

Description

For any given rate of supply of fuel, the temperature of the flame in a furnace from a burner that is operating with the combustion of pulverised fuel in air will theoretically be a maximum at stoichiometry. An excess of air or an excess of fuel in the combustion zone will result in a temperature lower than that. To achieve stoichiometry in the flame as nearly as possible is desirable for the sake of the most efficient utilization of the fuel. Beside that, if the flame is rich (in that too much fuel is supplied) unburnt fuel may result in corrosion on the furnace walls whilst if the flame is lean (in that too much air is applied), the oxidising conditions may result in the formation of noxious gases such as nitrogen dioxide and sulphur trioxide.

It is possible and desirable to monitor the flame temperature—by a light sensitive device, such as a photodiode device, for instance—and whilst this will indicate a departure from optimum combustion conditions, it will not tell whether the departure results from an excess of air or an excess of fuel. An object of the invention is to facilitate the use of a device responsive to the temperature of the flame from a burner in such a way as to indicate whether the flame is deficient in fuel or in air.

According to the present invention, there is provided means for use in controlling the operation of a burner that is supplied with a mixture of pulverized fuel and air, comprising means responsive to the flame temperature and arranged to produce a signal having a value which is dependent upon the flame temperature, means to indicate when the value corresponds to a predetermined flame temperature, means for disturbing the flow of fuel to the burner from a present rate so that its rate is first above or below the present rate and then below or above the present rate with the result that the value passes through a predetermined level corresponding to the predetermined flame temperature, and means by which the rate at which air or fuel is supplied to the burner is alterable according to whether or not the predetermined level is reached before or after a predetermined time after the disturbance has been instigated in the sense that would tend to reduce the interval between the predetermined level being reached and the predetermined time after the disturbance has been instigated.

According to the invention, there is also provided a method of controlling the operation of a burner that is supplied with a mixture of pulverized fuel and air comprising producing a signal having a value which is dependent upon the flame temperature, producing an indication when the value corresponds to a predetermined flame temperature, and disturbing the flow of fuel to the burner from a present rate so that its rate is first above or below the present rate and then below or above the present rate with the result that the value passes through, as a result of the disturbance, the predetermined value corres-

ponding to the predetermined flame temperature, and altering the rate at which air or fuel is supplied to the burner according to whether or not the predetermined level is reached before or after a predetermined time after the disturbance has been instigated, the alteration being in the sense that would tend to reduce the interval between the predetermined level being reached and the predetermined time after the disturbance has been instigated.

By way of example, an embodiment of the invention will now be described with reference to the accompanying somewhat diagrammatic drawings in which:

Figure 1 indicates a pulverized fuel burner and associated control equipment, and

Figure 2 illustrates a vortex amplifier included in a duct through which the burner is supplied with pulverized fuel.

The burner 1 is mounted in the wall 2 of a furnace and is one of a plurality of similar burners (not shown) by which the furnace is fired. A mixture of pulverized fuel and primary air is supplied to the burner 1 through the pipe 3 and secondary air is supplied through the duct 4, the rate of flow of secondary air being controlled by the trimming device 5.

The wall 2 of the furnace is also penetrated by means 6 defining a light path along which the photodiode device 6a may "look at" the flame of the burner 1. An effect of the means 8 is that the photodiode device 6a is largely unaffected by changes in the temperatures of the flames from the other burners. The device 6a is arranged to produce a signal that is dependent upon flame temperature in response to the colour of the flame. The signal from the photodiode device 6a is passed through a tuned amplifier 7 and detector circuit 8 to phase comparator 9.

The pipe 3 includes a vortex amplifier 10 by which controlled variations in the rate of flow of fuel through the pipe 3 can be effected. The amplifier 10 includes a drum 11 concentric with the pipe 3 and, in effect, forming a local enlargement of the pipe 3. A duct 12 opens tangentially into the drum 11. By discharging a blast of air into the drum 11 through the duct 12, the flow of fuel to the burner will be momentarily slowed down, with the result that the supply of fuel to the burner is first reduced below the present value but the fuel that is delayed will then flow to the furnace so that the rate of flow is momentarily increased above the present value.

