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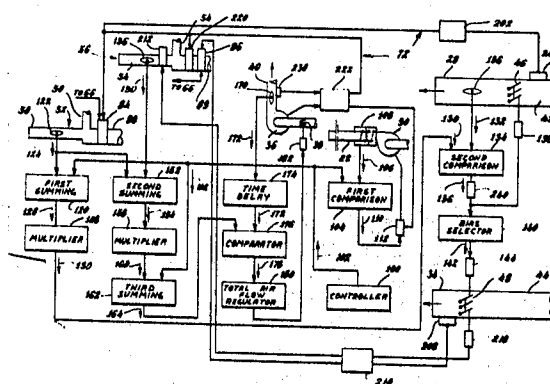
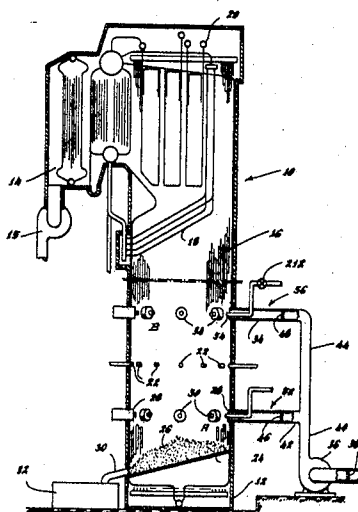
[54] **BLACK LIQUOR RECOVERY BOILER**
COMBUSTION AND SAFETY CONTROL SYSTEM
13 Claims, 3 Drawing Figs.

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110/32 C, 431/12, 236/14, 236/15 B, 236/15 E,
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C01b 17/22
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277, 262, 48; 110/22 A; 122/448; 236/14, 15 B;
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[56] **References Cited**
UNITED STATES PATENTS

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ABSTRACT: Recovery boiler operation is initiated by a control system responsive to selected preliminary conditions in the boiler. Once the boiler is in operation, a combustion system controls the total amount of air, black liquor, primary fuel and secondary fuel supplied to the recovery boiler to reduce explosion hazards. Actual primary and secondary fuel flow rates are added and a fuel-air demand signal is generated in proportion to the amount of air required to fully combust both fuels. A black liquor demand signal is added to the fuel-air demand signal to produce a total air demand signal which is compared to the actual rate of flow of combustion air to the boiler. A forced draft controller signal indicative of any difference between the total air demand and the actual airflow is applied to a circuit for controlling a forced draft fan to adjust the total airflow delivered to the boiler, which air is divided into primary air supplied to the reduction zone of the boiler and secondary air supplied to the oxidation zone. The flow of primary air to the reduction zone is automatically controlled in response to black liquor and primary fuel flow rates. The flow of secondary air to the combustion zone is selected automatically in response to the rate of flow of primary air. In the event certain boiler operation safety limits are exceeded, safety circuitry overrides the combustion system to initiate safety procedures which return the boiler operation to normal or shut down the boiler.



