Dec. 27, 1960 J. W. PEGRUM 2,966,209

FLAME RESPONSIVE MEANS

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FIG. 1.

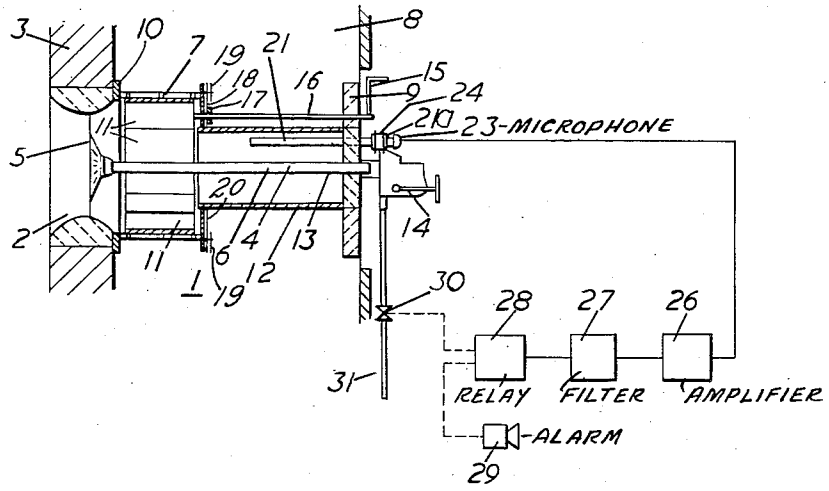
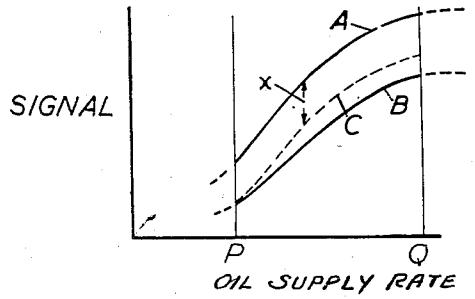


FIG. 2.



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FLAME RESPONSIVE MEANS

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FIG. 3.

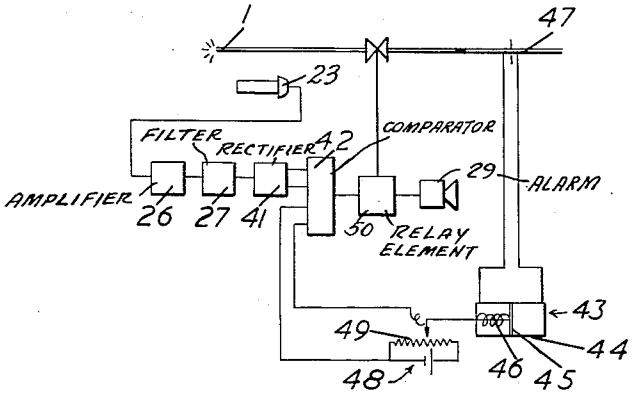
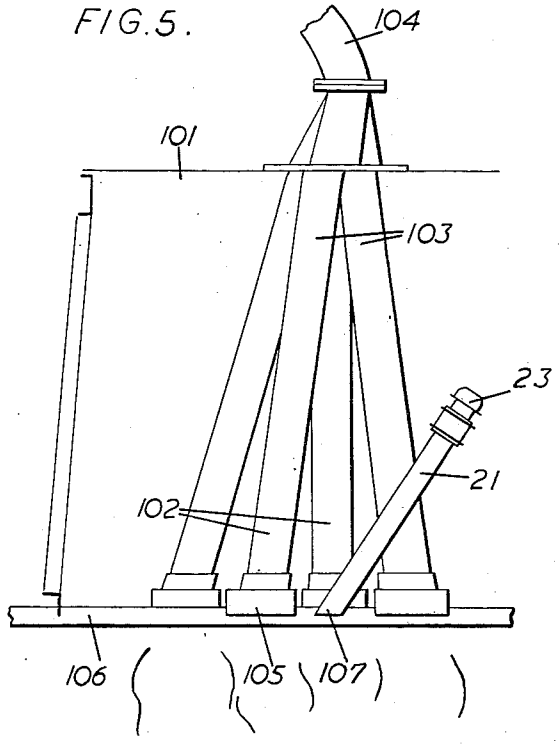


FIG. 5.



