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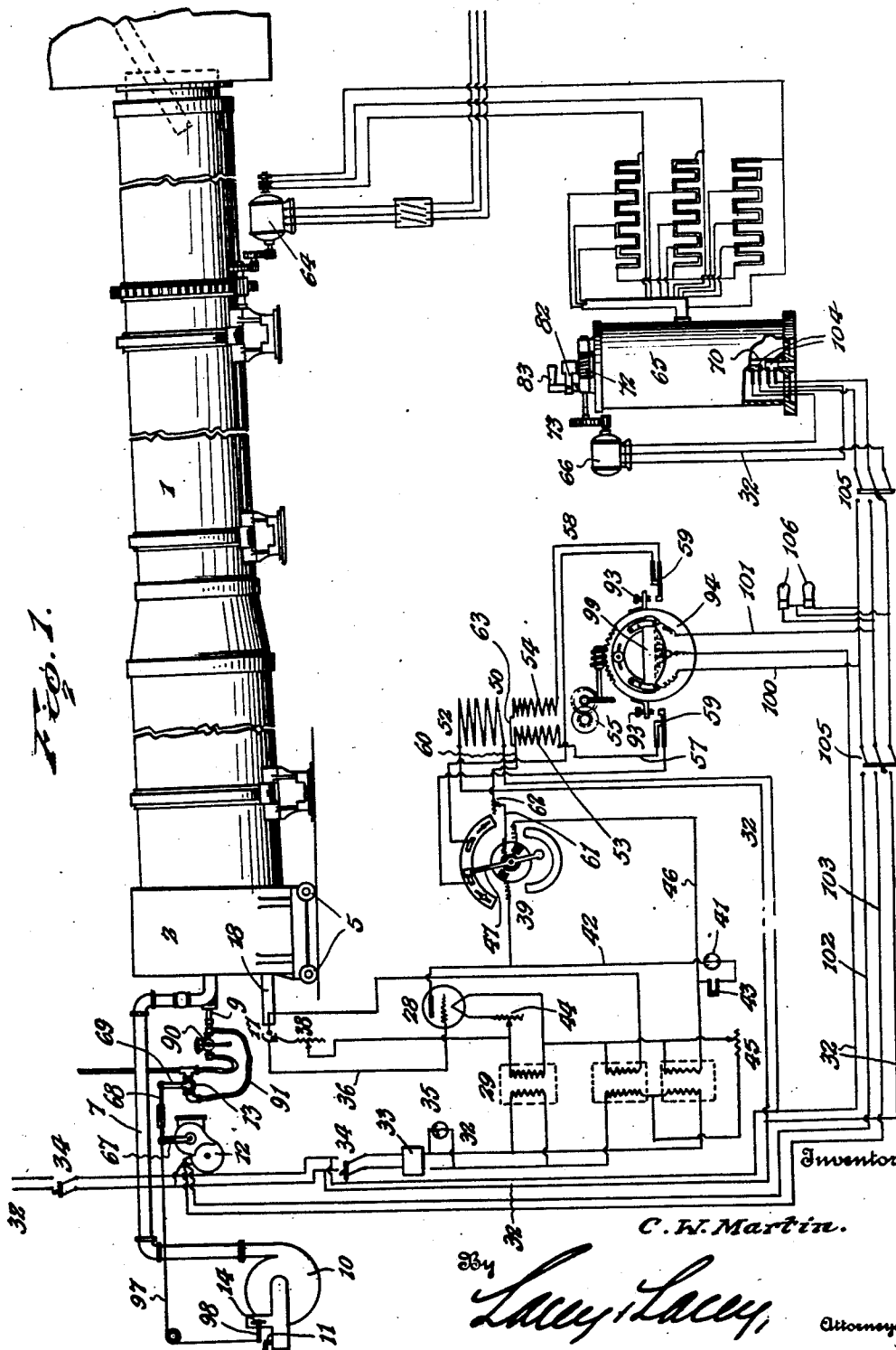
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MEANS FOR CONTROLLING OPERATION OF CEMENT KILNS

