

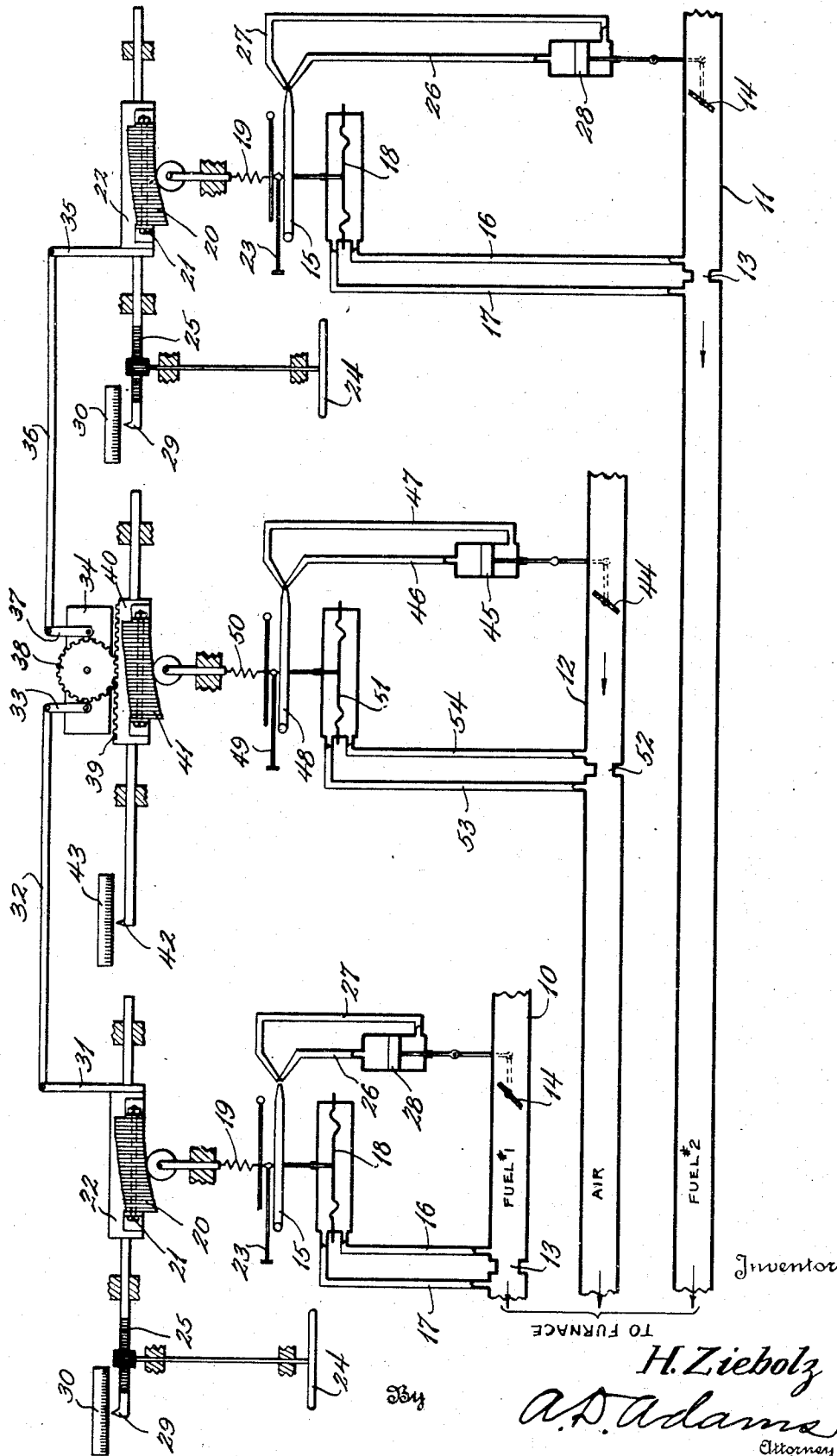
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FLOW PROPORTIONING APPARATUS

