No. 891,371. PATENTED JUNE 23, 1908.

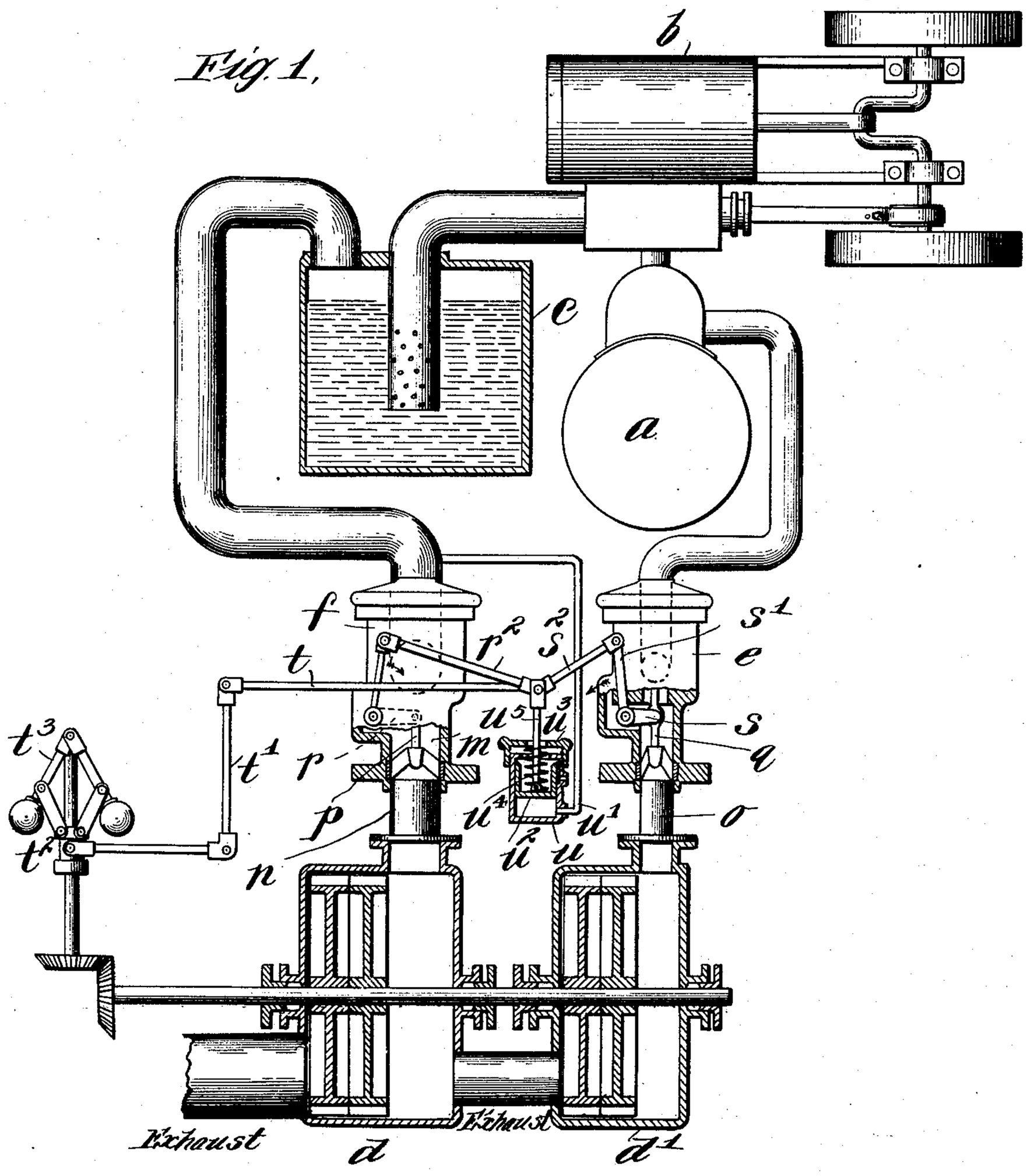
A. C. E. RATEAU.

EXHAUST REGENERATOR SYSTEM.

APPLICATION FILED SEPT. 9, 1905.

2 SHEETS—SHEET 1.

Fig. 1.



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= Mar. 8, 1908.

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2 SHEETS—SHEET 2.

Fig. 2.

