United States Patent [19]

Durrant et al.

[11] **3,922,859**

[45] **Dec. 2, 1975**

[54] **CONTROL SYSTEM FOR A POWER PRODUCING UNIT**

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[73] Assignee: **The Babcock & Wilcox Company**, New York, N.Y.

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[52] **U.S. Cl.** **60/665**

[51] **Int. Cl.²** **F01K 13/02**

[58] **Field of Search** 60/660–667, 60/646, 652; 290/2; 415/17

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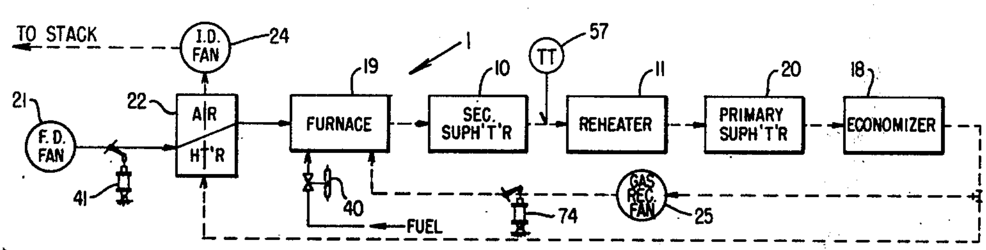
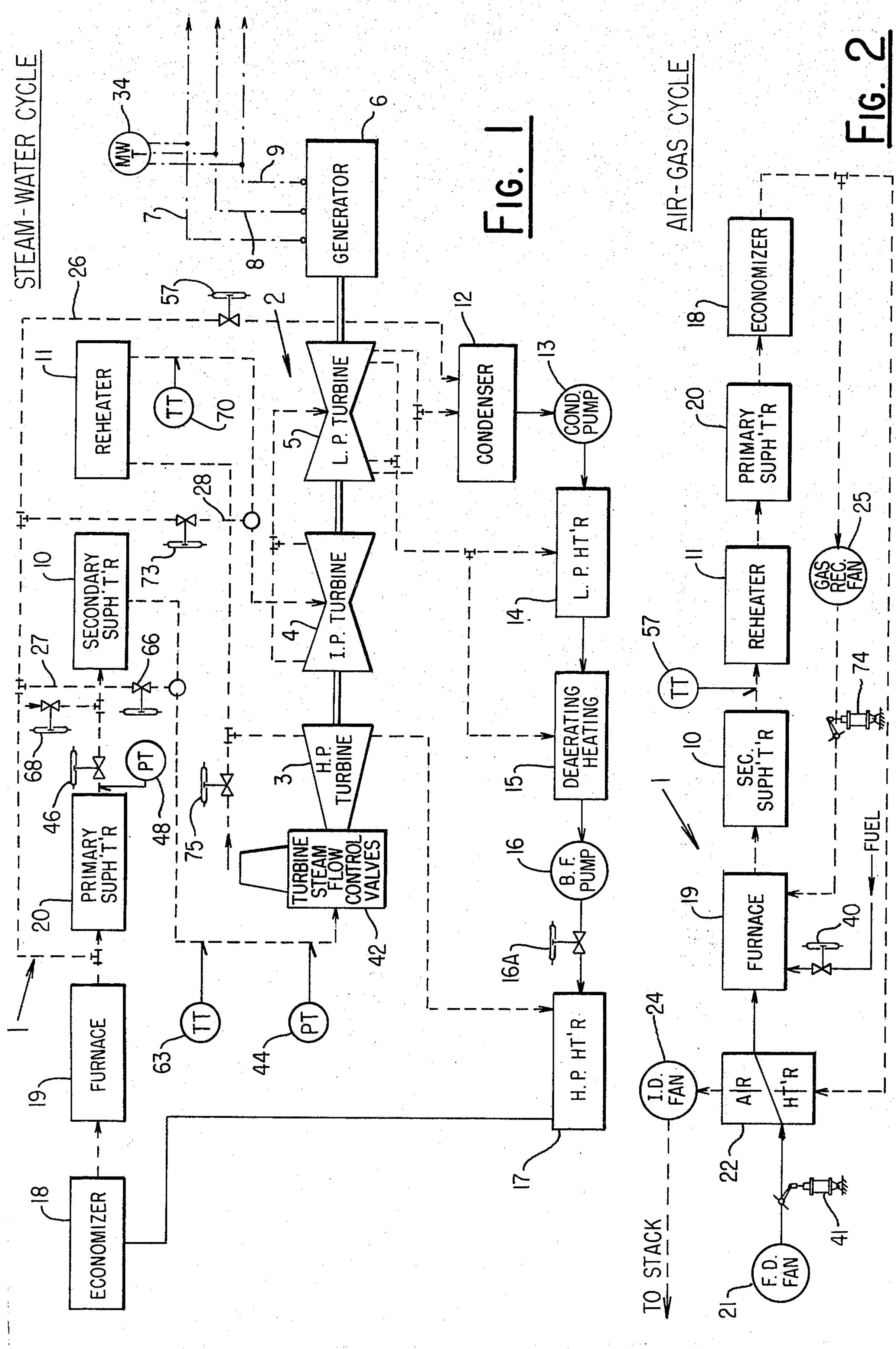
Assistant Examiner—Allen M. Ostrager
Attorney, Agent, or Firm—John F. Luhrs