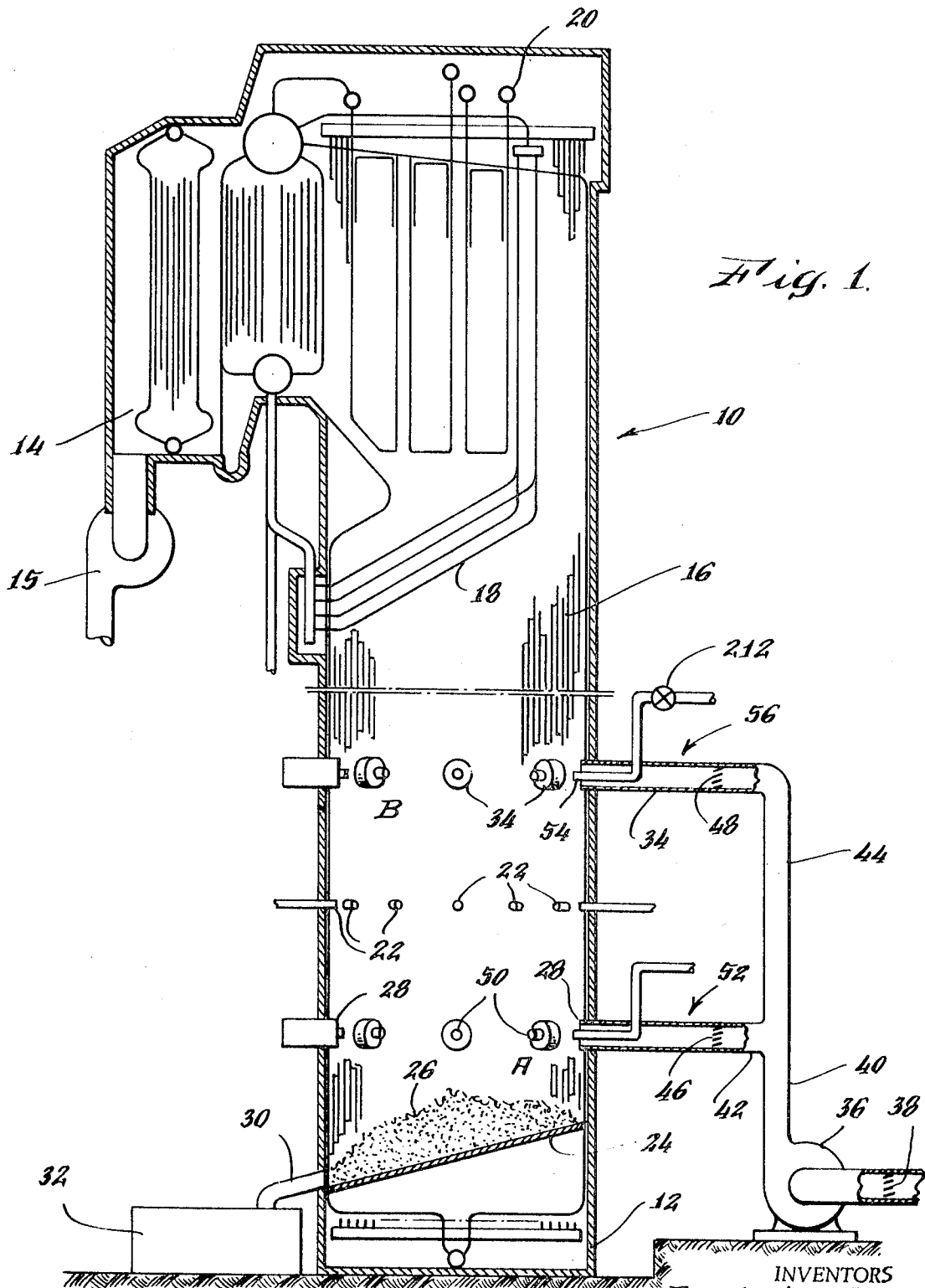
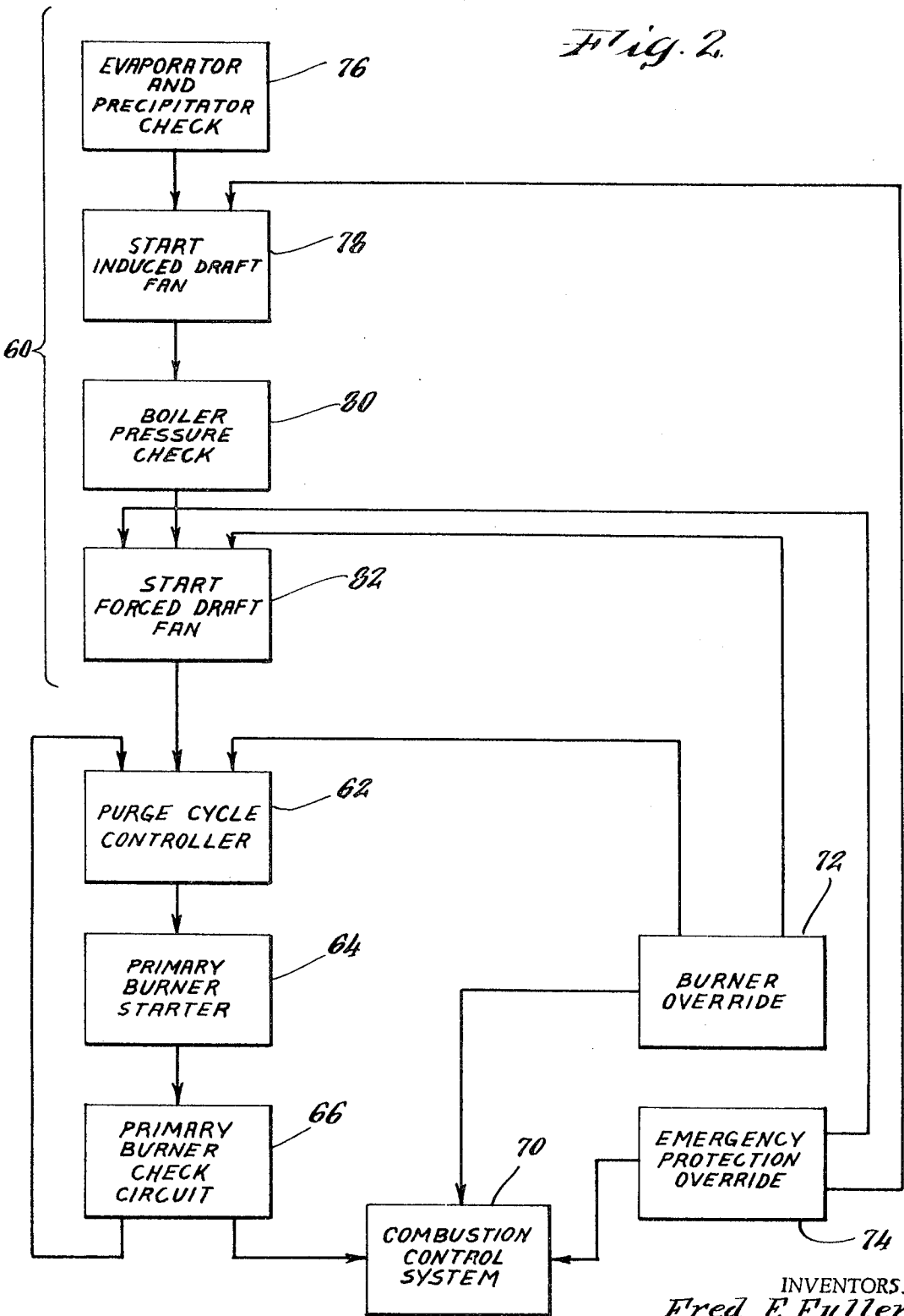


