Dec. 28, 1965 W. G. SCHUETZENDUEBEL **3,225,748**

COMMON STARTUP SYSTEM

Filed Dec. 30, 1963 2 Sheets-Sheet 1

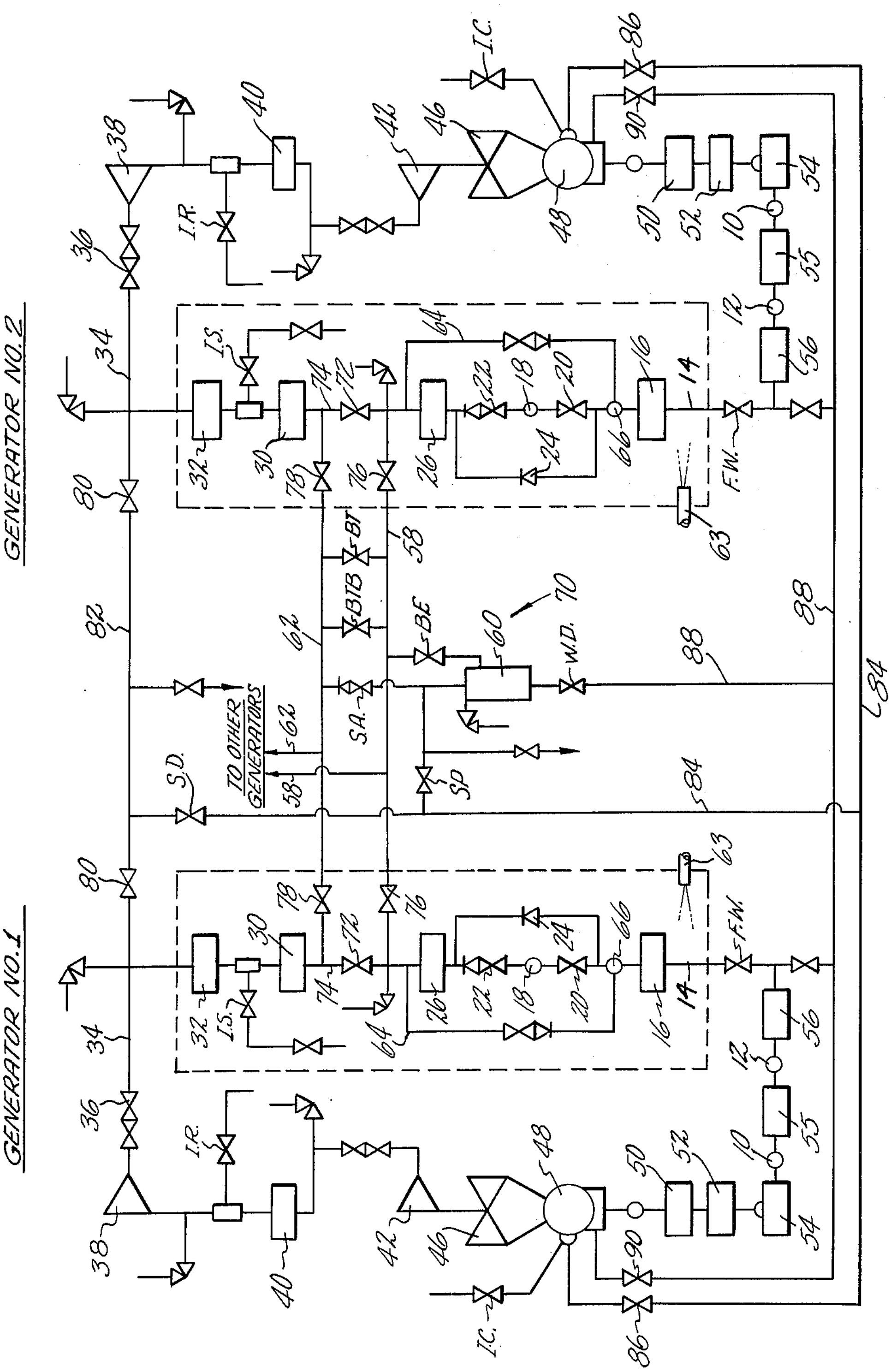

FIG. 1

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FIG. 2

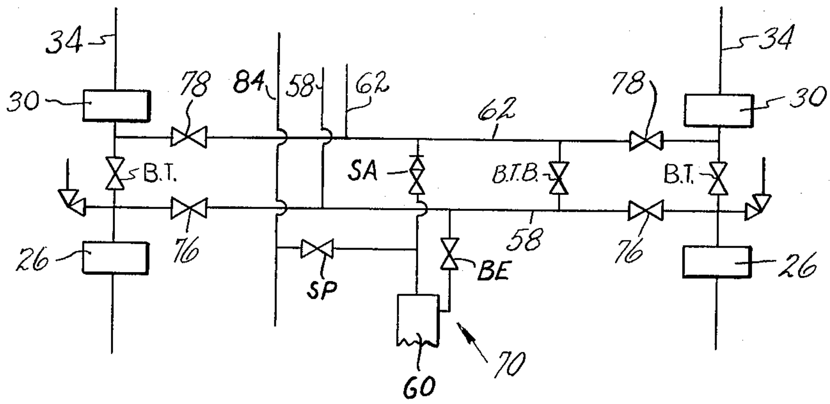
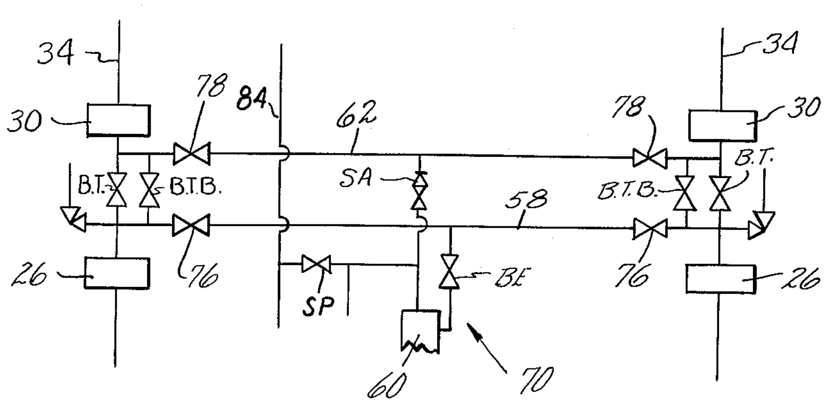


FIG. 3



United States Patent Office

3,225,748

Patented Dec. 28, 1965

3,225,748
COMMON STARTUP SYSTEM

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Filed Dec. 30, 1963, Ser. No. 334,409
9 Claims. (Cl. 122—1)

This invention relates to startup mechanism for vapor generators and particularly to common startup mechanism for use with a plurality of once-through forced-flow vapor generators.

An object of this invention is to provide a single startup mechanism which will serve to startup two or more generators.

A further object is a single control station from which the startup of any generator may be controlled.

A further object is to eliminate duplication of expensive startup equipment in a plant having more than one generator.

Further and other objects will be apparent from the following specification and claims and the attached drawing in which:

FIG. 1 is a schematic piping control and flow diagram of the common startup mechanism for two or more vapor generators; and

FIGS. 2 and 3 are schematic diagrams of modifications of the piping control and flow diagrams of FIG. 1.

The arrangement of the vapor generator, which is preferably a steam generator, and associated sub-systems within the plant cycle is shown in a simplified manner in FIG. 1. Modern steam generators, regardless of pressure level, have by their very nature, (1) a water heating section or economizer, (2) an evaporator or at supercritical pressures an intermediate section, which by convention is commonly termed "furnace walls" or a vapor generator section, and finally (3) a superheater. The pressure level at which the steam generator operates influences particularly the relative size of these sections and their temperature level.

The flow in economizers or the water heating sections and in superheaters in all steam generators is maintained by the feedwater pump head which for any load balances the pressure drop of the fluid from the pump outlet to the turbine throttle valve.

The circulation of water in the evaporator or furnace walls may be produced by the feedwater pump assisted by a recirculating pump and system for recirculating fluid through the furnace walls.

