Sept. 19, 1961 P. F. SULLIVAN 3,000,572

LOW FUEL DAMPER CONTROL

Filed March 26, 1957 3 Sheets-Sheet 1

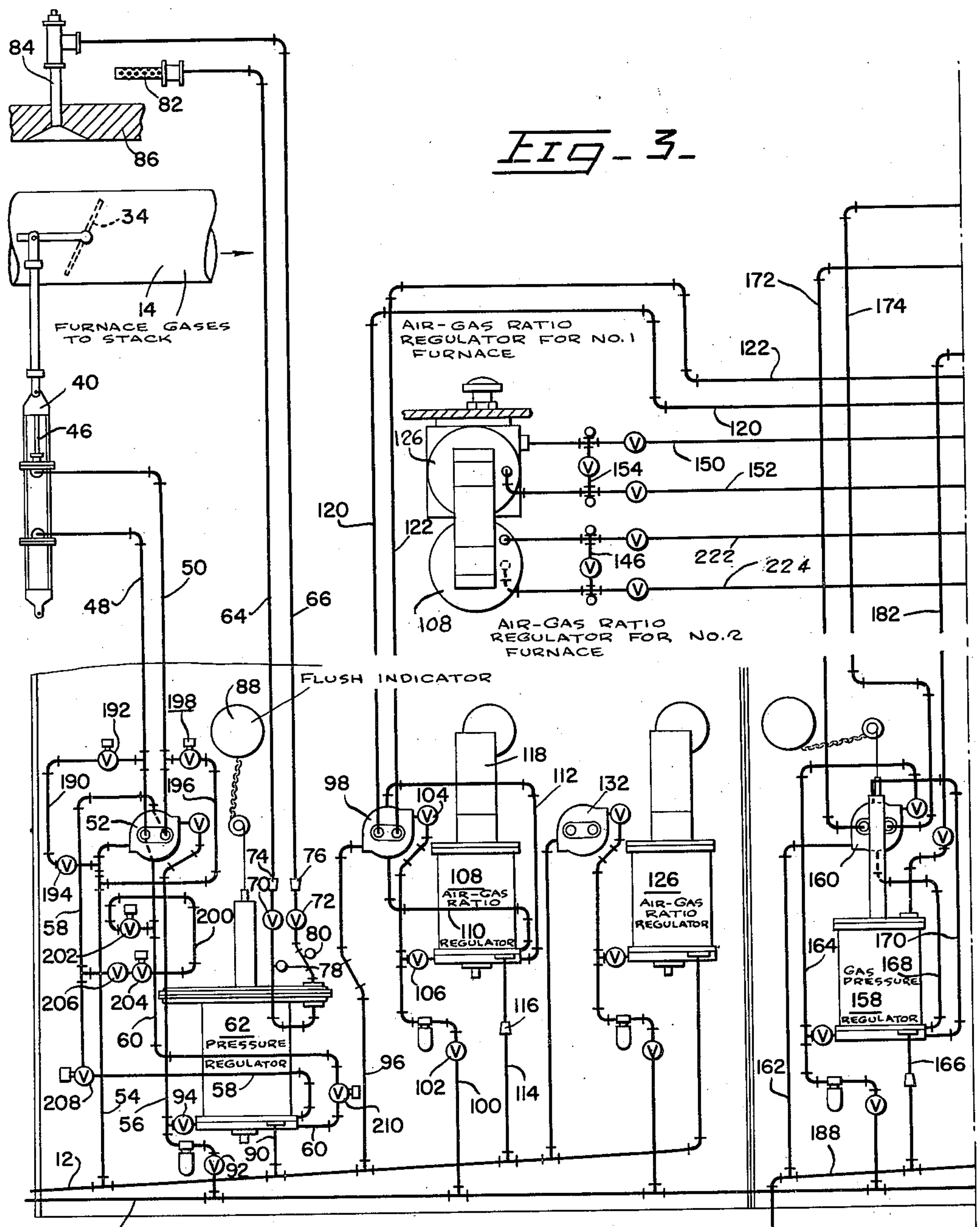