Filed March 19, 1931

6 Sheets-Sheet 1



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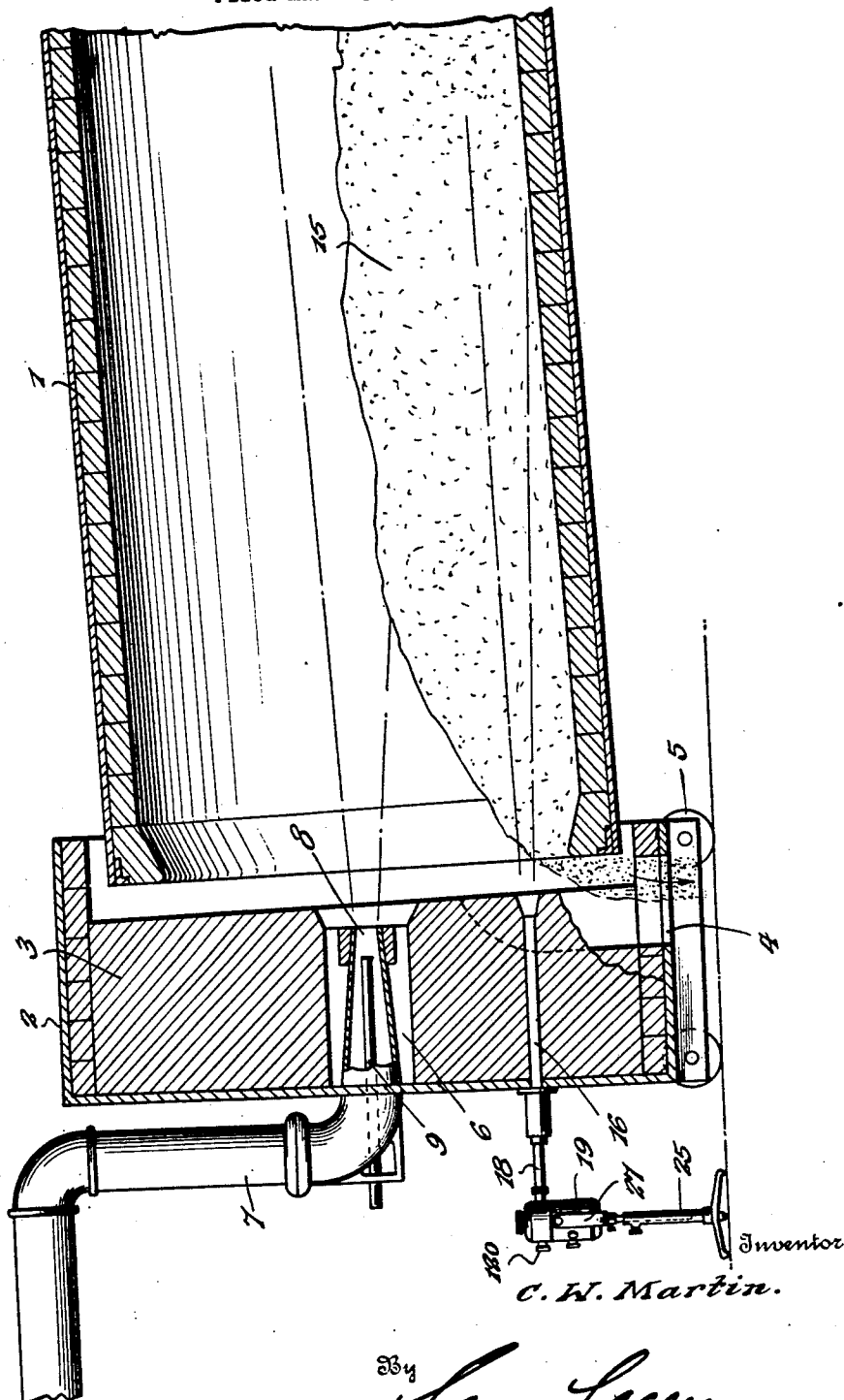
1,945,652

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Filed March 19, 1931

6 Sheets-Sheet 2

Fig. 2.



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Filed March 19, 1931

6 Sheets-Sheet 3

Fig. 3.

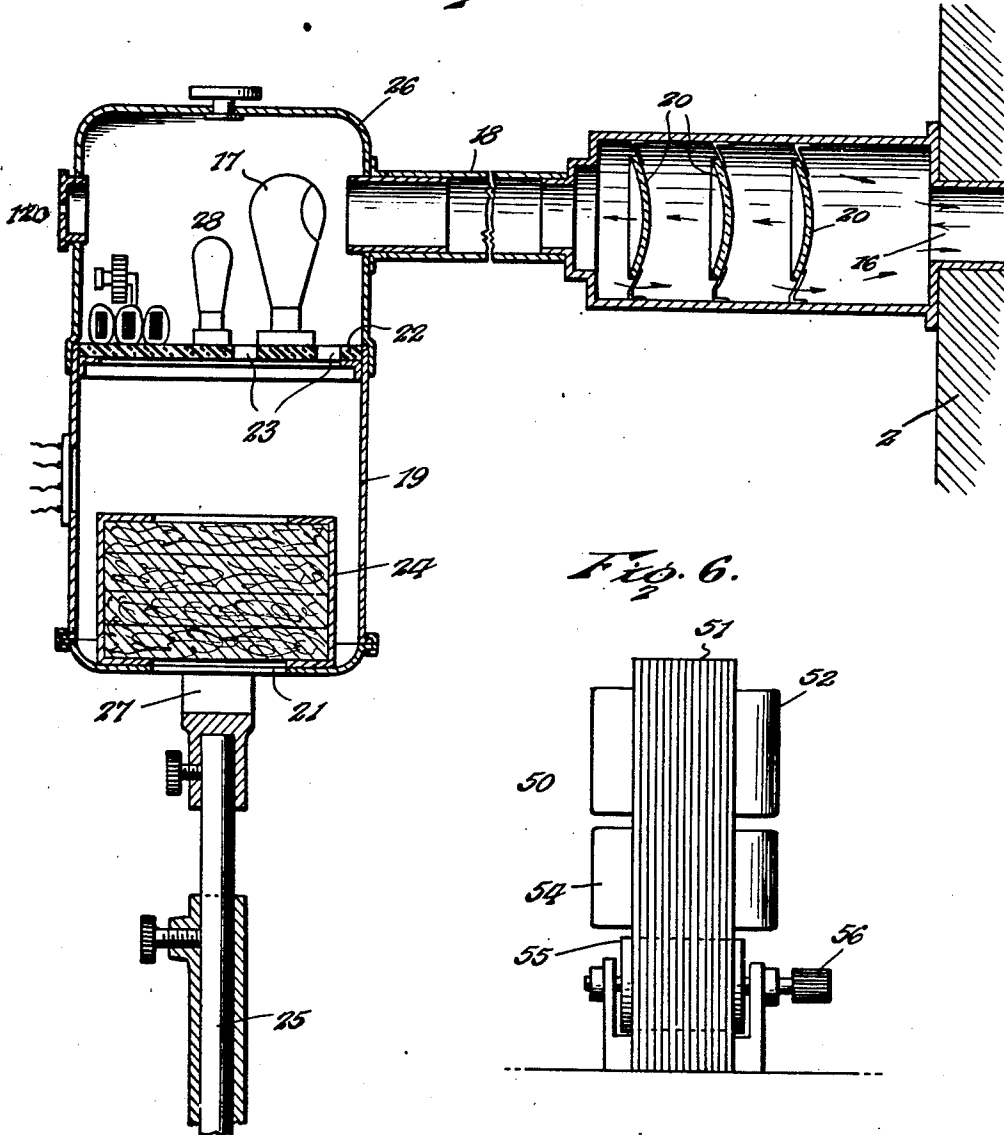
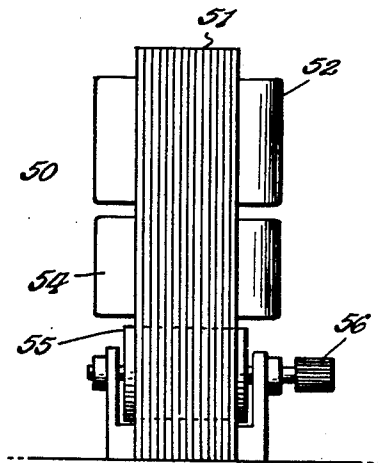