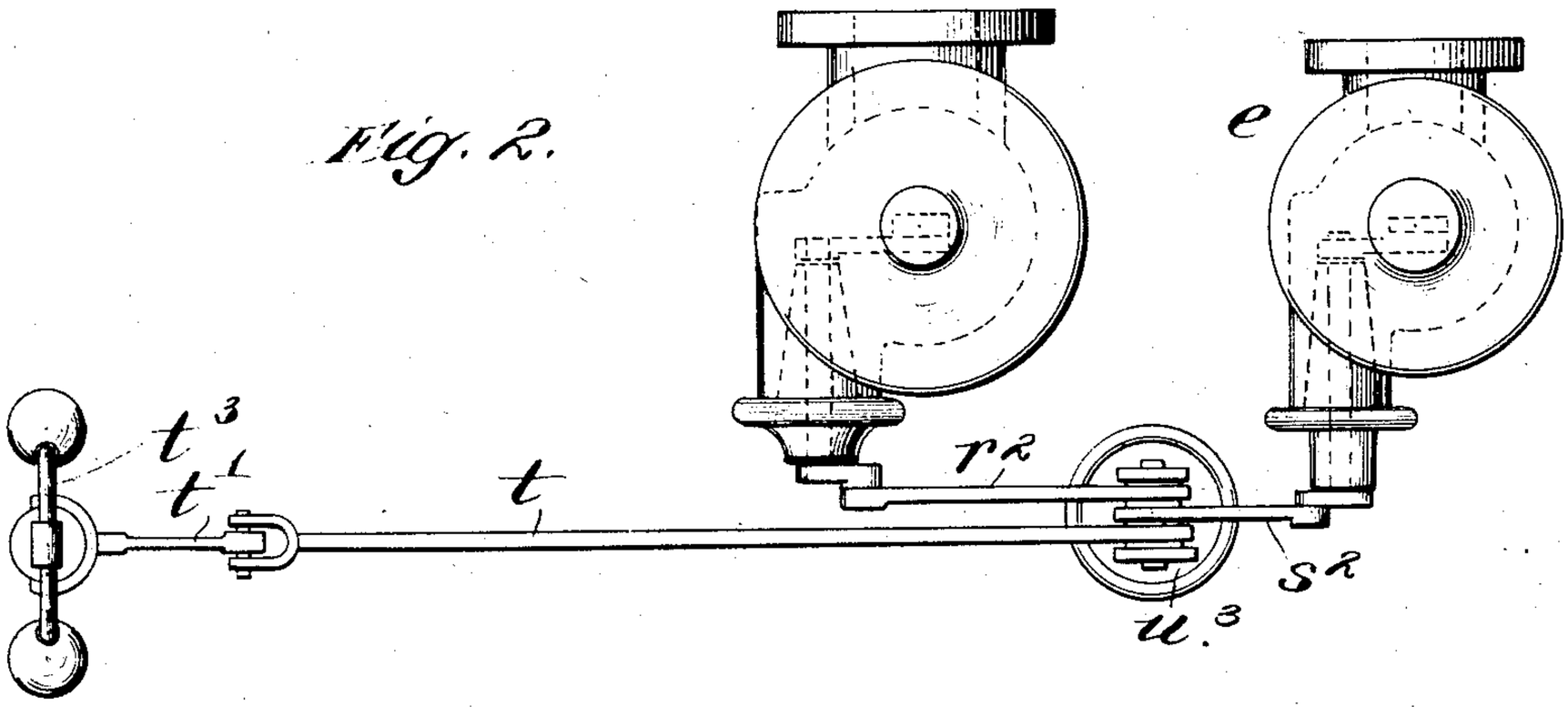

Fig. 3.