The feedwater from the feedwater pump **10** or **12** enters the steam generator system through feedwater valve F.W. and after some length of piping **14** reaches the economizer **16**. From the economizer **16** the fluid passes through the recirculating pump **18** and its associated isolating valves **20** and **22** or the check valve **24** to the furnace walls, where it flows in series through the center wall and outer walls **26**. When in operation, the steam from the furnace walls then passes through a system of boiler throttle valves B.T. and B.T.B. and then continues through sections of horizontal and pendant superheaters indicated as **30** and **32** and thence to the steam piping **34** leading to the turbine control valves **36** and the turbine **38**. The steam is returned from the turbine to a reheater **40**, subjected to heat from the furnace, and then returned to the turbine section **42**. Steam from the turbine section **42** is then passed through a section **46** of the turbine and is then conducted to a condenser **48**. The condensate passes through a filter demineralizer **50** and low pressure heaters **52** to a de-aerator **54** and intermediate pressure heaters **55**. The feed pumps **10** and **12** then return the feedwater through high pressure heaters **56** to the feedwater valves.

Components of particular utility in the startup system include the B.T. and the B.T.B. valves mentioned above. Upstream of these valves, piping **58** connects the furnace wall system with the boiler extraction valve B.E. and the water separator **60**. The steam side of the separator **60** is connected to the superheater system **30** and **32** through piping **62** and a steam admission valve S.A. and to the condenser **48** through a spill-over valve S.P. Water from the separator is discharged to the condenser hotwell through the water drain valve W.D. A steam lead drain valve S.D. connected to the line **34** may be used to discharge steam used for superheater cooling and heating of steam leads to the condenser. An injection valve I.C. controls desuperheating water flow for condenser protection. The I.S. valve is a superheater injection valve for controlling superheater output temperature and the I.R. valves are reheater injection valves for controlling the reheater output temperatures.

The furnace walls or vapor generator **26** define a furnace within which fuel, supplied by any suitable and well-known means such as pipe **63**, may be burned to supply heated gases and a source of heat for heating the fluid contained in the several sections **16**, **26**, **30**, **32** and **40** exposed to the hot gases. A bypass **64** across the furnace and steam cooled walls provides a path for return of recirculated fluid forced through these walls by the recirculating pump **18** which acts as a mixed flow pump, pumping both feedwater and recirculating fluid. The recirculating fluid is mixed with the incoming feedwater in a mixing chamber **66**. Reference may be made to application Serial No. 127,395 of W. W. Schroedter filed July 27, 1961, now Patent No. 3,135,252, for "Recirculation System for Steam Generator" for a more complete description of the recirculation system. With such a recirculation system the flow requirements of the furnace walls, such as 30% of full load flow, no longer determine the feedwater flow requirements during startup so that the through-flow may be limited to 5 or 10% of the full load requirements as determined by the steam cooling requirements of sections such as the superheaters or by steam heating requirements for the piping or by steam requirements for the turbine which may be for example, in the order of 3% of the full load steam flow during the initial turbine rolling and 7% during the initial loading after synchronizing the generator to gradually bring the turbine and generator up to operating temperatures simultaneously with bringing the entire vapor generator system up to operating temperature and pressure thoughout its several sections.

For several reasons, such as assurance that no slugs of water shall get into the turbine and for greater freedom in selection of material for manufacture of the superheaters, it is advisable, during startup particularly, to prevent any water from the furnace wall sections entering the superheater. This is the function of the B.T., B.T.B., and B.E. valves all of which are in the connections between the furnace walls and the superheaters and serve to block the passage of water from one section to the other. The B.T. valves are large, throttling, poppet-type valves designed for low pressure drop which at design load or full load conditions will pass the major part of the vapor flow from the furnace walls to the superheater with a minimum of pressure drop through the valves if they remain in the line as in FIGS. 2 and 3. The B.T.B. valves act as a bypass around the B.T. valves during startup conditions but remain wide open under full flow conditions when they will transmit a minor part of the full flow from the furnace walls to the superheaters if they remain in the line as in FIG. 3. The B.T.B.

valves are heavy duty, relatively expensive valves designed for severe throttling service to control vapor flow at temperatures in the neighborhood of 800° F. and at pressure differences on the opposite sides of the valve equal to and greater than the critical pressure drop.

At pressure differences equal to or greater than the critical pressure drop, flow through the valve reaches sonic velocity and has an eroding effect which leads to rapid deterioration of the valve. The B.T.B. valve is also a poppet-type valve but designed for much more severe service than the B.T. valve which is not adapted to operate at a critical pressure drop but only at flows having less than sonic velocity. Because of the nature of the valve and the service required of it, it is desirable to keep the B.T.B. valves as small as possible consistent with the requirements of the remainder of the system.