Fig. 6.



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1,945,652

MEANS FOR CONTROLLING OPERATION OF CEMENT KILNS

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6 Sheets-Sheet 4

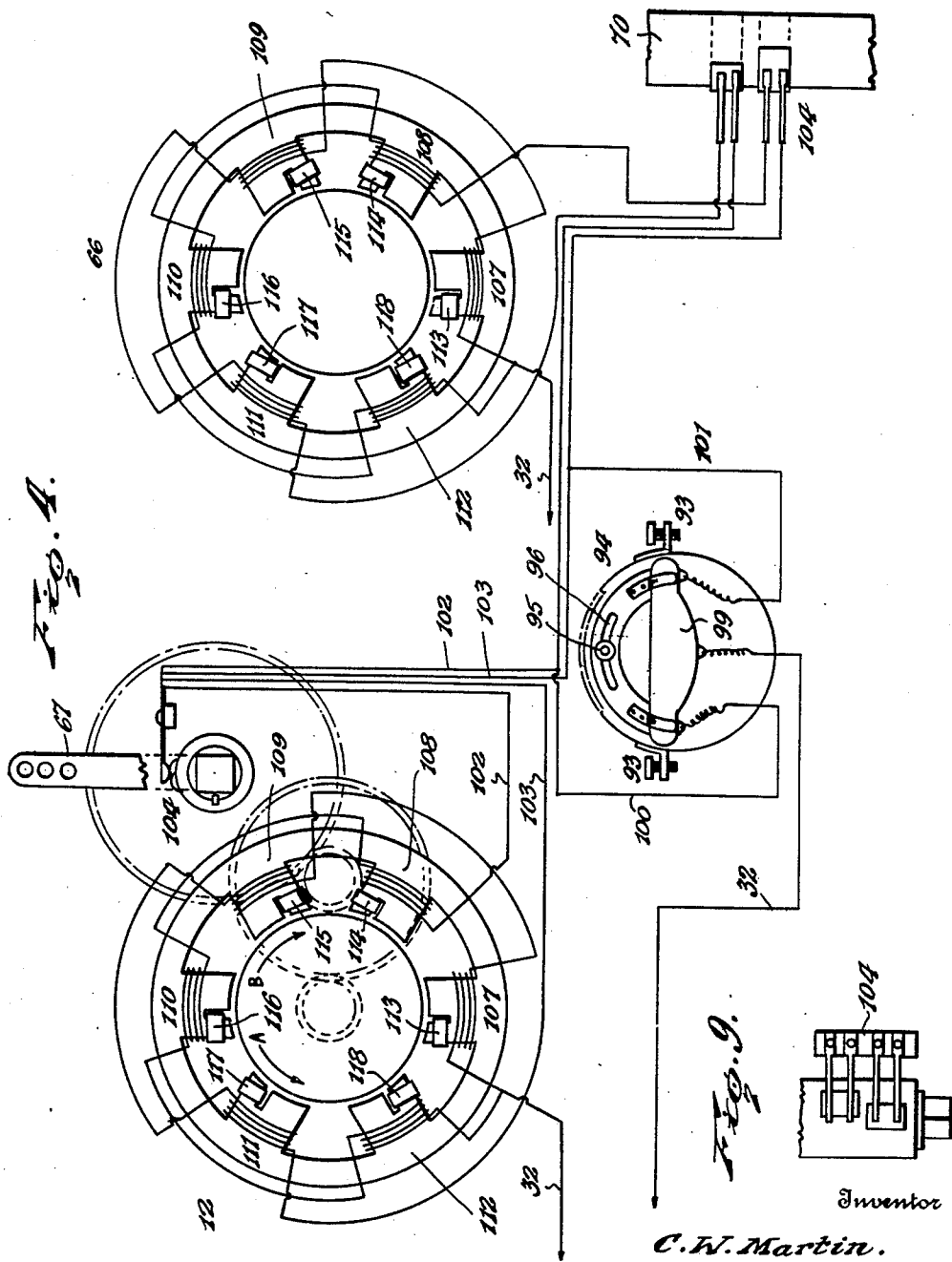


Fig. 8.