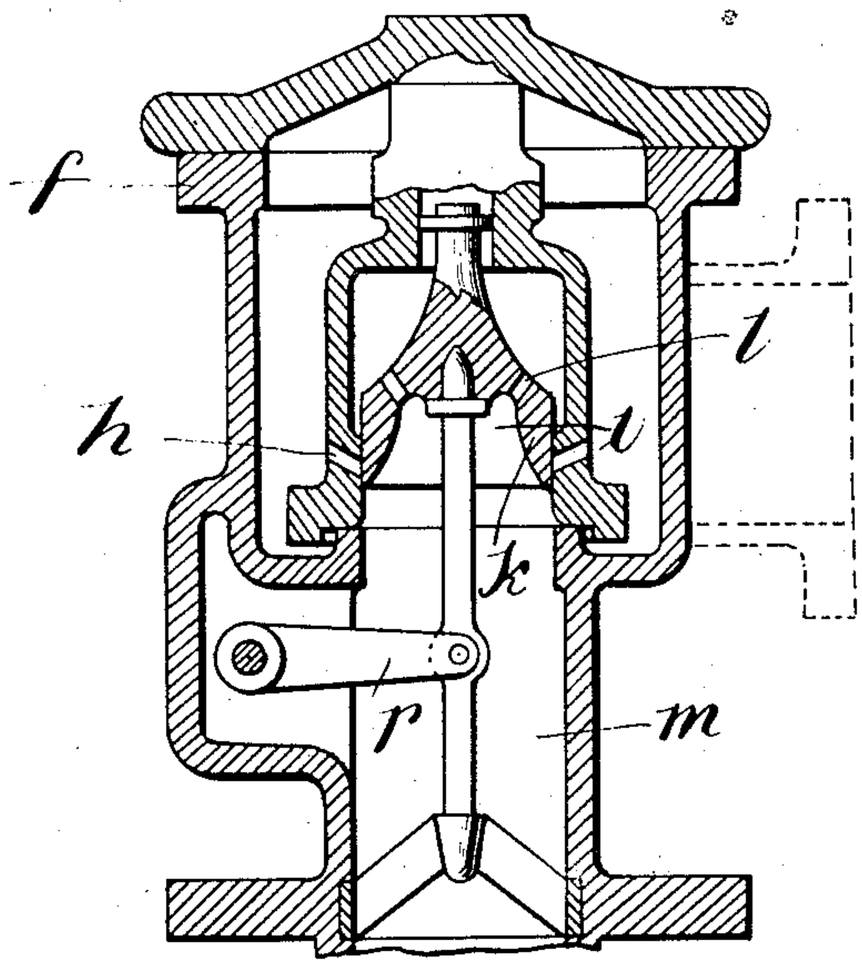

Fig. 4.

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UNITED STATES PATENT OFFICE.

AUGUSTE CAMILLE EDMOND RATEAU, OF PARIS, FRANCE, ASSIGNOR TO RATEAU STEAM REGENERATOR COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF WEST VIRGINIA.

EXHAUST-REGENERATOR SYSTEM.

No. 891,371. Specification of Letters Patent. Patented June 23, 1908.

Original application filed December 31, 1904, Serial No. 239,166. Divided and this application filed September 9, 1905. Serial No. 277,710.

To all whom it may concern:

Be it known that I, AUGUSTE C. E. RATEAU, citizen of France, residing at Paris, France, have invented a certain new and useful Improvement in Exhaust-Regenerator Systems, being a division of my application Serial No. 239,166, filed December 31, 1904, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to motors employing fluids preferably supplied to the engine or motors at different points, and preferably, though not necessarily, at different pressures derived from different sources. One source may be regenerated exhaust steam; the other source may be a source of steam of higher pressure, as the boiler steam, which I employ to supplement the lower pressure steam, in order that the deficiency thereof, which may vary, may be supplied.

My invention has been employed in connection with steam turbines, though it is not to be limited to this use, and in practicing my invention, I employ valves, one regulating the application of the low pressure steam to the engine and the other the application of the high pressure steam in conjunction with which valves, I employ a valve regulating apparatus whereby more or less of steam from each source may be admitted to the engine.

My invention has as an important object the control of the valves governing the admission of high and low pressure operating fluid or steam through the agency of operating steam or fluid, and the invention has been found of particular service in that class of power-producing mechanism where steam is admitted from the low pressure source to the low pressure motor or engine element and wherein steam is admitted from the high pressure source to the high pressure element of the motor or engine.

