R. H. WHITE.

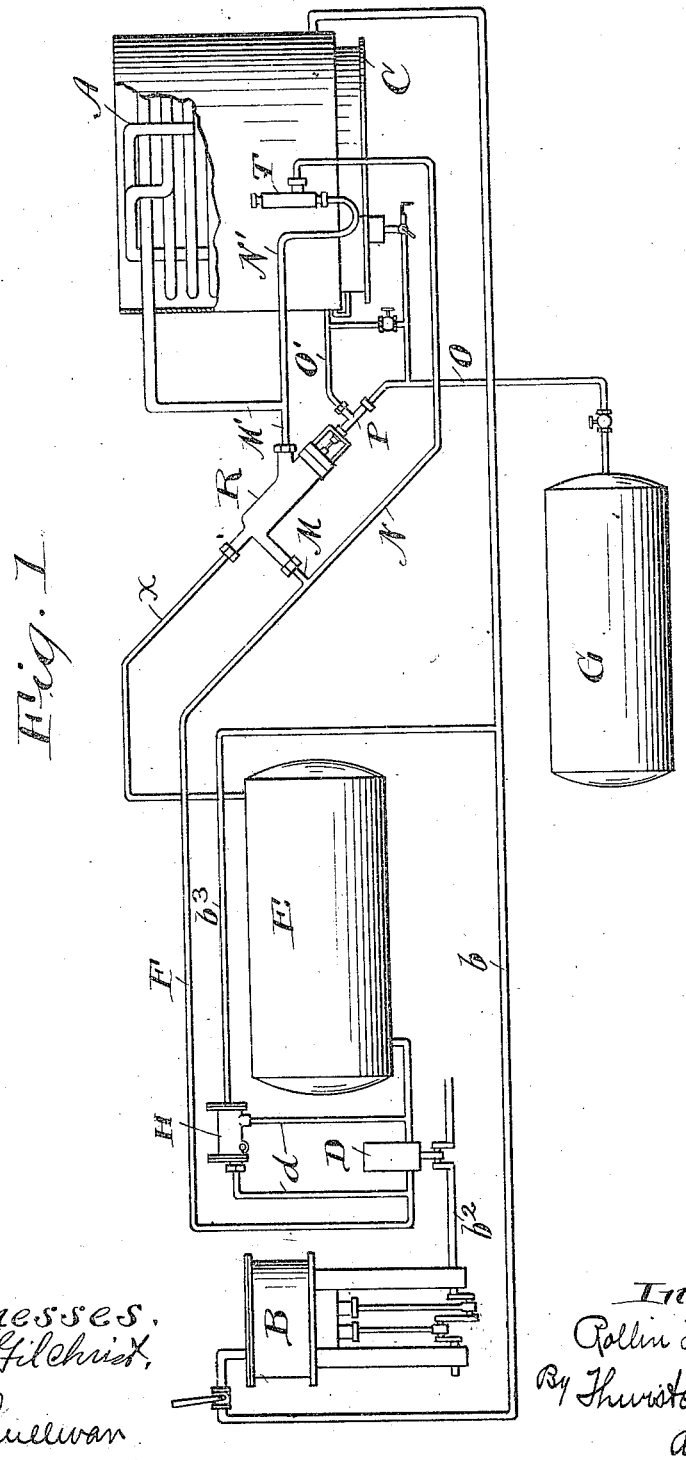
APPARATUS FOR GENERATING AND CONTROLLING THE GENERATION OF SUPERHEATED STEAM.

APPLICATION FILED NOV. 12, 1906.

987,933. Patented Mar. 28, 1911.

3 SHEETS—SHEET 1.

Fig. 1



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3 SHEETS—SHEET 2.

Fig. 2.