The duct 12 leads to the vortex amplifier 10 from a source 15 that is controlled by a pulse generator 16. The generator 16 is such as to generate pulses at a regular frequency of, say one every half, or one, or two seconds, and each of which is fed to the phase comparator 9 and simultaneously to the source 15. On receipt of a pulse at the source 15, a solenoid valve is activated to release from the source 15 a blast of air to the vortex amplifier 10. The effect of the blast is such as to ensure that, provided the flame is not initially excessively lean or excessively rich,

the flame will become lean and then rich, passing through optimum combustion conditions in between. The signal from the photodiode device 6a will follow the effect on the flame of these changes and be a maximum when the flame conditions pass through optimum. The delay at the phase comparator 9 between the initiating pulse and the consequent signal indicating that the flame has passed through optimum conditions will represent the condition of the flame prior to the generation of the pulse. The longer the delay, the leaner were the original conditions. The phase comparator 9 is connected to the trimming device 5 and adjusts the supply of secondary air automatically in the sense that tends to maintain the delay at the value that would result from the original conditions being optimum.

It will be realised that by supplying blasts of air to the vortex amplifier at a regular frequency, the consequent changes in flame temperatures will occur at a dependent frequency, being double that of the supply of blasts of air. The tuned amplifier is therefore adjusted to accept signal changes that derive from the blasts of air to the vortex amplifier and not other signals. Thus, when two or more burners are adjacent each other, the frequencies of the supply of blasts of air to the vortex amplifiers associated with the burners may be set to be different, and the turned amplifier associated with any one burner may be adjusted not to respond to signals of the frequency that derive from any of the other adjacent burners.

In use of the apparatus that has been described, the flow of fuel to the burner is interrupted regularly but more intermittent operation is envisaged.

The vortex amplifier that has been described makes efficient use of the air that is supplied in blasts to upset the flow to the burner but alternatives are envisaged. For instance, the enlargement shown in the drawings may not be provided, and the disturbing blasts of air be discharged tangentially into a fuel pipe of constant diameter or of which the diameter at the point of introduction of the disturbing air is reduced. It is also envisaged that, whatever the diameter into which the disturbing blasts of air are introduced, that air may be directed across the pipe so that a vortex by which the flow of fuel is disturbed results from reflection from the opposite wall of the pipe. It is also envisaged, where the fuel flows along a pipe of which the direction changes in the vicinity of the burner and a strike plate is provided at the bend, that the disturbing air may be introduced through a tube extending through the strike plate and parallel to the axis of the downstream part of the pipe. Discharge from the tube may be circumferentially within, or across, the pipe.

In general, it is desirable that the disturbance to the flow of fuel through the pipe 3 should be created close to the outlet from the pipe, although it may be displaced upstream and associated with

some other functional component in the fuel supply path.

The effect of the vortex amplifier that has been described is first to make the flame too lean and then too rich. It is envisaged that alternative devices could be used by which the flame is first made too rich and then too lean.

The invention is likely to find especial value in connection with furnaces that have several burners connected through a splitter to a common source, since the splitter may not be effective to divide consistently the fuel reaching it, and use of the invention will facilitate efficient combustion despite the vagaries of the splitter.

It will be realised that what has been described depends upon the detection of the peak of the flame temperature, and not the value of the peak, so that the photodiode device may get somewhat dirty without impeding the effectiveness of the apparatus.

In the apparatus that has been described, the supply of air is adjusted in the sense that would cause the burner to operate more nearly under optimum conditions. In modifications, it is envisaged, instead, that the supply of fuel might be adjusted in the same sense.