I have very successfully employed the apparatus of my invention in connection with steam regenerative accumulators or regenerators, such, for example, as are set forth in my Patent No. 679,242, dated April 12, 1901. I have employed a valve-regulating means having common influence upon the valves controlling the admission of the high and low pressure steam, which valve regulating means has been arranged to be within the influence of the low pressure steam admitted from the steam accumulator, whereby proper regulation of the low and high pressure valves may be effected to regulate the requisite application of steam to the engine, so that all possible steam of the low pressure source will be utilized in the turbine or engine and the high pressure steam is called upon only to supply a deficiency in the low pressure steam. I do not wish to be limited, however, to the source of steam that is employed for controlling the valve-regulating means. By means of my invention, it is not necessary to have two sources that supply steam in steady fluxes. I have preferably employed two distinct engine elements, to one of which the low pressure operating steam or fluid is admitted, and to the other of which the high pressure steam is admitted, but I do not wish to be limited to the precise way in which the low pressure and the high pressure steam are admitted to the composite engine or engine adapted for double pressures that I have practiced.

In the preferred embodiment of my invention, there has been employed a piston rod or plunger attached to piston mechanism, which piston mechanism is preferably constantly under the influence of the low pressure steam and of spring mechanism, the spring mechanism acting upon the piston mechanism in one direction, while the low pressure steam acts upon said piston mechanism in the opposite direction, these opposing forces, when operating, normally serving to maintain the piston mechanism in a given position, whereby the valves may be subject to the control of a speed regulator or governor to maintain the proper speed of the engine. By means of my invention, this same governing agency is also permitted to have the proper control of the speed irrespective of the positions the piston mechanism may assume through the influence of the low pressure steam and the spring mechanism acting thereupon. The governing mechanism preferably secures for each change in its condition of operation, a

similar change in the adjustment of the valves, while the valve regulating mechanism that is controlled by the steam preferably effects a differential or unlike adjustment of the valves.

I will explain my invention more fully by reference to the accompanying drawing showing one application and embodiment of the invention, in which—

Figure 1 is a view somewhat structural and somewhat diagrammatic, illustrating the application of my invention to a steam engine or turbine whose energy is supplied from a steam accumulator or regenerator and also from a source of higher pressure, as the boiler, from which the steam accumulator indirectly receives its steam, which has previously been used, for example, in an engine. Fig. 2 is a plan view of a portion of the apparatus illustrated in Fig. 1, excepting that the ball governor is swung at right-angles to the position shown in Fig. 1. Fig. 3 is a detail view showing one of many types of valve structures that may be employed in controlling the admission of steam into the steam engine or turbine. Fig. 4 is a view somewhat diagrammatic, illustrating a modification of the apparatus shown in Figs. 1 and 2.

Like parts are indicated by similar characters of reference throughout the different figures.

The invention having been shown in connection with a steam regenerator or accumulator, I have diagrammatically indicated various elements that enter into such system. The initial source of steam pressure is the boiler *a* that furnishes live steam to an engine *b* that may be employed for performing any suitable work, and which use is immaterial in connection with my present invention, the exhaust of which engine is received in a steam regenerative accumulator *c*, such as has been illustrated, for example, in my aforesaid patent. The steam from the steam regenerators, such as *c*, is frequently used in the operation of steam engines as turbines, to which end, there is employed a valve mechanism, such, for example, as that indicated in Fig. 3, that controls the entry of the steam from the steam accumulator to the low pressure element *d* of the steam engine or turbine. A valve mechanism *e*, preferably similar to the valve mechanism shown in Fig. 3, is employed for controlling the admission of steam which is at a higher pressure than that supplied from the accumulator *c*, which steam, at such increased pressure, may, for example, be received from the boiler *a*, this steam, at increased pressure, being thus live steam, though I do not wish to be limited to the particular source from which the steam at high pressure is received.