The B.E. valves which are also throttling poppet valves designed to operate at a critical pressure drop but differ from the B.T.B. valves in that they are designed to handle water flow at the critical pressure drop as well as vapor flow. These B.E. valves are also expensive and their service is severe so that they should be kept as small as is consistent with the requirements of the remainder of the system.

It should be noted that because of the recirculating system the through-flow requirements which these several valves, B.E., B.T.B. and B.T., are required to handle during initial startup may be reduced to less than 30% of the full load flow and will be determined largely by the load or use supplied during the startup, which in the example chosen is a turbine and generator which can be satisfied with a minimum of say 7% of the normal full flow when generating electrical power. This will permit much smaller valves than if a through flow of 30% of full flow were required during startup.

As a general description of the startup procedure, the relatively small quantities of feedwater flow during all startup operations are regulated by the feedwater valves F.W. Their operation is coordinated to proportion feedwater flow to firing rate. For boiler cleanup, which involves firing of the steam generator, and for initial turbine operation, the boiler throttling valves B.T. and B.T.B. are bypassed by way of a low pressure system including the B.E. valves and the flask tank **60**. This boiler throttling valve arrangement keeps the furnace wall operating at its proper pressure under all conditions while allowing the superheater to operate at a lower pressure level. There is thus in effect a liquid compartment provided by the furnace walls and a vapor compartment provided by the superheaters and separated by a valving system by means of which the liquid compartment can be kept under a preselected pressure while the vapor compartment is at a lower pressure.

During the initial phase of a startup, the boiler throttling valves B.T. and B.T.B. are closed and the turbine is heated and rolled on the low pressure separator-super-heater system. Furnace wall outlet temperatures are then increased and sufficient low pressure steam is generated to synchronize and initially load the turbine. Furnace wall pressure control which is by way of pressure controlled B.E. valve is now transferred from the B.E. valve to the boiler throttling valves B.T.B. The steam admission stop check valve S.A. will close when the steam pressure in section **30** passed through the B.T.B. valve exceeds the pressure in the separator or flash tank. Loading of the turbine then proceeds by increasing boiler input i.e. feedwater flow firing rate while maintaining the turbine governor valves at a preselected minimum fixed opening and first continuing to open the B.T.B. valve until the pressure drop becomes less than the critical value and then opening the B.T. valve to gradually increase the downstream pressure while maintaining the upstream pressure at the preselected substantially constant value.

The pressure in the superheater system rises propor-

tionally with load and may reach full operating pressure at about 30% load. The boiler throttling valves are then fully open and loading proceeds under control of the turbine control valves at essentially constant turbine throttle pressure.

In detail, to start up the system the liquid compartment including the economizer, the center, outer and steam cooled furnace walls are filled and vented up to the B.T. and B.T.B. valves separating the superheater system from the furnace wall system which valves at this time are closed. These valves are blocked against opening until the temperature at the steam cooled water outlet reaches some preselected temperature, such as 800° F. by known mechanism, such as a temperature actuated switch or valve, blocking valve actuating servo mechanism. The B.E. valve is closed and set for automatic pressure control at some selected vapor generator pressure, for example 1000 p.s.i. The feedwater pumps are started and establish a minimum feedwater flow of say 5% of full load flow and the feedwater flow as controlled by the feedwater bypass valve F.W.B. passes through the economizer and the furnace wall sytsem and is discharged through the boiler extraction valve B.E. to the separator. The water returns to the condenser hotwell through the water drain valve W.D. Pressure in the furnace wall system is maintained by the B.E. valve at the selected setting value. The steam admission stop check valve S.A. connecting the separator with the superheater system is open and the recirculating pump **18** is started.

Firing is initiated and maintained at a rate to bring the steam cooled wall outlet steam temperature up at a preselected rate consistent with gas temperature limitations for reheater protection. As the furnace wall outlet temperature rises above the saturation temperature equivalent to the pressure in the separator that fluid begins to flash into steam in the separator **60** with the steam portion passing into the superheater at saturated temperature. The steam flow cools the gas touched superheater tubing and heats the headers and interconnecting piping. The rate of flow through the steam piping and its rate of temperature rise is controlled by the manually actuated steam drain valve S.D. through which the low pressure steam is permitted to proceed to the condenser. The boiled extraction valve B.E. pressure control is reset to maintain the pressure in the furnace wall system at higher pressure than the saturation pressure equivalent to the highest fluid temperature in the walls. At same preselected temperature, say 550°, the pressure will be maintained, in the example chosen for illustrative purposes which is a supercritical system, at 3500 p.s.i.

