

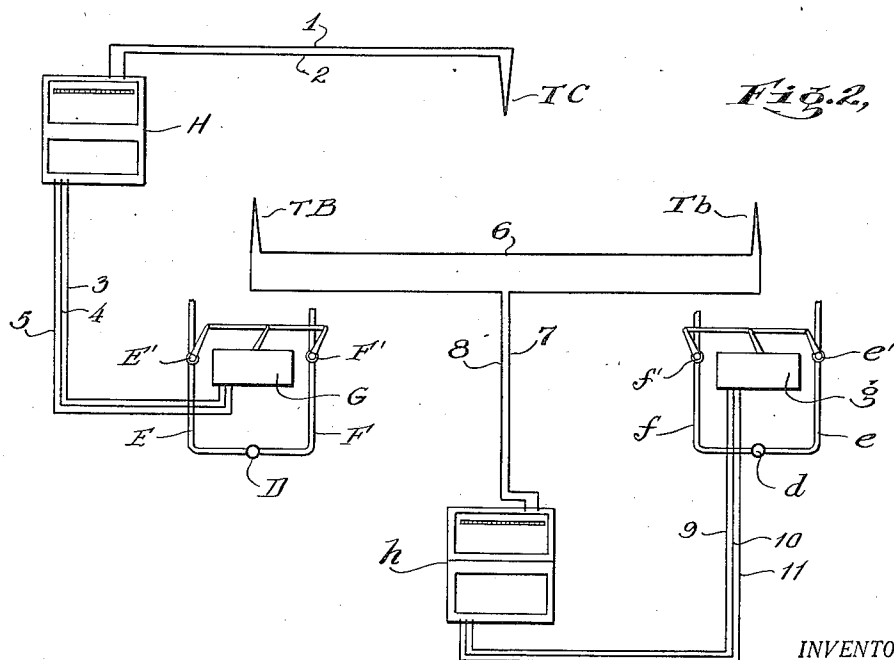
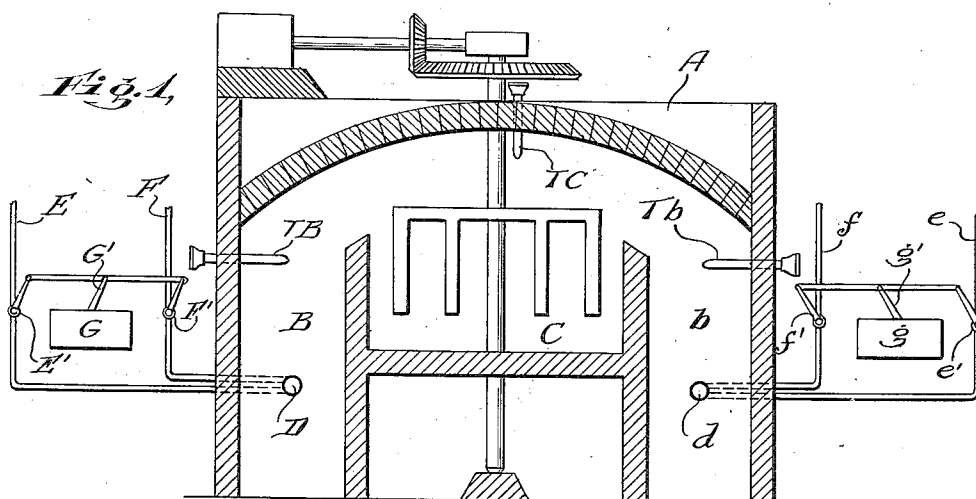
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1,603,729

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FURNACE CONTROL

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FURNACE CONTROL.

Application filed December 31, 1925. Serial No. 78,548.

My present invention consists in a novel method of and apparatus for controlling the supply of heat to a metallurgical or other furnace comprising a plurality of combustion chambers. The general object of the invention is to provide for the automatic control of the supply of heat by the different combustion chambers in a furnace of the character described in such manner as to maintain the desired general or working temperature of the furnace, while at the same time avoiding undesirable variations between the temperatures in the different combustion chambers, and in particular while avoiding excessive temperatures in either combustion chamber.