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FLAME RESPONSIVE MEANS

Filed May 28, 1957 3 Sheets-Sheet 3

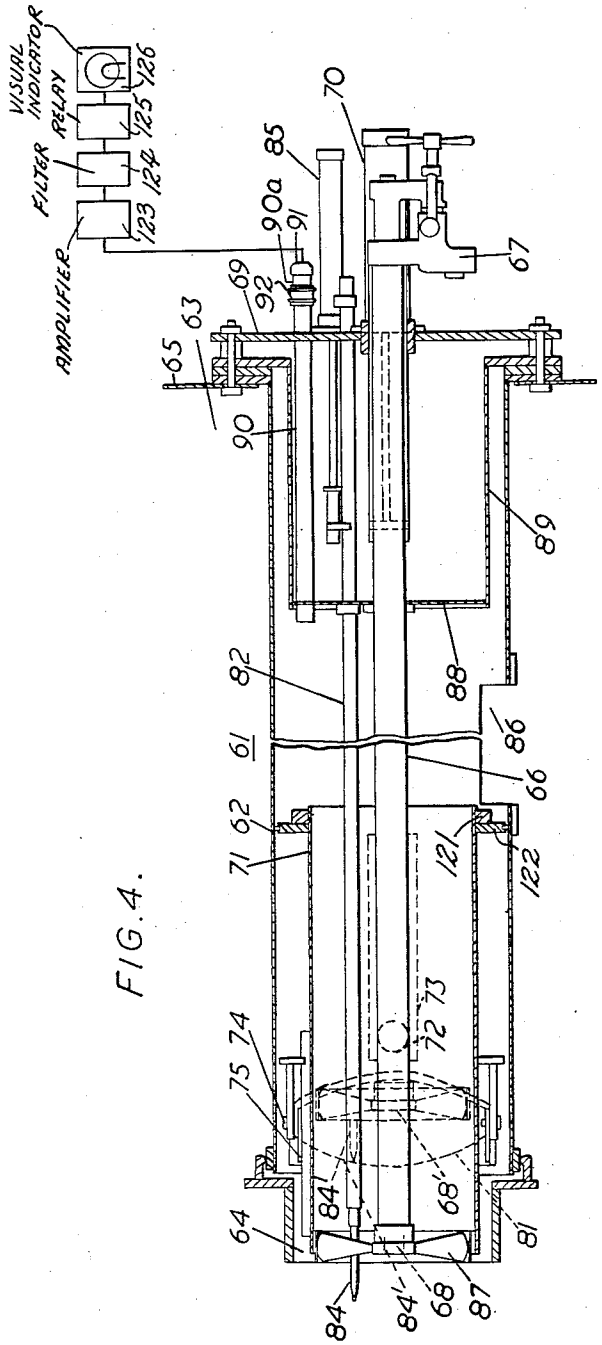


FIG. 4.

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2,966,209

FLAME RESPONSIVE MEANS

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Filed May 28, 1957, Ser. No. 662,183

Claims priority, application Great Britain May 28, 1956

8 Claims. (Cl. 158—28)

This invention relates primarily to flame responsive means for use with fluent fuel burners, e.g. oil, pulverised coal, or gas burners, to monitor the flame. It is desirable that extinction of the flame and combustion at too poor efficiency shall be indicated or/and that proper action should be automatically taken, and particularly important when dangerous conditions may arise upon extinction of a burner flame or upon the occurrence of combustion at too poor efficiency.

Flame responsive means responsive to radiant energy of the flame to be monitored have been proposed, but photo cells are responsive also to the light given out by the general flame in the furnace and therefore tend to yield an undesirably low ratio of useful signal to background signal, the background signal being particularly large when pulverised fuel burners are in use. Flame responsive means intended to respond to flame temperature are either difficult to protect from the high temperatures or if of indirect measuring type are somewhat complex.

