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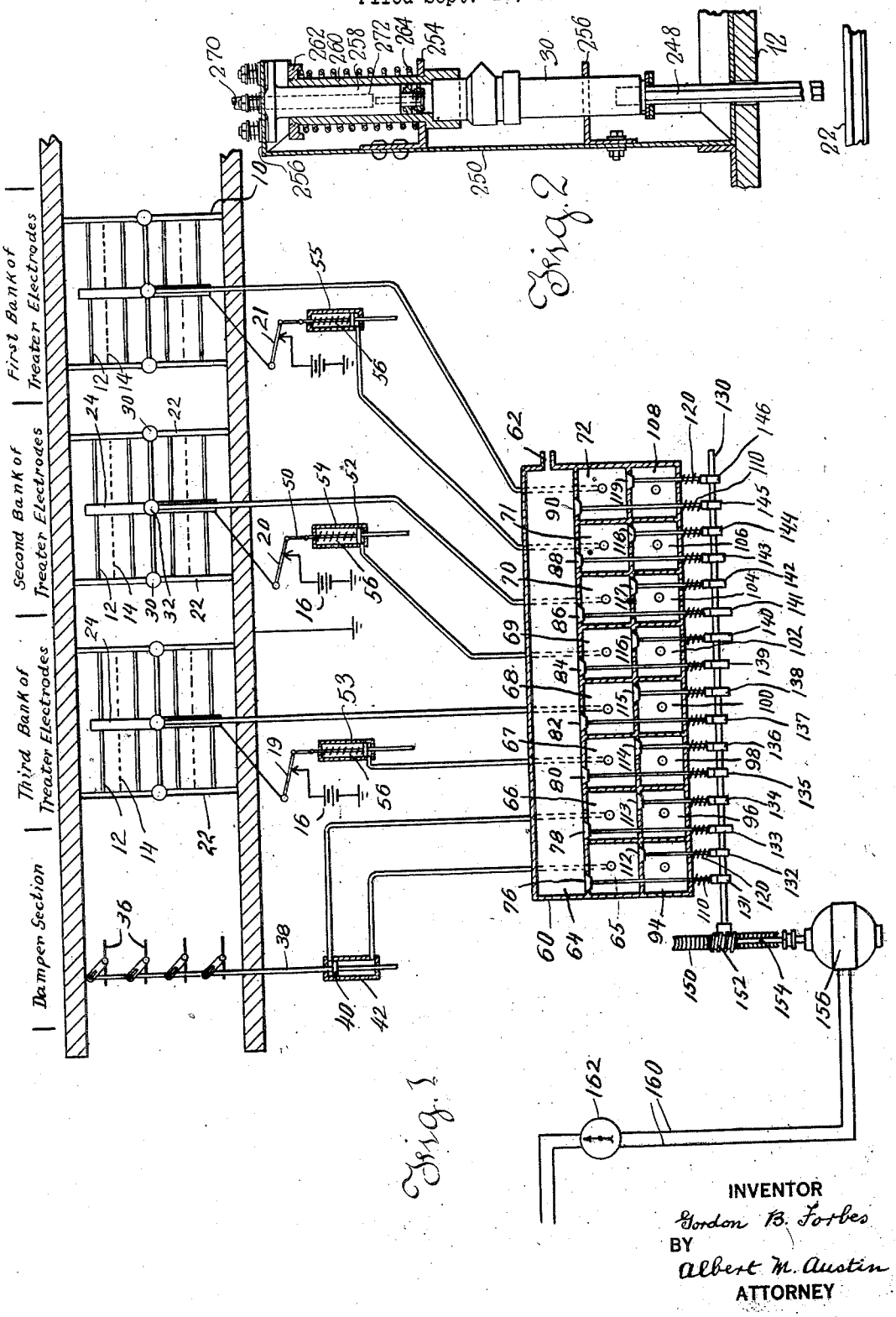

Fig. 2

Fig. 1

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APPARATUS FOR REMOVING DUST FROM PRECIPITATOR ELECTRODES.

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My present invention relates to apparatus for use in connection with apparatus which serves to jar or vibrate the electrodes of a high tension discharge apparatus for precipitating dust or other fine material particles. In the apparatus of my present invention automatic means are provided for stopping the flow of gases laden with dust past such precipitated electrodes, for opening and closing the high tension circuit of said electrodes, and for rendering operative and inoperative vibrators for jarring said electrodes, and for successively vibrating different sets of said electrodes.