[57] **ABSTRACT**

A control system for a power producing unit arranged for cycling operation including means for the rapid loading and unloading of the unit and on-line variable pressure operation throughout a selected load range.

14 Claims, 3 Drawing Figures




STEAM-WATER CYCLE
AIR-GAS CYCLE
FIG. 1
FIG. 2
GENERATOR
MW T
L. P. TURBINE
I. P. TURBINE
H. P. TURBINE
TURBINE STEAM FLOW CONTROL VALVES
REHEATER
SECONDARY SUPH'T'R
PRIMARY SUPH'T'R
FURNACE
ECONOMIZER
CONDENSER
COND. PUMP
L. P. HT'R
DEAERATING HEATING
B. F. PUMP
H. P. HT'R
TT
PT
SEC. SUPH'T'R
GAS REC. FAN
FUEL
A/R HT'R
I. D. FAN
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TO STACK

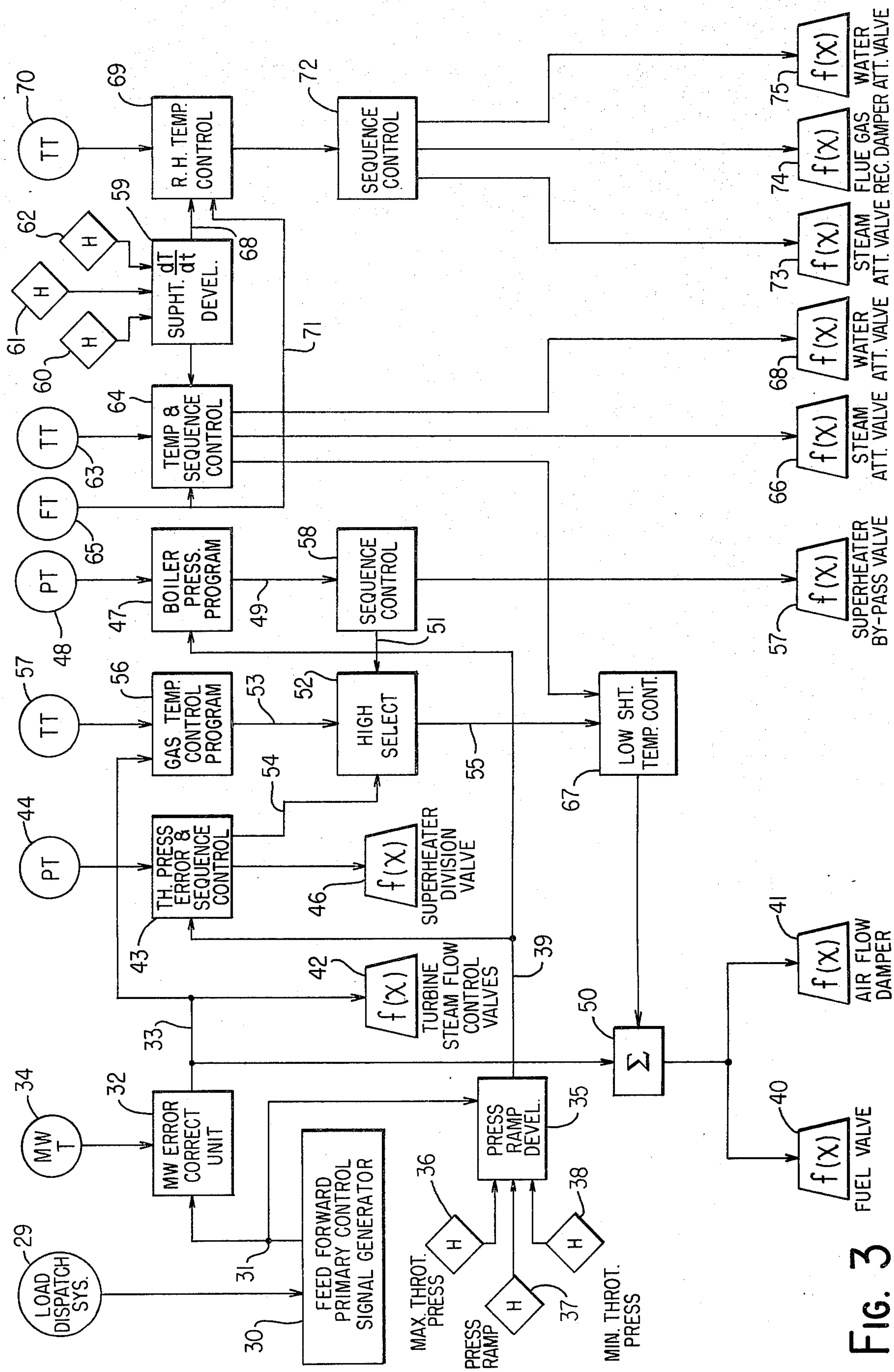
LOAD DISPATCH SYS.
FEED FORWARD PRIMARY CONTROL SIGNAL GENERATOR
MW T
MW ERROR CORRECT UNIT
PRESS RAMP DEVEL.
H
MAX. THROT. PRESS
PRESS RAMP
MIN. THROT. PRESS
Σ
f(X)
FUEL VALVE
AIR FLOW DAMPER
TURBINE STEAM FLOW CONTROL VALVES
PT
TH. PRESS ERROR & SEQUENCE CONTROL
SUPERHEATER DIVISION VALVE
TT
GAS TEMP. CONTROL PROGRAM
HIGH SELECT
LOW SHT. TEMP. CONT.
BOILER PRESS. PROGRAM
SEQUENCE CONTROL
SUPERHEATER BY-PASS VALVE
FT
TEMP & SEQUENCE CONTROL
STEAM ATT. VALVE
WATER ATT. VALVE
SUPHT. dT/dt DEVEL.
R. H. TEMP. CONTROL
FLUE GAS REC. DAMPER
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FIG. 3