If cleanup is required of the boiler water the steam cooled wall outlet temperature is held at 600 to 650° F. until the solids concentration of the water being circulated reaches acceptable limits. The flow sweeping the furnace wall system during this time is maintained by the recirculating system at a preselected rate which may be at an equivalent level of about 60% of full load flow. During this time the low pressure steam from the superheater outlet may be fed through the turbine to heat and roll the turbine.

As the fluid at furnace wall outlet gradually reaches acceptable levels of purity, firing rate is increased and the temperature level at the furnace wall outlet rises so that the discharge of the B.E. valve to the separator produces increasingly more steam and less water. The S.D. valve may now be closed and the steam not used to bring the turbine to speed increases the pressure in the separator and superheater system until the desired turbine valve chest pressure of say 800 pounds per square inch gage is reached. This level is then maintained by spilling the excess steam through the pressure controlled spill-over valve S.P. to the condenser.

At about 800° F. fluid temperature, all through-flow is turned to steam in the separator. The turbine is synchronized and initially loaded, and the excess steam previously discharged through the S.P. valve is now taken through the superheater and the turbine. In this manner, the startup system acts as a reservoir from which the turbine may be initially loaded without requiring a sudden and comparatively large firing rate or flow input charge to the steam generator.

In order to proceed with the boiler loading the bypass operation through the separator is replaced by operation through the boiler throttling valves. This is now possible since the furnace wall outlet enthalpy already is at a level at which throttling a supercritical fluid will produce steam only. The change-over is made by gradually transferring upstream pressure control, maintaining the pressure in the furnace walls at about 3500 p.s.i., from the pressure actuated B.E. valves to the pressure actuated B.T.B. valves. As the latter open and the former close the flow of steam through the separator ceases and the S.P. and the S.A. valves will close. All feedwater flow now passes through the superheater to the turbine. Firing rate and feedwater flow may be increased to further load the turbine.

The throttle valve system as described above has another advantage in that low pressure high temperature steam can be made available to the turbine on hot restarts. The throttle valve combination described above is capable of low flows at critical throttling pressure drop and high flows at low pressure drop both with a high degree of control at different points in the loading sequence.

A hot start follows the principal actions of a cold start by again using the low pressure separator-superheater system in order to provide low pressure, high enthalpy steam to the turbine valve chest. The boiler throttling valves are closed, the upstream boiler sections are pressurized to full operating pressure i.e. 3500 p.s.i. and superheater pressure is reduced to the separator operating level i.e. 800 p.s.i. by opening of the S.D. valve.

Firing may be re-established and about 5% feedwater flow admitted. With the higher temperature level in the furnace- and furnace wall sections sufficient separator steam for turbine rolling is available immediately. Furnace wall outlet temperature quickly reaches the 800° F. limit, if not there already, and steam to the turbine will be in the order of 850° F. Boiler input is increased to the initial loading level and the turbine synchronized.

The sequence again follows through the transfer from separator operation to boiler throttling operation and loading again follows the vapor generator until the control system can take over. On hot starts where rolling periods prior to synchronizing are comparatively short, the thermal inertia of reheater tubing in the gas pass allows temporary overfiring for higher superheater temperatures.

The most desirable enthalpy performance of steam delivered to the turbine is that which on the critical turbine part produces the lowest possible cumulative thermal fatigue damage under any operating condition. To meet such performance—generally low temperatures on a cold start and high temperatures on a hot start—the present system adds a large measure of flexibility and improved performance.