FIG. 1a

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LOW FUEL DAMPER CONTROL

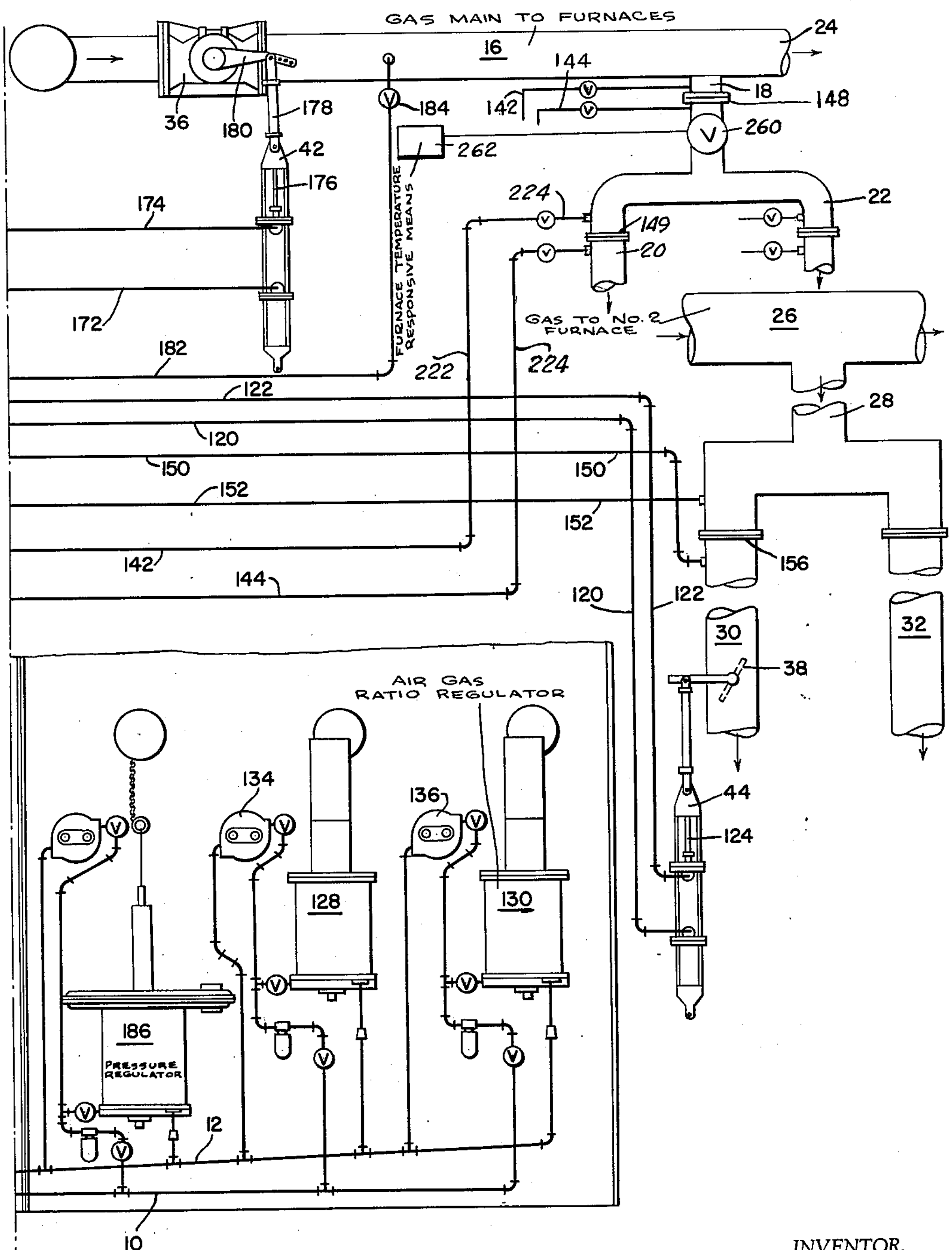

Fig. 1b.