The invention is characterized by the fact that the rate of combustion in one or more of the combustion chambers is directly controlled by means automatically responsive to the general or working temperature of the furnace, while the rate of combustion in the other chamber or chambers is made automatically responsive to the difference between the temperatures in the last mentioned combustion chamber or chambers and in the combustion chamber or chambers in which the rate of combustion is varied in direct response to the general or working temperature of the furnace.

In controlling the rates of combustion in the different combustion chambers as described, the time lag between changes in the rates of combustion and the resultant changes in furnace temperature and the time lag in the operation of the controlling provisions contribute to a regulation in which the hunting tendency of the general furnace or working temperature is minimized, while at the same time the maximum difference between temperatures in the different combustion chambers are kept smaller than those experienced with existing control system comprising provisions intended to simultaneously vary the rate of combustion in each of the different combustion chambers of the furnace as required to maintain the desired general or working furnace temperature.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention,

however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have somewhat diagrammatically illustrated a preferred embodiment of the invention.

Of the drawings:

Fig. 1 is a cross section of a furnace; and

Fig. 2 is a diagrammatic representation of the control provisions employed with the furnace shown in Fig. 1.

In the drawings A represents a furnace comprising two combustion chambers B and b each supplying heat to a working chamber C. The furnace A in the particular form conventionally shown in the drawing, is a so-called mechanical furnace employed in the manufacture of litharge, but the invention is applicable to a furnace of any type comprising a plurality of combustion chambers for supplying the furnace heat requirements. As shown, D and d represent fluid fuel burners for heating the chambers B and b, respectively. The burner D receives oil or other fluid fuel and air for its combustion through pipes E and F, respectively. The fuel supply pipe E contains a regulating valve E' and the air pipe F contains a regulating valve or cock F'. Similarly the burner d receives fuel through a pipe e having a controlling valve e', and receives air for combustion through a pipe f controlled by a valve f'. The supply of fuel and air to the burner D is directly controlled by a regulator G including an operating arm G' connected to the operating arms of the corresponding valves E' and F', and the supply of fuel and air to the burner d is directly controlled in the same manner by a regulator g which may be exactly like the regulator G, and has an operating arm g' connected to the operating arms of valves e' and f'.

The regulator G is adjusted to increase or decrease the rate of combustion in the combustion chamber B as the temperature in the working chamber C falls below or rises above a predetermined temperature by means shown as comprising a thermo-couple TC and a control instrument H, the latter being connected by conductors 1 and 2 to the thermo-couple, and connected by conductors 3, 4 and 5 to the regulator G.

The regulator g increases and decreases

the rate of combustion in the combustion chamber *b* as the difference between the temperatures in the combustion chambers B and *b* increases and diminishes. To this end I provide thermo-couples TB and T*b* responsive, respectively, to the temperatures in the combustion chambers B and *b*, and connect these thermo-couples as by conductors 6, 7 and 8 to a control instrument *h* which, through conductors 9, 10 and 11 energizes the regulator *g* to increase the rate of supply to burner *d* of fuel and air for its combustion when the temperature of the thermo-couples T*b* is below that of the thermo-couple TB, and to decrease the rate of fuel and air supply to the burner *d* when the temperature of thermo-couple T*b* is higher than the temperature of thermo-couple TB. The thermo-couples TB and T*b* are shown as connected in series to buck one another so that the voltage impressed by them on the instrument is proportional to the difference between the voltages of the two thermo-couples. As already stated, the regulator *g* may be identical with the regulator G, and the control instrument *h* may be identical with the control instrument H.

The control instruments H and *h* ordinarily will each comprise a galvanometer responding to the voltage of the corresponding thermo-couple, and the regulators G and *g* ordinarily will each include a reversible relay motor, the energization of which is regulated by the corresponding control instrument, but further description or illustration of the control instruments and regulators is unnecessary, as these devices may be of well known type. For example, the control instruments may be of the type disclosed in Patent No. 1,355,448, granted October 12, 1920, and the regulators may be of the type disclosed in Patent No. 1,397,680, granted November 22, 1921.