An object of the invention is the provision of flame responsive means operating upon a different principle from the flame responsive means mentioned, namely an acoustic principle, and in which in order that the monitoring shall be fully effective throughout an operating range regard is had to the rate at which it is intended that the burner shall function satisfactorily. The provision of such means is based on the appreciation of the fact that the combustion of atomised liquid fuel, provided adequate air is supplied to the burner means, whether the atomisation is effected by pressure of the liquid or by the use of atomising air or steam, is accompanied by a characteristic noise or roaring sound; that characteristic noises may also accompany the flames from gas and pulverised fuel burners respectively, for example the flames from gas burners and pulverised coal burners operating with supplies of combustion air under pressure; and that the noise level of the characteristic sound depends upon the combustion rate.

An acoustic device for the flame responsive means suitably includes a microphone, which may be situated at a position somewhat removed from the furnace space and arranged to receive sounds transmitted along an air path from a position at the furnace wall or a position in a combustion air space on the side of the burner head remote from the furnace. The apparatus may be inexpensive and very robust, and unaffected by normal conditions near the burner such as the presence of dust.

The sound associated with proper combustion has been found, particularly in the case of oil burners, to be intense and local and an oil lighting-up burner has been successfully monitored irrespective of the operation of main pulverised fuel burners of the furnace and of the operation of adjacent oil lighting-up burners of the same kind.

The characteristic noise associated with combustion at optimum efficiency is present at lower combustion rates

but falls off in intensity with reduced combustion and also with smaller rates of fuel supply.

Another object of the invention is to provide methods for monitoring fluent fuel combustion over varying rates of operation whereby suitable discrimination is effected between falls in signal outputs from acoustic means due to different causes.

Other objects are the provision of apparatus and methods adapted to detect and monitor normal and abnormal functioning of apparatus with the normal functioning of which sounds are produced the intensity of which varies with the rate or intended rate of operation of the apparatus.

Another object is the provision of apparatus adapted for signalling the successful accomplishment of stages in the putting into proper operation of an oil lighting-up burner.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 diagrammatically illustrates acoustic flame responsive means associated with an oil burner, which is represented in sectional elevation;

Figure 2 shows graphs referred to in connection with Figure 3;

Figure 3 schematically illustrates acoustic flame responsive means provided with means for adjusting in accordance with burner oil supply rate an operative signal passed to a relay;

Figure 4 is a sectional elevation through a lighting-up oil burner provided with a listening tube; and

Figure 5 illustrates pulverised coal burning means with which a listening tube is associated.

Referring to Figure 1 of the drawings, an oil burner 1 is arranged to fire through a port 2 in a furnace wall 3. The oil burner comprises an atomiser 4 of which the spraying head is encircled by an impeller plate 5 and positioned at the throat of the port, and a register 7 for controlling the admission to the port of air from a windbox 8.

The register consists of a circular outer plate 9 bolted to the windbox wall, a frame 10 adjacent the furnace wall carrying a peripheral series of pivotally mounted air doors 11, and between the frame 10 and the outer plate 9 a cylindrical casing 12 open at its end nearer the furnace; combustion air cannot attain to the port except past the air doors. The spraying head of the atomiser is supplied with oil through the atomiser barrel lying within the tube 6 carrying the impeller plate, to which barrel, outside the windbox, is secured the atomiser tail coupling 14. The air doors are adjustable in angular position on their pivots by a handle 15 operative to turn the air doors through an appropriate operating spindle 16, pinion 17, rack 18, levers 19 and linkages 20.

A listening tube 21 is mounted in the register outer plate 9 so as to extend therethrough parallel to the tube 6. The inner end of the listening tube terminates in the space within the cylindrical casing 12, whilst at the outer end, outside the windbox, of the listening tube a sound-power or balanced armature microphone 23 is mounted. The outer end length 21*a* of the tube carrying the microphone is a separate piece from the remaining length of the tube, and is attached thereto by a rubber sleeve, which inhibits the reception by the microphone of mechanical vibrations, consisting of a short length of rubber hose 24 secured to the two tube lengths by circular clips.

The output from the microphone is led to an amplifier 26, the output of which passes through an electrical filter 27 to an electro-magnetic relay 28 adapted to assume one state when it receives a signal corresponding to a predetermined noise level at the microphone and to assume

another state when it fails to receive a signal of such value. The relay is operative to control an audible alarm **29**, as well as a stop-valve **30** in the oil line **31** to the atomiser tail coupling **14**.