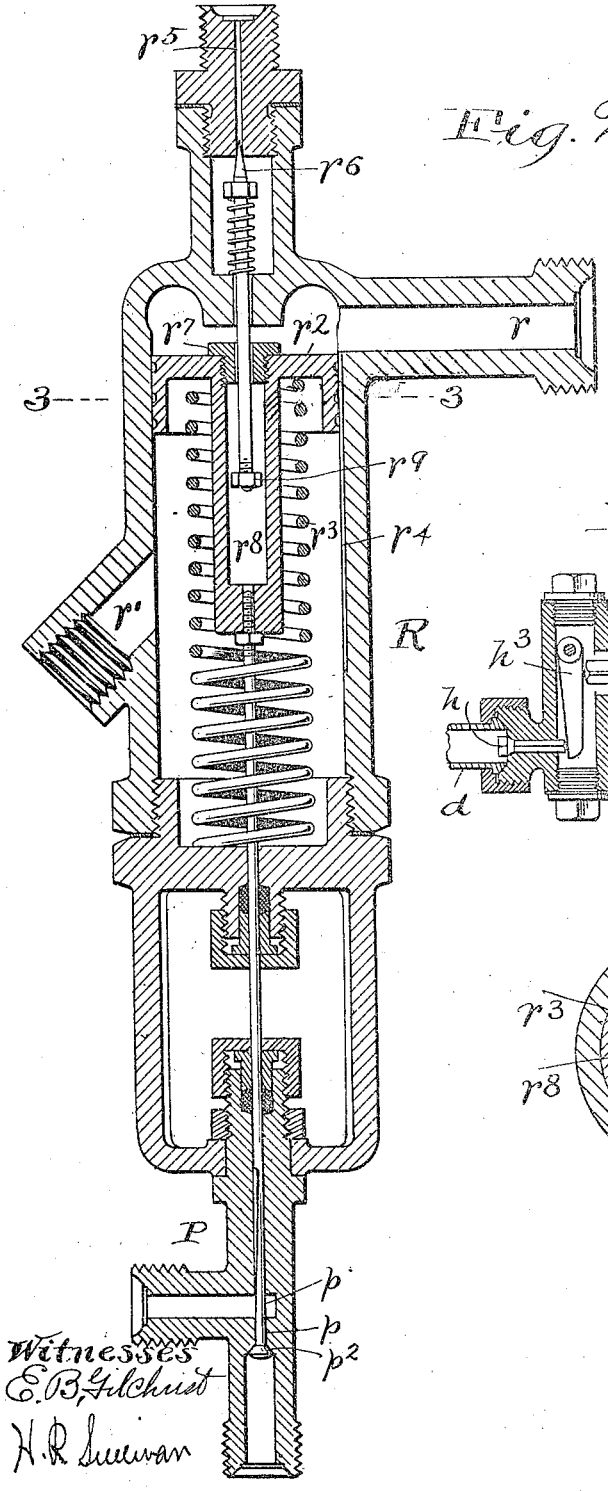


Fig. 5.

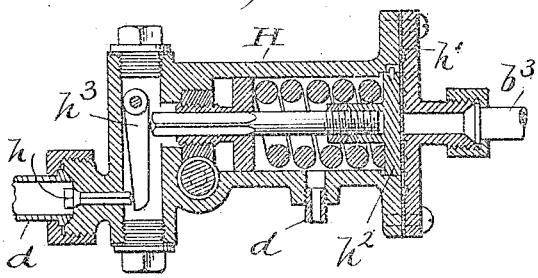
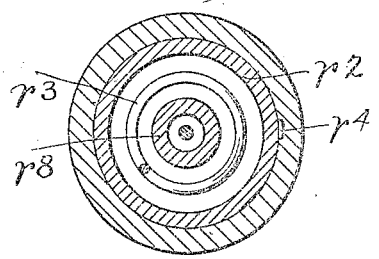


Fig. 3.



