J. W. KIRKLAND.

POWER SYSTEM.

APPLICATION FILED SEPT. 27, 1909.

992,209. Patented May 16, 1911.

2 SHEETS—SHEET 1.

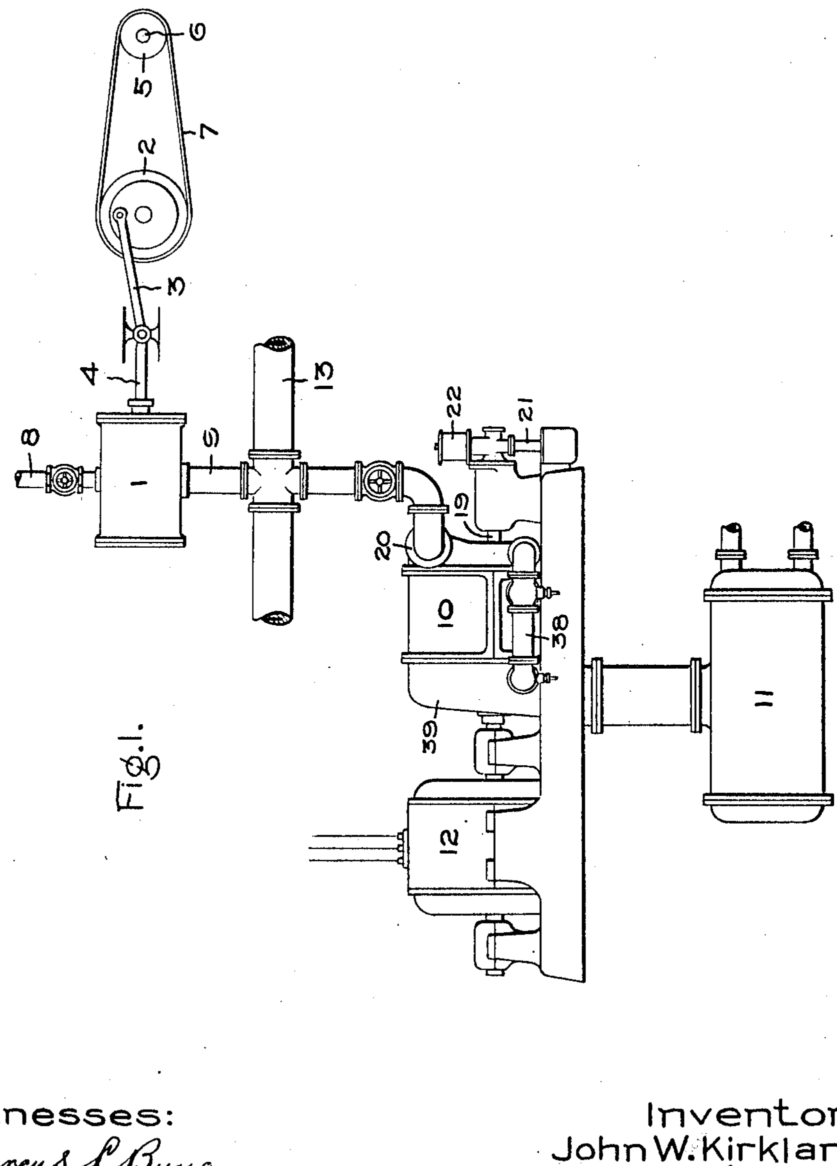

Fig. 1.

Witnesses:

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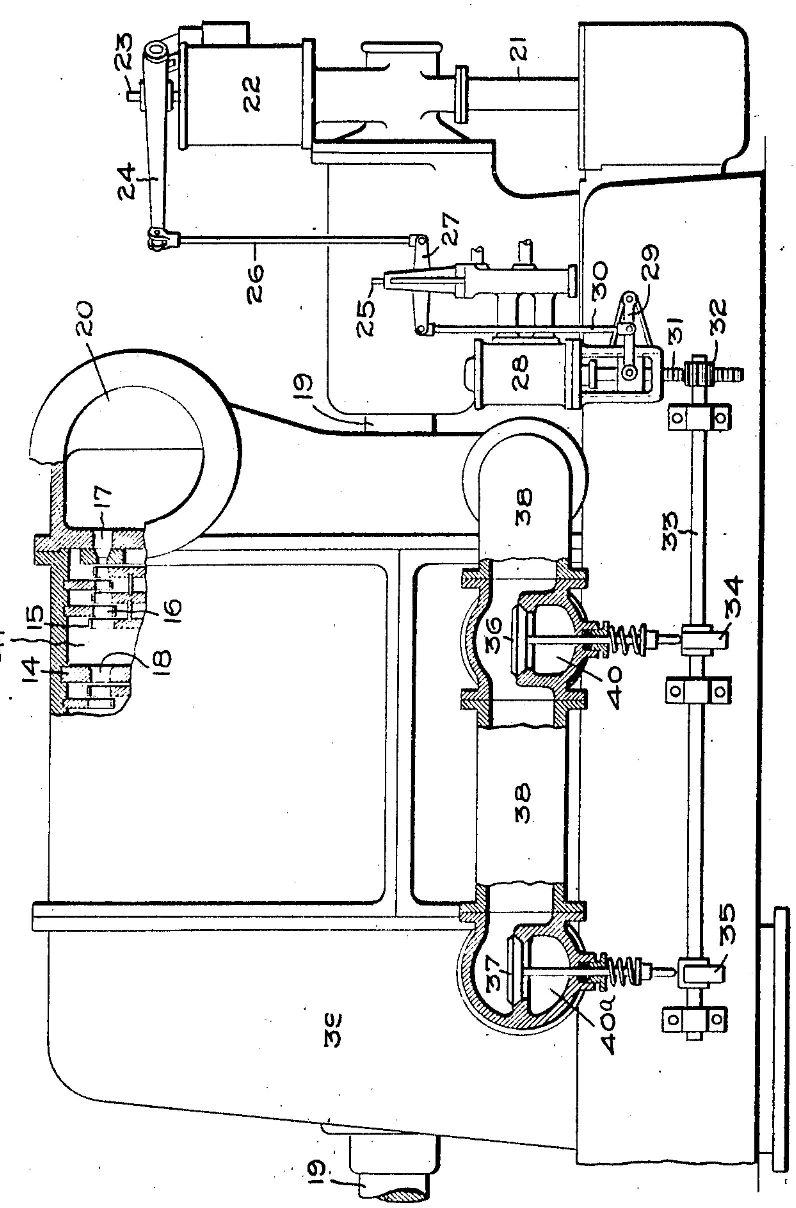
2 SHEETS—SHEET 2.

Fig.2



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UNITED STATES PATENT OFFICE.

JOHN W. KIRKLAND, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

POWER SYSTEM.

992,209. Specification of Letters Patent. Patented May 16, 1911.

Application filed September 27, 1909. Serial No. 519,802.

To all whom it may concern:

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

The present invention relates to power systems wherein high pressure prime movers exhaust into low pressure prime movers, the said prime movers driving independently variable loads.

More specifically my invention is directed to a system wherein a reciprocating engine drives one kind of a load, as for example the shafting in a factory, mill or other industrial concern, the exhaust from the engine passing into and driving a low pressure turbine. On the shaft of the turbine is an electric generator used for lighting, power or other purposes. It is evident that with such a system the loads on the engine and turbine may vary independently over wide ranges.

The object of my invention is to improve the economy of such a system.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and claims appended thereto.

In the accompanying drawing, which is illustrative of my invention, Figure 1 is a diagrammatic view of a high-pressure engine and low-pressure condensing turbine, and Fig. 2 is a view in side elevation of the low-pressure turbine.

1 indicates the cylinder of the engine and 2 its fly wheel, 3 the connecting rod and 4 the piston rod. The fly wheel is connected to the pulley 5 on the jack-shaft 6 or other power-consuming device by the belt 7. High pressure steam enters the engine by the pipe 8 under the control of suitable governing means, and the exhaust passes by the pipe 9 to the low pressure turbine 10. The exhaust from the turbine passes to the surface or other condenser 11. On the shaft of the turbine is an electric generator 12, which may be of the alternating or direct current type. The exhaust steam for the turbine may be supplied by one or more high pressure engines. When there is more than a single engine in the system a header 13 is provided, into which the engines exhaust. This header may supply one or more low pressure turbines.