The amplifier may be of a simple type, e.g. a two stage pentode amplifier with resistance-capacity coupling between the stages. The filter is designed, with reference to the character of the noise received by the microphone, to increase the useful part of the signal in relation to the background part, as will be described.

When the burner functions with combustion of fuel oil supplied to the atomiser at optimum efficiency the flame is accompanied by a characteristic noise or roaring sound of appropriate intensity which travels to the microphone **23** from the furnace through the port **2**, the space surrounded by the air doors **11**, and the space within the cylindrical casing **12**, and along the air path in the listening tube **21**. When combustion is not present at the burner, or when combustion efficiency at the burner is less than optimum, as for example when insufficient combustion air is employed so that the flame is oily or smoky, the said intensity of characteristic noise or roaring sound is not generated by the burner and even if other closely adjacent oil burners served by the same windbox are in proper operation, the noise picked up by the microphone is considerably less. The electro-magnetic relay is adapted to distinguish between, on the one hand, the values of signals associated with combustion at efficiencies deemed satisfactory and, on the other hand, the values of signals associated with combustion at efficiency deemed unsatisfactory, the values of signals associated with lack of combustion being special cases of the signals of this latter group; the relay is arranged to effect the sounding of the audible alarm and to effect operation of the stop-valve to cut off the supply of oil to the burner should a signal be received that corresponds to unsatisfactory combustion efficiencies. As hereinafter indicated with reference to Figures 3 and 4, the signal level of discrimination between signals which will and signals which will not operate the relay is made to vary in accordance with the rate at which it is intended that the burner shall operate.

The listening tube is mechanically robust and unaffected by the temperatures to which it will normally be subjected.

The noises at the microphone associated with different conditions are subjected to amplitude-frequency analyses, and the filter may be designed to suppress wholly or partly all frequencies outside a band in which it is found that the mean amplitude of the frequencies included when the characteristic noise or roaring sound of the flame is present has a particularly high ratio to the mean amplitude of the said frequencies when said sound is not present. The choice of said band depends upon said analyses; it may be, for instance, the band 400 to 600 cycles per second.

Said analyses may indicate that, as has been confirmed by the inventor's experiments, in very many cases no frequency selection is required, i.e. that the filter may be dispensed with; or may suggest the advantage merely of suppressing, wholly or partly, higher frequencies, such as those above 800 cycles per second. Sounds having such higher frequencies may be produced by the atomisation of the oil, more especially in the case of steam or air atomisation of the oil, which continues whether the flame is present or absent. Relatively low frequencies may also in some cases be suppressed with advantage; the response curve of the microphone may frequently be such as to ensure a suppression of relatively low frequencies that makes it unnecessary to design the filter with a low frequency cut-off.

The relay may be arranged to give a visual signal of the presence or absence of satisfactory combustion efficiencies at the burner. The relay, as well as cutting off the supply of oil to the burner in conditions of no or unsatisfactory combustion, may be arranged upon the occurrence of such conditions to bring into operation an alternative burner.

The sound associated with optimum combustion efficiency varies in noise level according to the rate of combustion. It may be that the noise level for optimum combustion efficiency at the lower end of a range of oil supply rates over which visual or audible signalling or control is required, and so the signal from the microphone, is less than the noise level at higher rates of oil supply in the range, and so the signal from the microphone, for combustion at intolerably bad efficiency or combustion conditions leading to danger. Thus, referring to Figure 2, in which the value of the signal from the microphone is plotted against rate of oil supply to the burner (the curves being not to scale and drawn merely to illustrate the principles involved), if curve A represents the average values of the signals accompanying different oil supply rates when combustion is throughout at optimum efficiency, and curve B the values of the signals accompanying different oil supply rates with combustion at the burner but combustion under conditions only just tolerable, it will be observed that the signal A at the lower end of the oil supply range PQ is lower than signal B over about the upper two-thirds of the said oil supply range. Under these circumstances, a reduction in the signal from a high value to a low value might indicate the onset of bad combustion conditions such as ought to be accompanied by operation of the relay; on the other hand, the same signal reduction might merely indicate the oil supply rate had been reduced say from Q to P while the burner continued to function at optimum efficiency, in which case the relay ought not to be operated. The apparatus is enabled to make a desirable discrimination between the significances of signal reductions in the manner that will now be described:

Referring to Figure 3, the output from the microphone **23** is passed through an amplifier **26** and a filter **27**; the relay **28** of Figure 1 is now shown split into a rectifier **41** for converting the signal from the amplifier into a D.C. signal, a comparator **42** to which the D.C. signal is supplied, and a relay element **50** operated by the signal from the comparator **42**. The rate of flow of oil to the burner **1** is measured by a measuring device **43** indicated as a cylinder **44** containing a piston **45** which assumes, under the influence of a biassing spring **46** and a pressure difference applied to the two faces of the piston by connections to the burner oil line in front of and behind a restriction **47** therein, a position depending upon the rate of oil supply to the burner. The measuring device is arranged to control a device **48** which supplies to the comparator **42**, in opposition to the signal from the rectifier **41**, a D.C. signal whose value depends in a specific manner upon the rate of oil supply; the device **48** is shown as a potentiometer in which the resistance per unit length of the resistor **49** varies along the length of the resistor in a manner which ensures production of a D.C. signal for application to the comparator whose value varies with the oil supply rate according to the curve C of Figure 2.

The curve C lies below the curve A by a constant value x corresponding to the smallest value assumed by the difference between the curves A and B over the oil supply rate range PQ. The relay element **50** is arranged to have one state when it receives a positive difference signal, i.e. when the microphone signal at the comparator is greater than the measuring device signal at the comparator and another state when it receives a negative signal difference, i.e. when the microphone signal at the comparator is less than the measuring device signal at the comparator. The relay element is shown as controlling an audible alarm **29** which it operates when it receives a negative difference signal and a stop valve **30** in the oil line to the burner 1, which stop valve it operates under the same circumstances. With combustion at oil supply rates in the range

PQ, the relay element 50 does not operate the alarm 29 or stop valve 30 if the combustion efficiency is the optimum or if the shortfall in combustion efficiency below the optimum is less than is represented by the signal differences x between the curves A and C; the relay element 50 operates, however, the alarm 29 and the stop valve 30 if the shortfall in combustion efficiency below the optimum is greater than is represented by the signal difference x between the curves A and C. Thus the shortfall in combustion efficiency represented by the signal difference x is the maximum permitted without operation of the alarm and stop valve. The oil supply rate may be changed freely within the oil supply range PQ and the relay will operate or refrain from operating the audible alarm and stop valve according to whether the combustion efficiency is worse or better than the minimum approved efficiency represented by the curve C, which by reason of the manner in which it is chosen never falls before the curve B, whereby the combustion efficiency can never, without operation of the alarm and cessation of oil flow to the burner, fall to an intolerably low level; large falls in sound level do not, however, effect operation of the alarm and stop valve if such falls are due to reduction in oil supply rates with continuance of combustion at minimum or better than minimum approved efficiency.

When a listening tube and microphone are associated with an oil burner adapted to serve as a lighting-up burner for effecting ignition of pulverised coal discharged into a furnace from a pulverised coal burner, visual or audible signalling means operated by a relay responsive to noise at the microphone make possible additional checks on the operation of the oil burner.

Referring to Figure 4, an oil burner 61 of the kind described in British patent specification No. 780,653, adapted for lighting-up pulverised fuel burners and adapted also to constitute firing means for the furnace over a lower range of loads, has a fixed outer cylindrical casing 62 extending across a space within a windbox 63 between a port 64 in the furnace wall and an outer wall 65 of the windbox.

Oil is carried along an atomiser barrel within a tube 66 from an atomiser tail coupling 67 outside the windbox to an atomiser spraying head 68 adjacent the port 64. The tube extends slidably through a front plate 69 bolted to the windbox outer plate 65 and is projectable in a direction towards and retractable in a direction from the furnace by the application of pressure fluid to a piston and cylinder arrangement 70 suitably associated with the front plate and with the tube 66. In its projective and retractive movements the tube 66, which carries with it the atomiser, carries with it also a centering tube 71 by the assistance of which the atomiser sprayer head is properly positioned centrally of the outer casing; the centering tube carries at each side thereof a respective roller 72 arranged to engage rails 73 suitably fixed with respect to the outer casing. The movement of the atomizer barrel beyond the projected operative position is prevented by a ring 121 secured to the end of the centering tube further from the furnace on the radially outer surface of the centering tube and an annular member 122 secured to the inner surface of the fixed casing 62.