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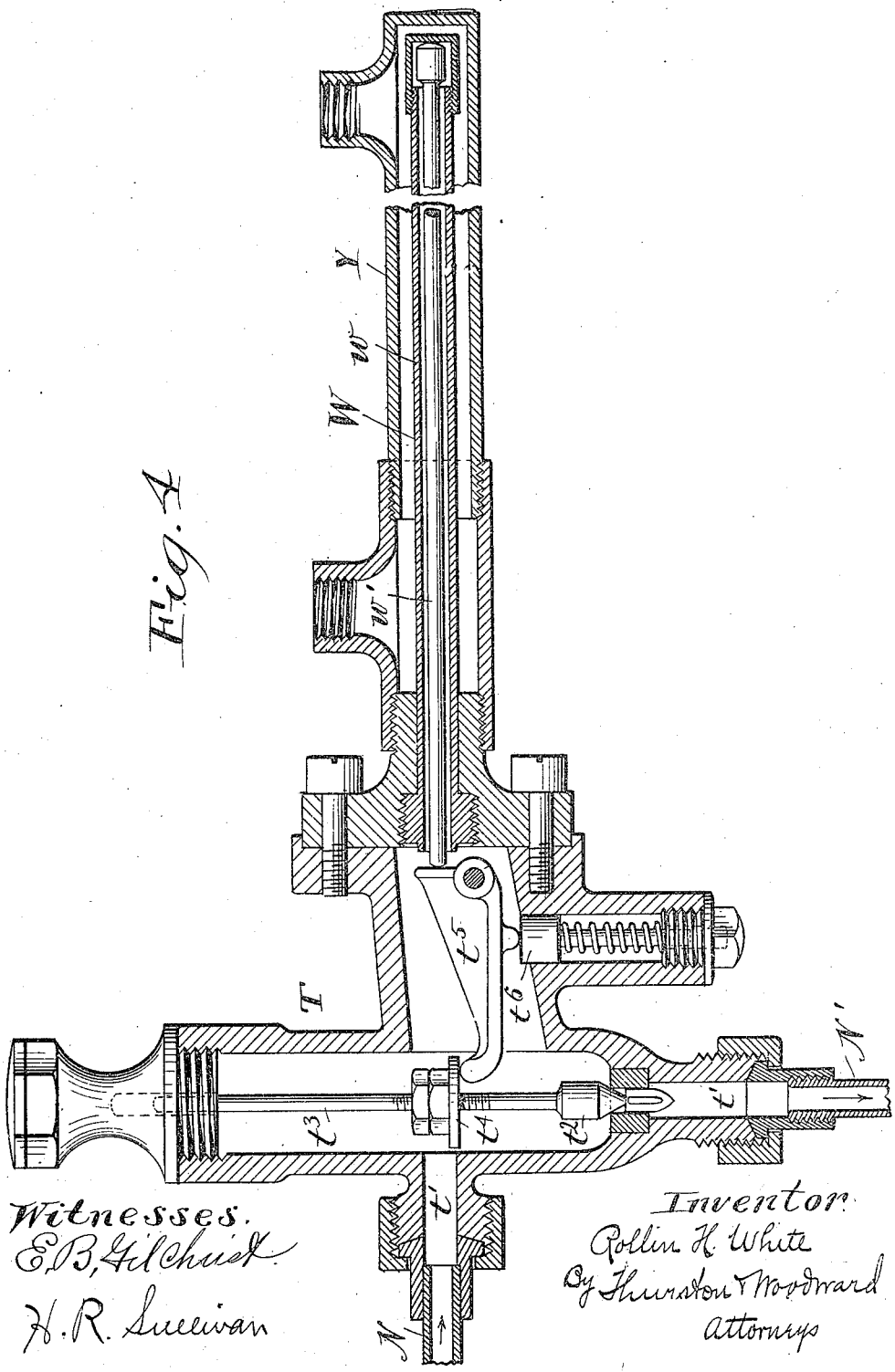
3 SHEETS—SHEET 3.

Fig. 4



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UNITED STATES PATENT OFFICE.

ROLLIN H. WHITE, OF CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE WHITE COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

APPARATUS FOR GENERATING AND CONTROLLING THE GENERATION OF SUPERHEATED STEAM.

987,933. Specification of Letters Patent. Patented Mar. 28, 1911.

Application filed November 12, 1906. Serial No. 342,973.

To all whom it may concern:

Be it known that I, ROLLIN H. WHITE, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Apparatus for Generating and Controlling the Generation of Superheated Steam, of which the following is a full, clear, and exact description.

This invention is an apparatus, constructed with especial reference to its use upon steam driven motor cars, by means of which to automatically so control the delivery of water to a suitable generator and the delivery of fuel to a suitable burner for heating the same, that superheated steam shall be generated in said generator in volume adequate to the varying demands therefor, and shall be maintained in substantially uniform condition as to pressure and temperature. It is not intended, however, that this patent shall be limited to the use above stated, for which the specific embodiment of the invention shown is especially contrived; because it may be used with good results in any analogous situation wherein the capacity of the feed water forcing device is variable, and wherein the demand for steam is not proportionate to the varying capacity of the feed water forcing device. The specific embodiment of the invention shown is, moreover, contrived with special reference to its use in connection with a generator of the semi-flasher type, such as is in common use in the White steam cars, and is exemplified in Letters Patent No. 659,837, granted Oct. 16, 1901. This patent is intended to cover the invention, when used in connection with that or any other type of generator with which it is adapted to be used.

The invention, as shown, is also contrived with special reference to adapting it to use liquid fuel, which is to be forced to the burner by pressure in the containing tank; but it is not intended to limit the claims to an apparatus in which liquid fuel is used or is so supplied to the burner.

This apparatus is a very good apparatus with which to carry into effect a process for generating and controlling the generation of superheated steam which forms the subject matter of another application filed contemporaneously with this one.

The invention, which is hereinafter described and shown in the drawings, may be here summarized as consisting of the combinations of parts as definitely pointed out in the claims.

In the drawing, Figure 1 is a diagrammatic view of an apparatus embodying the invention in the best form now known to me. Fig. 2 is a longitudinal sectional view of a flow motor, which forms part of the apparatus, and of certain valves which are operated thereby. Fig. 3 is a transverse sectional view in the plane of line 3—3 of Fig. 2. Fig. 4 is a longitudinal sectional view through a part of one of the generator tubes, the thermostat contained therein, and a valve casing containing a valve operated by said thermostat; and Fig. 5 is a longitudinal section of the water valve casing H.