As a description of one of the valve structures will answer as a description of both, the structure illustrated fully in Fig. 3 will only be specifically explained. The casing *f* defines a steam chamber from the upper part of which a bell-shaped element *g* is depended, which bell-shaped element is provided with a series of ports *h* that communicate with the space about said element *g*, in which space the steam from the source of supply is received. Within the bell-shaped element there is provided a reciprocating valve element *i* that has a vertical flange portion *k* that serves, when in a depressed position, to seal the ports *h*. When this valve element *i* is in an elevated position, the flange or piston portion *k* is uncovered from the ports *h*, whereby steam may find passage into the channel *m*. Openings *l* are provided in the plunger or piston *k* so that the steam admitted through the ports *i* may surround said piston and balance the same. There may be any suitable form of connection established between the low and high pressure controlling steam valves; I have indicated a pipe *n* conveying low pressure steam to the low pressure motor element and a pipe *o* for bringing high pressure steam to the high pressure motor element, *d'*. The valve stems *p* and *q* of the low and high pres ure valves are articulated to the bell-cranks *r* and *s* respectively, which bell-cranks are fixed upon shafts to which are also fixed bell-cranks *r'* and *s'*, which latter links are flexibly connected with links r^2 and s^2 that are pivoted or linked together at their adjacent ends. It will be seen that the stems *p*, *q* work in stationary guides that are shown at their lower ends. A connecting rod *t* is also linked to the links r^2 and s^2 where the latter are joined. The bell crank lever *t'* having a fixed axis of rotation at its elbow has one of its arms linked to the connecting rod *t* and the other of its arms in engagement with a collar t^2 that forms a part of a well known ball governor t^3 and which is diagrammatically indicated in connection with the engine or turbine. It will be apparent that this ball governor and the link mechanism that I have described in connection with it serve to rock the arms *r* and *s* as the speed of the engine changes, so that the valves controlling the low and high pressure steam will be simultaneously controlled to maintain the speed of the engine. The governing mechanism that has thus been particularly described is supplemented by a pressure governor which is desirably regulated by the low pressure steam. This pressure governor in Fig. 1 is illustrated in the form of a cylinder *u*, to the bottom of which is led a steam passage *u'* that leads preferably directly from the pipe immediately leading from the steam accumulator, so as directly to be subject to the low pressure steam. Within this cylinder there is located a piston u^2, interposed between which and the cap u^3 of the cylinder is a coil-

spring u^4. The low pressure steam is admitted below the piston, and, in conjunction with the spring above, serves to define the position of the piston within the cylinder. The piston is provided with a piston rod u^5 that may be pivoted thereto somewhat in the manner of the piston and rod construction of the Brotherhood engine. The other end of this piston rod u^5 is shown connected with the elements r^2, s^2 and t where these elements are joined, all of which elements, together with the element u^5, thus have a common axis of rotation. Where the pressure from the low pressure source of steam becomes excessive, the piston u^2 will rise against the force of the spring u^4, whereby the link r' will be moved in a counter-clockwise direction and the link s' will be moved in a clockwise direction, whereby the links r and s are respectively moved in counter-clockwise and clockwise directions, whereby the low pressure valve permits the flow of more low pressure steam and the high pressure valve permits the flow of less high pressure steam. When, however, the low pressure steam decreases in pressure, the spring u^3 effects depression of the piston u^2, causing a clockwise movement of the arm r' and the link r and a counter-clockwise movement of the arm s' and the link s, thereby reducing the flow of low pressure steam and increasing the flow of high pressure steam, whereby the said engine may have the requisite amount of energy applied thereto to secure its effective operation. I have immediately above described some specific positions or conditions of the throttles or inlet valves for the high and low pressure steam. It is obvious that under certain circumstances the low pressure valve may be altogether closed and the high pressure valve opened and under other circumstances that the high pressure valve may be altogether closed and the low pressure valve opened. It will be thus seen that I have provided automatically operated throttles which, in association with the speed governor, will enable the engine to take care of varying loads at requisite speed.

It will also be seen that I have provided an improved power generating system including two sources of operating fluid, an engine adapted to be operated by fluid received from these sources, valves controlling the passage of said fluid from said engine, mechanism controlled by operating fluid (preferably received from the low pressure source) for effecting opening action upon one valve as it has closing action upon the other valve, whereby the relative positions of said valves are determined, and a speed governor simultaneously exerting opening or closing action upon said valves whose relative positions are thus determined. In the specific embodiment of the invention which I have practiced the engine will be operated by fluid received from the source c altogether as long as there is sufficient fluid receivable from said source, but when the fluid supplied from the source c is deficient, the quantity required will be made up from the source a supplied through the pipe o.

In Fig. 4, I have illustrated one of many other forms of my invention. In this construction, I have employed two dash-pots instead of one, as shown in Fig. 1, the pistons v whereof are shown attached to the pipe w and within cases x—x', which are provided with link connections y—y', which control respectively the low and high pressure valves. The pipe w has attached thereto a flexible duct z communicating with the source of low pressure steam. The pipe w is connected with a connecting rod t which is provided for the same purpose as the connecting rod t in the arrangement shown in Fig. 1. The pipe w serves to admit steam between the pistons v and their casings, springs being upon the other side of the said pistons. A reciprocation of the pipe w will cause movement of the links y—y' for purposes of speed regulation. Motion of the links y—y' independent of the pipe w is effected upon variation in the pressure of the steam behind the pistons, as has been explained and will be understood.

