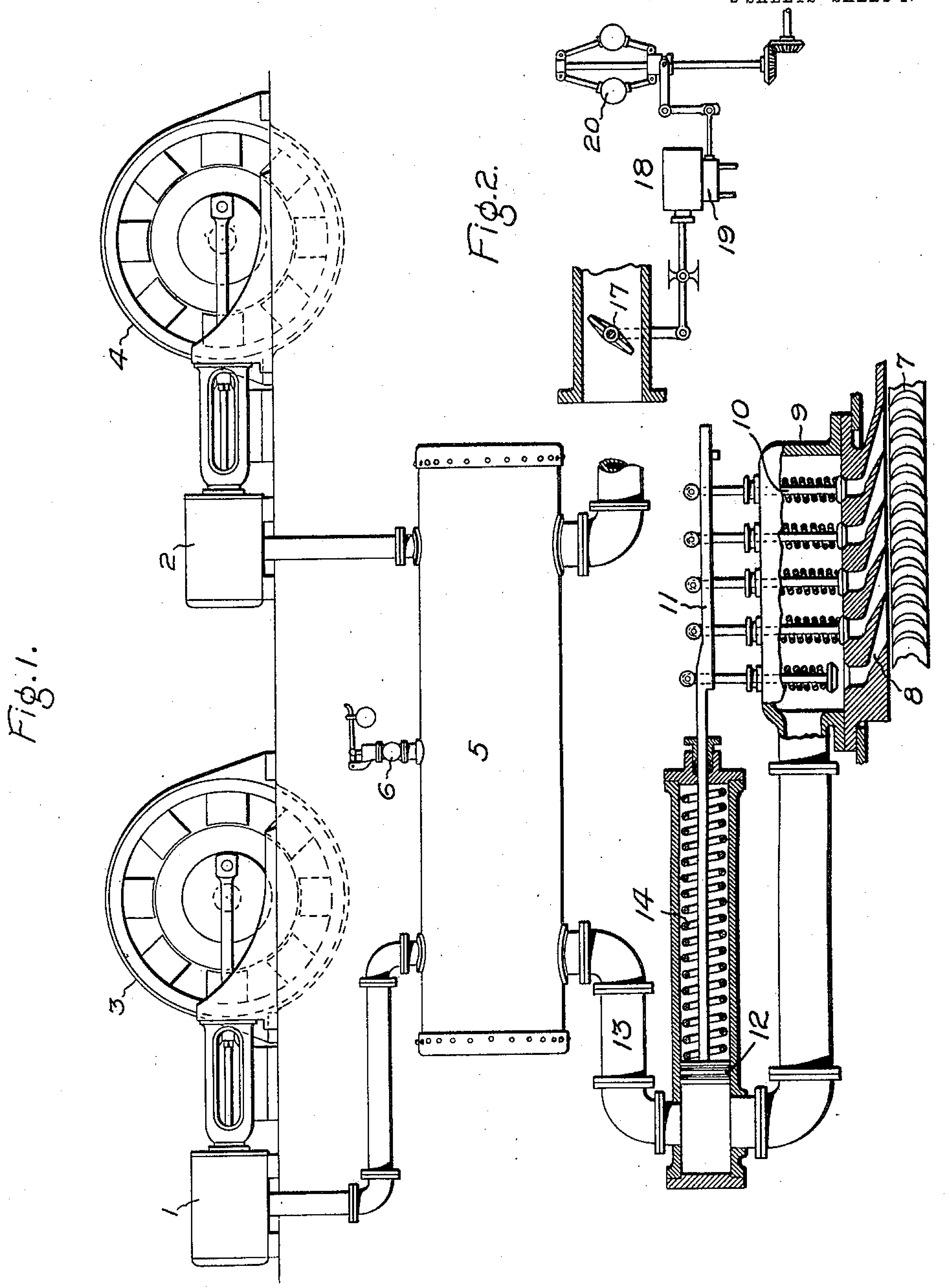
No. 822,261. PATENTED JUNE 5, 1906.

W. L. R. EMMET.

POWER SYSTEM.

APPLICATION FILED OCT. 7, 1905.