The apparatus includes, of course, a generator A, which is preferably of what is sometimes known as the semi-flash type. Such a generator is, as before stated, shown in the Letters Patent No. 659,837, above mentioned,—the essential characteristics of such generator being that it consists of a plurality of connected coils of pipe into which water is introduced at a point remote from the fire, and wherein the water travels through said coils gradually approaching the fire, being transformed into steam at some intermediate point therein and subsequently superheated before it leaves said coils. The apparatus also includes a steam engine B, which is to be supplied with steam from the generator, as, for example, through a pipe *b*. The apparatus also includes a feed water pump D which is driven by the engine, and whose capacity, therefore, is proportioned to the speed of the engine. Consequently when the apparatus is used upon a steam driven vehicle, which travels at varying speeds, the capacity of the pump is proportionate to the rate at which the vehicle is traveling. This pump may be driven from the crank shaft b^2 of the engine; and it may draw the water which it throws from a tank E. The apparatus also includes a water valve whose position is controlled by the pressure of steam in the generator. This valve and its casing, in a very satisfactory form for the intended use, is shown in Fig. 5. It includes a casing H

across which a diaphragm h' is secured. Steam at the generator pressure is admitted to the casing on one side of this diaphragm. On the other side of the diaphragm is a chamber through which water will flow when the valve is open. In this chamber is a spring-pressed piston h^2 which engages with the diaphragm and may be moved thereby in opposition to its spring. This piston actuates a lever h^3, which in turn, actuates a valve h and this valve controls the flow of water through the casing. The valve casing H is preferably connected in a by-pass d around the pump; and is also connected by a small pipe b^3 with the steam pipe b. When the pressure of steam exceeds a predetermined pressure the valve will be opened, and thereby permit all of the water which the pump is throwing to be diverted from the generator and by-passed to the other side of the pump. When the steam pressure in the generator falls a little below the predetermined pressure this water valve will be closed, and thereby all of the water thrown by the pump will be required to pass toward the generator.

F represents the pipe leading from the pump toward the generator. At a suitable point this pipe is branched, forming thereby the two branches, one indicated by M, M′ and one by N, N′. In the branch M M′ a flow motor R is connected. The specific construction of a suitable flow motor will be subsequently described. It will be sufficient for the present purpose to say that it is an apparatus containing a movable member whose position depends upon the rate of flow of the water through said flow motor. The water as it emerges from said flow motor goes to the generator through a pipe M′.

The generator is to be heated by a burner C of any suitable construction, which receives its supply of fluid fuel from a tank G; and the fuel may be forced from the tank to the burner by the air pressure within said tank. The fuel flows from this tank through pipe O into a valve casing P, which contains a valve for controlling the rate of flow of the fuel through the said valve casing, and thence through pipe O′ to the burner. This valve is connected with the movable member of the flow motor so as to be closed or opened more or less thereby, and preferably it is to be so constructed and connected with the movable member of the flow motor, that the ratio between the rate at which fuel will flow through the valve casing P to the burner, and the rate at which water will flow through the flow motor to the generator will remain constant, however much the actual volumes of such fuel or water, flowing during a given period, may be increased or diminished.

A valve casing T is connected in the branch feed water pipe N N′, which is constructed as a by-pass around the flow motor. In this casing is a valve which controls the rate at which water may flow to the generator through the conduit of which said valve casing and the pipe N N′ are parts. A thermostat, which is subjected to the influence of the steam in the generator is provided for operating this valve so that it will move the valve away from its seat as the temperature of the steam increases, and will move it toward its seat as the temperature of the steam decreases. This valve and the thermostat should be so arranged that, under average conditions, this valve permits about one-third of the water which flows into the generator to flow through the conduit of which the valve casing T is a part, while about two thirds of said water will flow to the generator through that conduit of which the flow motor is a part.

Before describing the operation of the described mechanism in the carrying out of the process herein claimed, it will be well to first describe the construction of the flow motor and of the valves which it controls, in the form in which these parts are shown in the drawing.

The flow motor includes a casing R having an inlet r near one end and an outlet r' near the other end. Within the casing is a piston r^2 which occupies a position between said inlet and said outlet, and is subject to the influence of a spring r^3 thrusting it toward the inlet end of said casing. Within the casing is a restricted passage r^4, through which water may flow past the piston, irrespective of the position of the piston, in going from the inlet to the outlet. When water is forced into the casing through the inlet r the piston will be moved in opposition to its spring. The higher the rate at which the water is forced into the casing, the more rapidly will the water flow past the piston through said restricted passage; and, as the result of the increased pressure upon the piston, it will be moved a proportionately greater distance from its normal position, which is that shown in Fig. 1. The movement of the piston from its normal position will therefore be substantially proportionate to the rate at which water flows through the casing past said piston.