The centering tube 71 carries pins 74 adapted to engage shaped lugs or cams 75 adapted for limited rotation about pivots fixed in relation to the outer casing; to the lugs or cams are attached lune-shaped doors 81; the arrangement is such that when the atomiser tube and centering tube are moved in the projective direction, the doors are opened to permit the atomiser head 68 to move into the port 64, and when the tube 66, and centering tube are withdrawn into their fully retracted position (see dotted position 68' of the spraying head), the doors are shut to screen the atomiser head from furnace heat.

For igniting the oil discharged by the atomiser spraying head there is provided an electric igniter tube 82 extending parallel to the atomiser through the outer plate 69 and carrying at its inner end a sparking head 84. The igniter tube can be projected and retracted longitudinally of the burner by cylinder and piston means 85 appropriately connected to the outer plate and to the igniter tube. The cylinder and piston means 85 provides stop means preventing the movement of the igniter beyond its projected operative position inasmuch as the movement of the igniter is limited by the possible travel of the piston in the cylinder. In its fully projected position, the sparking head of the igniter tube extends beyond the atomiser spraying head 68 in the direction towards the furnace; its fully retracted position is indicated by the dotted position 84'.

Combustion air for the burner enters the space within the outer casing 62 through a port 86 formed in the wall of the outer casing, flows along the space within the centering tube, and flows through the furnace port into the furnace past a swirler 87 comprising vanes arranged between the spraying head and the centering tube. A suitable channel through the swirler is provided for the igniter.

Both the tube 66 and the igniter tube pass through apertures in the circular inner end wall 88 of a sealing cover 89 also bolted to the windbox wall. Also projecting through the outer plate and the end wall of the sealing cover is a listening tube 90 parallel to the tube 66 and the igniter tube, and carrying at its outer end a microphone 91. The outermost end length 90*a* of the listening tube is separate from the remainder of the listening tube and connected thereto by a rubber sleeve 92 secured by clips to the two separate tube lengths of the listening tube.

The output from the microphone is led to an amplifier 123, a filter 124, and a relay 125, as in the system described in connection with Figure 1. The filter, as well as preferably being adapted to suppress high frequency components of the noise received by the microphone, is preferably adapted also to suppress low frequency components of said noise, for the background noise may include the noise of combustion of pulverised fuel burners which may be expected to include appreciable amounts of low frequency components. The relay in the present case is adapted to control a visual indicator 126 so that the latter effects a visual signal when there is applied to it from the filter an electric signal corresponding to the reception by the microphone of the sound associated with satisfactory combustion at the oil burner.

When the oil burner is to be operated, pressure fluid is led to the cylinder and piston means 70 to effect projection of the atomiser towards the fully advanced position in the port; when it is mechanically brought to rest in such position the sound, generated by the impact of the ring 121 upon the annular member 122, of a mechanical blow is picked up by the microphone, and, since the said sound cannot fail to include frequencies in the pass band of the filter, the relay controls the visual indicator so that a transient visual signal is given thereby provided that the relay is quick-acting. Pressure fluid is then led to the cylinder and piston means 85 for the igniter tube 82 which advances towards its fully projected position and when it also is mechanically brought to rest by the piston in the piston and cylinder means 85 reaching the end of its travel in the cylinder and generating the sound of a mechanical blow as it is brought to rest, a further transient signal is observable. When voltage is applied to the igniter, the sparks caused at the sparking head are accompanied by sounds which give further transient signals, and when finally the oil is ignited and satisfactory combustion results, the state of affairs is indicated by a steady signal effected by the relay. The operator may, therefore, readily observe whether the burner and the igniter respond to control to project those parts to their operative positions, whether electric discharges occur in response to control, and whether satisfactory combustion ensues.

The flame responsive means is capable of distinguishing whether the oil burner is alight or not even with other oil burners alight and with the pulverised fuel burners operating at full load.