CONTROL SYSTEM FOR A POWER PRODUCING UNIT

This invention relates to a control system for power producing units and more particularly to a control system for fossil fuel fired electric power producing units such as found in modern central stations. As nuclear units come into operation, there are strong incentives for them to be base loaded because of their low incremental fuel cost and because of operating restrictions. As a result other units in the system must be capable of changing load frequently and rapidly, including complete shutdown during periods of low system demand. Typical cycling units may, for example, be rated at between **400–600** MW with initial steam conditions of **2400** psig and **1000**F. In such units, the steam usually passes first through a high pressure turbine, thence through a reheater pass in the steam generator wherein the steam is raised to a hot reheat temperature of **1000**F, thence through an intermediate pressure turbine and thence through a low pressure to a condenser.

As such units may be operated at partial load over extended periods of time, it is an objective of our invention to provide a control system wherein throttle pressure is programmed in accordance with load, thereby increasing the thermal efficiency of the unit and maintaining a substantially constant turbine impulse chamber steam temperature throughout the load range, permitting rapid load change without thermal shock to the turbine.

Further, in accordance with our invention, the turbine valves are utilized to obtain short-term transient changes in steam flow to the turbine to thereby satisfy, temporarily, load changes, while firing is adjusted to maintain balance between energy input and output to and from the unit on a relatively long term steady state basis.

Further, in accordance with our invention, firing rate may be controlled to maintain a programmed gas temperature at a selected point in the boiler during start-up and low loads and by MW demand during on-line operation.

Further, in accordance with our invention, during start-up and on-line transient conditions, the demand for energy input to the unit is established to meet the requirements of various conditions such as, but not necessarily limited to load, steam pressure and temperature, by firing the boiler to meet the highest of these requirements, while the lower ranking demands are accommodated by control instrumentalities such as super heater division and super heater by-pass valves, and by steam and water attemerators.