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FLOW PROPORTIONING APPARATUS

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This invention relates to improved apparatus for proportioning and controlling the supply of combustion air to a furnace supplied with a plurality of fuels. Heretofore, it has been suggested that rates of fuel flow be summarized by means of fuel flow meters or by pilot air flows which are directly proportional to the individual B. t. u. rates of fuel flow and the total air proportioned to the sum of the individual fuel flows in terms of their heating values. The design of such mechanisms is based on the fact that a definite amount of air is required for theoretically complete combustion of a given quantity of fuel in terms of its B. t. u. value. In the operation of industrial furnaces or boiler furnaces a number of factors must be taken into consideration which render the supply of the calculated or exact amount of air necessary for theoretically complete combustion, improper. Such factors do not vary as a direct function of the rate of fuel flow but present different values at different rates of fuel flow. Some of these factors are, for example, air used to atomize liquid fuels or primary air used for conveying pulverized fuel, which air is not subject to control by the well known air control apparatus. Such factors may be termed "burner factors." The calculated amount of air, which would be supplied by the control apparatus to support theoretically complete combustion of a single fuel, modified by the amount of air which finds its way into the burner installation by reason of these factors, is referred to herein as "compensated air requirements" of that fuel. If more than one fuel is supplied, the calculated amount of air which would be supplied by the control apparatus to support theoretically complete combustion of the plurality of fuels, modified by the amount of air which finds its way into the burner installation, as a result of the feeding of more than one fuel, is referred to herein as "totalized compensated air requirements" for the fuels. Further correction factors may be necessary in any furnace installation to take into account infiltration of air into the furnace, other sources of air of determinable amounts admitted to the furnace, or the desired condition of the furnace atmosphere. All of these factors are subject to variations which are not direct functions of the rate of total fuel supply. They may be termed furnace factors. These furnace factors may require further adjustment in the "total compensated air requirements" called for by the fuels. The total compensated air requirements, thus modified by these furnace factors, is herein termed "adjusted total air requirements."

It is therefore a more specific object of this invention to provide a control system wherein at least two separate fuel regulators are adapted to be manually adjusted so that the movements of the adjusting means are directly proportional to the compensated air requirements necessary to support complete combustion of the respective fuels in a burner installation and summarizing means is connected through a regulator to control the flow of air in accordance with the adjusted total air requirements of the fuels.

This invention involves certain improvements over my copending application, Ser. No. 401,666, filed July 9, 1941.

Other aims and advantages of the invention will appear in the specification, when considered in connection with the accompanying drawing, wherein the figure is a diagrammatic illustration of one form of apparatus embodying the invention applied to the control of air of two fluid fuels.

Referring particularly to the drawing, the control mechanism is shown as being applied to control the amount of combustion supporting air in proportion to the adjusted total air requirements of two separate fuels of different character flowing through individual conduits 10 and 11. The combustion air is supplied for both fuels through a single conduit 12, and all of the conduits lead to a furnace, not shown. The fuels may be fuel oil or blast furnace gas and coke oven gas, the flows of which are separately and manually adjusted and maintained constant by means of suitable regulators or automatic control devices. The purpose is to enable an operator to set the fuel regulators in accordance with any desired ratio of the fuels required to meet the heat demand or the desired heat input of the furnace and to proportion the flow of air, taking into account the variable burner and furnace factors. In other words, he can control the quantity flows according to the cost or availability of the respective fuels.