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

In my application Serial No 239166 filed December 31st, 1904, I have specifically claimed apparatus illustrated in Figs. 1, 2 and 3. In my present application, which is a division of the aforesaid application I broadly claim the system containing the regenerator herein illustrated and specifically claim the apparatus shown in Fig. 4.

It will be seen that I have produced an apparatus that works to particular advantage in connection with operating fluid of different pressures supplied to the engine or turbine construction at such different pressures, but I do not wish to be limited to the application of fluid at different pressures.

It is obvious that many changes may be made in the apparatus of my invention without departing from the spirit thereof, and I do not, therefore, wish to be limited to the precise embodiments of my invention, but

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

1. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment at different points, valves controlling the passage of fluid from said accumulator and equipment to the lat-

ter engine, and valve operating mechanism operating said valves and operated by fluid received from one of said sources.

2. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment at different points, valves controlling the passage of fluid from said accumulator and equipment to the latter engine, and valve operating mechanism operating said valves and operated by fluid received from said accumulator.

3. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment at different points, a valve controlling the flow of steam from one of said sources to the engine, and valve operating mechanism governing said valve and operated by fluid received from the other source.

4. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment at different points, a valve controlling the flow of steam from said equipment to the engine, and valve operating mechanism governing said valve and operated by fluid received from the accumulator.

5. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment, valves controlling the passage of fluid from said accumulator and equipment to the latter engine, and valve operating mechanism operating said valves and operated by fluid received from one of said sources

6. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment, valves controlling the passage of fluid from said accumulator and equipment to the latter engine, and valve operating mechanism operating said valves and operated by fluid received from said accumulator.

7. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment, a valve controlling the flow of steam from one of said sources to the engine, and valve operating mechanism governing said valve and operated by fluid received from the other source.

8. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, an engine receiving steam from said accumulator and equipment, a valve controlling the flow of steam from said equipment to the engine, and valve operating mechanism governing said valve and operated by fluid received from the accumulator.

9. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment at different points, valves controlling the passage of fluid from said accumulator and equipment to the steam turbine, and valve operating mechanism operating said valves and operated by fluid received from one of said sources.

10. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment at different points, valves controlling the passage of fluid from said accumulator and equipment to the steam turbine, and valve operating mechanism operating said valves and operated by fluid received from said accumulator.

11. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment at different points, a valve controlling the flow of steam from one of said sources to the steam turbine, and valve operating mechanism governing said valve and operated by fluid received from the other source.

12. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment at different points, a valve controlling the flow of steam from said equipment to the steam turbine, and valve operating mechanism governing said valve

and operated by fluid received from the accumulator.

13. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment, valves controlling the passage of fluid from said accumulator and equipment to the steam turbine, and valve operating mechanism operating said valves and operated by fluid received from one of said sources.

14. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment, valves controlling the passage of fluid from said accumulator and equipment to the steam turbine, and valve operating mechanism operating said valve and operated by fluid received from said accumulator.

15. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment, a valve controlling the flow of steam from one of said sources to the steam turbine, and valve operating mechanism governing said valve and operated by fluid received from the other source.

16. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, a steam turbine receiving steam from said accumulator and equipment, a valve controlling the flow of steam from said equipment to the steam turbine, and valve operating mechanism governing said valve and operated by fluid received from the accumulator.

17. A system for producing power including a boiler equipment for supplying steam, an engine operated by steam furnished from said equipment, a steam regenerative accumulator supplied from said engine, and a second engine, said second engine receiving steam from said accumulator at one point and steam from said boiler equipment at another point, a pipe w, a flexible duct z for conveying steam thereto, pistons $v\,v$ attached to pipe w, cases $x\,x'$ for the pistons, and link connections $y\,y'$ adapted to control the low and high pressure valves.

In witness whereof, I hereunto subscribe my name this twenty-second day of August A. D., 1905.

AUGUSTE CAMILLE EDMOND RATEAU.

Witnesses:

JACK BAKER,

HANSON C. COXE.