Further, in accordance with our invention, throughout start-up and on-line operation, the steam generating section and primary super heater of the boiler are maintained at set point pressure, thereby maintaining a relatively large amount of energy storage which may be borrowed from or added to to meet rapid load changes and reducing the amount of over firing or under firing required to satisfy load changes and to minimize start-up times.

These and further objectives of our invention will be apparent as the description proceeds in connection with the drawings, in which:

IN THE DRAWINGS

FIG. **1** is a block diagram of the basic steam-water cycle of a power producing unit.

FIG. **2** is a block diagram of the air-gas cycle of the boiler shown in FIG. **1**.

FIG. **3** is a block diagram of our invention as applied to the power producing unit illustrated in FIGS. **1** and **2**.

DETAILED DESCRIPTION

Referring to FIG. **1** there is shown the elementary steamwater cycle for a more or less conventional generator-turbine generator power producing unit comprising a steam generator, or boiler, generally indicated at **1** and a turbine-generator unit generally indciated at **2,** having a high pressure (HP) turbine **3,** an intermediate pressure (IP) turbine **4** and a low pressure (LP) turbine **5.** As shown, the HP turbine **3,** IP turbine **5** drive a single generator **6,** producing electric power transmitted therefrom by conductors **7, 8** and **9.** Alternately, each turbine unit may be arranged to drive a separate generator all feeding into a common buss. The particular arrangement of turbine-generator which may be used forms no part of the present invention.

Steam discharged from secondary superheater **10** of steam generator **1** passes through HP turbine **3,** thence through reheater **11.** The hot reheat steam then passes through IP turbine **4,** LP turbine **5** and is discharged into condenser **12.** Condensate from condenser **12** is pumped by condensate pump **13** through a low pressure heater string **14,** heated by extraction steam from LP turbine **5,** into deaerating heater **15,** also heated by extraction steam. Feedwater is drawn from the deaerating heater **15** by boiler feed pump **16** and is discharged through high pressure heaters **17,** also heated by extraction steam, into steam generator **1** shown as having an economizer **18,** furnace **19** and primary superheater **20** in addition to secondary superheater **10** and reheater **11** previously mentioned. Flow control valve **16A** is shown as representative of any one of several conventional control means which may be employed to regulate the flow of feedwater to the boiler.

Referring to FIG. **2** there is shown in elementary form the air-gas cycle for the steam generator **1.** Air for combustion, supplied by forced draft fan **21,** passes through an air heater **22** and is discharged into furnace **19.** Fuel, which may be oil, gas, coal, or a combination thereof, is discharged into furnace **19** from any conventional means (not shown, but schematically represented by line **23**). The gasses of combustion, or flue gas, as it is commonly called, leaving furnace **19,** pass through secondary superheater **10,** reheater **11,** primary superheater **20,** economizer **18,** air heater **22** and induced draft fan **24** whence they are discharged to the atmosphere through a stack (not shown). Flue gas leaving the economizer **18** may also be recirculated into the furnace **19** by gas recirculating fan **25** as one of controlling the temperature of the hot reheat steam discharged from reheater **11** within part or all of the normal operating range of the unit. In general, the rate of flow of recirculated gas is maintained in inverse proportion to the heat or energy input to the steam generator **1.** The order shown in which the products of combustion pass over the several heating sections is not the exclusive order. The order may be, for example, primary superheater, secondary superheater, and reheater: or secondary superheater, primary superheater, and reheater.

A by-pass system is provided around the primary and secondary superheaters comprising a conduit **26** having its inlet connected to the inlet of the primary superheater **20** and its discharge opening into the condenser **12** which is arranged to receive and condense the steam transmitted through conduit **26** for return to the feedwater system. Further, as shown, provisions are made for diverting steam from the conduit **26,** through a conduit **27,** to the outlet of the secondary superheater **10** and from the conduit **26,** through a conduit **28** to the outlet of the reheater. The diversion of substantially saturated steam into the superheated and hot reheat steam to the turbine provides a means for moderating the temperatures thereof as may be required during start-up and low load operations.

Referring now to FIG. **3,** the control system as applied to the power generating unit illustrated in FIGS. **1** and **2** is shown in block diagram form. The control components so represented or hardware, as it is sometimes called, are commercially available and their operation well understood by those familiar with the art. Furthermore we have chosen to represent the control system in block diagram form to avoid identification of the control system with any particular type of control, such as pneumatic hydraulic, electronic, electric or any combination of these, as the invention may be incorporated in any one of these. The primary controllers shown in FIG. **3** have been referred into FIGS. **1** and **2** as have the final control elements. Further, in the interests of brevity, conventional local feedback control loops customarily associated with final control elements have been omitted, their purpose being to maintain the value of the controlled variable in predetermined functional relationship to the value of the control signal. It should also be understood that conventional control actions such as set point, summing, integral, derivative and reset are to be considered as included in the various control loops when as and if required, their use and application being well understood.