Fig. 9.

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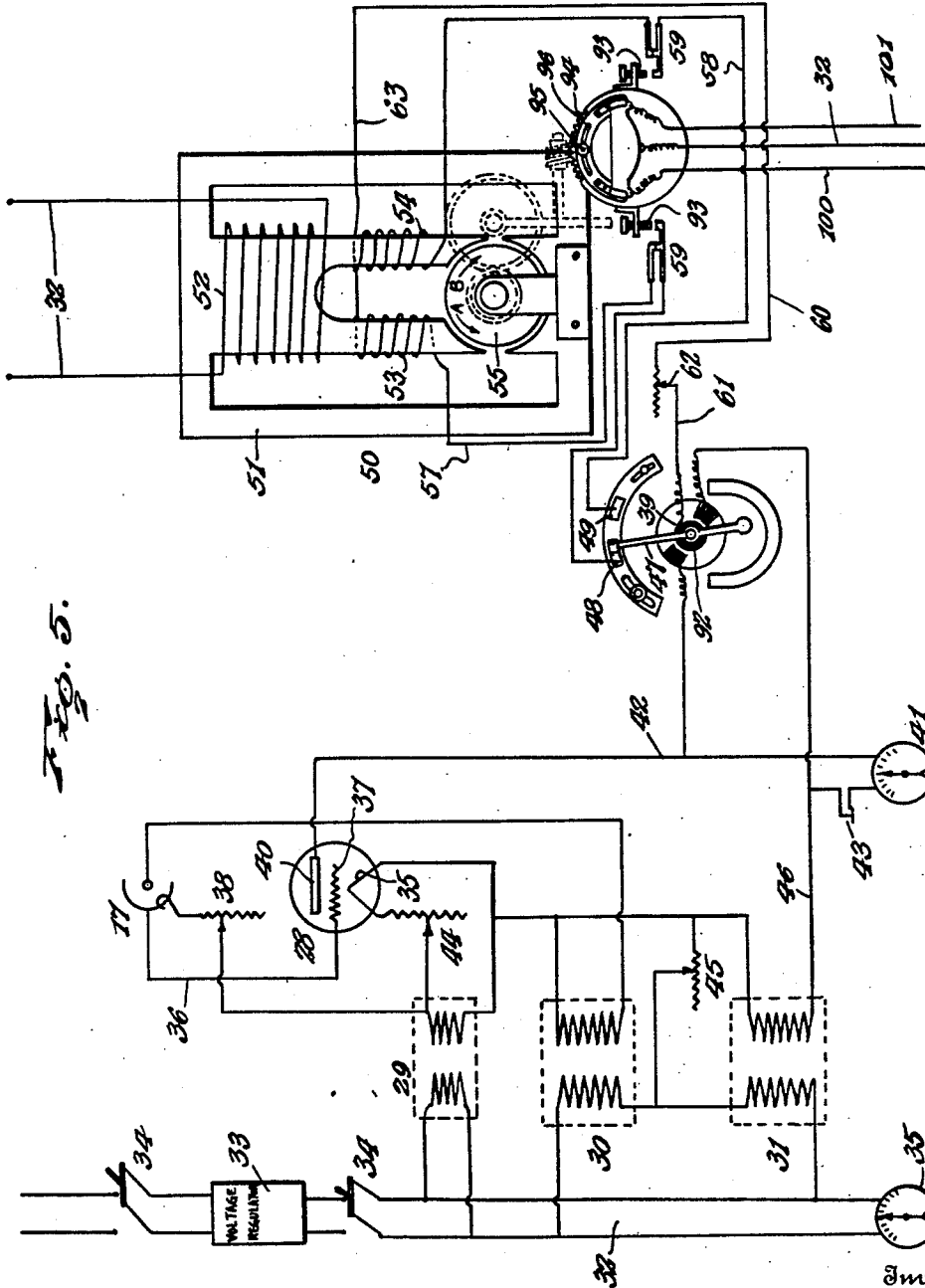
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MEANS FOR CONTROLLING OPERATION OF CEMENT KILNS