In the upper end of the casing is a relief port r^5 which is connected by a pipe X with the water tank E. This relief port is normally closed by a self-closing valve, preferably a spring-actuated valve r^6,—the stem of which passes loosely through a nut r^7 which is screwed into the upper end of the hollow stem r^8 of piston r^2, and a nut r^9 is secured on the lower end of said stem. When water is being forced into this casing at a rate greater than the capacity of the generator, the piston r^2 will be moved far enough to draw valve r^6 from its seat, and thereby per-

mit the escape through the relief port r^5 of all water in excess of the capacity of the generator.

A valve casing P is secured to the valve casing R. It contains a port p through which fluid must flow in passing from pipe O to pipe O'. The stem p' of a valve p^2 passes through this port and out of the casing P through a suitable stuffing box, and its upper end is adjustably secured to the piston stem r^3 by being screwed into said stem a suitable distance. The spring r^3 will, therefore, not only move the piston r^2 toward the inlet end of the flow motor casing, but it will also draw the conical valve p^2 against its seat. The adjustable connection between the valve stem p' and the flow motor piston is for the purpose, among others, of regulating the tension of the spring r^3. Just above the port p, the valve stem p' is gradually reduced in cross sectional area, so that the farther it is moved down in said port, the larger will be the opening in said port through which fuel may flow from the tank G to the burner through the pipes O, O'. This reduction in the cross sectional area of the valve stem is of such character that the rate of flow which is thereby permitted through the port p will be increased in proportion to the distance which said valve stem is moved down by the action of the flow motor piston.

The valve casing T, and the valve therein, and the thermostat which is provided for operating it will now be described.

The valve casing is provided with an inlet t and an outlet t'. It also contains a valve t^2 whose valve stem t^3 carries an adjustable shoulder t^4. Within the casing is a bell crank lever t^5, one arm of which engages below the shoulder t^4, so that the valve may be raised from its seat. A spring actuated plunger t^6 acts always upon this lever t^5, pushing it in the direction to so raise said valve. The movement of the lever in this direction is limited, and it is moved in the opposite direction by means of a thermostat W. This thermostat consists of an outer tube w which is made of metal, wherefore, it will be elongated as it is heated. This outer tube is contained in a tube Y which is connected in the generator coils and forms a part of the generator, near the outlet end thereof. The inner end of the tube w is closed, and the outer end is firmly secured to the valve casing T, and is opened to the interior of said valve casing. Within the tube w is a rod w', which is made of practically non-expansible material, for example, glass or porcelain. One end of this rod abuts the inner end of the tube w, while its other end, projecting into the valve casing, engages with one arm of the lever t^5. It is evident, therefore, that as the steam in tube Y gets hotter, the tube w gets longer, and therefore the lever t^5 may be moved a greater distance by the spring actuated plunger t^6. This results in a wider opening of the valve t^2, and this, as before explained, permits the water to flow to the generator at a higher rate through that conduit of which the valve casing T is a part.

This apparatus is, as before stated, of especial value when applied for controlling the generation of steam on a steam driven motor car; the reason being that on such a vehicle any feed water forcing apparatus which is driven by the vehicle motor will vary in capacity as the speed of the vehicle and its motor varies; whereas the demand upon the apparatus for steam is not at all proportionate to the speed of the motor. For example, if the vehicle be running at 15 miles an hour, the demand for steam for the purpose of maintaining that speed will be very much less than it would be if the vehicle were on an up grade or going through sand or mud; and on the other hand it will be very much less than if the vehicle were on a down grade of a smooth surface road. Moreover it is desirable, and sometimes essential that the generator shall be working to its full capacity even when the car is going slowly, as for example when the car is going up hill or over a particularly bad road. As a result of much consideration and experimenting, it is thought that the various parts of the apparatus, when used upon a motor car, should be so constructed and adjusted that the capacity of the pump, when the vehicle is going at about 15 miles an hour, should be equal to the capacity of the generator. It is also quite apparent that it is unwise to deliver water to a generator of this character at a rate beyond its capacity to transform it into superheated steam of the desired degree of superheat. The purpose of a relief valve or its equivalent is therefore apparent. It is for the purpose of diverting from the generator so much of the water thrown by the pump as is in excess of the capacity of the generator to transform into superheated steam of the required pressure and temperature; and it and the flow motor should be so constructed and connected that when the speed of the vehicle exceeds 15 miles per hour the relief valve will be opened so as to permit all of the water thrown by the pump in excess of the capacity of the generator to be by-passed or returned to the water tank. It is apparent that the speed of the car mentioned, to wit, 15 miles per hour is arbitrarily selected; but some speed must be determined upon and the apparatus must be adjusted with regard to that speed, so that the process shall be efficient.