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LOW FUEL DAMPER CONTROL

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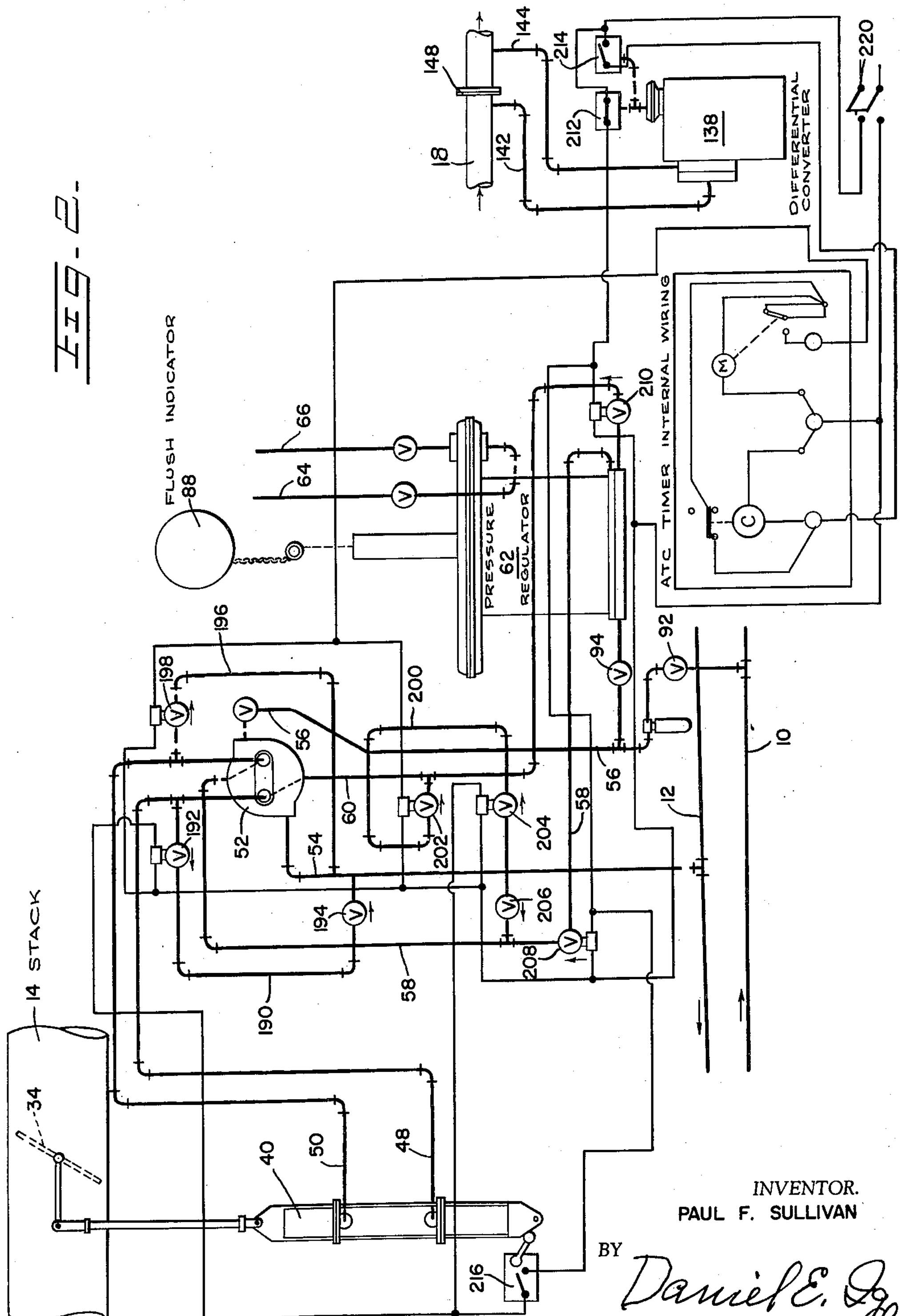

FIG-2.

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3,000,572
LOW FUEL DAMPER CONTROL

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6 Claims. (Cl. 236—15)

The present invention relates to a low fuel damper control, to be added to existing types of automatic pressure furnace control systems, and is particularly adapted for use with said existing systems of control for soaking pits and furnaces, and in stainless and clad heating.

An object of the invention is to provide an improved means for saving fuel which comprises a low fuel damper control system.

An additional object is to provide an automatic control system for the stack damper that may be installed in supplement to existing control systems used on furnaces and soaking pits to thereby provide a closer control of furnace atmospheres and to eliminate hot spots by maintaining more even temperatures throughout the operation of said soaking pits or furnaces.

Another object is to provide a system of the type set forth above for overcoming the limitations imposed by existing furnace control systems now in use on such furnaces and soaking pits, and particularly to maintain a close control of the stack damper of such furnaces or soaking pits when in closed or substantially closed position.

A further object is to provide a stack damper control which automatically takes control of the stack damper mechanism from the existing control mechanism when a predetermined point is reached in the closing movement of the stack damper.

Another object is to maintain in the operation of automatic pressure furnace control mechanism, a positive pressure in the pit or furnace to thereby eliminate cold air infiltration.

Yet another object is to provide a control which provides a more even distribution of the heat in the pit or furnace, and to prevent this heat from escaping out of the stack as wasted gas or fuel and heat.

Other objects will appear hereinafter throughout the specification.

Referring to the drawings,

FIGURE 1(*a*) is a partial schematic view of a system of furnace and soaking pit control of the present invention;

FIGURE 1(*b*) is a schematic view of the remainder of the furnace control mechanism;

FIGURE 2 is a view of the wiring system, and showing its connection to various parts of the furnace control mechanism; and

FIGURE 3 is a detailed bottom plan view of certain of the parts shown in FIGURE 1(*a*) and the connections thereto.

Soaking pits and furnaces are charged with various size ingots, ranging from sizes 29″ x 9″ x 60″ weighing 3500 lbs., to 108″ x 40″ x 123″ weighing up to 132,000 lbs. These are heated and soaked at temperatures ranging from 2100° F. to 2400° F., depending on the temperature required to roll the various types of steel ingots.

In order to perform this type of heating and soaking of steel ingots, a rather complex control system is installed on these soaking pits and furnaces to automatically control the temperature, and correct amount of fuel to air ratio for proper combustion. This control system includes automatic pressure control means to maintain a positive pressure in the pit or furnace, to eliminate cold air infiltration, and to give a more even distribution of

the heat in the pit or furnace, as well as to prevent the escape of this heat out of the stack as wasted heated gas or fuel.

Such loss is due to the limitations of existing automatic furnace pressure controls in use today, and this condition has made the present invention necessary. The invention therefore is a supplemental control whereby to improve the efficiency of existing control systems.