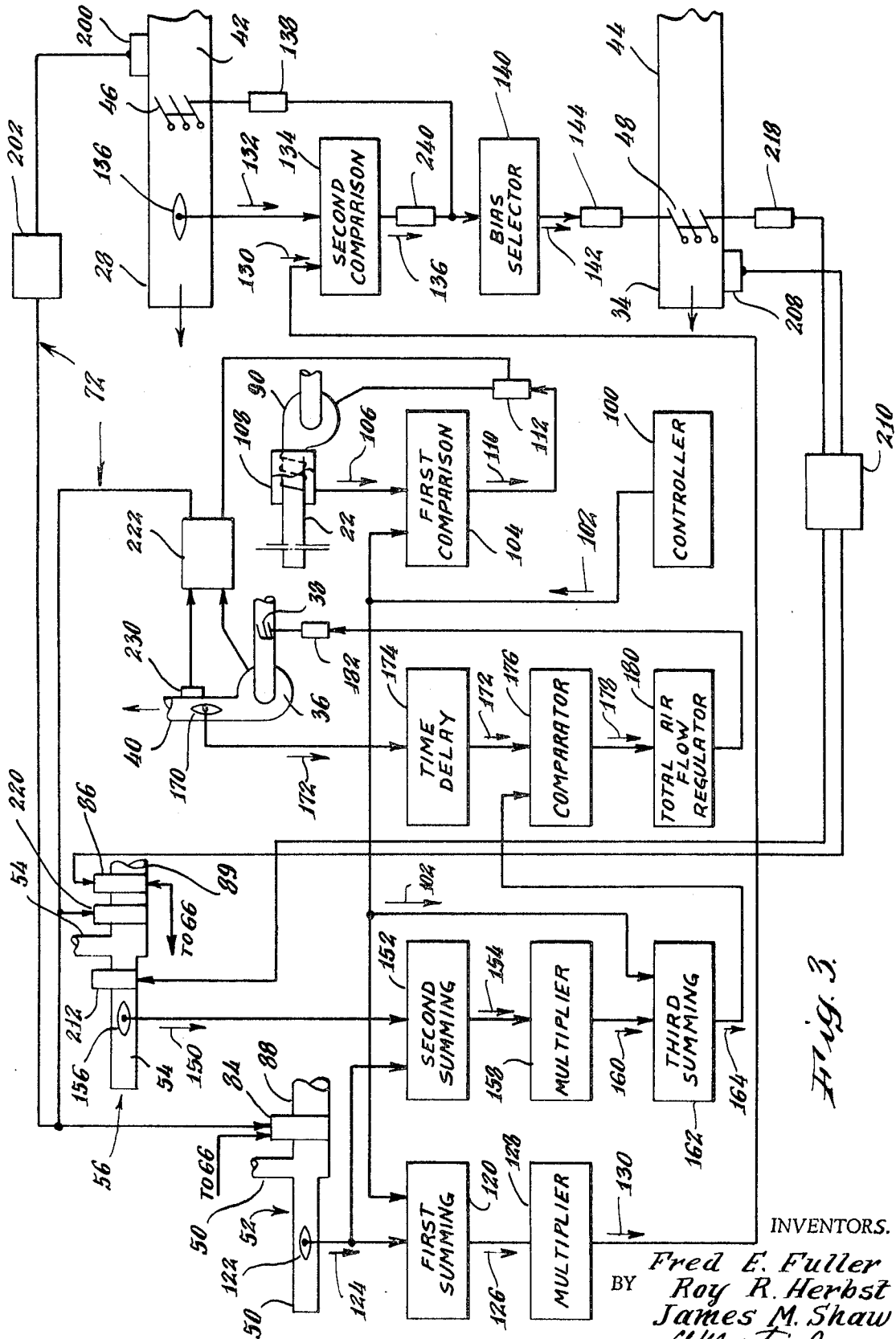
Fig. 1.

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Fig. 2



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BLACK LIQUOR RECOVERY BOILER COMBUSTION AND SAFETY CONTROL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a recovery boiler combustion and safety control system and, more particularly, to a system for measuring the total amount of fuel supplied to a black liquor recovery boiler and automatically controlling the total flow of combustion air to selected zones of the boiler in response to the amount of fuel measured.

In the production of pulp, wood chips are cooked in a digester with white liquor. The active chemicals (sodium hydroxide and sodium sulfide) in the white liquor separate the lignin from the cellulose in the wood to provide pulp for paper manufacture. The lignin and spent chemicals form black liquor which is concentrated in an evaporator and burned in a black liquor recovery boiler. The operation of the recovery boiler is effective to recover the chemicals for reuse in the digester and to produce heat for steam generation purposes. Thus, safe and properly controlled boiler operation is essential to the operation of a profitable papermill.

2. Description of the Prior Art

Notwithstanding the importance of recovery boilers in the operation of papermills, it has been customary in the past to manually control the critical aspects of recovery boiler combustion. The problems faced by boiler engineers in manually controlling recovery boiler operations may be appreciated when it is understood that recovery boilers are operated under extremely variable conditions. For example, even when a recovery boiler is operated as a base-loaded boiler using black liquor as the only fuel, the airflow and black liquor flow must be adjusted to maintain a relatively constant steam output because the chemical composition of black liquor is variable. Moreover, when an auxiliary primary fuel, such as gas, is burned in the boiler to melt down the smelt bed, the flow of primary and secondary air must be regulated according to the amount of both the black liquor and primary gas inputs.

In addition, to increase the steam output of a recovery boiler, a secondary fuel, such as gas, may be burned in the boiler. This adds another variable which must be controlled by the engineer.