In Figure 5 a listening tube **21** of the kind already described is disposed within the windbox **101** of a pulverised coal burner comprising a group of burner units **102**. The burner units comprise branch conduits **103** for streams of primary air with entrained pulverised coal which branch from a common duct **104** and lead to burner tips **105** providing elongated nozzles of known kind which discharge between adjacent roof water tubes **106** of a furnace. The end **107** of the listening tube **21** remote from the microphone **23** is positioned between adjacent roof tubes and between adjacent burner tips and is open to the furnace space. The output from the microphone is to be passed through an amplifier and a filter to a relay according to the system described with reference to Figure 1. The filter may be a band pass filter designed to pass frequencies in a range which includes the frequency components of highest amplitude of the sound characteristic of normal combustion of the pulverised coal burners. Such range may be determined in any given case by amplitude-frequency analysis.

What is claimed is:

1. A monitor for the functioning of a fluent fuel burner which when functioning at minimum approved efficiency produces a characteristic noise of intensity variable in functional relation to the rate of fuel flow to the burner, comprising, means for producing an electrical effect corresponding to the intensity of the noise produced by the combustion of the fuel discharged from said burner, means responsive to the rate of fuel flow to said burner for producing an electrical effect corresponding to the intensity of characteristic noise produced by said burner when functioning at minimum approved combustion efficiency for the then existing rate of fuel flow to the burner, means for comparing said effects to ascertain the sign of the difference between said electrical effects, and means responsive to the sign of the difference between the two electrical effects indicative of combustion at greater than minimum approved efficiency or functioning at less than minimum approved combustion efficiency according as the said difference has one sign or the opposite sign.

2. A flame-responsive control system comprising in combination, fluent fuel burner means combustion at which at minimum approved efficiency is accompanied by noise of which the intensity varies with the rate of fuel supply to the burner means, sound-measuring means adapted in response to the reception of noise associated with the operation of the burner means to generate a signal representative of the intensity of said noise, fuel-measuring means adapted to generate a signal representative of the rate of fuel supply to the burner means, means responsive to the signals generated by the sound-measuring means and by the fuel-measuring means and adapted to supply a control signal indicative over a range of rates of fuel supply to the burner means of the difference between the intensity of the noise associated with the operation of the burner means and the intensity of the noise variable over said range accompanying combustion at minimum approved efficiency at said burner means, and a controlled device arranged to receive said control signal and to assume one condition indicative of combustion at greater than minimum approved efficiency when the said difference is of one sign and another condition indicative of functioning at less than minimum approved combustion efficiency when the said difference is of opposite sign.

3. A flame-responsive control system comprising in combination, fluent fuel burner means combustion at which at optimum efficiency is accompanied by noise of which the intensity varies with the rate of fuel supply to the burner means, sound-measuring means adapted in response to the reception of noise associated with the operation of the burner means to generate a signal representative of the intensity of said noise, fuel-measuring means adapted to generate a signal dependent upon the rate of fuel supply to the burner means and so varying with the rate of fuel supply to the burner means as to be less by a predetermined constant amount, representative of maximum approved shortfall of combustion efficiency below the optimum, than the signal that would be generated at varying load by the said sound-measuring means with combustion at optimum efficiency, a controlled device adapted to assume alternative conditions indicative of functioning at combustion efficiency greater or less than that corresponding to said maximum approved shortfall according to whether the value of a signal applied thereto is of one sign or of the opposite sign, and means responsive to the signals generated by the sound-measuring means and the fuel-measuring means and arranged to apply to the controlled device a signal representative of the difference between the signal generated by the sound-measuring means and the signal generated by the fuel-measuring means.