The control means of this invention, automatically takes over as the fuel is cut back by the existing automatic temperature control means during the period when the steel in the pit or furnace approaches the temperature control point. At this point in the heat, i.e. as the damper approaches its closed or nearly closed position, the position of adjustment of the stack damper is of prime importance, due to the fact that a small movement of the damper toward an opened or closed position, will mean the loss or gain of heat in the pit or furnace. When using present day systems of automatic furnace pressure control, this damper position at low flow, is strictly dependent upon the initial furnace pressure setting which has to be made when firing at high fuel rates. When firing at low fuel rates, however, this initial setting will only allow the damper to close to maintain the pressure at the pit or furnace required at high fuel rate. When using the control means of this invention, however, when the pit or furnace is firing at low fuel rate, the pressure will be increased substantially due to the modified regulation of the stack damper by said control means. This control means takes over the operation of the stack damper and moves the same to a position where it remains stationary until the controls come into operation to again open the damper and switch back to the conventional or existing automatic control means heretofore used.

The supplemental control means of this invention is installed to bring about a more positive control of the stack damper and in order to bring about this increase in furnace pressure, and the subsequent saving of fuel when firing at low fuel rates. Referring again to the conventional controls, such controls when firing at low fuel rate, do not substantially fully close the damper but cause the damper to continuously move toward opening and closing resulting in an operation termed "hunting." This will result over a given period of time in loss of heat and pressure in the furnace or pit. Such loss can only be made up by frequent increases of fuel and pressure in the furnace or pit as the furnace pressure regulator and the air and gas regulators are operated to make up for the loss of heat and pressure due to the continuous opening and closing movements of the stack damper when firing at low fuel rates when using the conventional control means. The fixed position of the stack damper at the lower fuel rates in its minimum position maintains fixed pressure and temperature conditions in the furnace or pit, without loss of heat and pressure through the stack. The control means of this invention, therefore, takes over the control of the stack damper when the furnace or pit temperature has reached the control point, i.e., when the heat and pressure of the furnace or pit would normally operate the conventional controls to change from high fuel rates to low fuel rates. In taking over the controls at low fuel rates the furnace pressure regulator is cut out of operation or "blocked" until high fuel rates are called for again as described hereinafter.

Referring to FIGURES 1(*a*) and 1(*b*), there is shown a typical control piping for ingot heating pits and furnaces, in which has been incorporated the supplemental control means of this invention. Such typical control piping includes furnace pressure control means as well as the stack damper control means and the furnace air inlet damper control means. The furnace temperature responsive means, hereinafter described, may be either the conventional pneumatic or the electric modulating control types.

Referring to the several figures of the drawings illustrating one embodiment of the invention, and in which like reference numerals indicate like parts, 10 is a pipe connected to a suitable fluid source such as a high pressure oil pump, not shown, and 12 is a pipe for conducting the fluid back to the reservoir, not shown, which will in turn be connected to the high pressure pump, in order to form a complete fluid cycle. The fluid may, of course, be either air, or oil or other liquid, as stated above, and it is used to operate the several moving parts of the apparatus, hereinafter to be described, and is not used as the source of furnace or soaking pit fuel.

As hereinafter described, a furnace will be referred to, it being understood that this term includes one or more furnaces or soaking pits. In practice a plurality of furnaces are simultaneously operated.

As shown, 14 indicates a conduit or stack for furnace gases, 16 a gas main for fuel gas, such as natural gas, having a side conduit 18 which has branch conduits 20 and 22, said conduits being connected to one of the furnaces, say No. 2 furnace. Gas is conducted to other side conduits, each having branch conduits, not shown, which convey gas to other furnaces of the plant, from the point 24 of main 16, as shown in FIGURE 1(*b*).

Air for No. 2 furnace is forced through conduit 26 by a blower, not shown, the said conduit having a side conduit 28 and branch conduits 30 and 32 leading to said furnace.

Air for other furnaces moves to the right from the point 26 to other furnaces of the plant.

Stack 14, gas conduit 16 and branch conduit 30 are provided with dampers 34, 36 and 38 respectively, each being automatically operated by the mechanism now to be described.

These dampers 34, 36 and 38 are each operated from open to closed position by power cylinders 40, 42 and 44 respectively.

Referring specifically to stack damper 34 and its power cylinder 40, this damper is opened and closed by movements of piston rod 46, which is moved by a piston, not shown, in cylinder 40. Movements in opposite directions of the piston are controlled by fluid from lines 48 and 50 that are connected to the cylinder on opposite sides of the piston in a conventional manner, and the other ends of these pipes are connected to the 6-way relay valve 52, referred to as a relay valve means in the appended claims.

Line 54 is directly connected to fluid outlet pipe 12, while line 56 is connected to the fluid inlet pipe 10, both lines having their opposite ends connected into 6-way valve 52. Other lines 58 and 60 are connected into this 6-way valve, and are connected to furnace pressure regulator 62.