During startup, while maintaining furnace wall pressure at the supercritical level of say 3500 p.s.i., the turbine is synchronized at some combination of superheater pressure and flow which assures that the generator will be driven by the turbine and not motorized. It is desirable to have a minimum flow through the turbine when it is synchronized and initially loaded of about 7% of the total full load flow. It is also desirable, from a control simplicity standpoint, to minimize manipulation of the turbine control valves while the pressure in the furnace walls is under control of the B.T.B. valves. In order to accomplish these two desirable features the position of the turbine control valve is fixed to provide a fixed opening which will provide the desired minimum flow through the turbine under the synchronizing steam pressure of about 800 p.s.i.g. maintained by the spill-over valve S.P. The steam required to operate the turbine, after transferring from the startup system to the main system, i.e. from the B.E. valve to the B.T.B. valve, passes through the B.T.B. valve with a critical throttling pressure drop. It is highly desirable to achieve a superheater pressure which will not require a critical throttling pressure drop through the B.T. or the B.T.B. valves at as low a flow as possible. This superheater pressure is indicated by SC×R which indicates supercritical pressure, which is 3500 p.s.i. in the example used for illustration, multiplied by the critical throttling drop ratio which is approximately .545. As soon as the superheater pressure is raised above the pressure indicated say to 2000 pounds per square inch, then the B.T. valves may be opened. The B.T. valve is pressure operated or controlled by two different pressures. It is controlled by the pressure in the furnace walls by any well-known mechanism so as to maintain that pressure at the preselected value of say 3500 p.s.i. and it is controlled by the pressure in the superheater system by known mechanism, such as a pressure actuated switch or valve, blocking operation of servo operating mechanism for the valve so as to prevent opening of the B.T. valve until the drop across that valve is less than the critical pressure drop. The size and hence the economic cost of the B.T.B. valves are minimized when the flow they must be designed for is also minimized. By fixing the opening of the turbine control valves to establish the minimum permissible flow through the turbine and maintaining the turbine control valves at that fixed opening while the flow through the B.T.B. valves is increased by increasing the feedwater through flow rate and correspondingly increasing the firing rate the flow will increase to say 17% flow at which time the B.T. valves may be opened, the B.T.B. valves being essentially wide open at this point. This procedure will hold for any arrangement of turbine admission throttle valves. After the B.T. valve has started to open in the startup procedure any of several paths may be followed to reach full superheater pressure and full load depending primarily upon the arrangement of turbine admission valves. For the special condition in which the fixed opening selected happens to coincide with the wide open position of the then controlling turbine throttle valves as would be the case of the "sequential valve point" or "partial admission" turbine control valve arrangement in which the turbine control valves comprising the first admission arc would be opened wide at synchronizing, both the superheater pressure and the flow would increase until the full superheater pressure was reached. As the feedwater flow was increased to provide this additional flow the B.T. valves would be automatically opened to maintain the 3500 p.s.i. in the water wall section. Thus when the full superheater pressure is reached the B.T. valves would be wide open to pass full flow and the pressure in the entire system would be maintained by operation of the turbine throttle valves and the flow control mechanism. In all cases maximum turbine efficiency is obtained when turbine throttle valves are throttled the minimum amount and in the above case maximum turbine efficiency would be obtained from synchronizing all the way to full superheater pressure. From the full superheater pressure point at partial flow to the full load point normal sequencing of the turbine control valves for the remaining admission arcs is used since this again is the path of maximum turbine efficiency.

For further details of the startup procedure reference may be made to application Serial No. 267,512 filed March 25, 1963, by F. J. Hanzalek for "Economic Combination and Operation of Boiler Throttle Valves."

As indicated above, the startup mechanism or unit including the several B.E., B.T. and B.T.B. valves and their associated controls are quite expensive and are utilized only during the starting up of the steam generator either from a cold condition or from a hot condition known as a "hot start." In order to prevent duplication of this expensive startup unit on each generator where there are two or more generators in a single installation applicant has devised a control system by which a single startup unit may be utilized for starting up any one of the several generators without interfering with the other generators whether they be running or idle. By utilizing the single or common startup unit all the controls for starting up any of the generators may be brought to a single control point convenient to all the generators in the station and thus reduce duplication of control points or control lines.