In the operation of cycling units there are two types of start-up which may be defined as, "cold start" and "hot start." Regardless of the boiler-turbine condition i.e. whether hot or cold or at an intermediate temperature, on-line operation can be reached most quickly by firing the boiler to satisfy the most citical requirement and satisfying the other requirements by auxiliary control instrumentalities. For example, for a hot start it may be assumed that the steam generating section and primary superheater of the boiler are at relatively high pressure and at saturation temperature whereas the secondary superheater and reheater are at relatively low temperature, under such conditions the most critical requirement is uperheated steam temperature, accordingly the boiler is fired to raise this temperature at the maximum allowable rate, and if necessary steam may be dumped to the condenser to maintain boiler pressure at the desired value. Conversely under cold start conditions it is necessary to heat up the boiler to generate steam flow. This consequently raises steam temperatures when the turbine is cold and accordingly needs to be reduced. Thus under cold start conditions the critical requirement is boiler pressure which controls the firing rate whereas excessive steam temperatures are reduced by the use of steam and water attemperators. Regardless of the type of start the control system automatically selects the critical requirement and controls firing accordingly while maintaining other critical conditions at set point values through selected control instrumentalities.

Referring to FIG. **3,** the unit load demand signal may be established by an automatic load dispatch system as shown as **29,** or by other automatic or manual means, inputing to a primary control signal generator **30,** the purpose of which is to generate a feed forward control signal corresponding to the desired energy output of the power producing unit. The feed forward primary control signal transmitted over signal conductor **31,** as modified in Load Error Correct Unit **32,** generates a steam flow demand signal transmitted over line **33.** Also inputing into unit **32** is a signal corresponding to megawatts output generated in transmitter **34** which signal may be considered a feedback signal and the unit **32** generating an output demand signal as required to maintain equality between the two signals inputing thereto.

The primary control signal is also transmitted over line **31** to a Throttle Pressure Ramp Development Unit **35** provided with manually adjustable selectors **36, 38,** and **37** whereby the minimum, maximum and ramp throttle pressures respectively may be established. As an example, max. throttle pressure may be set at **2400** psi, min. throttle pressure at **600** psi, and the ramp set to vary the throttle pressure from **600** psi to **2400** psi from **20%** full load to **70%** full load. That is to say, unit **35** develops a turbine throttle pressure demand signal transmitted over line **39,** demanding, until the **20%** load point is reached a constant pressure of **600** psi, and thence a throttle pressure increasing as load demand increases until the **70%** load point is reached and thereafter to full load a constant pressure of **2400** psi. Adjusters **36, 37** and **38** enable an operator to set, as desired, the minimum, and maximum throttle pressures and the load span covered by the ramp.

The steam flow demand signal transmitted over line **33,** after modification as here and after described, adjusts in parallel fuel flow control valve **40** and air flow control damper unit **41** to thereby maintain energy input to the unit in accordance with energy demand. The steam flow demand signal is also transmitted over line **33** to turbine steam flow control valves **42** to maintain a rate of flow of steam to high pressure turbine **3** in accordance with steam flow demand. By virtue of the variable pressure operation, the turbine valves will, for the min., and max. and ramp pressures heretofore described remain approximately **70%** open from min. pressure to max. pressure as established at the **70%** load point and thereafter proportionality as load demand increases. However, throughout the min. and ramp pressures, the control valves will modulate from the **70%** open position to immediately satisfy demands for increasing or decreasing steam flow, but will be restored to the **70%** open position as such changes in demand are satisfied by changes in firing rate. That is to say, transient changes in load demand are satisfied by borrowing from or giving to the energy storage in the boiler and the energy storage is then brought to its desired level by appropriate changes in the firing rate.