Lines 64 and 66 are connected on opposite sides of the pressure regulator diaphragm, not shown, and are provided with valves 70, 72, reducers 74, 76 and tip-ended petcocks 78 and 80 respectively. Line 64 is provided with a connection 82 to the atmopshere, and line 66 is provided with a pipe connection 84 leading within the furnace wall 86 of say No. 2 furnace.

A flush indicator 88 is connected to the pressure regulator 62. There is a pipe connection 90 operatively connected to the pressure regulator and fluid outlet pipe 12. It will be further noted that line 56 has two branches, one connected to fluid inlet line 10, as previously described, and the other connected to the pressure regulator 62, each having valves 92 and 94 respectively.

Line 96 leads to fluid outlet 12 from a second 6-way valve 98, and line 100 leads through valve 102 to the other side of said second 6-way valve through another valve 104, there being a valved connection indicated at 106 leading to the air-gas ratio regulator 108 for No. 2 furnace, the latter being connected to the 6-way valve 98 by lines 110 and 112. Line 114 having reducer 116 connects regulator 108 to fluid pipe outlet. The air connection of regulator 108 is shown at 118. Lines 120 and 122 lead from 6-way valve 98 to the opposite sides of the piston, not shown, in power cylinder 44 whose piston rod 124 controls the damper 38 in branch air conduit 30.

Referring to FIGURES 1(*a*) and 1(*b*) numerals 126, 128 and 130 each indicate air-gas ratio regulators, having 6-way valves 132, 134 and 136 respectively. Each air-gas ratio regulator is the same as regulator 108 and its 6-way valve the same as 6-way valve 52.

It is to be understood that each air-gas ratio regulator and its 6-way valve is connected to a separate furnace. For each furnace there is one furnace pressure regulator and two fuel-air ratio regulators, one for each burner. Under normal practice there are usually two burners in a furnace. Pipe lines, not shown for the sake of clarity, are identical with the pipe line connections to 6-way valve 98, and air-gas ratio regulator 108, i.e., pipe line connections corresponding to lines 96, 100, 110, 112, 114, 120 and 122 with valves placed as in these lines, are provided for each air-gas ratio regulator and its 6-way valve, the same to be connected to a separate furnace.

The previously described gas-air ratio regulators 108, 126, 128 and 130 regulate the amount of air for each burner. FIGURE 3 shows a top plan view of fuel-air ratio regulator 108.

Regulator 108 has lines 222 and 224 connected to each other by a valved cross line 146. As seen in FIGURE 1(*b*) branch conduit 20 is provided with an orifice 149, the lines 222 and 224 being connected to side conduit 20 on either side of said orifice 149.

As seen in FIGURES 1(*b*) and 2, side conduit 18 has an orifice 148 on opposite sides of which are lines 142 and 144 that connect to the gas regulator 138 shown in FIGURE 2.

Regulator 108 is provided with lines 150 and 152 having a valved cross line 154. Lines 150 and 152 are connected into air branch conduit 30 on opposite sides of orifice 156.

Gas pressure regulator 158 is connected to 6-way valve 160, and to fluid inlet and outlets 10 and 188 respectively by lines 162, 164, 166, 168 and 170, and the 6-way valve is connected to opposite sides of the piston, not shown, of power cylinder 42, by lines 172, 174. The piston is provided with a piston rod 176. This rod is connected to clevis 178 that is mounted on arm 180, the arm being operatively connected to a valve, not shown, in gas main 16. This gas main is also connected by a pipe line 182 having a valve 184 directly to 6-way valve 160. Drain line 188 is connected so as to drain fluid into the same reservoir as line 12.

Furnace pressure regulator 186 is connected to a separate furnace than furnace regulator 62, and is connected into the system in the same manner as furnace pressure regulator 62, except as stated hereinafter.

Due to heat and pressure conditions within the pit or furnace, it becomes necessary to accurately control the stack damper so that it is not allowed to open from its substantially closed position when firing at low fuel rates as noted herein. When the low point is reached the damper must be held in a fixed position wherein it is closed to the point of maximum prevention of heat and pressure losses and is so maintained while the furnace is still in operation. Additionally, as explained in prior art structures, the setting of the damper has heretofore been strictly dependent upon initial furnace pressure setting, this setting having been made or adjusted in accordance with maximum operation, i.e., high fuel rates. In the present invention, the supplementary control system takes over when a point has been reached as the fuel intake is cut back, whereby to more accurately position and hold the damper in a fixed position at low fuel rates to conserve heat and pressure in the pit or furnace. When the control point has been reached and the stack damper has been moved to a fixed stationary setting that provides a small enough opening to maintain pressures in the furnace or furnaces which are higher than the furnace pressure regulating means heretofore used maintains while the furnace is being brought up to its control point, the said damper is then in a semi-closed position. The term semi-closed position in the claims, therefore, indicates the position of the stack damper under these conditions wherein a small opening is provided, as illustrated in FIGURE 2.