2 SHEETS—SHEET 1.



Witnesses:
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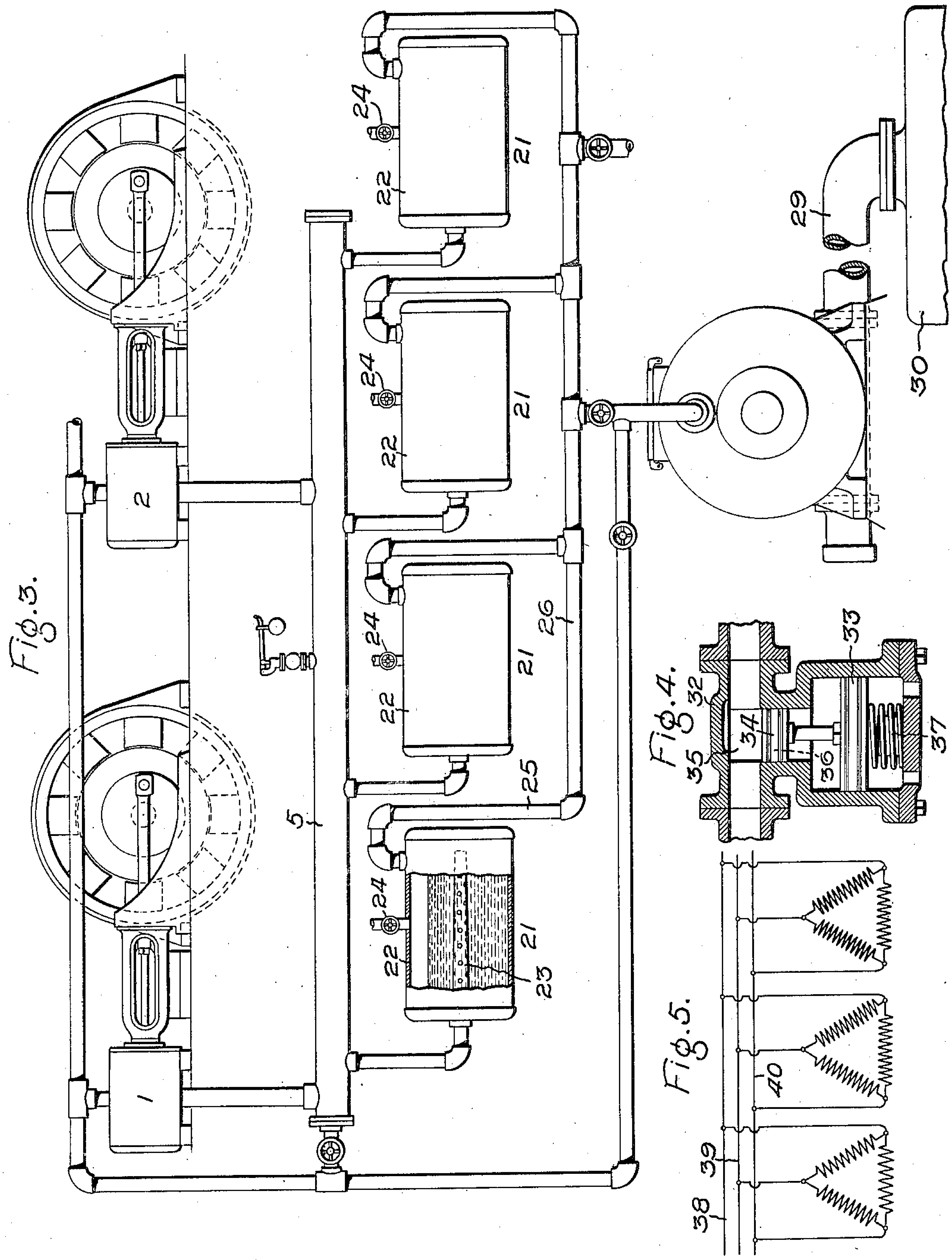

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UNITED STATES PATENT OFFICE.

WILLIAM L. R. EMMET, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

POWER SYSTEM.

No. 822,261. Specification of Letters Patent. Patented June 5, 1906.

Application filed October 7, 1905. Serial No. 281,787.

To all whom it may concern:

Be it known that I, WILLIAM L. R. EMMET, a citizen of the United States, residing at Schenectady, county of Schenectady, and State of New York, have invented certain new and useful Improvements in Power Systems, of which the following is a specification.

The present invention has for its object to increase the economy of operation of existing power plants equipped with reciprocating engines.

In carrying out my invention one or more suitably-constructed low-pressure turbines are provided, which are connected to the exhaust-conduit of one or more high-pressure reciprocating engines. Preferably the engines discharge into a suitable header having sufficient capacity to handle the steam therefrom, the header in turn discharging into the turbine or turbines. The header is provided with a relief-valve set to open at any predetermined pressure and to close when the pressure decreases.

In event of the load being of a rapidly-fluctuating character the admission of steam to the turbine is controlled by one or more valves responding to changes in pressure of steam in the header. The valves may be of the throttling type or those having an open and a closed position, but no intermediate. Whatever type of valve is employed, they should be arranged to operate successively on the different turbines, thereby preventing the pressure in the header from falling below the atmosphere or rising above the pressure for which the relief-valve is set.