The throttle pressure demand signal is transmitted through line **39** to a Throttle Pressure and Sequence Unit **43,** also receiving a signal proportional to actual throttle pressure generated in pressure controller **44** and generating an output signal transmitted along line **45** to position valve **46,** located between primary superheater **20** and secondary superheater **10** as required to maintain throttle pressure at the desired value. In general terms it may said that valve **46** acts as a down stream pressure regulator to maintain throttle pressure at the programmed value as established in unit **35.**

The throttle pressure program control signal is also transmitted along line **39** to a Boiler Pressure Program Control Unit **47,** also receiving a signal proportional to actual primary superheater outlet pressure generated in pressure controller **48,** and generating an output signal, varying in functional relationship to turbine pressure, transmitted along line **49,** which after various modifying devices is effective, through summing unit **50,** to modulate the firing rate as required to maintain steam pressure at the primary superheater outlet at the desired value.

During start-up, as heretofore described firing rate must be modified to maintain the most critical condition at desired value and maintain other conditions at desired value by various auxiliary control instrumentalities. At one extreme there is the so called hot-start wherein boiler pressure through the primary superheater is at approximately the desired value, and at the other extreme the so called cold-start wherein boiler and turbine are at low temperatures. Regardless of the type of start, the primary consideration is that mismatch between steam temperatures and turbine metal temperatures must be maintained within acceptable limits, while raising steam and metal temperatures as rapidly as possible to bring the unit on line in minimum time.

During start-up regardless of whether a cold, hot or intermediate start, the unit is fired as required to maintain the condition, among the conditions such as, but not necessarily limited to throttle pressure, gas temperature at the steam outlets of the secondary superheater and reheater and superheated steam pressure, having the greatest demand at the programmed value. To this end, for example, a control signal upon valve **46** being unable to satisfy the demand for throttle pressure, is transmitted through line **51** to a high signal selector **52** into which is also introduced a control signal, through line **53,** proportional to the deviation in gas temperature from the programmed value and a control signal through line **54** proportional to the deviation in throttle pressure from the programmed value. The highest of these signals is then transmitted through line **55** to summing unit **50** and effective to modify the firing rate as required to maintain the selected condition at the programmed value.

The gas temperature control signal, transmitted through line **33,** is generated in a programming unit **56** which is responsive to the steam flow demand signal transmitted through line **33** and signal corresponding to actual gas temperature generated in temperature controller **57.** At low steam flow as generated during start-up, steam temperature at the outlets of the secondary superheater and reheater is substantially equal to the gas temperature at that point, hence as shown in FIG. **2,** the temperature controller **57** responds to the gas temperature at this point. As gas temperature can be used as an index of steam temperature only under start-up and low flow conditions, conveniently the gas temperature controller **57** may be of the retractable type and withdrawn from the gas duct during operation of the unit in the normal operating range, when gas temperatures may be far in excess of the superheat and reheat steam temperatures.

If while gas temperature and influentially steam temperature is the critical condition and firing is being modified to maintain gas temperature at the programmed value, excessive steam pressure results, the latter is maintained at the programmed value by passing steam around the superheater sections **20** and **10** through conduit **26** to condenser **12,** the flow therethrough being controlled by valve **57** responsive to the control signal generated in sequence control unit **58.**

Our invention further comprehends controlling super-heated steam temperature by instrumentalities now to be described when the critical condition is throttle pressure, or gas temperature or superheated steam pressure during start-up conditions, as well as maintaining steam temperature at desired value during normal on-line operation. Temperature Rate of Change Development Unit **59,** responsive to manually set signals generated in stations **60, 61** and **62** establish a signal corresponding to initial desired steam temperature and increasing at an adjustable rate until corresponding in value to the desired on-line operation temperature. The initial temperature is ordinarily set to give a desired temperature differential between steam and turbine metal temperatures and the rate of change set to increase steam temperature from initial to final value as required to maintain the difference between steam temperature and turbine metal temperature within prescribed limits. Thus, for example, the initial temperature may be **600F,** the rate of change **150F** per hour and the final temperature **1000F.**