Filed March 19, 1931

6 Sheets-Sheet 5



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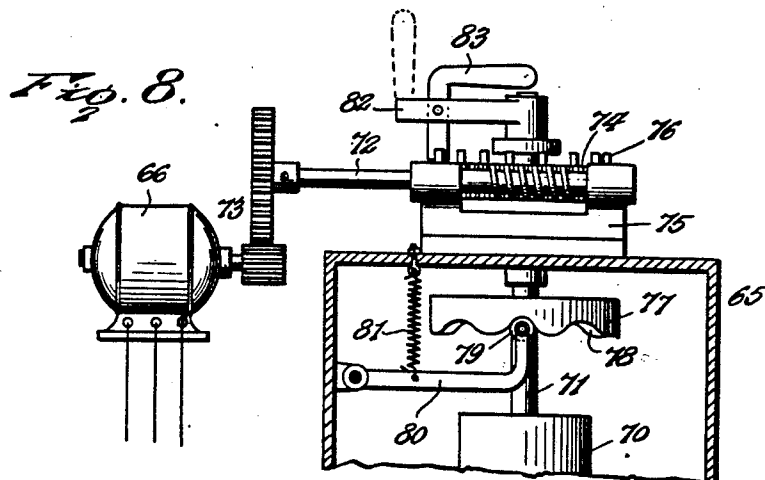
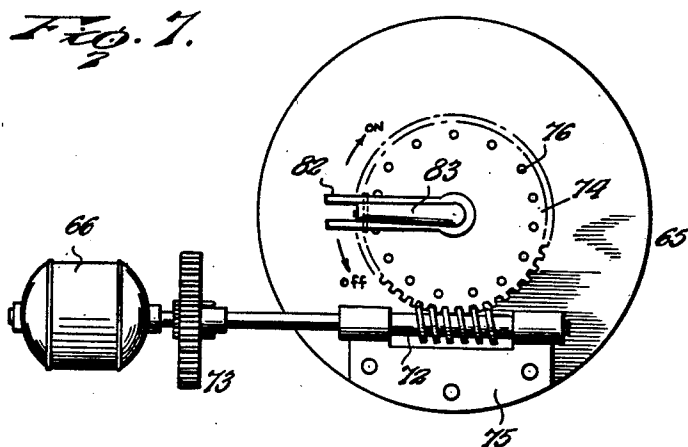
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MEANS FOR CONTROLLING OPERATION OF CEMENT KILNS

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6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

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MEANS FOR CONTROLLING OPERATION OF
CEMENT KILNS

Claude Worth Martin, Gold Hill, Oreg.

Application March 19, 1931. Serial No. 523,881

10 Claims. (Cl. 222-7)

This invention has for its object the provision of means whereby the speed of rotation of a cement kiln and the supply of fuel thereto may be automatically regulated.

5 Cement kilns as now generally constructed consist of a cylinder of sheet metal lined with fire-brick and supported on heavy rollers in an inclined position, a motor being geared to the cylinder to rotate it slowly about its longitudinal axis. The upper end of the kiln projects into a brick flue which is surrounded by a brick lined stack for carrying off the waste products of combustion, and the material to be burned is fed into the kiln at the upper end of the same, the feeding mechanism being usually geared to the kiln-rotating means so that when the rotation of the kiln stops the feeding also stops. The material fed into the kiln travels toward the lower front end of the same by reason of the inclination of the cylinder and also because of its rotation, the front end of the kiln being disposed within a fire-brick hood which may be moved toward and from the kiln and which carries fuel-supplying elements. The hood is provided at its low point with an opening through which the burnt material is discharged and through which the greater quantity of air to support combustion enters. The time required for material to pass through the kiln depends on the speed of rotation, the inclination of the kiln and physical conditions that are entirely within the kiln and, due to such conditions, the material at times forms rings and dams which cause an uneven flow of material to the calcining and reaction zones near the discharge end of the kiln. This condition is the critical problem in the production of uniformly burned clinker as the fuel value must be varied according to the quantity of material in the burning zone, and means are provided for controlling the speed of rotation of the kiln and the supply of fuel which means now are operated manually by an attendant. The duties of this attendant, however, are very exacting and it is only after long experience that he is able to turn out a reasonably uniform product. The present invention provides means whereby the speed of rotation of the kiln, the passage of material through the kiln and the relation of the fuel to the charge may be automatically regulated. The invention is illustrated in the accompanying drawings and will be hereinafter first fully described and then more particularly defined in the appended claims.

In the drawings:

55 Figure 1 is a diagram partly representing an

elevation of the furnace and the hood with the invention in connection therewith,

Fig. 2 is a central longitudinal vertical section through a portion of a kiln and the hood showing my improved apparatus applied thereto,

Fig. 3 is an enlarged vertical section through the container for the light-sensitive cell and the parts associated immediately therewith,

Figs. 4 and 5 are diagrams,

Fig. 6 is an edge elevation of a relay which forms part of the apparatus,

Fig. 7 is a top plan view of a controller, which regulates the motor for turning the kiln,

Fig. 8 is a side elevation, partly in section, of the mechanism shown in Fig. 7,

Fig. 9 is a detail.

The kiln is indicated by the reference numeral 1 and may be of any usual or approved detailed construction, being shown in the accompanying drawings only to such an extent as is deemed necessary to an understanding of the invention. The front end of the kiln is disposed within a hood 2 which is of the usual sheet metal construction having fire-brick or other refractory lining, indicated at 3, and in the bottom of this hood is an opening 4 through which the burnt clinker is discharged and air is admitted to the kiln to support combustion, the hood being mounted upon rollers 5 in the usual manner so that it may be moved toward and from the kiln as may be necessary. The fuel is admitted through an opening 6 formed through the hood at such point as may be deemed most advantageous. The fuel most generally used is oil or finely powdered coal which is delivered through a fuel supply pipe and is blown into the kiln by an air blast discharged through a pipe 7 which leads into the opening 6 of the hood and terminates in a nozzle formation 8 which is disposed concentrically about the fuel supply pipe 9. In Fig. 1 of the accompanying drawings, the air pipe 7 is equipped with a blower, indicated conventionally at 10, having its inlet provided with a hand valve 11, the blower being operated by its own motor, preferably an electric motor of known type, which is not illustrated in the drawings as it forms no part of the present invention. The air pipe is also equipped with a valve 14 which is opened and closed through the action of a motor 12, as will hereinafter appear. A valve 13 is mounted in the oil feed line and is controlled by the same motor 12, there being also a hand valve 90 and the oil flowing through the valve 13 passing around the valve 90 through a by-pass pipe 91. The charge of material is indicated in Fig. 2