In the past, the boiler engineer has been assisted by safety systems which indicate only whether an auxiliary burner is operating. Thus, the control of the total combustion air and fuel requirements of the recovery boiler have been dependent upon the skill and experience of the boiler engineer. Despite the experience and efforts of boiler engineers to closely control recovery boiler operation, accidents have resulted from manual operation of recovery boilers. The frequency and severity of such accidents lead the Technical Association of The Pulp and Paper Industry to form a committee to study recovery boiler operations. The committee determined that 22 recovery boiler explosions which occurred prior to 1967 were related to problems in firing auxiliary fuel. This finding indicates that it is not safe to continue to rely upon manual control of recovery boiler operations.

In attempting to develop other ways of controlling recovery boilers, it was recognized that combustion controls have been provided for power boilers. It is clear, however, that the problems encountered in recovery boiler operation are significantly different from those in power boilers. Initially, although there are no physical barriers between the reduction and oxidation zones of a recovery boiler, the reduction zone must be maintained in a deficient air condition, whereas an excess air condition must be maintained in the oxidation zone.

Further, in power boilers, no residual fuel is maintained in the boiler. On the other hand, the smelt bed which forms in the recovery boiler is a source of volatile gas which remains in the boiler after the black liquor has been supplied. Moreover, power boiler fuels have easily determined properties of combustion, whereas black liquor is the result of a variable process and is used in infinite combination with auxiliary fuels.

Because of these differences, it can be understood that power boiler control techniques have been found to be unsuitable for solving the problems encountered in operating black liquor recovery boilers.

SUMMARY OF THE INVENTION

Research conducted in an endeavor to provide an automatic system for safely controlling the combustion process in a black liquor recovery boiler, indicates that prior explosion hazards and operational problems may be minimized by automatically controlling the operation of a recovery boiler. During boiler operation, the total fuel input to the recovery boiler (including the black liquor input) is related to the supply of air to selected zones in the boiler by adding a black liquor-air demand signal and a gas-air demand signal to produce a total air demand signal which is compared to the actual total combustion air flow to the boiler. A controller is responsive to the difference between the compared signals for regulating the total amount of combustion air supplied to the boiler by a forced-draft fan. The fan supplies the total amount of combustion air to primary and secondary air manifolds. Black liquor-air demand and primary gas flow signals are added and applied to a multiplier circuit which generates a signal indicative of the primary air demand required to maintain a reducing condition in the reduction zone. The primary air demand signal is compared to a signal indicative of the actual primary airflow to produce a primary air control signal which regulates the flow of air from the primary air manifold to the reduction zone. The primary air control signal is also fed to a secondary air control selector which generates a secondary air control signal for regulating the flow of secondary air from the secondary manifold to the combustion zone.

Further, the critical boiler conditions are monitored during boiler operation. In response to abnormal conditions, a safety system is effective to return the boiler operation to normal or, in an emergency, to shut down the boiler.

An object of the present invention is to provide a new and improved black liquor recovery boiler combustion and safety control system.

A further object of the present invention resides in a system for controlling the total flow of air and fuel to a black liquor recovery boiler.

Another object of the present invention is to automatically maintain a reducing condition in a first zone of a recovery boiler and an excess air condition in a second zone in accordance with varying demand for a number of different fuel inputs to the boiler.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the present invention may be appreciated upon reference to the following description of the preferred embodiment when taken in conjunction with accompanying drawings, in which:

FIG. 1 is a schematic elevational view of a black liquor recovery boiler for use with the control system of the present invention;

FIG. 2 is a chart illustrating the relationship between recovery boiler startup controls, combustion controls and override controls of the control system of the present invention; and

FIG. 3 is a schematic diagram of the control system illustrating selected structural elements of the recovery boiler shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters are used throughout to designate like elements, the illustrative and preferred embodiment of the present invention is shown in FIG. 1 including a chemical recovery unit, such as a boiler 10. The boiler 10 extends vertically from a base 12 for a height of up to 15 stories, for example, and is provided with a reduction zone A at the lower end thereof and an oxidation zone B spaced upwardly from the reduction zone A. The zones

A and B are in open communication relative to each other to facilitate the upward flow of products of combustion to an exhaust stack 14 under the operation of an induced draft fan 15.

The walls of the boiler 10 are lined with steam generating tubes 16 of a boiler heat exchange system which includes additional heat exchanger tubes 18 located at the upper end of the boiler 10. A mixture of steam and water (at saturation temperature for the particular pressure at which the boiler unit is the flows upwardly through the tubes 16 and 18 to a header 20. The boiler 10 may be operated to produce steam at a pressure of 875 lbs. per sq. inch and superheated to a desired value, such as 825° F. The steam is supplied from the header 20 to a desired point of use within the papermill.

In the normal operation of the boiler 10, black liquor which has been evaporated in the Kraft process to a desired density (such as a 50-65 percent solids content), is sprayed into the boiler 10 through nozzles 22 at a suitable pressure and temperature. Most of the sprayed liquor particles fall to the bottom 24 of the boiler 10 in counterflow to the products of combustion rising from the reduction zone A. The falling particles are dried and form a pile or smelt bed 26. Preheated primary air is supplied to the reduction zone A through primary wind boxes 28 in amounts sufficient to produce a reducing atmosphere or condition therein. The residual chemicals from the black liquor flow through a spout 30 to a receiving tank 32 for reuse in the Kraft process. The combustible materials in the products of combustion which rise from the smelt bed 26 are burned with preheated secondary air which is supplied to the boiler 10 through secondary wind boxes 34. The temperature in the reduction zone A is generally in the range of 2,100-2,200° F., whereas the products of combustion leave the combustion zone B at about 1,700° F.