It is evident from the description of the apparatus, that, if the speed of the vehicle is less than the speed determined upon at

which it is desired to have the generator receive water to its full capacity, for example, 15 miles per hour, a further reduction in the speed of the vehicle will reduce the speed of the pump, and thereby, the supply of water passing to the flow motor will be correspondingly reduced, and the amount of fuel delivered to the burner will be correspondingly reduced,—this being due to the fact that the piston of the flow motor will occupy a different position, because less water is being pumped through it and consequently the fuel valve will occupy a different position.

When the steam pressure in the generator exceeds the required pressure, the water valve *h* will open and all of the water thrown by the pump will be by-passed. When the pressure in the generator falls below the desired pressure the water valve will be closed, and thereafter all of the water thrown by the pump will be forced toward the generator. The duration and frequency of the periods of time when all of the water is by-passed or none of it is by-passed by this water valve, play a very large part in determining the volume of water actually supplied to the generator during a given time. It is only when the water is not by-passed by this valve that the other parts of the described regulating apparatus act at all. When they are operating, however, they operate after the following fashion.

If the car is going more than 15 miles an hour, or whatever may be the rate for which the apparatus is adjusted, the quantity of water forced by the pump will be greater than the capacity of the generator. All of the excess above the capacity of the generator, will, however, be discharged from the flow motor casing through the relief opening therein. Water equal to the capacity of the generator will be flowing thereto through the two conduits described—that is to say, under what may be called the balanced condition of the apparatus, about two-thirds of it will be flowing through the conduit of which the flow motor is a part, and about one-third of it will be flowing through the conduit whose capacity is controlled by the thermostatically operated valve. The resultant movement of the piston of the flow motor, due to the passage of this water through said motor, will have opened the fuel valve so that the fuel will flow to the burner at approximately the rate required to transform into superheated steam all of the water which flows into the generator. But it seldom, if ever, happens that the ratio between the water supply to the generator and the fuel supply to the burner is exactly right. One or the other is in the excess—and it is for the purpose of alternating these excesses at proper intervals and of confining them within small limits that the thermostat is provided. If, for example, when the pump is throwing water at a rate below the capacity of the generator (as when the car is traveling at fifteen miles or less per hour) the temperature of the steam rises above the required temperature, it is because the rate at which fuel is supplied to the burner is too great for the rate at which water is then being supplied to the generator. The result will be that the thermostat will move the valve which it controls farther from its seat, so that a greater volume of water will be delivered to the generator through that conduit of which valve casing T is a part. But if the car is going at such speed that the water thrown by the pump is above the capacity of the generator, the rate at which water is flowing through the other conduit will not, however, be changed, nor will the rate at which fuel is being delivered into the burner, because there is never any change in the ratio between the rate at which water is flowing into the generator through that conduit of which the flow motor is a part. In other words, the readjustment of the proportions of water and fuel will be brought about by increasing the rate at which water is delivered to the generator without increasing the rate at which fuel is delivered to the burner. If, however, when the car is traveling at the rate of 15 miles per hour or greater, the burner is not delivering heat enough to take care of the water being delivered into the generator, the temperature of the steam therein will be reduced, and the thermostat will operate in the other direction, and will force the valve which it controls, toward its seat, and thereby will reduce the quantity of water passing to the generator through the conduit whose capacity is controlled by said valve. The quantity of the water flowing to the generator through the other conduit, which includes the flow motor, will not be changed, however, and therefore the quantity of fuel being fed to the burner will not be changed. In other words, the readjustment will be brought about by decreasing the quantity of water delivered to the generator without decreasing the quantity of fuel delivered to the burner. If, however, the speed of the car be reduced to less than 15 miles an hour, so that the capacity of the pump is not equal to the capacity of the generator, a slightly different action of the apparatus will take place, but with substantially the same results. In the first place, the amount of water flowing through the flow motor may be decreased without at the same time decreasing at all the rate of flow of water through the thermostatically controlled valve casing. This will, of course, cause a change in the position of the flow motor pis-