The turbine I have elected to show is of the Curtis multi-stage type, but I do not wish to limit myself thereto, since other types of turbines may be employed. The turbine is divided into stages or regions having different pressures by suitable means, such as the diaphragms 14. In each compartment thus formed in the casing is a wheel having one, two or more rows of wheel buckets 15. Where two or more rows are employed intermediate buckets 16 are provided between each two rows. Steam or other motive fluid is admitted to the first stage by nozzles 17. Each diaphragm is provided with stage nozzles, passages or other devices 18 which convert, as do the admission nozzles, a certain amount of the pressure of the fluid into velocity and discharge it against the buckets. The wheels act to extract the energy from the motive fluid and transmit it to the shaft 19 in the form of rotary motion. Steam is admitted to the nozzles by the annular conduit or steam chest 20. The admission nozzles may extend wholly or partially around the machine, depending upon its character, output, etc. In the present case the nozzles surround the wheel, as do the stage nozzles and the machine is, therefore, of the total flow type, although as stated above, it may be of the partial flow type.

The main shaft 19 drives through suitable gearing a vertically disposed governor shaft contained in the casing 21. On the shaft is a speed governor of any well known type that is inclosed by the casing 22. The movements of the governor weights are communicated to the rod 23 and the latter moves the free end of the governor lever 24 up or down as the case may be. The governor lever controls the movements of the pilot valve 25 through the rod 26 and lever 27, and the valve controls the movements of the hydraulic motor 28. The movements of the piston of the motor are communicated to the pilot valve by the lever 29, link 30 and lever 27, the parts 27, 29 and 30 forming a follow-up device to prevent overtravel of the motor piston in a manner well understood.

On the end of the piston rod is a rack 31 that meshes with a pinion 32 carried by the rock shaft 33, the latter being supported by bearings attached to the base of the machine. On this shaft are cams 34 and 35 which control the operation of by-pass valves 36—37 located in the conduit 38 that is connected to and extends from the steam chest to and is connected with the exhaust conduit 39. This conduit 38 is connected by passages such as 40 to one or more stages or regions of intermediate pressure and by the passage 40ª to the conduit 39 and forms a low resistance shunt path for the steam from the steam chest to said stages and to the exhaust conduit 39 of the turbine. The conduit 38 may be on the outside of the turbine casing or within it, as desired. The pressure in the conduit 39 is the same as that of the condenser, disregarding any slight difference due to losses by friction. It is evident that when the valves 36—37 are closed (I have shown two, but more or less can be provided depending upon conditions) all of the steam entering the steam chest must pass through the nozzles 17 and buckets of the turbine and perform useful work. Under these conditions the pressure in the chest will correspond to that of the engine exhaust disregarding friction losses, and the turbine will give its full output, assuming the supply of steam from the engine or header to be sufficient. Assuming now that the load on the turbine decreases and that on the engine remains constant, the turbine will increase its speed and the governor will move the pilot valve in a direction to cause the piston of the motor to move up, and in so doing rotate the cam 34 in a direction to open the valve 36 against its closing spring by an amount depending upon the speed change. This means that a certain amount of steam will flow through the conduit 38 and the passage 40, thereby shunting the first stage. The amount of steam passing, and hence the effect of the shunt depends upon the valve opening. When fully open virtually all of the steam will pass through the conduit 38. A certain relatively small amount will however flow through the nozzles and buckets and hold the turbine speed normal. The distribution of steam will be determined by the relative resistances of the two paths.

Inasmuch as the pressure in the stage 41 will be less than the pressure in the steam chest 20, due to the increased area of the working passage for the steam leading therefrom and to the effects of the condenser, it follows that the back pressure on the engine will be reduced when the valve 36 is open, and hence the efficiency of the engine will be increased. Under these conditions there may be a very good vacuum existing in all of the piping back to the engine, in which case the engine will act as a condensing instead of as a non-condensing unit. Assuming a further decrease in load the second valve 37 will open against its closing spring by a greater or less amount and the back pressure on the engine will be still further decreased. When the load is removed from the generator, as by opening its circuit for example, the amount of steam which flows through the nozzles and buckets will be just sufficient to keep the turbine running at normal speed and no more. All of the steam will pass into the condenser and none will escape to the open air and be wasted.