The system described above represents a typical control system provided with fuel-air ratio control mechanism. Each furnace has its own pressure regulator, such as shown at **62** or **186**. This is provided to mtaintain a constant pressure condition within the furnace. Each pressure regulator consists essentially of a spring-balanced sensitive diaphragm to which is connected a spinning and vibrating type valve. When the diaphragm is in its neutral or mid position, the relay valve is so adjusted that is also is in its neutral or mid position. The diaphragm is sensitive to furnace pressure which is balanced by an adjustable spring tension. This spring tension is so adjusted as to balance the furnace pressure when the diaphragrm is in its neutral position, and any variation from the set value will move the diaphragm and hence the relay valve so as to direct high pressure to one or the other end of a double ended power cylinder operating the stack damper. The direction in which the relay valve operates to move the stack damper will be in such manner as to restore furnace conditions to the proper value. When conditions are restored, the diaphragm and relay valve will again be in neutral position, and the stack damper will be stationary. The relay valve exhausts fluids, such as oil at either end depending upon the direction of movement of the power cylinder piston. Its function is to connect high pressure oil to one end of the cylinder and exhaust oil at the other end thereof.

When the piston moves in the opposite direction, high pressure and exhaust ports are reversed by the relay valve, such as shown at **52** in FIGURE 1(*a*). When in neutral, the valve will show a slight discharge from the top and bottom ports. Oil exhausted by the relay valve, is discharged inside the regulator **62** and flows through a drain line **90** through line **12** to the oil reservoir.

The use of a typical control including a fuel-air ratio control system and an automatic furnace pressure control system lacks complete control of the stack damper when firing at low fuel rates, inasmuch as the initial setting which has to be made when firing at high fuel rates does not function well when firing at low fuel rates. This invention is utilized to prevent hunting and to bring about an increase in furnace pressure due to a more positive control of the stack damper **34** to thereby eliminate the loss of heat out of, or emitted from the stack during low fuel rates.

The above system has been referred to as the "primary control system" and the additional parts described hereinafter are referred to as the "supplementary control system" in the claims.

The invention consists of additional piping connections between the 6-way valve **52** and the furnace pressure regulator **62**, having metering valves and solenoid valves. A typical installation would include two metering valves, and six 3-way solenoid valves in the hydraulic lines or air lines, depending upon the type controls existing upon the particular pit or furnace. The following description is in no way intended to limit the number or type of valves used.

Referring to FIGURE 1(*a*), pipe **48** is interconnected with pipe **54** in such manner as to by-pass 6-way valve **52**, by providing a branch line **190**, having a solenoid actuated valve **192** and a metering valve **194**. Branch line **196** is also added by connecting this line to pipe **50**

and to pipe **54**, also by-passing 6-way valve **52**. Branch line **196** has a solenoid actuated valve **198**.

It will be noted that each branch line is connected to pipes **48** and **50** leading to power cylinder **40** from 6-way valve **52**, that each branch line by-passes the valve **52**, and that each is connected to the same line **54** that connects with outlet or drain pipe **12**.

A third branch line **200** connects lines **58** and **60** to each other, this line being provided with solenoid actuated valves **202** and **204** and a metering valve **206**.

In addition to these lines and valves, lines **58** and **60** are provided with a solenoid actuated valve **208** and **210** respectively.

Referring to FIGURE 2 which shows in full lines the stack damper and power cylinder connected thereto, together with the switch actuated thereby and other parts of the control system and the various electrical circuit connections thereto, the current supply line, and the switch therefor is indicated generally by the numeral **220**.

This line is connected to the pressure control switches **212** and **214**. The ATC timer **218** shown in this figure is connected into the circuit and to the damper limit switch **216**. This switch is opened by the downward movement of the power cylinder **40** that is connected into the circuit. It will be noted that "C" stands for clutch solenoid and "M" stands for electric motor of a conventional timer such as Series 305 made by the Automtaic Temperature Control Company, Inc., as shown in FIG. 2.

Operation

As has been set forth herein, the present invention is an addition to existing systems of control for soaking pits or furnaces, whose principal object is to improve the operation and efficiency of such soaking pits and furnace controls by saving fuel and heat losses when operating at low fuel. Before the supplemental system starts its operation, the amount of fuel fed to the furnaces must have been reduced (by the conventional controls for controlling heat and pressure in the furnaces) to a point sufficient to show that the temperature of the furnaces and pressure has reached its set control point. When the control point has been reach, the stack damper is moved to a fixed stationary setting which provides an opening small enough to maintain pressures in the furnaces that are higher than the pressure which the furnace pressure regulating means heretofore used maintains while the furnace is being brought up to its control point.