The total flow of combustion air to the boiler 10 is provided by a forced draft fan 36 having vanes 38 which are effective to vary the total air flow at constant blower speed. The fan 36 supplies combustion air through a duct 40 to a primary air manifold 42 and a secondary air manifold 44. The flow of primary air to the primary wind boxes 28 is controlled by vanes 46 in the manifold 42, whereas the flow of secondary air to the wind boxes 34 is controlled by vanes 48.

In the operation of the boiler 10 under normal conditions, black liquor is the only fuel supplied to the boiler 10. However, when the boiler is started up, auxiliary fuel is supplied through a nozzle 50 of primary burners 52 and is burned in the boiler 10. For purposes of illustration, the auxiliary fuel described herein will be gas, but it should be understood that other fuel, such as fuel oil, may be used as the auxiliary fuel. After the burning primary gas has initiated combustion of the black liquor, the gas supply is shut off. During the burning of the primary gas, primary air is supplied to the reduction zone A through the primary wind boxes 28 for complete combustion of the primary gas.

In the event the demand for steam exceeds that which can be supplied by burning the available black liquor, auxiliary fuel, such as secondary gas or fuel oil, is supplied to nozzles 54 of secondary burners 56. Secondary air sufficient to complete the combustion of the secondary gas is supplied through the secondary manifold 44.

In the past, the supply of black liquor, primary and secondary fuels and air has been controlled manually. However, such manual control has often been unsatisfactory, especially when auxiliary fuels are burned in conjunction with the black liquor. In particular, 22 black liquor recovery boiler explosions have been attributed to problems in manually controlling such boilers during auxiliary fuel burning. Accordingly, the present system for automatically controlling recovery boiler operation makes it possible to minimize the conditions which have in the past contributed to such explosions.

Referring now in general to FIG. 2, the system of the present invention is shown including a boiler startup circuit 60 which includes a series of circuits which are responsive to certain initial conditions in the boiler 10. Completion of the startup circuit 60 initiates a boiler purge cycle controller 62. The

purge cycle places the zones A and B in condition for operation of the primary burners 52, whereupon the primary burners 52 are ignited by a starter 64. The primary burners 52 are effective to heat the boiler 10 and to initiate sustained ignition of black liquor which is sprayed into the boiler 10 from the nozzles 22. A primary burner check circuit 66 is responsive to the establishment of burner flame at the primary burners 52 to permit continued flow of black liquor and primary gas under the control of a combustion control system 70 shown in detail in FIG. 3.

The system 70 controls the operation of the boiler 10 and is responsive to a burner override circuit 72 which monitors the operation of the individual burners 52 and 56. The system 70 is also responsive to an emergency protection circuit 74 to effect boiler shutdown.

Referring now in detail to FIG. 2, the boiler startup circuit 60 is shown including a check circuit 76 which is completed in response to selected boiler precipitator and evaporator temperatures, for example. In response to the completion of the circuit 76, a circuit 78 is energized for starting the induced draft fan 15. The fan 15 is effective to produce a desired pressure, such as 2 inches W.G., in the boiler 10. In response to such pressure, a circuit 80 energizes a circuit 82 to initiate operation of the forced draft fan 36. The circuit the circuit 82 renders the purge cycle controller circuit 62 effective. The circuit 62 is completed in response to 60 The circuit percent primary air flow in the primary manifold 42 and, for example, the sensing of predetermined pressure in gas headers 88 and 89 (FIG. 3) which supply gas to the burners 52 and 56. The completed circuit 62 initiates a purge cycle for a selected time period, such as 5 minutes, so that no volatile gases or other fuel remains in the boiler 10.

At the end of the purge cycle, the circuit 62 initiates operation of the starter 64 and the primary burner check circuit 66. In the event burner flames are not established within a selected time period, such as 6 minutes, the check circuit 66 is effective to interrupt the flow of primary gas by closing a primary gas header valve 84 and a secondary gas header valve 86 (see FIG. 3). Further, the check circuit 66 recycles the purge cycle controller circuit 62 to require a complete purge cycle before the primary burners 52 are reignited.

In the event burner flames are established at the primary burners 52 within the 6-minute time period, the check circuit 66 is satisfied and permits operation of the boiler 10 under the control of the system 70.

Referring now in detail to FIG. 3, when the boiler 10 has reached a temperature sufficient to initiate ignition of black liquor, a black liquor pump 90 is started to supply black liquor to the nozzles 22. As soon as sustained ignition of the black liquor occurs, the flow of primary gas may be discontinued for operation of the boiler 10 with black liquor as the only fuel.

In the system shown in FIG. 3, the steam demand of the paper mill is used to set a black liquor flow demand controller 100 which generates a black liquor demand signal 102 which is indicative of the flow of black liquor required to meet the steam demand of the papermill. The signal 102 is applied to a first comparison circuit 104 which compares the signal 102 and a signal 106 which is indicative of the actual black liquor flow rate through the nozzles 22. The magnetic field in a flow meter 108 is varied according to the velocity of black liquor there through to generate the signal 106. The signal 106 from the flow meter 108 may be in millivolts or the corresponding milliamperage value for application to the comparison circuit 104.