In order to accomplish this applicant provides a single control unit or system indicated generally at **70** which is connected by line **58** to the water wall outlets of each of the generators one of which is indicated as generator No. 1 and another of which is indicated as generator No. 2. The unit **70** is also connected to each of the generators by the line **62** connected with the inlet to the superheater **30** of each of the generators. A shut-off valve **72** is provided in the line **74** connecting the evaporator section **26** with the superheater **30** in each unit. Additional valves **76** and **78** are provided in the lines **58** and **62** between the startup unit **70** and each of the generators. By means of these valves **76** and **78** the unit **70** may be connected with any selected generator and isolated from all the others. By closing the valve **72** in the selected generator line **74** through-flow from the evaporator **26** to the superheater **30** in the selected generator is directed through the startup unit **70** and is prevented from going directly from the evaporator **26** to the superheater **30** and bypassing the startup mechanism. Valves **80** in the line **82** connecting the steam discharge lines **34** of the several generators may be used to connect the single steam drain valve S.D. with any selected generator and isolate it from all the others. The single S.D. valve and the single spill-over valve S.P. discharging into the common line **84** leading to the condensers of the several units may be connected with any selected unit and isolated from all the others by valves **86**. The water drain valve W.D. directing water from the separator **60** to a condenser through the line **88** may be connected to any selected unit and isolated from all the others by the valves **90**.

Under normal conditions, either idle or operating, all of the valves **76**, **78**, **80**, **86** and **90** are closed and valves **72** are open so that the startup unit **70** is isolated from all of the generators and steam flows directly from the evaporator **26** to the superheater **30** through line **74** in any operating generator. When it is desired to start up any selected generator valves **76**, **78**, **80**, **86** and **89** connecting the startup unit **70** with the selected generator are opened and valve **72** of the selected generator is closed. The through-flow path through the generator through the line **74** is thus blocked and the through-flow is thus required to go through the startup unit **70**. The normal startup procedure described above may thus take place in the selected generator and the pressure and temperature in that generator brought up by the described use of the B.E. valve and the separator **60** and then by the B.T.B. valve and then the B.T. valve. When the pressure in the superheater **30** has been brought up to full operating pressure i.e. when the B.T. valve is fully opened then the valve **72** may be opened and the valves **76** and **78** closed and the selected generator allowed to operate entirely independent of the startup mechanism. The valves **80**, **86** and **90** may then be closed to completely isolate the selected generator from the startup unit **70** and condition the system for utilizing the startup unit to start any other selected generator.

By thus selectively connecting the single startup unit **70** to the several generators applicant provides a single startup unit including the expensive B.E., B.T.B. and B.T. valves for starting each of the several generators. Thus only a single set of S.D. valves, S.P. valves, B.E. valves, B.T.B. valves, B.T. valves, S.A. valves and W.D. valves and a single separator **60** is required for starting a plurality of generators.

While the valve **72** which is a normal shut-off valve is less expensive than the throttling B.T. valve it may be found desirable in some installations to eliminate the valve or set of valves **72** for each generator and substitute a B.T. valve or set of B.T. valves in each generator. To do this, a modification such as shown in FIG. 2 would be utilized in which all of the valves **72** have been eliminated and the individual or single valve B.T. of FIG. 1 has also been eliminated. Each generator is then provided with its own individual B.T. valve or set of valves in place of the eliminated valve **72**. The shut-off valves **76** and **78** will then be in the bypass circuit **58**, **62** or parallel circuit around the B.T. valve and will serve to connect or isolate the startup system **70** including the B.T.B. valve with or from any individual generator. The B.T. valve will however always remain in the through-flow circuit in this modification and not be connected or isolated by the shut-off valves **76** and **78**. Such a modification would be more expensive than that of FIG. 1 by the cost of the extra B.T. valve or valves minus the costs of all of the shut-off valves **72**. Some additional saving might be realized because the valves **76** and **78** could be smaller than in the FIG. 1 system because they would have to handle only the volume passed through the B.T.B. valve which is smaller than the capacity of the B.T. valve. The remainder of the system would remain the same as shown in FIG. 1.

A still further modification is shown in FIG. 3 in which the valve **72** of each generator are replaced by B.T. and B.T.B. valves connected in parallel. In this case the shut-off valves **76** and **78** serve to isolate the B.E. valve, the separator **60** and the associated mechanism from the several generators but do not serve to isolate the B.T. and the B.T.B. valves which are permanently incorporated in the individual generator circuits including the through-flow circuit. In this modification only a single set of B.E., S.A., and S.P. valves and the single separator and its drain valve are required but each generator would have its own set of B.T. and B.T.B. valves. In this modification the central control station would be built around the single startup mechanism and controls would be led from the several generators to the single station.