ton, and a consequent change in the position of the fuel valve, so that temporarily too little fuel will be fed to the burner. The result of this will be a reduction in the temperature of the steam. This will operate the thermostat in the direction which will cause the valve to move toward its seat, and thereby reduce the quantity of water flowing past it. Since the total quantity of water delivered into the generator is not thereby reduced, it is obvious that the quantity of water flowing through the flow motor will be correspondingly increased, and this will draw the fuel valve farther open and so increase the supply of fuel to the burner. This is also the manner in which the device is readjusted, if the car is running below 15 miles per hour, and the apparatus is thrown out of balance by any of the conditions which may arise. That is to say, the rate of flow of water to the generator is not changed, but there is a change in the ratio between the rate at which the water flows through the flow motor, and the rate at which it flows through the thermostatically controlled valve, and these changes, which are due to the action of the thermostat, result in changing the rate at which fuel is fed to the burner, without there being any change in the rate at which water is supplied to the generator.

It will be seen from the foregoing that, the variations in the demand for steam are taken care of by either by-passing all of the water thrown by the pump, or none of it, and by automatically changing the duration and frequency of these periods of time in which water is so by-passed, or is not. All of these matters are dependent upon changes in the pressure of steam. The maintenance of a proper average ratio between fuel and water so as to vaporize the water discharged into the generator and to superheat it to the required degree are accomplished by means of variations in the temperature of the steam, which, while it does not cause the change in ratio between the rate at which water is flowing to the generator through one conduit, viz: that containing the flow motor, and the rate at which fuel is flowing to the burner, does cause a change in the ratio between the water flowing to the generator through the two conduits provided for that purpose, and consequently does change the ratio between the total volume of water supplied to the generator and the volume of fuel supplied to the burner during the same period, and all water in excess of the capacity of the generator is diverted therefrom and returned to the water tank.

It will also be understood that the described apparatus is not organized with a view of maintaining any definite ratio between the rate at which fuel is fed to the burner, and water fed to the generator, or between either of those rates and the rate at which steam is withdrawn from the generator. The ratios between these rates is constantly changing. The apparatus is organized to operate on the principle of rapidly alternating excesses and deficiencies in the rate of supplying water and fuel, relative to each other and to the volume of steam withdrawn, and for changing these ratios with such rapidity, and confining the changes to such narrow limits, that the practical result is the maintenance of substantial uniformity of steam pressure and temperature irrespective of variations in demand for steam. The thermostat is almost constantly in operation when the water valve H is closed, thereby alternating the excess of fuel and water relatively to each other. When the water is in excess of the fuel the temperature of the steam goes down quickly, the thermostat acts to so change the ratio that for the time being fuel will be in excess. This results in a quick raising of the temperature of the steam, whereupon the thermostat again acts to change the ratio with the result that for the time being water will be supplied in excess. When any water is going into the generator, as when water valve H is closed, that water is in excess of that quantity which is required to replace the steam withdrawn during the same period. When no water is going into the generator, as when water valve H is open, obviously, the water supply is less than the quantity required to replace the steam which is withdrawn from the generator during that time. When no water is flowing past the water valve H, none goes through the flow regulator, and therefore the flow of fuel is reduced to the minimum, and the fire is practically out; in other words, during the time when no water is being supplied to the generator an insufficient quantity of fuel is being fed to the burner for the generation and superheating of enough steam to take the place of that withdrawn from the generator during said periods.

Having described my invention, I claim:

1. In an apparatus for generating steam, the combination of a generator of the type specified, a burner for heating the generator, a feed water pump whose efficiency varies directly as its speed varies, and whose capacity, when running at less than its maximum speed is equal to the capacity of the generator, means for positively driving said pump at varying speeds and causing it to deliver feed water generally in excess but regardless of the requirements of the generator, means whereby, when the speed of the pump is such that it forces toward the generator water in excess of the capacity of the generator, the excess water is automatically diverted from said generator, and means for automatically sup-

plying to the burner the fuel which is required to transform into superheated steam of the required degree of superheat all of the water supplied to the generator.

2. In an apparatus for generating and using steam, the combination of a generator of the type specified, a motor supplied thereby, a burner for heating the generator, a feed water pump whose efficiency varies directly as its speed varies, and whose capacity, when running at less than its maximum speed, is equal to the capacity of the generator, operative connections between the pump and the motor whereby the speed of the pump will be proportionate to the speed of the motor, means whereby, when the speed of the pump is such that it forces toward the generator water in excess of the capacity of the generator, the excess water is automatically diverted from said generator, and means for automatically supplying to the burner the fuel which is required to transform into superheated steam of the required degree of superheat all of the water supplied to the generator.