The conduits 10 and 11 are each shown as having a constriction 13 and a butterfly control valve 14, the position of which is adapted to be automatically varied and the flow maintained by a jet pipe regulator 15, here shown as being of the well known hydraulic type. A pair of pipes 16 and 17 are connected to opposite sides of the constriction and lead to opposite sides of a diaphragm 18 connected to act on one side of the pivoted jet pipe 15. The force exerted by the diaphragm acts in opposition to a spring 19, the compression of which is controlled by a cam 20 of variable contour. The cam is shown as being composed of a multiplicity

of relatively adjustable, slotted pieces clamped together by a bolt 21 secured to a carriage 22 which is slidably mounted in fixed bearings. The contour of each cam is adjusted or changed to take into account variable burner factors, such as air admitted with the respective fuel, so that the adjusting movement of the cam is directly proportional to the compensated air requirements necessary to support complete combustion of the particular fuel at any adjusted constant rate of flow.

Each regulator has a ratio slider 23 which may be employed to vary the ratio between the compensated air requirements and the flow of the particular fuel in accordance with variations in the density, chemical analysis and viscosity of the fuel, as well as other factors. The force exerted on the jet pipe by the fuel flow impulses acting on the diaphragm, due to the differential pressure on opposite sides of the constriction 13, is always counterbalanced by the force of the spring to restore the jet pipe to neutral position and maintain the flow of fuel constant. The carriages 22 on which the cams 20 are mounted, are each adapted to be adjusted longitudinally by means of a hand wheel 24 carrying a pinion meshing with a rack 25 connected to the carriage. Of course, the manual adjustment may be effected in any one of a number of ways.

Each cam 20 is set so that its position corresponds with the compensated air flow requirements for the respective fuels supplied at any desired constant rate and the rate of flow of the fuel is maintained by the regulator, the jet pipe of which acts through a pair of pipes 26 and 27 on the piston 28 of a servo-motor connected to the butterfly valve 14 to control the position of the valve. The adjusted position or manual setting of the cam is indicated by means of a pointer 29 cooperating with a scale 30 reading in terms of the compensated air requirements for the fuel or fuel rate. The left hand carriage 22 is shown as being connected by means of an arm 31 and link 32 to a crank arm 33 mounted on one shaft of a differential gear 34. The right hand carriage is also shown as being connected by means of an arm 35 and link 36 to a crank arm 37 mounted on a second shaft of the differential gear 34. Such a differential gear is shown in detail in my aforesaid application. As explained in the aforesaid application, the differential gear summarizes the adjusting movements of the two cams and the sum of these movements is imparted through it to a spur gear 38 which operates a rack 39 on a slidable carriage 40, similar to the carriages 22. The carriage 40 also carries a loading cam 41 made like the cams 20 which is shaped to proportion the supply of air in accordance with the movements imparted to it and also to take into account total air infiltration in the furnace. In other words, it is shaped so that it calls for the necessary adjusted total air requirements for each increment of change in its total movement. The carriage 40 operates a pointer 42 cooperating with a scale 43, to indicate the sum of the compensated total air requirements of the separate fuels, because the movement imparted to the gear 38 and, through it, to the cam 41, is the sum of the movements imparted by the separate cams 20 through the differential gear 34.

The air conduit 12 is shown as having a control valve 44 operated by the piston of the servo-motor 45, which is actuated by jet pipe fluid passing through receiving pipes 46 and 47 from a jet

pipe 48, having a ratio slider 49 and a spring 50 acting on one side to counteract the pressure on the opposite side exerted by a diaphragm 51 which is operated by impulses received from opposite sides of a construction 52 and transmitted to the diaphragm chamber through pipes 53 and 54. As the spring 50 is compressed by the movement of the cam to the right, the jet pipe 48 turns clockwise and thereby causes the servo-motor 45 to open the valve 44 until the increase in air flow creates a differential pressure across the constriction 52 which is sufficient to counterbalance the force of the spring. Thus, the adjusted total air flow is so controlled that it is directly proportional to the sum of the individual compensated air requirements of the individual fuels, modified by a factor which represents air infiltration into the furnace. The "adjusted total air requirements" may be modified by any given factor to provide for the "total controlled air supply." The ratio between the "total controlled air supply" and the "adjusted total air requirements" may be varied by the ratio slider 49, such adjustments control the percentage of excess or deficiency of the total controlled air supply.