The furnace or soaking pit will operate on normal automatic furnace pressure control until the soaking pit or furnace temperature has reached the control point. When this control point is reached, the gas flow will cut back gradually, and when the gas flow has reached a predetermined value, measured by the gas orifice **148** as seen in FIGURE 1*b*, the low fuel damper control means of this invention takes over. As in existing automatic furnace controls of the type for controlling soaking pits and furnaces, the stack damper **14** is at all times under the control of the combined electrical control means heretofore described, that includes the power cylinder **40**, valve **52**, and the electrical circuit with its solenoid valves. The conventional control means does not include, however, the additional control means as exemplified by the solenoid valves, such as the ones indicated by numerals **198**, **202**, **206**, **208** and **210**, and the circuit means connecting the valves into the conventional electrical circuit. At this time the differential converter **138** of FIGURE 2 closes the pressure control switch **212**, energizing or closing the solenoid valves **208** and **210** thus shutting off the operation of the furnace pressure regulator **62**. The closing of the pressure control switch of the normal automatic furnace control, and the closing of its switch **212** also energizes or opens solenoid valves **192** and **204**, thus forcing power cylinder **40** downwardly to slowly close the stack chamber **34**. The speed of this closing is determined by the adjustment of the degree of opening of the two metering valves 194 and 206. When the stack damper has closed as far as is practical, with the power cylinder 40 moving downwardly, said power cylinder opens the stack damper limit switch 216, deenergizing or closing solenoid valves 192 and 204 and locking the stack damper 34 in this position.

At this point, heat loss from the stack is cut to a minimum, and the temperature of the soaking pit or furnace is increased, while at the same time the fuel flow through the side conduit 18 which connects to gas main 16 is substantially reduced. The stack damper 34 will remain in this position until the temperature control calls for more gas, this resulting from the pressure differential that is established across the gas orifice 148 at side conduit 18. At this time the differential converter 138 closes pressure-operated switch 214, starting the ATC switch timer which, in turn, energizes or opens solenoid valves 198 and 202. This action drives the power cylinder 40 in the opposite direction, or in an upward direction, as seen in FIGURE 2, the degree of opening of the stack damper being determined by the number of seconds set on the ATC timer. At this time also the stack damper limit switch 216 is automatically closed. As soon as the ATC timer has timed out, solenoid valves 198 and 202 become deenergized or closed. At the same time, the gas flow has exceeded the predetermined value set on the differential converter 138, which thereupon opens pressure control switch 212, deenergizing or opening solenoid valves 208 and 210. This action automatically places the soaking pit or furnace on normal operating furnace control again.

This invention adds the following elements to known apparatus for controlling the position of the stack damper 34, namely, the pairs of solenoid valves 198, 202; 192, 204; and 208 and 210, damper limit switch 216, pressure operated switches 212, 214, ATC timer 218, metering valves, 194, 206, and the wiring connections to these parts as shown in the drawings, also regulator 138.

Solenoid switches 208, 210 are normally open; switches 192, 204 are normally closed; and switches 198, 202 are normally closed, i.e. when operating at high fuel rates and when the fuel rate is gradually being cut down until the control point is reached, whereupon the position of these switches is reversed. While valves 198 and 202 are normally closed up to the time the control point has been reached, these valves momentarily open on fluid flow increase.

The control point is reached as the fuel flow through conduits 16 and 20 becomes lower as controlled by valve 36 as governed by the conventional controls that are connected to the several furnaces such as shown at 82, 84 that connect furnace 86 to furnace pressure regulator 62, see FIGURE 1(*a*). When the control point has been reached, measured by gas orifice 148, differential converter 138 (which has been added to the conventional system) is operated to close pressure switch 212 and open pressure switch 214, whereupon solenoid valves 208 and 210 are energized to close them and to open valves 192 and 204, to by-pass furnace pressure regulator 62, the fluid from fluid lines passing through valve 52 so as to permit passage of fluid through conduit 50 into the upper portion of power cylinder 40 above its piston, and exhaust fluid below the cylinder through pipe 48 and valve 52 to pipe 54 to exhaust pipe 12. Valves 198 and 202 are normally closed but are opened upon the timing out of timer 218.

It will be noted at this time, i. e., when the control point has been reached, that conventional furnace pressure regulator 62 has been cut out of operation for controlling damper 34, and differential converter 138 has taken its place in controlling the position of the stack damper 34. This control is also taken over by the stack limit switch 216, for as the power cylinder reaches the limit of its downward travel, it operates limit switch 216,

thereby closing solenoid valves 192 and 204, that locks the stack damper 34 in its maximum closing position.

Atcotrol timer 218 is of the type No. 305 shown in the description bulletin Form IN–140 (Temporary) published by the Automatic Temperature Control Co., Inc. of Philadelphia, Pennsylvania.

The furnace pressure regulators are supplied by the Hagan Corporation of Pittsburgh, Pennsylvania and are illustrated in Bulletin DR–36 and Bulletin MYP–510 of that corporation.

The flush indicator noted at 88 is conventional and permits adjustment of the furnace pressure regulator 62 and others.