4. A flame-responsive control system comprising in combination, fluent fuel burner means combustion at which at optimum efficiency is accompanied by noise of which the intensity varies with the rate of fuel supply to the burner means, sound-measuring means adapted in response to the reception of noise associated with the operation of the burner means to generate a signal representative of the intensity of said noise, fuel-measuring means adapted to generate a signal dependent upon the rate of fuel supply to the burner means and at each rate of fuel supply to the burner means within a range of rates of fuel supply to the burner means differing by a constant predetermined amount, representative of maximum approved shortfall of combustion efficiency below the optimum, from the signal generated by said sound-measuring means under circumstances of optimum combustion efficiency at the burner means, means responsive to the signals generated by the sound-measuring means and by the fuel-measuring means and adapted to supply a control signal indicative of the difference between the values of said signals and a controlled device arranged to receive said control signal and adapted to assume one condition indicative of combustion at efficiency greater than that corresponding to maximum approved shortfall when the said difference is of one sign and another condition indicative of functioning at combustion efficiency less than that corresponding to maximum approved shortfall when the said difference is of the opposite sign.

5. A flame-responsive control system comprising in combination, fluent fuel burner means combustion at which at optimum efficiency is accompanied by noise of which the intensity varies with the rate of fuel supply to the burner means, means for measuring the intensity of the noise associated with the operation of the burner means, means for measuring the rate at which it is desired that the burner means shall burn fuel, means for effecting a comparison between the intensity of the noise associated with the operation of the burner means and the intensity of the noise appropriate to the combustion at the burner means at minimum approved efficiency at the rate determined by the last measuring means, and a controlled device arranged to receive said comparison as input and adapted to assume one condition indicative of combustion at efficiency greater than that corresponding to maximum approved shortfall when the intensity of the noise associated with the operation of the burner means is above, and another condition indicative of functioning at combustion efficiency less than that corresponding to maximum approved shortfall when the intensity of the noise associated with the operation of the burner means is below, the intensity of the noise appropriate to the

combustion at the burner means at minimum approved efficiency of fuel at the rate determined by the measuring means.

6. In an oil-fuel-burning system the combination of an oil-fuel atomiser comprising an atomiser barrel supported for axial movement between a projected operative position and a retracted inoperative position, means arranged for moving the atomiser between its projected and retracted positions, stop means preventing the movement of the atomizer barrel beyond the projected operative position and operative to produce the sound of a mechanical blow, a microphone arranged to receive said sound of a mechanical blow when the atomiser attains its projected position, and means responsive to the output from the microphone adapted to effect a signal upon the reception by the microphone of said sound of mechanical blow.

7. In an oil-fuel-burning system the combination of an oil-fuel atomiser comprising an atomiser barrel supported for axial movement between a projected operative position and a retracted inoperative position, means arranged for moving the atomiser between its projected and retracted positions, stop means preventing the movement of the atomiser barrel beyond the projected operative position and operative to produce the sound of a mechanical blow, an igniter for the fuel oil delivered by the atomiser and also supported for movement between a projected operative position and a retracted inoperative position, means arranged for moving the igniter between its projected and retracted positions and providing stop means preventing the movement of the igniter beyond the projected operative position and operative to produce the sound of a mechanical blow, a microphone arranged to receive the sound of a mechanical blow when the atomiser attains its projected position and the sound of a mechanical blow when the igniter attains its projected position, and means responsive to the output from the microphone adapted to effect signals upon the reception by the microphone of said sounds of mechanical blows.

8. In an oil-fuel-burning system the combination of an oil-fuel atomiser comprising an atomiser barrel supported for axial movement between a projected operative position and retracted inoperative position, means arranged for moving the atomiser between its projected and retracted positions, stop means preventing movement of the atomiser barrel beyond the projected operative position and operative to produce the sound of a mechanical blow, an electric spark igniter for the fuel oil delivered by the atomiser and also supported for movement between a projected operative position and a retracted inoperative position, means arranged for moving the igniter between its projected and retracted positions and providing stop means preventing the movement of the igniter beyond the projected operative position and operative to produce the sound of a mechanical blow, a microphone arranged to receive the sound of a mechanical blow when the atomiser attains its projected position, the sound of a mechanical blow when the igniter attains its projected position, the sounds of ignition sparks at the igniter, and the noise of combustion of the oil fuel discharged by the atomiser and responsive to said sounds and noise, and means responsive to the output from the microphone adapted to effect signals upon the reception by the microphone of said sounds of mechanical blows, upon the reception by the microphone of the said sounds of ignition sparks, and upon the reception by the microphone of the noise of combustion at approved satisfactory combustion efficiency of the fuel oil discharged by the atomiser.

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