3. In an apparatus for generating and using steam, the combination of a generator, of the type specified, a burner for heating the generator, a feed water pump whose capacity when running at less than the maximum speed is equal to the capacity of the generator, means for driving said pump at varying speeds, means whereby, when the speed of the pump is such that it forces toward the generator water in excess of the capacity of the generator, the excess water is automatically diverted from said generator, means for automatically supplying to the burner the fuel which is required to transform into superheated steam of the required degree of superheat all of the water supplied to the generator, and means, governed by the pressure of steam in the generator, for alternately by-passing all of the water thrown by the pump or allowing it all to go to the generator, and for varying the frequency and duration of the periods of time during which the water is or is not so by-passed.

4. In an apparatus for generating and using steam, the combination of a generator, of the type specified, a motor supplied thereby, a burner for heating the generator, a feed water pump whose capacity when running at less than the maximum speed is equal to the capacity of the generator, operative connections between the pump and the motor whereby the speed of the pump will be proportionate to the speed of the motor, means whereby, when the speed of the pump is such that it forces toward the generator water in excess of the capacity of the generator, the excess water is automatically diverted from said generator, means for automatically supplying to the burner the fuel which is required to transform into superheated steam of the required degree of superheat all of the water supplied to the generator, and means, governed by the pressure of steam in the generator, for alternately by-passing all of the water thrown by the pump or allowing it all to go to the generator, and for varying the frequency and duration of the periods of time during which the water is or is not so by-passed.

5. In an apparatus for generating and using superheated steam, the combination of a steam generator, a burner for heating the generator, and a feed water pump, two conduits through which the water thrown by the pump may pass to the generator, a flow motor connected in one of said conduits, means governed by said flow motor for determining the rate at which fuel shall be supplied to the burner, means governed by the temperature of the steam for varying the rate at which water is supplied to the generator through the other conduit.

6. In an apparatus for generating and using superheated steam, the combination of a steam generator, a burner for heating the generator, and a feed water pump, means for driving said pump at varying speeds, two conduits through which the water thrown by the pump may pass to the generator, a flow motor connected in one of said conduits, means governed by said flow motor for determining the rate at which fuel shall be supplied to the burner, means governed by the temperature of the steam for varying the rate at which water is supplied to the generator through the other conduit, and means governed by the pressure of steam for alternately by-passing all of the water thrown by the pump or for allowing it all to go to said two conduits and for varying the duration and frequency of the periods of time in which the water is or is not so by-passed.

7. In an apparatus for generating and using superheated steam, the combination of a steam generator, a steam motor supplied thereby, a burner for heating the generator, and a feed water pump which is operatively connected with said motor, two conduits through which the water thrown by the pump may pass to the generator, a flow motor connected in one of said conduits, means governed by said flow motor for determining the rate at which fuel shall be supplied to the burner, means governed by the temperature of the steam for varying the rate at which water is supplied to the generator through the other conduit, and means governed by the pressure of steam for alternately by-passing all of the water thrown by the pump or for allowing it all to go to said two conduits and for varying

the duration and frequency of the periods of time in which the water is or is not so by-passed.

8. In an apparatus for generating and using steam, the combination of a steam generator of the type specified, a burner for heating the same, a steam engine supplied by the generator and adapted to be run at various speeds, a feed water pump driven by said motor at speeds which are proportionate to the speeds of the motor said pump having a capacity equal to the capacity of the generator when the pump is running at less than its maximum speed, two feed water conduits through which feed water may be forced by the pump to the generator, a flow motor connected in one of said conduits, means governed by the flow motor for regulating the rate at which fuel is delivered to the burner, means for automatically diverting from the generator so much of the water forced by the pump as is in excess of the capacity of the generator, means governed by the temperature of the steam for varying the rate of flow of the water to the generator through the other feed water conduit.

9. In a steam motor car, the combination of a steam generator, a burner for heating the same, a steam engine supplied by the generator for driving the car at various speeds, a feed water pump driven by said motor at speeds which are proportionate to the speeds of the motor and consequently to the rate of travel of the car, said pump having a capacity equal to the capacity of the generator when the pump is running at less than its maximum speed, two feed water conduits through which feed water may be forced by the pump to the generator, a flow motor connected in one of said conduits, means governed by the flow motor for regulating the rate at which fuel is delivered to the burner, means for automatically diverting from the generator so much of the water forced by the pump as is in excess of the capacity of the generator, means governed by the temperature of the steam for varying the rate of flow of the water to the generator through the other feed water conduit, and means governed by the steam pressure for alternately by-passing all of the water thrown by the pump, or allowing it all to go into said two conduits, and for varying the frequency or duration of the periods of time during which the water is or is not so by-passed.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

ROLLIN H. WHITE.

Witnesses:
E. B. GILCHRIST,
H. R. SULLIVAN.