The charge of material is indicated in Fig. 2

by the reference numeral 15, and the burning zone is from five to twenty feet from the discharge end of the kiln. Mounted through the hood at a point below and at one side of the fuel nozzle 8 is a tube 16 which is so located that the light emitted from the burning charge will pass into and through the tube to play upon a photo-electric cell or other light-sensitive element 17 which is focused upon the charge at the hottest point or burning zone of the same through a tubular housing 18 extending from the container 19 to the tube 16, as shown in Figs. 2 and 3, the container 19 housing the cell 17 and the parts immediately cooperating therewith. The tubular housing 18 has its portion immediately adjacent the hood of larger diameter than the remaining portion and within this enlarged portion is a series of glass screens 20 which serve to arrest the heat waves from the burning zone while permitting the light waves to flow to the cell 17. It is obviously desirable to have the cell 17 unaffected, as far as possible, by variations in temperature and to be energized solely by the rays of light and for this purpose the screens 20 are interposed between the cell and the light source. The container 19 is preferably of cylindrical formation having an opening 21 in its bottom and provided intermediate its height with a shelf 22 having openings 23 therethrough. The openings 21 and 23 provide inlets for air to circulate through the container and about the cell 17, and then flow through the tube 18 around the screens 20 into the kiln, thereby providing ventilation and resisting a rise in temperature within the container and about the photo-electric cell. An air filter 24 is disposed within the container 19 and rests upon the bottom of the same over the opening 21, said filter being of any approved construction and consisting preferably of plies of coarse mesh cloth which will serve to filter or strain the air and between which is placed raw cotton or other material which will serve to remove from the air flowing therethrough any impurities which might affect the operation of the sensitive apparatus. The container is supported upon a telescopic post 25 whereby it may be set at the proper height to focus upon the burning material through the tubes 18 and 16 notwithstanding depressions or irregularities in the floor of the furnace room. The container has a removable cover, indicated at 26, and is pivotally mounted between the upper ends of a fork 27 which is carried by the upper end of the post 25 so that, when necessary, the container may be swung pivotally to permit adjustment or repair or renewal of any of the parts.

The photo-electric or light-sensitive cell 17 is mounted upon the shelf 22, as shown clearly in Fig. 3, and immediately adjacent the cell an amplifier tube 28 is mounted on the shelf, the container having a sight-opening, as at 120, aligned with the cell and the tube 18 to facilitate the focusing of the cell. Mounted upon the shelf in association with the photo-electric cell and the amplifier tube is a relay consisting essentially of three transformers 29, 30 and 31, the primary windings of the several transformers being connected to the trunk lines 32. The trunk lines pass through a voltage regulator, indicated at 33, as it is important that the voltage supplied to the apparatus be as nearly uniform as possible, and switches 34 are provided in the trunk lines to cut off or permit the flow of current in an obvious manner. A voltmeter 135 is also connected with the trunk lines in order that the

strength of the current may be noted whenever desired. The secondary winding of the transformer 29 is connected with the heating filament 35 of the amplifier tube 28, while the secondary winding of the transformer 30 is connected with the cell 17, a lead 36 extending from the cell 17 to the grid element 37 of the amplifier and a variable resistance 38 being interposed between the cell and the secondary winding of the transformer 29, said secondary winding being in series with the secondary winding of the transformer 30 so that the current supplied to the cell 17 passes through both said secondaries. The secondary winding of the transformer 31 is in series with the secondary windings of the other transformers and at one side leads out to a switch or relay 39 which will be presently more particularly described. The plate element 40 of the amplifier is connected with one side of the switch 39 and a direct current voltmeter 41 is also connected with the lead 42, extending from said plate element, and with one side of the secondary winding of the transformer 31, a switch 43 being interposed in the last-mentioned connection so that the voltmeter may be made active or inactive as desired. The direct current voltmeter, like the alternating current voltmeter 135, is intended to be rendered active only at such times as the operator desires a reading and is for the purpose of checking the direct current output of the amplifier. A variable resistance 44 is interposed in the connection between the filament 35 and the secondary winding of the transformer 29 and a variable resistance 45 is interposed between the primary and secondary windings of the transformers 30 and 31. The variable resistance 45 permits close regulation of the volume of current between the windings of the transformers 30 and 31 while the resistance 44 permits a regulation of the current to the heater filament 35. These variable resistances increase the sensitivity of the amplifier, and the output of the photo-electric cell 17 is more than doubled by increasing the electric discharge between the electrodes of the cell, thereby insuring extreme sensitivity and accuracy. The provision of the three transformers is for the purpose of securing a decided direct current polarity in the terminals of the secondary windings of the transformers 30 and 31 and to protect the amplifier from outside interference.