Where the engine and turbine drive independent loads which are reasonably steady, the turbine can with advantage be controlled by a throttle-valve that responds to its speed changes, the said valve being located between the header and the turbine. In this case, as before, an automatic relief-valve is provided for the header to prevent excessive pressures. I may also provide a conduit for supplying the steam to the turbine in case of emergency.

Where the load fluctuates rapidly, an apparatus for storing heat should be provided, and in connection therewith it is sometimes desirable to introduce a reducing-valve in the pipe delivering exhaust-steam to the turbine. To obtain the best effect from the heat-storage apparatus, a considerable range of pressure should be permitted. A suitable heat-storage apparatus for this purpose comprises one or more water-containing drums of suitable size, which may be set in the ground, so as not to occupy valuable space and to reduce the dissipation of heat. In cases where a rapid absorption of heat by the water is particularly desirable the steam from the high-pressure reciprocating engine can be made to discharge into the chambers in the drum or drums in such a manner as to agitate the water and to expose an increased surface, and consequently obtain rapid absorption. When the water is giving up heat, the act of ebullition increases the surface and makes unnecessary a very large surface for the release of steam.

In the accompanying drawings, which illustrate embodiments of my invention, Figure 1 shows reciprocating high-pressure engines supplying steam to the low-pressure turbines through an exhaust-header. Fig. 2 is a detail view showing a throttle-valve for a low-pressure turbine that responds to changes in speed. Fig. 3 is a view showing high-pressure reciprocating engines exhausting into low-pressure turbines with heat-storing apparatus included between the high and low pressure machines. Fig. 4 is a detail view of a pressure-actuated throttle-valve, and Fig. 5 is a diagram showing alternating-current generators which are driven by the engines and turbines and connected in parallel.

1 and 2 represent high-pressure reciprocating engines, either of the simple or compound type. The engines drive electric generators 3 and 4 or other loads. The generators may be of the alternating or direct current type and suitably connected to the same or different circuits. The engines are provided with the usual governing mechanism to control their speed under variations in load. The exhaust from the engines is conveyed to a header 5, having sufficient storage capacity to prevent puffs of exhaust-steam from the engines from passing as such to the low-pressure turbine or turbines. The header is provided with an automatic relief-valve 6, set to open at a definite increase in pressure and to close when the pressure falls.

7 represents the wheel-buckets of a low-pressure turbine, preferably, but not necessarily, of the Curtis type. Steam is supplied thereto by the sectionalized nozzle 8. The noz-

zle receives steam from the chest 9, the latter containing a plurality of successively-acting nozzle-valves 10. As shown, each nozzle has its own valve, but two or more nozzles may be controlled by the same valve. The stems of the valves extend through a wall of the chest and are provided with rollers which engage with the cam-bar 11. As the bar moves to and fro the valves are opened one after the other and closed in reverse order. The cam-bar is actuated by a piston 12, that responds to changes in pressure in the header and in the conduit 13, leading therefrom to the turbine. The piston is inclosed in a suitable cylinder, and steam is admitted to one end thereof in a manner to act thereon. The movement of the piston is opposed by a spring 14 or equivalent means that normally tends to close the valves. The advantage of this type of governor resides in the fact that the number of nozzles in service will always bear a definite relation to the pressure, and hence to the amount of steam received from the header. As each valve has only an open and a closed position, no throttling takes place, and the volume of the fluid delivered to the turbine can be changed without changing its velocity.

In case the turbine is of a different type or the economy of operation is not of first importance I may substitute a throttle-valve, as typified in Fig. 4.

Where a high-pressure reciprocating engine and a low-pressure turbine drive separate loads that are comparatively steady, I provide a governing mechanism for the turbine which is responsive to speed changes. Such a mechanism is shown in Fig. 2 and comprises a butterfly throttle-valve 17, mounted on a spindle and actuated by a hydraulic motor 18 through a suitable connector. The motor is controlled by a pilot-valve 19 in response to changes in speed of the turbine-shaft. The governor 20, driven directly or indirectly by the turbine, is connected to the pilot-valve. As the speed changes the pilot-valve starts and stops the motor and the latter adjusts the butterfly-valve. The remainder of the apparatus may be the same as in Figs. 1 or 3.