Claims

1. Means for use in controlling the operation of a burner (1) that is supplied with a mixture of pulverized fuel and air, comprising means (6a) responsive to the flame temperature and arranged to produce a signal having a value which is dependent upon the flame temperature, means (8) to indicate when the value corresponds to a predetermined flame temperature, characterized by means (10, 12, 15) for disturbing the flow of fuel to the burner from a present rate so that its rate is first above or below the present rate and then below or above the present rate with the result that the value passes through a predetermined level corresponding to the predetermined flame temperature, and means (5) by which the rate at which air or fuel is supplied to the burner is alterable according to whether or not the predetermined level is reached before or after a predetermined time after the disturbance has been instigated in the sense that would tend to reduce the interval between the predetermined level being reached and the predetermined time after the disturbance has been instigated.

2. Means as claimed in claim 1 in which the means (10, 12, 15) for disturbing the flow of fuel to the burner is such as to disturb the flow automatically at regular intervals.

3. Means as claimed in either of the preceding claims comprising a pipe (3) through which pulverized fuel entrained in air can be supplied to the burner and the means for disturbing the flow of fuel to the burner includes means (12) for discharging a blast of air into the pipe laterally of the direction of flow of fuel through the pipe.

4. Means as claimed in claim 3 in which the means (12) for discharging a blast of air is such



the flame will become lean and then rich, passing through optimum combustion conditions in between. The signal from the photodiode device 6a will follow the effect on the flame of these changes and be a maximum when the flame conditions pass through optimum. The delay at the phase comparator 9 between the initiating pulse and the consequent signal indicating that the flame has passed through optimum conditions will represent the condition of the flame prior to the generation of the pulse. The longer the delay, the leaner were the original conditions. The phase comparator 9 is connected to the trimming device 5 and adjusts the supply of secondary air automatically in the sense that tends to maintain the delay at the value that would result from the original conditions being optimum.

It will be realised that by supplying blasts of air to the vortex amplifier at a regular frequency, the consequent changes in flame temperatures will occur at a dependent frequency, being double that of the supply of blasts of air. The tuned amplifier is therefore adjusted to accept signal changes that derive from the blasts of air to the vortex amplifier and not other signals. Thus, when two or more burners are adjacent each other, the frequencies of the supply of blasts of air to the vortex amplifiers associated with the burners may be set to be different, and the turned amplifier associated with any one burner may be adjusted not to respond to signals of the frequency that derive from any of the other adjacent burners.

In use of the apparatus that has been described, the flow of fuel to the burner is interrupted regularly but more intermittent operation is envisaged.

The vortex amplifier that has been described makes efficient use of the air that is supplied in blasts to upset the flow to the burner but alternatives are envisaged. For instance, the enlargement shown in the drawings may not be provided, and the disturbing blasts of air be discharged tangentially into a fuel pipe of constant diameter or of which the diameter at the point of introduction of the disturbing air is reduced. It is also envisaged that, whatever the diameter into which the disturbing blasts of air are introduced, that air may be directed across the pipe so that a vortex by which the flow of fuel is disturbed results from reflection from the opposite wall of the pipe. It is also envisaged, where the fuel flows along a pipe of which the direction changes in the vicinity of the burner and a strike plate is provided at the bend, that the disturbing air may be introduced through a tube extending through the strike plate and parallel to the axis of the downstream part of the pipe. Discharge from the tube may be circumferentially within, or across, the pipe.

In general, it is desirable that the disturbance to the flow of fuel through the pipe 3 should be created close to the outlet from the pipe, although it may be displaced upstream and associated with

some other functional component in the fuel supply path.

The effect of the vortex amplifier that has been described is first to make the flame too lean and then too rich. It is envisaged that alternative devices could be used by which the flame is first made too rich and then too lean.

The invention is likely to find especial value in connection with furnaces that have several burners connected through a splitter to a common source, since the splitter may not be effective to divide consistently the fuel reaching it, and use of the invention will facilitate efficient combustion despite the vagaries of the splitter.

It will be realised that what has been described depends upon the detection of the peak of the flame temperature, and not the value of the peak, so that the photodiode device may get somewhat dirty without impeding the effectiveness of the apparatus.