Control unit **64** generated an output signal corresponding to the difference between the signals generated in unit **59** and superheated steam temperature controller **63** which may further be modified by a feed forward signal generated in flow controller **65** responsive to the rate of air flow to the furnace **19.** During start-up and low load operation the output signal from unit **64** controls saturated steam attemporator valve **66** introducing relatively cool steam into the superheated steam to thereby restore the steam temperature to the desired value. Conversely if during the start-up and low load operations actual steam temperature decreases below the programmed value the control signal generated in unit **64** is effective through control unit **67** to adjust the firing rate in an increasing sense. The control arrangement is such that the signal values corresponding to the decrease in actual steam temperature below the programmed value is effective for modulating the firing rate, whereas only signal values corresponding to the increase in actual steam temperature above the programmed value is effective for modulating, by means of valve **66,** the flow of saturated steam into the superheat steam. Further, at about the termination of the low range operation, normally about **20%** of full load, the use of saturated steam to control superheated steam temperature becomes ineffective, the valve **66** being positioned to a closed position, thereafter superheated steam temperature may be controlled throughout the normal operating range by introducing water as required through water attemporator valve **68** responsive to a signal generated in unit **64** corresponding to deviation in actual superheated steam temperature from the programmed value (normally the final steam temperature as set in manual station **62**).

Reheat steam temperature control is generally similar to that described for superheat steam temperature control. A signal output from temperature ramp unit **59** through line **68** is transmitted to control unit **69** wherein it is compared with a signal corresponding to actual steam reheat temperature generated in temperature controller **70.** Also introduced into control unit **69** is the feed forward signal, transmitted along line **71,** from air flow controller **65.** The output signal generated in control unit **69** is transmitted to a sequence controller **72,** operating in sequence steam attemporator valve **73,** gas recirculating control damper unit **74** and reheat water attemporator control valve **75.** Similar to the operation of the superheat steam control instrumentalities, the steam attemporator is effective during certain start-up conditions when firing to maintain the most critical condition produces a high reheat temperature. Within the normal operating range gas recirculation is effective to control reheat temperature, in general a rate of recirculation varying inversely with rating being required. At high ratings, when gas recirculation is reduced to a minimum, reheat steam temperature is effectively controlled by means of water attemporator.

We claim:

1. In a control system for a power producing unit comprising a vapor generator and a turbine-generator supplied with vapor from said vapor generating unit, the combination comprising; a first means generating a first feed forward signal corresponding to the desired power output of the power producing unit, a second means responsive to said first feed forward signal generating a second feed forward signal proportional in value to said first feed forward signal modified by the difference between desired and actual power output of the power producing unit, a third means responsive to said second feed forward signal maintaining the rate of flow of vapor to the turbine proportional to said second feed forward signal, a fourth means responsive to said first feed forward signal maintaining the pressure of the vapor admitted to said turbine at a set point value varying in a first functional relationship to said first feed forward signal and a fifth means responsive to said first feed forward signal maintaining the pressure in said vapor generator at a set point value varying in a second functional relationship to said first feed forward signal.

2. In a control system as set forth in claim **1** wherein said fifth means includes means venting vapor from said vapor generator as required to inhibit the pressure in said vapor generator from exceeding set point value.

3. In a control system as set forth in claim **1** wherein said vapor generator is provided with fuel and air supply means and wherein said fifth means includes means adjusting the rates of fuel and air supplied said vapor generator as required to maintain the pressure in said vapor generator in said second functional relationship to said first feed-forward signal.

4. In a control system as set forth in claim **1** wherein said fourth means includes manually adjustable means establishing an initial set point value, a final set point value and the desired rate of change in set point value with the magnitude of said first forward signal from said initial set point value to said final set point value.

5. In a control system as set forth in claim **1** wherein said vapor generator is provided with a primary superheater, a secondary super-heater and a control valve for regulating the flow of vapor from the primary to the secondary superheater and wherein said turbine is provided with admission valves for regulating the flow of vapor into said turbine and wherein said third means includes means adjusting said admission valves as required to maintain the rate of flow of vapor to the turbine proportional to said second feed forward signal and said fourth means includes means adjusting said control valve as required to maintain the pressure of the vapor on the inlet side of said admission valves at a set point value varying in functional relationship to said first feed forward signal.

6. In a start-up system for a power producing unit comprising a vapor generator provided with fuel and air supply means, a primary and a secondary superheater and a reheater, and a turbine-generator comprising a high pressure unit supplied vapor from said secondary superheater, a lower pressure unit supplied vapor from said reheater and a condenser condensing vapor discharged from said lower pressure unit, the combination comprising; means selecting the one of a plurality of measured conditions in said power producing unit having the greatest deviation from set point value generating a control signal varying in functional relationship with said deviation, means responsive to said control signal adjusting the rates of fuel and air supplied said vapor generator as required to maintain said selected one of the plurality of measured conditions at set point value and auxiliary instrumentalities maintaining the other of said plurality of measured conditions at set point values.