The comparison circuit 104 may be an integral operational amplifier having a potentiometer (not shown) in the signal 106 input circuit to provide gain and reset rate based upon boiler response so that the control system 70 is stable. The circuit 104 compares the signals 102 and 106 to produce a black liquor flow control signal 110 which is used to control the flow rate of black liquor, such as by positioning a valve (not shown) or by regulating the black liquor pump 90. The signal 110 is applied across an interlock switch 112 which is connected to the burner override circuit 72.

The black liquor demand signal 102 is also applied to a first summing circuit 120. An orifice plate 122 is provided upstream from the primary gas nozzles 50 to produce a primary gas flow signal 124 which, after processing in a standard manner, is indicative of and varies linearly with primary gas flow to the nozzles 50.

The summing circuit 120 algebraically adds the signals 102 and 124 and produces a primary fuel demand signal 126 which is applied to a multiplier circuit 128. The multiplier circuit 128 has a manually adjustable gain which can be set according to the applicable fuel-to-air ratio to produce a primary air demand signal 130 which is indicative of the amount of air required to completely burn the primary gas and to partially burn the black liquor.

The primary air demand signal 130 and a signal 132 indicative of the actual flow of primary air are compared by a second comparison circuit 134. The signal 132 is generated by a flow sensor which includes an orifice plate 136 mounted in the primary manifold 42 downstream from the vanes 46. The flow sensor also includes standard circuitry to produce the signal 132 linearly with respect to the flow of primary air.

The circuit 134 generates a primary air control signal 136 which is converted to linear motion by a transducer 138 to adjust the position of the vanes 46 so that the desired amount of primary air is supplied to the primary wind boxes 28.

Because the reduction zone A is supplied with less air than is required for complete combustion of the black liquor, excess air is supplied to the combustion zone B under the control of the primary air control signal 136. In particular, in response to the signal 136, a bias selector circuit 140 generates a secondary air signal 142 which is converted to linear motion by a transducer 144 to adjust the vanes 48 at the entry to the secondary wind boxes 34 to supply excess air to the combustion zone B. The bias selector circuit 140 may be adjusted to vary the ratio of primary to secondary air in accordance with desired changes in the amount of excess air, for example.

The total airflow to the boiler 10 from the forced draft fan 36 is determined in response to the total amount of fuel supplied to the boiler 10. Thus, the primary gas flow signal 124 and a signal 150 indicative of the flow rate of secondary gas from the secondary burners 56 are applied to a second summing circuit 152 to develop a signal 154 representing the total gas flow. The signal 150 is generated in the same manner as the signal 124 by a flow rate sensor having orifice plates 156 so that the signal 150 varies linearly with secondary gas flow.

A multiplier circuit 158 converts the total gas flow signal 154 to a signal 160 corresponding to the air demand for complete primary and secondary combustion. The signal 160 and the black liquor demand signal 102 are added by a third summing circuit 162 to generate a signal 164 which is indicative of the total air demand of the boiler 10.

The actual airflow provided by the forced draft fan 36 is sensed by a flow rate sensor having an orifice plate 170 so that a signal 172 which varies linearly with total air flow is produced. Because the orifice plate 170 is mounted in the duct 40 upstream from the location of the orifice plates 122 and 136, the signal 172 is applied to a time delay circuit 174 to delay the signal 172 to account for the time difference between taking the gas and air flow measurements. The delayed signal 172 is applied to a comparator circuit 176 along with the signal 164. The comparator circuit 176 is similar to the circuit 104 and responds to the difference between the signals 164 and 172 to produce a control signal 178 which operates a total airflow regulator 180. The regulator 180 operates a transducer 182 to adjust the vanes 38 of the fan 36 to provide the required total air demand to the boiler 10.

Still referring to FIG. 3, it may be understood that under normal operating conditions, the system 70 will regulate the process of combustion in the boiler 10 by relating the total fuel input to the boiler to the total air demand. In the event, however, that a failure occurs in equipment which is critical to the safe operation of the boiler 10, the burner override circuit 72 will sense the failure and initiate protective action. In par-

ticular, if during the operation of the primary burners 52 there is a loss of primary air pressure in the manifold 42, a sensor 200 senses this condition and energizes a primary burner protection circuit 202 which is effective to close a valve 84 in the primary gas header 88. Closure of the valve 84 interrupts the flow of primary gas to all of the primary burners 52 to avoid the accumulation in the boiler 10 of unburned gas. The system 70 responds to the interruption of primary gas flow by reducing the amplitude of the primary fuel demand signal 126 and reducing the total airflow to the boiler 10.

As shown in FIG. 3, the circuit 72 includes secondary burner protection in the form of sensors 208 mounted on each secondary wind box 34. In the event the pressure is lost in a particular wind box 34, the adjacent sensor 208 energizes a burner control circuit 210 which is effective to close a secondary burner valve 212 associated with the burner 56 in the particular wind box 34 which lost air pressure. The orifice plate 156 in the respective burner 56 responds accordingly and initiates combustion control changes in the system 70.

The secondary burner protection also includes a switch 218 which is responsive to a closed position of the vanes 48 upstream from the secondary wind boxes 34. Upon actuation, the switch renders the circuit 210 effective to close the secondary gas header valve 86 to interrupt secondary gas flow to all of the burners 56. As described above, the orifice plates 156 in all of the burners 56 respond to the interruption of secondary gas flow and initiate required combustion control changes in the system 70.