In the operation of the apparatus, the hand wheels 24 are used to set the respective fuel cams 20 in terms of the compensated air requirements, as observed on the scales 30, to maintain the desired rates of fuel flow. These adjustments impart movement, through the differential gear, to the air cam 41 and the cams 20 remain fixed in their adjusted positions, due to friction of the parts. Thus, the manual adjustment of either or both hand wheels 24 automatically changes the control setting of the air flow regulator 48 to adjust the position of the valve 44. It is possible to cut off the supply of either fuel and regulate the flow of air in accordance with the supply of the other fuel. Moreover, any number of fuels may be used and a single regulator employed to control the supply of air for all of them, as explained in the aforesaid copending application.

It will be understood that the regulators, servo-motors and the cams may be mounted on any suitable support, such as a table. The stroke of the cams can be made the same for all controls by choosing the necessary gear ratios and the cams may be guided for straight line movement in any convenient manner, for example, by wheeled carriages or the like. Moreover, the indicators may be either mechanical or electrical and all of them may be located at any convenient point.

Obviously, the present invention is not restricted to the particular embodiment thereof herein shown and described. Moreover, it is not indispensable that all the features of the invention be used conjointly, since they may be employed advantageously in various combinations and sub-combinations.

What is claimed is:

1. Apparatus for proportioning the supply of combustion air to the supplies of at least two separate fuels comprising, in combination, a single conduit for the air and separate conduits for the respective fuels; adjustable regulators connected to the respective fuel conduits, each constructed and arranged to maintain a constant flow of fuel; manually movable proportioning means connected to set the respective fuel regulators to maintain the desired fuel flows and so constructed and arranged that the adjusted movements of each proportioning means from a zero position corresponding to zero fuel flow are proportional to compen-

sated air requirements necessary to support complete combustion of the respective fuels; summarizing means operated by and responsive to the adjusted movements of the respective proportioning means; a regulator connected to the air conduit to control the flow of air therein; and actuating means for said air regulator connected to and set by said summarizing means.

2. Apparatus for proportioning the supply of combustion air to the supplies of at least two separate fuels comprising, in combination, a single conduit for the air and separate conduits for the respective fuels; adjustable and automatic regulators connected to the respective fuel conduits, each constructed and arranged to maintain a constant flow of fuel; manually movable spring loading cams connected to set the respective fuel regulators to maintain the desired fuel flows and so constructed and arranged that the adjusted movements of each proportioning means from a zero position corresponding to zero fuel flow are proportional to compensated air requirements necessary to support complete combustion of the respective fuels; summarizing means operated by and responsive to the adjusted movements of the respective cams; a regulator connected to the air conduit to control the flow of air therein; and a spring loading cam for said air regulator connected to be actuated and set by said summarizing means.

3. Apparatus, as set forth in claim 1, wherein the actuating means for said air regulator comprises a member of adjustable shape to allow for air infiltration into a furnace.

4. Apparatus, as set forth in claim 2, wherein the air regulator is provided with a ratio varying device constructed and arranged to multiply the total compensated air requirements by a given factor to allow for percentages of excess or deficiency of air in a furnace.

5. Apparatus, as set forth in claim 1, wherein the fuel regulators are also provided with ratio varying means constructed and arranged to change the ratio between the flows of the respective fuels and the compensated air requirements.

6. Apparatus, as set forth in claim 2, wherein all of said regulators are provided with ratio varying means.

7. Apparatus, as set forth in claim 2, wherein each of the fuel cams has an adjustable contour and its shape may be adjusted to provide for the compensated air requirements of the respective fuels.

8. Apparatus, as set forth in claim 2, wherein indicators are associated with the respective cams and read in terms of the compensated air requirements of the respective fuels.

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