In the apparatus that has been described, the supply of air is adjusted in the sense that would cause the burner to operate more nearly under optimum conditions. In modifications, it is envisaged, instead, that the supply of fuel might be adjusted in the same sense.

Claims

1. Means for use in controlling the operation of a burner (1) that is supplied with a mixture of pulverized fuel and air, comprising means (6a) responsive to the flame temperature and arranged to produce a signal having a value which is dependent upon the flame temperature, means (8) to indicate when the value corresponds to a predetermined flame temperature, characterized by means (10, 12, 15) for disturbing the flow of fuel to the burner from a present rate so that its rate is first above or below the present rate and then below or above the present rate with the result that the value passes through a predetermined level corresponding to the predetermined flame temperature, and means (5) by which the rate at which air or fuel is supplied to the burner is alterable according to whether or not the predetermined level is reached before or after a predetermined time after the disturbance has been instigated in the sense that would tend to reduce the interval between the predetermined level being reached and the predetermined time after the disturbance has been instigated.

2. Means as claimed in claim 1 in which the means (10, 12, 15) for disturbing the flow of fuel to the burner is such as to disturb the flow automatically at regular intervals.

3. Means as claimed in either of the preceding claims comprising a pipe (3) through which pulverized fuel entrained in air can be supplied to the burner and the means for disturbing the flow of fuel to the burner includes means (12) for discharging a blast of air into the pipe laterally of the direction of flow of fuel through the pipe.

4. Means as claimed in claim 3 in which the means (12) for discharging a blast of air is such



that the air is discharged tangentially into the pipe (1) the diameter of the pipe in the region (10) of the discharge is larger than that of the pipe upstream and downstream of that region.

5. Means as claimed in any of the preceding claims in which the burner is connected to a source of auxiliary air (5), and means is provided for varying the supply of auxiliary air in the sense that would tend to reduce the interval.

6. Means as claimed in any of the preceding claims in which the means (6a) responsive to the flame temperature is a photodiode device.

7. A method of controlling the operation of a burner (1) that is supplied with a mixture of pulverised fuel and air comprising producing a signal having a value which is dependent upon the flame temperature, producing an indication when the value corresponds to a predetermined flame temperature, characterized in disturbing the flow of fuel to the burner from a present rate so that its rate is first above or below the present rate and then below or above the present rate with the result that the value passes through, as a result of the disturbance, a predetermined level corresponding to the predetermined flame temperature, and altering the rate at which air or fuel is supplied to the burner according to whether or not the predetermined level is reached before or after a predetermined time after the disturbance has been instigated, the alteration being in the sense that would tend to reduce the interval between the predetermined level being reached and the predetermined time after the disturbance has been instigated.

8. A method as claimed in claim 7 in which the flow of fuel to the burner is disturbed at regular intervals.

9. A method as claimed in claim 8 by which the operation of an adjacent burner is controlled, the regular intervals at which the flows of fuel to the burners is disturbed being different.

10. Means as claimed in any of claims 1 to 6 or a method as claimed in any of claims 7 and 9 in which the predetermined flame temperature is that of the flame burning in optimum combustion conditions.

Patentansprüche

1. Gerät zur Verwendung bei der Steuerung des Betriebs eines Brenners (1), dem eine Mischung von zerstaubtem Brennstoff und Luft zugeführt wird, mit einer auf die Flammentemperatur ansprechenden Einrichtung (6a), die ein Signal erzeugt, dessen Wert von der Flammentemperatur abhängt, mit einer Einrichtung (8) zur Anzeige, wann der Wert einer vorbestimmten Flammentemperatur entspricht, gekennzeichnet durch eine Einrichtung (10, 12, 15) zur Störung des Zuflusses des Brennstoffs zum Brenner von einem Augenblickswert, so daß der Wert zunächst oberhalb oder unterhalb des Augenblickswertes liegt und dann unterhalb oder oberhalb des Augenblickswertes gelangt mit der Folge, daß der Wert durch einen vorbestimmten Pegel entsprechend der

vorbestimmten Flammentemperatur hindurchgeht, ferner gekennzeichnet durch eine Einrichtung (5), durch welche der Wert, mit welchem Luft oder Brennstoff dem Brenner zugeführt wird, änderbar ist, je nachdem, ob der vorbestimmte Pegel vor oder nach einer vorbestimmten Zeit erreicht wird, nachdem die Störung in dem Sinne veranlaßt wurde, daß das Intervall zwischen dem Erreichen des vorbestimmten Pegels und dem vorbestimmten Zeitpunkt nach Veranlassung der Störung verringert wird.