It will be noted that when an impulse is received in the differential converter 138 due to the drop in pressure across the gas orifice 148, the differential converter operates to close switch 212 and open switch 214 and also is governed by the amount of gas at orifice 148. Following the operation at low fuel rates, the additional gas flow as governed by the temperature control (not shown) will cause a difference in pressure in the differential converter 138 to close the switch 214 and open the switch 212. The closing of the switch 214 and opening of switch 212 starts the timer 218. This energizes solenoid valves 198 and 202 to permit fluid to flow beneath the piston to cause the piston rod 46 to move upwardly and cause exit of fluid through pipe 50 above the piston, whereby the stack damper 34 is moved to open position. When the switch 212 opens and switch 214 closes, the higher rate of fuel operation takes place again, restoring the normal operation of the parts and placing the furnace pressure regulator back in operation. At this time the timer 218 has run out and stopped.

The above description and drawings disclose a single embodiment of the invention, and specific language has been employed in describing the several figures. It will, nevertheless, be understood that no limitations of the scope of the invention are thereby contemplated, and that various alterations and modifications may be made such as would occur to one skilled in the art to which the invention relates.

I claim:

1. A control mechanism for a soaking pit or furnace control comprising a primary control system including a source of gas fuel having a main conduit means, damper means for said conduit, means for controlling said damper means, an air conduit means, a damper means in said air conduit means, and means for controlling said damper means in said air conduit means, stack means connected to said soaking pit or furnace, stack damper means in said stack means, and means for controlling said stack damper means, said several control means including air to gas ratio regulating means, furnace pressure regulating means, a hydraulic circuit connected to each of said damped controlling means, and relay valve means in said hydraulic circuit: the combination with said primary control system of a supplementary control system for taking over the control of said stack damper controlling means when the gas flow in said main conduit has been reduced to a point sufficiently low and to a point where the furnace temperature has reached a set control position and wherein said stack damper has reached a predermined point in its closing movement as actuated by said primary control system, said supplementary control system having a fluid control means and electrical means interconnected with said primary control system including a plurality of electrically actuated valves for controlling the flow of fluid in said hydraulic circuit to said relay valve means and from said relay valve means to said stack damper control means to thereby hold said stack damper in fixed semi-closed position, said valves being connected to said electrical means, whereby to increase and maintain positive pressure in the furnace when firing at low fuel rates.

2. A control mechanism for a soaking pit or furnace control comprising a primary control system, a main fuel

conduit, damper means for said conduit, control means for said damper means, stack means connected to said soaking pit or furnace, stack damper means in said stack means, a hydraulic circuit connected to each of said damper controlling means, and relay valve means in said hydraulic circuit: the combination with said primary control system of a supplementary control system for taking over the control of said stack damper controlling means when the gas flow in said main conduit has been reduced to a point sufficiently low and to a point where the furnace temperature has reached a set control position and wherein said stack damper has reached a predetermined point in its closing movement as actuated by said primary control system, said supplementary control system having a fluid control means and electrical means interconnected with said primary control system including a plurality of electrically actuated valves for controlling the flow of fluid in said hydraulic circuit to said relay valve means and from said relay valve means to said stack damper control means to thereby hold said stack damper in fixed semi-closed position, said valves being connected to said electrical means, whereby to increase and maintain positive pressure in the furnace when firing at low fuel rates.

3. The structure of claim 2 wherein said supplementary control system includes timer means, a pressure operated switch, and wiring connecting the timer means to certain of said solenoid operated valves whereby to operate said damper control means to restore said stack damper to open position.

4. The structure of claim 3 wherein said supplementary control system includes a differential converter, said electrical means including means electrically connecting said differential converter to said timer means, conduit means connecting said differential converter to said main conduit means, and switch means forming part of said electrical means and connected to said differential converter.

5. The structure of claim 4 wherein said switch means includes a plurality of pressure-operated switches and means connecting said switches to said differential converter, whereby one of said switches is closed under low pressure conditions and another switch is opened under said conditions, and whereby the operation of said switches is reversed under high pressure conditions, both within said differential converter.

6. The structure of claim 2 wherein said supplementary control system includes timer means and supplemental switch means therefor electrically connected to said electrical means for controlling the operation of at least some of said electrically actuated valves whereby when conditions require firing at higher rates said supplemental switch means operates to start said timer to thereby restore said stack damper to open position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,266,871	Krogh	Dec. 23, 1941
2,567,892	Osterman	Sept. 11, 1951
2,612,319	Wadenstein	Sept. 30, 1952
2,698,717	Sisco	Jan. 4, 1955
2,788,175	Bourek et al.	Apr. 9, 1957

OTHER REFERENCES

Stone: pages 161–163 of Metallurgia for July 1948.

Flagg: pages 59–63 of Iron and Steel Engineer for October 1948.

Lancaster: pages 69–76 of Iron and Steel Engineer for December 1953.