The amplified currents pass over the leads 42 and 46 to the opposite sides of the armature winding in the relay or switch 39, the rocking switch arm 47 having its free end arranged to play between contacts 48 and 49 and the hair spring 92 being adjusted to balance the clockwise torque or magnetic pull of the current when the temperature of the material in the reaction or burning zone of the kiln is at the lowest permissible degree, say 1800° F. When current flows through the switch 39, the arm 47 is rocked so that its free end makes contact with either of the contacts 48 or 49. A new and stronger current is then brought into action to start, stop or reverse the small motor of the relay 50 which, in turn, starts, stops or reverses the motor 12 and a motor which actuates the controller governing the motor by which the kiln is rotated. The polarized relay 50 has a laminated frame or core 51, about the upper portion of which is wound the primary winding 52, which is connected directly with the intake trunk lines 32 and is constantly active, and secondary windings 53 and 54 are mounted upon the respective legs of the frame, 150

as will be understood upon reference to Fig. 5. The motor 55 is disposed adjacent the lower ends of the legs carrying the windings 53 and 54 and its shaft is mounted in suitable bearings in the lower portion of the frame and at one end is equipped with a pinion 56, as shown in Fig. 6. One end of the winding 53 is connected through a lead 57 with the contact 48 while the lower end of the winding 54 is connected through a similar lead 58 with the contact 49, interrupting circuit-closers, indicated at 59, being interposed in both these leads, as shown in Figs. 1 and 5, and being opened by impact of the respective strikers 93 on opposite sides of the casing or frame of the mercury switch 94, the latter being connected by suitable gearing with the pinion 56 to be rocked thereby. The mercury switch is secured to the gear which directly rocks it by a bolt 95 inserted through a slot 96, which provides for adjustment, and the opening of either circuit-closer 59 arrests the rocking movement of the switch. The upper end of the winding 53 is connected through a lead 60 and a lead 61 with one side of the switch 39, a variable resistance 62 being interposed in the line, while the upper end of the winding 54 is connected by a lead 63 with the same variable resistance 62 to complete a circuit through the arm 47 and the contact 48 or 49.

By referring to Fig. 1, it will be noted that there is a motor 12 for regulating the air-controlling valve and the oil-controlling valve and a motor 64 for turning the kiln, the latter generally being a slip-ring variable speed electric motor of from 25 to 100 H. P., according to the size of the kiln and other physical conditions. It will also be noted that there is a controller 65 for regulating the speed of the motor 64, and a motor 66 by which the operation of the controller 65 may be automatically accomplished. The motor 12 is connected through speed-reducing gearing with a lever or crank arm 67 which is connected by a link 68 with a similar lever or crank arm 69 on the stem of the valve 13, and is connected by a cable or other flexible connection 97 with a lever 98 on the stem of the valve 14. Thus, when the motor 12 is actuated, the air and fuel valves will be opened or closed automatically. Independent regulation of the air and fuel supply may be effected by manually setting the valves 11 and 90 as will be understood.

The controller 65 may be of any well known construction and electrically connected with the motor 64 in the usual manner. It is, therefore, illustrated in a more or less conventional manner. The controller drum 70 has its shaft 71 extended through the top of the cylinder or casing of the controller and upon the top of the cylinder is a bracket 75 in which is mounted a worm shaft 72 geared to the motor 66, as shown at 73. The worm on shaft 72 meshes with a worm gear 74 which is provided at one side of the bracket 75 and is fitted loosely upon the shaft 71. Upon the upper side of this worm gear 74 are pins or studs 76 which are spaced equidistantly around the gear adjacent the margin of the same, as clearly shown in Fig. 7, and fixed upon the shaft 71 within the casing of the controller is a cam wheel or disk 77 having convolutions 78 on its under side which correspond in number and spacing to the pins or studs 76. The wheel or disk 77 is engaged by a roller 79 mounted at the free end of a lever 80 to which is attached one end of a retractile spring 81 which has its opposite end secured to the top of the

controller casing, as clearly shown in Fig. 8. This spring permits the lever to ride under the apexes of the several convolutions of the disk and when an apex has cleared the roller the spring will lift the lever, whereupon the roller, riding down the side of the convolution, will propel the disk sharply and cause it to come to a stop, as will be understood upon reference to Fig. 8. The usual controller lever 82 is secured to the upper end of the shaft 71 and a handle 83 is pivoted to said lever. This handle, as shown clearly in Fig. 8, is of right angular formation and ordinarily it will be in the position shown in full lines in Fig. 8 whereby one end thereof will engage between adjacent pins or studs 76 so that, if the worm gear 74 be rotated through the action of the motor 66, the movement will be transmitted to the shaft 71 and the controller set to regulate the speed of the kiln. If it be desired to control the speed of the kiln by hand, the handle 83 is rocked to the dotted line position and may then be moved freely without actuating the worm gear. It is thus possible to regulate the speed of the kiln by hand or automatically.

The switch 94 comprises a glass tube having a central well 99 in which is a quantity of mercury and to which one of the trunk lines is connected so that its end is immersed in the mercury. At the ends of the tube conductors 100 and 101 are attached to be covered by the mercury when the tube is rocked, and these conductors are connected to leads 102 and 103, respectively, which carry the current to the motors 12 and 66, interrupters 104 being provided in both circuits to prevent the crank 67 or the controller handle being turned so far as to cause damage. Switches 105 are also provided so that either motor may be cut out when necessary or desirable. Pilot lights 106 are connected respectively with opposite sides of the motors 12 and 66 and have a common return to the trunk lines 32 and serve to inform the attendant whether the temperature in the kiln is high or low. They may be given different colors to promote certainty in their indications.

The motors 12 and 66 are single phase reversible motors and are identical in construction as will be understood on reference to Fig. 4. It will be noted that each motor has six pole pieces 107, 108, 109, 110, 111 and 112 and a shading coil 113, 114, 115, 116, 117, 118, is associated with each respective pole piece. It will also be noted that while the windings have a common return connection with the trunk line the input leads 102 and 103 are connected to alternate windings and run in opposite directions so that the windings 108, 110 and 112 are in the circuit A and the windings 107, 109 and 111 are in the circuit B.