The burner override circuit 72 is also effective to sense the loss of power to the induced draft fan 15. As shown in FIG. 2, in response to this condition, the circuit 72 renders the forced draft fan control circuit 82 effective to shut down the forced draft fan 36. Referring again to FIG. 3, the shutting down of the forced draft fan 36 renders a fuel control circuit 222 effective to close the primary gas header valve 84, a secondary gas header valve 220, and a main header valve (not shown) to interrupt the flow of gas to the boiler 10. Further, the circuit 222 opens the interlock switch 112 to interrupt operation of the black liquor pump 90. Accordingly, in the event either or both the forced draft fan 36 and the induced draft fan 15 become ineffective, the circuit 72 will prevent the continued supply of fuel to the boiler 10.

When the forced draft fan 36 becomes inoperative such that there is a loss of air pressure in the duct 40, a sensor 230 is effective to render the circuit 222 effective to close the valves 84 and 220 and the main header valve and to open the switch 112.

As described above, the burner protection override circuit 72 automatically initiates certain safety operations. On the other hand, the emergency protection override circuit 74 may be manually operated in the event an emergency condition develops. Upon actuation of the circuit 74 by a push button, for example, the circuit 74 is effective to open the switch 112 to stop the black liquor flow to the nozzles 22. Further, gas flow is interrupted, for example, by energizing the circuit 222 which closes valves 84 and 220. To exhaust combustible materials from the boiler 10, the circuit 74 also renders the induced draft fan circuit 78 effective to operate the induced draft fan 15 at minimum speed.

The circuit 74 also prevents fresh air from entering the boiler by closing the primary air vents 46 and the secondary air vents 48 through the operation of an interlock 240. Also, the forced draft fan 36 is shut down by the circuit 74 through a signal which is applied to the circuit 82.

As a result of the emergency operations controlled by the circuit 74, the introduction into the boiler 10 of combustible materials (air, gas and black liquor) is discontinued and products of combustion which may be produced by the smelt bed 26 are removed from the boiler 10 by the induced draft fan 15.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of this invention. Numerous other arrangements may be

readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. In a unit for recovering chemicals from black liquor, said unit including a combustion chamber having a plurality of combustion zones, means for supplying black liquor to a first zone of said chamber, means including a conduit for supplying auxiliary fuel to at least one other zone of said chamber, and means provided with separate conduits for supplying air to each of said zones, the improvement in said unit which comprises:
 - means for generating a first signal indicative of black liquor demand;
 - means in said auxiliary fuel conduit for generating a second signal indicative of auxiliary fuel being supplied to said chamber;
 - means for summing the above two signals to generate a third signal indicative of the total fuel being supplied to the zones of said chamber;
 - means responsive to said third signal for controlling said air supply means to provide a total air supply in excess of that required to completely combust the black liquor and the fuel supplied to said chamber;
 - flow control means responsive to said first signal for delivering through a first of said conduits a portion of said total air supply to maintain a reducing atmosphere in the first of said zones so that a portion of the black liquor remains unburned; and
 - means responsive to said flow control means for continuously delivering through said other conduits the remaining portion of said total air supply to said other combustion zones.
2. A unit according to claim 1 for recovering chemicals from black liquor, said unit further including:
 - means responsive to a reduction of the air flow supplied by said air supply means for interrupting operation of said black liquor and auxiliary fuel supply means.
3. A unit according to claim 1 for recovering chemicals from black liquor, said unit further including:
 - means responsive to a reduction of the airflow in said other conduits for interrupting the supply of auxiliary fuel from said auxiliary fuel supply means to prevent fuel from entering said chamber in the absence of sufficient air to combust the fuel.
4. A unit for recovering chemicals from black liquor, as recited in claim 1, in which said unit also comprises, means including a conduit for supplying auxiliary fuel to said first zone, and which further comprises:
 - means in said last recited conduit for generating a fourth signal indicative of said auxiliary fuel being supplied to the first zone;
 - said third signal generated by the summing means being the summation of said first, second, and fourth signals, and
 - said flow control means being responsive to said first and fourth signals.
5. In a chemical process unit for burning black liquor to recover chemicals, said unit including a chamber having a reduction zone and an oxidation zone, means for feeding black liquor into said chamber means for burning auxiliary fuel in said oxidation zone, and means including a main input line, a first conduit to said reduction zone and a second conduit to said oxidation zone for supplying air to said chamber, the improvement in said unit which comprises:
 - means for generating a signal indicative of black liquor demand;
 - means for comparing said demand signal to the actual flow of black liquor into said chamber to regulate said black liquor feeding means;
 - means in said main input line for generating a signal indicative of the total air supplied to said chamber;
 - means responsive to said black liquor demand signal and the actual flow rate of auxiliary fuel for generating an air de-