From the above description it will be appreciated that I have provided an arrangement of parts and connections by means of which a single startup unit for a once-through forced flow steam generator utilizing forced recirculation preferably of the mixed or combined flow type in which the recirculating pump is in the through-flow line in series with the feed pump may be utilized in starting up any selected one of a number of separate generators. It will also be appreciated that the startup unit may include all three of the sets of throttling valves utilized in starting up a generator of this type or the startup unit may include only two of the throttle valves with the third valve being a permanent part of each separate generator or the startup unit may include only one of the throttle valves the other two throttle valves being incorporated in and permanently connected with each generator so that each generator will have its own two throttle valves and be connected with the third throttle valve only for startup purposes.

If desired the line **82**, FIG. 1, connecting the steam discharge lines **34** of the several generators may be omitted together with the isolating or shut-off valves **80** and each generator provided with its own S.D. valve. The common line **84** receiving the discharge from the spill-over valve S.P. and the shut-off valves **86** will however remain.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit and that various changes can be made which would come within the scope of the invention which is limited only by the appended claims.

I claim:

1. In combination a plurality of once-through forced flow vapor generators each having a first heating section and a second heating section, conduit means interconnecting the inlets to all of said second heating sections, conduit means interconnecting the outlets of all of said first heating sections, valve means for each generator connecting said conduit means and connecting said heating sections of the respective generator in series flow relation, a common startup unit connecting said conduit means in parallel with said valve means and including a separator and a throttling valve in series, and shut-off valves in each of said conduit means between said startup unit and each generator.

2. A combination as claimed in claim 1 in which said valve means includes throttling valves.

3. A combination as claimed in claim 1 in which said unit comprises additional throttling valves connecting said conduit means and said shut-off valves are between said additional valves and each generator.

4. A combination as claimed in claim 3 in which said valve means consists of shut-off valve means.

5. A combination as claimed in claim 3 in which said valve means comprises throttling valve means.

6. In combination with a plurality of supercritical forced flow once-through vapor generators each having a first heating section and a second heating section, connecting means connecting said section for series flow of working fluid therethrough, a common startup mechanism including a vapor-liquid separator having an outlet and an inlet and a series of selectively operable valves connected in parallel and connecting said outlet with said inlet, means for blocking flow through said connecting means from the first to the second heating section of any selected generator and means for connecting said startup mechanism to said sections of said selected generator in parallel with said connecting means and selectively directing flow from said first to said second section in said selected generator through said valves and separator, and means disconnecting said startup mechanism from said selected generator and disabling said blocking means and connecting said startup mechanism to another selected generator.

7. In combination with a plurality of vapor generators of the once-through forced-flow type each having a first heating section, a second heating section and separate throttle valve means connecting said sections of each respective generator, a single startup unit for all the generators including a pressure reducing valve and a separator in series, means connecting said unit to all said sections across all said throttle valve means, said connecting means including means selectively connecting said unit across the separate throttle valve means of any selected one of said generators to bypass the said separate throttle valve means of said selected generator during startup of the selected generator, and disconnecting said unit from the remainder of said sections.

8. In combination with a once-through forced-flow steam generator system having a plurality of separate steam generators each generator comprising a first heater section connected to a second heater section, for series fluid flow from said first to said second section, by a passageway, valve means in said passageway, first conduit means connecting the outlets of said first sections on the upstream side of said valve means and second conduit means connecting the inlets of said second sections on the downstream side of said valve means, a single startup system connecting said first conduit means with said second conduit means, and means including valves in said conduit means selectively connecting said startup system to any one of said generators and isolating said startup system from all the others.

9. In combination with a plurality of forced flow once-through steam generators for supercritical pressure operation, each having an evaporator section and a superheater section connected in series flow relation, a common startup system preventing the flow of water, and limiting the flow of steam, from the evaporator section to the super-heater section during startup, comprising, a pressure reducing valve and a separator connected in series and means for selectively connecting said startup system with any selected generator including a plurality of parallel passageways connecting said evaporator section with said superheater section, conduit means, including a pair of conduits, connecting the parallel passageways of all the generators in parallel, means connecting said reducing valve and separator across said conduit means to connect said startup mechanism in parallel with said passageways, valve means in each of said parallel passageways and shutoff valves in said conduit means between selected parallel passageways to connect said startup mechanism with a selected generator and isolate all the other generators from said startup mechanism and a predetermined number of said parallel passageways.

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