7. In a start-up system as set forth in claim **6** wherein said vapor generator is provided with a vapor by-pass from the vapor inlet of said secondary superheater to said condenser, one of said plurality of conditions is the vapor pressure at the vapor outlet of said primary superheater and one of said auxiliary instrumentalities includes means responsive to the deviation in said vapor pressure above set point value and means responsive to said last named means adjusting the rate of flow of vapor through said vapor by-pass to reduce said vapor pressure to set point value.

8. In a start-up system as set forth in claim **6** wherein said vapor generator is provided with a vapor by-pass from the vapor inlet of said primary superheater to the vapor outlet of said secondary superheater, one of said plurality of conditions is the temperature of the vapor discharged from said secondary superheater and one of said auxiliary instrumentalities includes means responsive to the deviation in said vapor temperature above set point value, and means responsive to said last named means adjusting the rate of flow of vapor through said last named vapor by-pass to reduce said vapor temperature to set point value.

9. In a start-up system as set forth in claim **6** wherein said vapor generator is provided with a vapor by-pass from the vapor inlet of said primary superheater to the vapor outlet of said reheater, one of said plurality of conditions is the temperature or the vapor discharged from said reheater and one of said auxiliary instrumentalities includes means responsive to the deviation in said reheated vapor temperature above set point value, and means responsive to said last named means adjusting the rate of flow of vapor through said last named vapor by-pass to reduce said reheated steam temperature to set point value.

10. In a start-up system as set forth in claim **6** wherein said vapor generator is provided with a valve in the vapor conduit between said primary and secondary superheaters and one of said auxiliary instrumentalities includes means responsive to the deviation in pressure of the vapor at the inlet to said high pressure turbine from set point value, and means responsive to said last named means adjusting said valve to maintain said last named pressure at set point value.

11. In a start-up control system as set forth in claim **8** wherein the set point value of the superheat steam is established by manually adjustable means establishing an initial set point value, a final set point value and the desired rate of change with time in set point value from said initial set point value to said final set point value.

12. In a start-up system as set forth in claim **6** wherein said plurality of measured conditions includes pressure of the vapor at the inlet to said high pressure turbine, temperature of the flue gas in said vapor generator between said secondary superheater and said reheater, pressure of the vapor is said vapor generator at the outlet of the primary superheater and temperature of the vapor at the inlet to said high pressure turbine.

13. In a start-up system as set forth in claim **6** wherein said one of a plurality of measured conditions is the temperature of the flue gas between said primary and secondary superheaters, means generating a feedforward signal varying in functional relationship with the energy demand from said power producing unit, means responsive to the temperature of the flue gas between said primary and secondary superheaters, and means under the joint control of said last two named means adjusting the fuel and air supplied said vapor generator to maintain said flue gas temperature at desired value.

14. In a control system as set forth in claim **6** wherein said one of a plurality of measured conditions is the temperature of the flue gas between said primary and secondary superheaters, means responsive to said temperature generating a control signal varying in accordance with changes in said flue gas temperature from set point, means generating a feedforward signal varying in functional relationship with the desired power output from said power producing unit, means responsive to said feedforward signal raising said set point in functional relationship with increases in said feedforward signal, and means responsive to said control signal adjusting the rates of fuel and air supplied said vapor generator as required to maintain said flue gas temperature at set point.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3, 922,859 Dated Dec. 2, 1975

Inventor(s) Oliver W. Durrant and Robert R. Walker

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 20, after "pressure" insert -- turbine -- ; line 51, change "attemerators" to -- attemperators -- .

Column 2, line 15, after "IP turbine" insert -- 4 and LP [illegible] turbine -- ; lines 46 and 47, after "shown" delete "but schematically represented by line 23"; line 54, after "one" insert -- means -- .

Column 3, line 53, change "uperheated" to -- superheated -- .

Column 4, lines 65 and 66, delete "transmitted along line 45 to position" and insert -- positioning -- .

Column 6, line 1, change "influentially" to -- inferentially -- ; line 31, change "generated" to -- generates --; lines 38 and 60 change "attemporator" to -- attemperator -- .

Column 7, lines 8, 10, 12 and 20 change "attemporator" to -- attemperator -- .

Claim 7, line 3, cancel "secondary" and insert -- primary -- .

Claim 9, line 5, change "or" to -- of -- .

Signed and Sealed this

twenty-third **Day of** *March 1976*

[SEAL]

Attest:

RUTH C. MASON

C. MARSHALL DANN