2. Gerät nach Anspruch 1, in welchem die Einrichtung (10, 12, 15) zur Störung des Brennstoffzuflusses zum Brenner so ausgebildet ist, daß der Zufluß automatisch in regelmäßigen Intervallen gestört wird.

3. Gerät nach einem der vorhergehenden Ansprüche, umfassend ein Rohr (3), durch welches zerstaubter, durch Luft mitgerissener Brennstoff dem Brenner zugeführt werden kann und die Einrichtung zur Störung des Brennstoffzuflusses zum Brenner eine Einrichtung (12) zur Einführung eines Luftstrahls in das Rohr seitlich zur Richtung des Brennstoffzuflusses durch das Rohr aufweist.

4. Gerät nach Anspruch 3, in welchem die Einrichtung (12) zur Abgabe des Luftstrahls derart ausgebildet ist, daß die Luft tangential in das Rohr abgegeben wird, und der Durchmesser des Rohrs im Zufuhrbereich (12) größer ist als stromauf und stromab von dieser Stelle.

5. Gerät nach einem der vorhergehenden Ansprüche, in welchem der Brenner mit einer Quelle von Zusatzluft (5) verbunden ist und eine Einrichtung zur Variation der Zufuhr von Zusatzluft in dem Sinne vorgesehen ist, daß das Intervall verringert wird.

6. Gerät nach einem der vorhergehenden Ansprüche, in welchem die auf die Flammentemperatur ansprechende Einrichtung (6a) eine Vorrichtung mit Fotodiode ist.

7. Verfahren zur Steuerung des Betriebs eines Brenners (1), der mit einer Mischung aus zerstaubtem Brennstoff und Luft versorgt wird, mit folgenden Schritten: ein Signal mit einem Wert in Abhängigkeit von der Flammentemperatur wird erzeugt; eine Anzeige, wann der Wert einer vorbestimmten Flammentemperatur entspricht, wird erzeugt; gekennzeichnet durch: ausgehend von einem Augenblickswert wird der Brennstoffzufluß zum Brenner so gestört, daß der Wert zunächst oberhalb oder unterhalb des Augenblickswertes liegt und dann unterhalb oder oberhalb des Augenblickswertes gelangt, so daß der Wert infolge der Störung durch einen vorbestimmten Pegel entsprechend der vorbestimmten Flammentemperatur hindurchgeht; der Wert, mit dem die Luft oder der Brennstoff dem Brenner zugeführt wird, wird je nachdem geändert, ob der vorbestimmte Pegel vor oder nach einer vorbestimmten Zeit nach Auslösen der Störung erreicht wird, wobei die Änderung in dem Sinne erfolgt, daß das Intervall zwischen dem Erreichen des vorbestimmten Pegels und dem vorbestimmten Zeitpunkt nach Auslösen der Störung verringert wird.



8. Verfahren nach Anspruch 7, in welchem der Brennstoffzufluß zum Brenner in regelmäßigen Intervallen gestört wird.

9. Verfahren nach Anspruch 8, in welchem der Betrieb eines benachbarten Brenners gesteuert wird, wobei die regelmäßigen Intervalle, mit welchen der Brennstoffzufluß zu den Brennern gestört wird, zueinander unterschiedlich sind.

10. Gerät nach einem der Ansprüche 1 bis 6 oder Verfahren nach einem der Ansprüche 7 bis 9, in welchen die vorbestimmte Flammentemperatur die der Brennerflamme bei optimalen Verbrennungsbedingungen ist.