- mand signal indicative of the total amount of air necessary to completely combust said black liquor and auxiliary fuel;
 - means for comparing said total air signal to said air demand signal to regulate said air supply means;
 - air flow control means responsive to said black liquor demand signal for supplying through said first conduit a first portion of said total air to said reducing zone to partially combust the black liquor in said zone; and
 - means responsive to said air flow control means for continuously supplying the remainder of said total air through said second conduit to said oxidation zone to completely combust both said black liquor and any auxiliary fuel, said remainder being supplied to said oxidation zone even though no auxiliary fuel is being burned.
6. A chemical process unit according to claim 5 in which:
 - said auxiliary fuel burning means includes a plurality of auxiliary fuel burners each having a wind box for supplying air to said oxidation zone; and
 - means are provided for response to a decrease in the air flow in one of said wind boxes for interrupting the operation of the burner associated with said one of said wind boxes.
 7. A unit for burning black liquor to recover chemicals and produce heat, said unit including a combustion chamber having a reduction zone and an oxidation zone, means for supplying primary fuel to said reduction zone, means for supplying secondary fuel to said oxidation zone, means for feeding black liquor into said chamber, and means for supplying air for combustion of the black liquor and the primary and secondary fuels, the improvement in said unit which comprises:
 - means for producing a black liquor demand signal indicative of desired black liquor flow;
 - means for comparing said black liquor demand signal to a signal indicative of actual black liquor flow to control said black liquor supply means;
 - means for adding said black liquor demand signal and first and second signals indicative of the actual primary fuel flow and the actual secondary fuel flow to produce a total air demand signal;
 - air-sensing means responsive to the total actual air flow to said chamber for producing an actual airflow signal;
 - first means for comparing said total air demand signal and said actual airflow signal to generate a signal for controlling said air-feeding means to supply total air in excess of that required to completely burn both said fuels and said black liquor;
 - means for summing said black liquor demand signal and said first primary fuel signal to produce a primary air demand signal indicative of the air required to completely combust said primary fuel and to partially combust said black liquor;
 - second means for comparing a primary air signal indicative of actual primary airflow to said primary air demand signal to produce a primary air control signal;
 - means responsive to said primary air control signal for distributing to said reduction zone air to completely combust said primary fuel and partially combust said black liquor; and
 - means responsive to said primary air control signal for controlling the air flow to said oxidation zone to provide excess air in said oxidation zone to completely burn said primary and secondary fuels and said black liquor.
 8. A unit according to claim 7, in which:
 - said means for supplying primary fuel includes a primary fuel header and a plurality of separate primary fuel burners connected to said header;
 - said means for supplying air includes a primary air manifold and a wind box for each of said primary fuel burners;
 - means are provided for sensing the air flow in said primary manifold, said sensing means being effective to generate an override signal in response to reduced airflow in said primary manifold; and

means are provided for response to said override signal for interrupting the flow of fuel from said primary fuel header to said primary fuel burners.

9. A unit according to claim 8, in which:

said means for supplying secondary fuel includes a secondary fuel header and a plurality of secondary fuel burners connected to said secondary fuel header; and means are provided responsive to an interruption in the air flow from said air supply means for interrupting the flow of fuel in both said primary and secondary fuel headers and for discontinuing the operation of said black liquor feeding means.

10. A unit according to claim 7 in which;

said means for supplying primary fuel includes at least one primary fuel burner which receives fuel from said primary fuel supply means;

said means for supplying secondary fuel includes at least one secondary fuel burner which receives fuel from said secondary fuel supply means;

said first and second signals are generated in response to the respective flow of primary and secondary fuel in said primary and secondary burners;

said air supply means includes a fan having an outlet duct spaced from said combustion chamber;

said air-sensing means is responsive to the air flow in said outlet duct for producing said actual air flow signal; and

means are provided for delaying said actual airflow signal prior to application thereof to said first comparing means to synchronize said actual air flow signal with said total air demand signal.

11. A system for controlling combustion in a black liquor recovery unit wherein black liquor is burned to recover chemicals therefrom and to generate heat for producing steam and wherein primary fuel is burned for burning down a smelt bed and secondary fuel is burned for increasing the heat output of the unit, the unit including a combustion chamber having a reduction zone, an oxidation zone and a bottom for receiving the smelt bed, the unit further including a primary fuel burner adjacent said reduction zone, a secondary fuel burner adjacent said oxidation zone, a primary duct for supplying primary air to said primary burner, at least one additional duct for supplying air to said secondary burner and to said chamber, a fan for supplying combustion air to said primary and additional ducts and means for feeding black liquor to said chamber; said system comprising:

means for measuring the flow of primary fuel to said primary burner to generate a first signal;

means for measuring the flow of secondary fuel to said secondary burner to generate a second signal;

means for generating a third signal in response to black

liquor flow;

means responsive to said first, second and third signals for generating a fourth signal indicative of the total air demand of said unit;

means responsive to the total flow of air supplied by said fan for generating a fifth signal;

means responsive to said fourth and fifth signals for controlling said fan to provide a total airflow sufficient to satisfy the total air demand;

means responsive to said first and third signals for generating a sixth signal indicative of the amount of primary air required to fully combust the primary fuel and to partially combust the black liquor;

means responsive to the primary airflow in said primary duct for generating a seventh signal indicative of actual primary air flow;

comparison means responsive to said sixth and seventh signals for controlling the flow of primary air in said primary duct to provide the primary air required;

means responsive to said comparison means for regulating the flow of air to said additional duct so that sufficient air is supplied to said secondary burner and said oxidation zone of said chamber for completely burning the secondary fuel and the black liquor;

means for producing an eighth signal indicative of the black liquor demand of said unit; and

black liquor control means responsive to said third and eighth signals for regulating said feeding means to supply the desired amount of black liquor to said chamber.

12. A combustion and safety system in accordance with claim 11, in which;

means are provided responsive to an interruption in the operation of said fan for generating a safety control signal; and

safety means are provided responsive to said safety control signal for turning off said primary and secondary fuel burners, said safety means being effective to override said black liquor control means for stopping the flow of black liquor to said chamber.

13. A combustion control system according to claim 11, in which:

said means for generating said fifth signal measures total air flow at a selected location spaced from said chamber;

said means for generating said first and second signal measure fuel flow rates adjacent the respective primary and secondary fuel burners; and

means are provided for delaying said fifth signal to synchronize said fourth and fifth signals so that the total air flow measurement will correspond in time to the measurement of the primary and secondary fuel flow.

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