With the apparatus arranged and operating as described, on any decrease in the furnace working temperature below the predetermined value, the thermo-couple TC, control instrument H, and regulator G cooperate to adjust the valves E' and F' as required to increase the rate of combustion in the combustion chamber B. Some of the heat generated, as the rate of combustion is thus increased, passes directly into the working chamber C, but a portion is absorbed by and stored up in the walls of the combustion chamber B, the temperature of which increases as the rate of combustion in the chamber is increased. Following the resultant increase in the temperature of the thermo-couple TB above that of the thermo-couple T*b*, the rate of combustion in the chamber *b* is correspondingly increased. In general, however, the absorption of heat by the walls of the chamber B, coupled with the natural time lag in the operation of the

control instruments, prevents any increase in the rate of combustion in the chamber *b* until some time after the rate of combustion in the chamber B has been increased. Under normal operating conditions, therefore, the temperature of the working chamber C will rise to its predetermined normal value, and the rate of combustion in the chamber B will be diminished before the temperature of the walls of the combustion chamber *b* have risen to an equality with the temperature of the walls of the chamber B. In consequence, with the method of control described herein, the maximum average of the temperatures of the walls of the two chambers B and *b* under ordinary operating conditions will be lower than it would be if the rates of combustion in the two chambers were simultaneously increased when the temperature in the chamber C fell below normal and were simultaneously diminished when that temperature rose above normal.

This is an important characteristic of the invention, because when the rate of combustion in either combustion chamber after being above normal for a period again becomes normal, or less than normal, the rate of heat transfer from the combustion chamber to the working chamber continues to be above the normal rate for some time, as a result of the heat stored in, and the high temperature of the combustion chamber walls. Under normal operating conditions, therefore, the rise above normal of the temperature in the chamber C occurring after the rate of combustion in the chamber B is reduced, will be less marked with the described method of control, than with a method of control which results in heating the walls of the combustion chamber *b* to the same temperature as the walls of the chamber B at the instant at which the temperature in the chamber C rises to normal and the rate of combustion in each combustion chamber is diminished, notwithstanding the fact that with the described method of control combustion, the increased rate may continue in the chamber *b* for some time after the temperature in the chamber C attains its normal value. The mode of control herein described tends, therefore, to a reduction in the tendency to a fluctuation or hunting of the temperature in the chamber C, a tendency which inevitably exists with any practical mode of automatic temperature control.

Furthermore, the control of combustion in the chamber *b*, while dependent on the difference between the temperatures in the chamber B and *b*, prevents such temperature difference from being as great as occasionally occurs in practice when it is attempted to directly regulate the combustion in both combustion chambers in direct response to the working chamber temperature. The in-

vention, therefore, contributes not only to a better regulation of the working chamber temperature, but also to a better distribution of the load borne by the two combustion chambers, and in particular, to the avoidance of a maximum temperature in either combustion chamber which is as high as the maximum occasionally obtained with prior modes of control. The reduction in maximum combustion chamber temperature is highly important because it is the maximum temperature and not the average temperature which ordinarily causes combustion chamber walls to be injured by overheating. Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In controlling the temperature of a furnace comprising a working chamber and a plurality of combustion chambers supplying heat to said working chamber, the method which consists in increasing and decreasing the rate of combustion in one of said combustion chambers as the working chamber temperature falls and rises, and increasing and decreasing the rate of combustion in another of said combustion chambers as the temperature thereof falls and rises relative to the temperature in said one combustion chamber.

2. The combination with a furnace comprising a working chamber and two combustion chambers supplying heat to the working chamber, of means responsive to the temperature in the working chamber for

increasing and decreasing the rate of combustion in one of the combustion chambers as the working chamber temperature falls and rises, and means regulating the rate of combustion in the other combustion chamber in response to the difference between the temperatures in the two combustion chambers and tending to increase and decrease the rate of combustion in said other combustion chamber as the temperature in said one combustion chamber rises and falls.

3. The combination with a furnace comprising a working chamber and two combustion chambers supplying heat to the working chamber, of a thermo-couple responsive to the working chamber temperature, means controlled by said thermo-couple for increasing and decreasing the rate of combustion in one of said combustion chambers as the furnace chamber temperature falls and rises, two thermo-couples, one responsive to the temperature of one, and the other to the temperature of the second of said combustion chambers, and means jointly controlled by the last mentioned thermo-couples for increasing and decreasing the rate of combustion in the second combustion chamber as the temperature in said one combustion chamber rises and falls relative to the temperature in said second combustion chamber.

Signed at Philadelphia, in the county of Philadelphia, and State of Pennsylvania, this 29th day of December, A. D. 1925.

CHRISTIAN WILHJELM.