Assuming that the engine supplies too much steam for the turbine, either because it is of larger capacity or any other reason, the valve mechanism of the turbine will act in the same manner as described and the amount of steam in excess of that required by the turbine will be shunted past one or more stages, finally doing work in one or more stages on its way to the condenser. An advantage of this arrangement resides in the fact that fractional loads on the turbine are driven with lower pressure steam than would be possible if the steam had to traverse the whole turbine, and hence steam of lower pressure can be utilized. Further, the back pressure exerted on the engine at these fractional loads is also decreased.

It is unnecessary with my improved arrangement in order to obtain good economy to closely proportion the load on the turbine to that carried by the engine, since a heavy load on the engine and a light load on the turbine simply means that the initial pressure on the turbine will be reduced and the engine will have the benefit of partial vacuum in its exhaust. The normal final pressure of the reciprocating engine may be that of atmosphere, or it may be above that pressure, as desired.

I have used the terms "high pressure" and "low pressure" in their relative sense, meaning that one is higher than the other.

I have shown the conduit 38 connected to the steam chest 20 and to the exhaust conduit 39 of the turbine, but the same effect will be obtained if the conduit is connected to the pipe leading to the steam chest and to the pipe leading from the turbine to the condenser. The particular arrangement shown is, however, desirable, because it requires the minimum amount of piping and fittings.

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 prime

mover, a low pressure prime mover receiving the exhaust from the first, a conduit connected to the low pressure prime mover and which forms a shunt therefor, a valve in the conduit which controls its communication with a region of intermediate pressure in the low pressure prime mover, and a device responsive to speed changes of the low pressure prime mover for controlling the action of the valve.

2. In combination, a high pressure prime mover, a low pressure prime mover receiving the exhaust from the first, a conduit connected to the low pressure prime mover and which forms a shunt therefor, valves in the conduit that control its communication with regions of different pressures within the low pressure prime mover, and means responsive to load changes for operating the valves.

3. In combination, a high pressure engine, a low pressure turbine, a conduit which is connected to the inlet of the turbine and to regions in the interior of the turbine having different pressures and forms a low resistance shunt, valves controlling the passage of motive fluid through the conduit into said regions, and a speed responsive device driven by the turbine for operating the valves successively.

4. An elastic fluid turbine that is provided with rows of buckets arranged within a casing, a motive fluid chest and an exhaust conduit therefor, a conduit which is connected to regions within the turbine casing having varying pressures and which forms a low resistance shunt path for the motive fluid, valve means controlling the distribution of motive fluid between the turbine and conduit, and a governor for the valve means which opens said means as the speed of the turbine increases.

5. An elastic fluid turbine comprising a rotor, a stator, a supply chest and an exhaust conduit, a conduit connected to the chest and to an intermediate pressure region of the turbine and also to the exhaust conduit, the said conduit forming a low resistance shunt from the point of admission to said region and to the exhaust of the turbine, valve means in the conduit, and a speed governor for controlling the opening and closing of the valve means.

6. In combination, a multi-stage elastic fluid turbine, a source of motive fluid supply therefor, a conduit connected to the source and to different stages of the turbine, valves controlling the admission of fluid from the conduit to the stages, and a governing mechanism acting on the valves to cut one stage of the turbine after another out of service as the load decreases beginning with the initial stage.

7. In combination, a high pressure engine, a low pressure turbine receiving the exhaust from the engine, the engine and turbine driving independently variable loads, a condenser for the turbine, a conduit that is connected to the inlet and to exhaust of the turbine and also to a region of intermediate pressure therein, valve means in the conduit for cutting portions of the turbine into and out of service as the load changes, thereby permitting the condenser to reduce the back pressure on the engine as the load on the turbine decreases, and a governor for said valve means that is sensitive to load changes of the turbine.

8. In combination, a high pressure prime mover, a low pressure turbine receiving exhaust from the prime mover, a condenser connected to the turbine, a conduit that is connected to the inlet of the turbine, to the condenser, and also to a region within the turbine whose pressure is intermediate that of the inlet and exhaust, a valve controlling the passage of fluid from the conduit to said region, a second valve that controls the passage of fluid from the conduit to the condenser, and means for actuating said valves.

In witness whereof, I have hereunto set my hand this twenty sixth day of August, 1909.

JOHN W. KIRKLAND.

Witnesses:
SIDNEY SMITH,
THOS. G. MURPHY.