The tubes 16 and 18 exclude all lateral light and combustion of fuel occurs in mid-air, no fuel striking the material to be burned, so that the photoelectric cell is affected solely by the rays emanating from the incandescent body of material. The material in the reaction or burning zone does not actually burn but is heated to a point of fusion and advances steadily to its greatest temperature, about 2500° F., at which temperature a brilliant white heat is produced, but fresh material entering the reaction or burning zone reduces the temperature and the quality of light passing to the cell 17, the output of the cell varying accordingly. Assuming the point on which the cell 17 is focused to be at the normal or mean temperature, the control mechanism will remain at rest as long as this temperature

is maintained. Should the burning zone be flooded with fresh unburned material, the cooler dark charge will quickly push the incandescent body of clinker forward beyond the focus or vision of the cell so that its output of current will be reduced. The current is intensified by the amplifier and the intensified current varies, as does the current from the cell with the incandescence of the material upon which the cell is focused, and is used for the sole purpose of actuating the switch 39 whereby, in the assumed case of reduction of temperature, the arm 47 will be rocked into engagement with the contact 48, thereby closing the circuit through the coil 53 and energizing the same. The motor 55 is, consequently, caused to rock the mercury switch 94 and close circuits through the motors 12 and 66 which will thereupon set the valves 13 and 14 and the controller 65 so that the supply of fuel will be increased and the rotation of the kiln and feeding of the charge will be retarded. Should the temperature in the kiln rise beyond the set degree, the arm 47 will be caused to engage the contact 49 and the coil 54 will be energized, the mercury switch will be rocked in the opposite direction, and the supply of fuel will be diminished while the speed of the kiln and the material will be accelerated. It will be understood that, normally, the tube of the switch 94 is in a horizontal position and the mercury is contained wholly in the well but when the switch is rocked the mercury flows to the low end of the tube and bridges the terminals of two conductors so that the input lead will be electrically connected with the lead 100 or 101, as the case may be, and the motors 12 and 66 turned in one or the opposite direction accordingly.

It is to be understood that, in actual practice, the transformers, relays and switches are small enough to be easily mounted within the container 19 with the amplifier and the photo-electric cell.

Having thus described the invention, I claim:

1. The combination of a valve controlling the flow of fuel to a cement kiln, a light-sensitive element focused upon the material burning within the kiln, means for excluding lateral light from said element, a motor for setting said valve, means controlled by said element for rotating the kiln, and means controlled by the light-sensitive element for driving said motor.

2. The combination with a rotatable cement kiln, and a motor for rotating the same, of a controller connected with said motor for regulating the same, a light-sensitive element focused upon the burning material within the kiln, means for excluding lateral light from said element, a motor geared to the controller for operating the latter, and means controlled by the light-sensitive element for operating the last-mentioned motor.

3. The combination with a rotatable cement kiln, of a light-sensitive element focused upon material burning within the kiln, means for excluding lateral light from said element, and means controlled by the light sensitive element for rotating the kiln.

4. In means for controlling the operation of a cement kiln, the combination with a light-sensitive element of tubular connections between said element and the kiln whereby the element may

be focused upon material burning in the kiln and closed against outside light, means controlled by said light-sensitive element for rotating the kiln, and fuel and air-regulating means controlled by said light-sensitive element.

5. The combination with a rotatable cement kiln including a hood and a motor for rotating the kiln, of a tube extending through the hood and communicating with the interior of the kiln, a light sensitive element focused through the tube upon material burning in the kiln, and means controlled by the light-sensitive element for operating said motor.

6. The combination with a rotatable cement kiln including a hood and a motor for rotating the kiln, of a tube extending through the hood and communicating with the interior of the kiln, a housing having one end thereof connected with the tube, spaced screens disposed within the tube, a light sensitive element connected with the other end of the housing and focused through the screens and tube upon material burning in the kiln, and means controlled by the light-sensitive element for operating the motor.

7. The combination with a rotatable cement kiln including a hood and a motor for rotating the kiln, of a tube extending through the hood and communicating with the interior of the kiln, a housing having one end thereof connected with the tube, screens disposed within the housing, a standard, a casing pivotally mounted on the standard and connected with the other end of the housing, a light sensitive element disposed within the casing and focused through the screens upon material burning in the kiln, and means controlled by the light-sensitive element for operating said motor.

8. The combination with a rotatable cement kiln including a hood having an opening therein communicating with the interior of the kiln, and a motor for rotating the kiln, of a standard spaced from the hood, a casing pivotally mounted on the standard, a housing connected with the casing and communicating with the opening in the hood, screens disposed within the housing and spaced from the interior wall thereof, a light sensitive element disposed within the casing and focused through the screens and opening in the hood upon material burning in the kiln, and means controlled by the light-sensitive element for operating the motor.

9. The combination with a rotatable cement kiln including a hood having a portion thereof projecting over the kiln and provided with an opening, and a motor for rotating the kiln, of a housing communicating with the opening in the hood, a screen disposed in the housing, a light sensitive element focused through the screen and opening in the hood upon material burning in the kiln, means controlled by the light-sensitive element for introducing fuel through the hood into the kiln, means controlled by the light-sensitive element for conducting air to the delivery end of the fuel conducting means, and means controlled by the light-sensitive element for operating said motor.

10. The combination with a rotatable cement kiln, of a light-sensitive element focused upon material burning in the kiln, and means controlled by said element for rotating the kiln.

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