Revendications

1. Dispositif devant servir à régler le fonctionnement d'un brûleur (1) alimenté par un mélange de combustible pulvérisé et d'air, comprenant des moyens (6a) sensibles à la température de la flamme et agencés pour fournir un signal dont la valeur dépend de la température de la flamme, des moyens (8) pour indiquer quand la valeur correspond à une température de flamme déterminée, caractérisé par des moyens (10, 12, 15) pour perturber l'écoulement du combustible vers le brûleur à partir d'un débit actuel de façon que son débit soit d'abord supérieur ou inférieur au débit actuel puis inférieur ou supérieur au débit actuel avec pour résultat le passage de la valeur par un niveau déterminé correspondant à la température de flamme déterminée, et des moyens (5) pouvant modifier le débit d'arrivée d'air ou de combustible au brûleur selon que le niveau déterminé est ou non atteint avant ou après un temps déterminé après établissement de la perturbation dans le sens qui tendrait à réduire l'intervalle entre le passage par le niveau déterminé et le temps déterminé après établissement de la perturbation.

2. Dispositif selon la revendication 1 dans lequel les moyens (10, 12, 15) de perturbation de l'écoulement du combustible vers le brûleur sont de nature à perturber automatiquement l'écoulement à intervalles réguliers.

3. Dispositif selon l'une ou l'autre des revendications précédentes comprenant un tuyau (3) à travers lequel du combustible pulvérisé entraîné dans de l'air peut arriver au brûleur et les moyens de perturbation de l'écoulement du combustible vers le brûleur comportent des moyens (12) pour émettre une bouffée d'air dans le tuyau transversalement à la direction d'écoulement de combustible à travers le tuyau.

4. Dispositif selon la revendication 3 dans lequel les moyens (12) d'émission d'une bouffée d'air sont tels que l'air est émis tangentiellement dans le tuyau et le diamètre du tuyau dans la région (10) de l'émission est plus grand que celui que le tuyau présente en amont et en aval de cette région.

5. Dispositif selon l'une quelconque des revendications précédentes dans lequel le brûleur est relié à une source d'air auxiliaire (5) et des moyens sont prévus pour faire varier l'arrivée d'air auxiliaire dans le sens qui tendrait à réduire l'intervalle.

6. Dispositif selon l'une quelconque des revendications précédentes dans lequel les moyens (6a) sensibles à la température de la flamme sont un dispositif du type photodiode.

7. Procédé de réglage du fonctionnement d'un brûleur (1) alimenté par un mélange de combustible pulvérisé et d'air comprenant la génération d'un signal dont la valeur dépend de la température de la flamme, la génération d'une indication quand la valeur correspond à une température de flamme déterminée, caractérisé en ce qu'on perturbe l'écoulement du combustible vers le brûleur à partir d'un débit actuel de façon que son débit soit d'abord supérieur ou inférieur au débit actuel puis inférieur ou supérieur au débit actuel avec pour résultat que la valeur passe, par suite de la perturbation, par un niveau déterminé correspondant à la température de flamme déterminée, et l'on modifie le débit d'arrivée d'air ou de combustible au brûleur selon que le niveau déterminé est ou non atteint avant ou après un temps déterminé après l'établissement de la perturbation, la modification ayant lieu dans le sens qui tendrait à réduire l'intervalle entre le passage par le niveau déterminé et le temps déterminé après l'établissement de la perturbation.

8. Procédé selon la revendication 7 dans lequel l'écoulement du combustible vers le brûleur est perturbé à intervalles réguliers.

9. Procédé selon la revendication 8 par lequel on règle le fonctionnement d'un brûleur voisin, les intervalles réguliers auxquels sont perturbés les écoulements de combustible vers les brûleurs étant différents.

10. Dispositif selon l'une quelconque des revendications 1 à 6 ou procédé selon une quelconque des revendications 7 et 9 dans lequel la température de flamme déterminée est celle de la flamme existant dans des conditions de combustion optimales.