In Fig. 3 is shown a slight modification of my invention wherein the high-pressure engines exhaust into a header 5, as before. Instead of discharging steam directly into the low-pressure turbine or turbines, as before, the steam passes through one or more heat-storing means 21. The latter comprise a sealed tank 22 of suitable size, partly filled with water, and a nozzle or discharging device 23, that receives steam from the header and discharges it through the water in a number of small streams to agitate the water and expose an increased surface and cause rapid absorption by it of the heat. The tank is provided with a suitable opening for filling and a plug or valve 24 for sealing it. To the tank is connected a conduit 25, leading to one or more low-pressure turbines. As the exhaust-steam passes into the tank some of its energy will be given up to the water and the remainder will pass to the turbine. When the load on the latter increases above a certain point, it is accompanied by a fall in pressure at the turbine, which in turn causes the water in the tank to give up its heat and form steam, thereby augmenting the supply from the header. When the steam is giving up heat to the water, the act of ebullition increases the surface and makes unnecessary a very large area for the release of steam. As many of these heat-storage tanks may be provided as are necessary. The header serves as a means for equalizing the pressures in the several tanks at the receiving end, and the conduit 26 serves the same purpose at the discharge end. One, two, or more low-pressure turbines are arranged to receive steam from the equalizing-conduit 26. I prefer to use a number of relatively small tanks and connect them in multiple, as shown. Where only a single tank is employed, the conduit serves only to convey steam to the turbine. The turbine is provided with rows of relatively movable buckets and the necessary nozzles or other fluid-discharging devices. The conduit 29 conveys the exhaust-steam from the turbine to the surface or other condenser 30. Steam is supplied to the engines by the conduit 31, and the latter is extended, so that live steam can be fed to the header or the turbine, or both, for emergency conditions. Between the conduit and the header and also between the conduit and the turbine are valves to control the flow of steam.

In Fig. 4 is shown a type of pressure-actuated throttle-valve for throttling the passage of fluid to the low-pressure turbine. It comprises a casing 32, bored to receive the piston 33. To the piston is connected a valve 34, that tends to close the passage 35 against the pressure therein. The valve is perforated at 36, so that the upper surface of the piston is subjected to the pressure of the steam in the conduit. Situated below the piston is a spring 37, which normally tends to close the valve. This action is assisted by the air-pressure in the cylinder. As the steam-pressure changes this valve will rise and fall and throttle the steam-flow to a greater or less extent.

In Fig. 5 are shown diagrammatically the windings of alternating-current generators driven by the engines and turbines and connected to the bus-bars or circuit-wires 38, 39, and 40.

In certain cases the low-pressure turbines may be provided with hand-operated valves for changing the effective area of admission as the load changes.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In combination, a high-pressure reciprocating engine, a header which receives the exhaust from the engine, a low-pressure turbine connected to the header, and a valve mechanism for automatically governing the admission of motive fluid to the turbine in accordance with the load conditions.

2. In combination, a high-pressure reciprocating engine, a header which receives the exhaust from the engine, a low-pressure turbine connected to the header, a valve mechanism responding to changes in pressure of the exhaust for increasing the volume of fluid admitted to the turbine as the pressure rises and decreasing it as it falls.

3. In combination, a high-pressure reciprocating engine, a header which receives the exhaust from the engine, a relief-valve that opens when the pressure on the header exceeds a certain amount and closes when it falls, and a valve for governing the admission of motive fluid to the turbine.

4. A high-pressure reciprocating engine, a low-pressure turbine receiving the exhaust from the engine, in combination with a heat-storage device receiving the exhaust from the engine and discharging it into the turbine and comprising a liquid-containing tank and a means for discharging the exhaust from the engine into the liquid in the tank.

5. In combination, a high-pressure reciprocating engine, a header receiving the exhaust from the engine, a heat-storage device receiving the exhaust from the engine after it passes through the header and comprising a liquid-containing tank and a means for discharging the engine-exhaust into the liquid therein, and a low-pressure turbine arranged to receive the exhaust from the engine after it passes through the header and storage device.

6. A high-pressure reciprocating engine and a low-pressure turbine receiving the exhaust therefrom, in combination with a heat-storage device through which the exhaust passes that comprises a liquid-containing tank and a device that discharges the exhaust in the form of small jets or streams into and through the liquid in the tank.

7. In combination, a high-pressure reciprocating engine, a header connected thereto for receiving the exhaust, a plurality of heat-storage devices connected to the header and receiving the exhaust therefrom, and one or more low-pressure turbines arranged to receive the fluid discharged by the heat-storage devices.

8. In combination, a high-pressure reciprocating engine, a header connected thereto for receiving the exhaust, a plurality of heat-storage devices connected to the header and receiving the exhaust therefrom, a conduit for equalizing the pressures of the fluid discharged by the heat-storage devices, and one or more low-pressure turbines arranged to be driven by the fluid from said devices.

9. In combination, a high-pressure reciprocating engine, a heat-storage device arranged to receive the exhaust therefrom, a low-pressure turbine arranged to receive the engine-exhaust after it passes through said device, and a conduit for conveying high-pressure fluid to the turbine for emergency conditions.

In witness whereof I have hereunto set my hand this 5th day of October, 1905.

WILLIAM L. R. EMMET.

Witnesses:
BENJAMIN B. HULL,
MARGARET E. WOOLLEY.