In the precipitating apparatus and control apparatus therefor according to my invention there is comprised a duct in which are positioned successively a number of sets of precipitating apparatus comprising cooperating electrodes connected to a high tension electric source such as is exemplified in the usual electrostatic precipitator. Each of said sets comprises a series of spaced apart grounded plate electrodes and a set of spaced apart wire electrodes in repose between the said plate electrodes and connected to a source of high tension electric current one side of which is grounded. Each precipitating apparatus is provided with vibrators for its electrodes such as electric vibrators or air hammers. Across the said duct is provided a set of dampers for opening and closing the duct. An electric switch is provided for each set of precipitators for opening and closing the high tension circuit thereof. For controlling this apparatus, to open and close said duct, and to successively electrically disconnect the said precipitator sets and vibrate them I provide a clock adapted to make an electrical contact at a predetermined time for rendering operative in a manner hereinafter fully described the vibrating apparatus, and for opening and closing the duct dampers, and for maintaining said vibrator apparatus operative for a predetermined period of time after which the vibrating apparatus is rendered inoperative. The electric circuit opened by said clock is connected to an electric motor which drives a reduction worm and gear for rotating a camshaft and a series of cams attached thereto for operating a series of valves included in a pneumatic system. The pneumatic system controls said electric circuits, said sets of vibrating apparatus, and said dampers as hereinafter fully described.

In the accompanying drawing Fig. 1 shows an embodiment of my invention comprising a gas transmission duct, high tension electrical precipitators and dampers in said duct, vibrators for the electrodes of said precipitating apparatus, pneumatic apparatus for opening and closing the electric circuits on said precipitators, for vibrating the electrodes on said precipitators, and for opening and closing said dampers, an electric motor and a set of cam operating valves for controlling said pneumatic means, and a time clock for controlling the circuit to said electric motor for rendering it active at predetermined intervals for predetermined periods of time; and

Fig. 2 illustrates a type of air hammer which may be employed for vibrating the electrodes.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

In the drawing the duct 10 serves for transmission of dust-laden gases from which it is desired to precipitate said dust, for example, the flue gases from a zinc smelting furnace from which it is desired to precipitate valuable metal particles and particles of metal solids which would otherwise pass out with the exhaust gases and be lost. In said duct are mounted three banks of high tension electrodes 12 and 14 which are connected to respective sources of high tension electric current 16, the electrodes 12 being grounded, the electrodes 14 being connected through the respective switches 19, 20 and 21 to one side of said source, the other side of said source being grounded. Said electrodes 12 are preferably plates and the electrodes 14 are preferably wires, interposed between the spaced apart electrodes 12. Said electrodes 12 are mounted on and electrically connected to the ground through the supporting rail 22 and the electrodes 14 are mounted to the rail 24 which also serves as their electric connection to one source of the high tension electric circuit.

In operable relation to said rail 22 is the air hammer 30 adapted to vibrate said electrodes 12 through hammering on said rail 22. Likewise in operable relation to said

rail 24 is the air hammer 32 adapted to vibrate electrodes 14. At one end of duct 10 is a set of shutters or dampers 36 adapted for movement by means of the rod 38 to be opened and closed to permit or prevent the passage of gases through said duct 10. On said shaft 38 is mounted the piston 40 which operates in the double ended cylinder 42 whereby said rod 38 is adapted to be moved to one limiting position by piston 40 in cylinder 42 to close said dampers 36 and at the other limit of movement to open said shutters 36. Connected to each of said switches 19, 20 and 21 are piston rods 50 carrying pistons 52 which operate in the cylinders 53, 54 and 55 respectively and which are operable to open said switches, said switches being normally held closed by tension springs 56 which are mounted between said piston and the top of said cylinders.

The air hammer may be constructed as shown in Fig. 2, wherein the standard 250 supports the hammer 30 by means of the brackets 252, 254 and 256. Said bracket 256 carries an auxiliary piston 258 which operates within the auxiliary cylinder 260 mounted at the top of hammer 30. Between the upper surface of said bracket 254 and the lower surface of a flange 262 secured to the top of cylinder 260 the compression spring 264 is mounted, which tends to move upwardly said cylinder 260 and hammer 30 to which it is attached. The air pressure pipe 270 which is supplied with a valve (not shown) connects through a duct 272 extending through piston 258 into the space between said piston 258 and said cylinder 260 and from said space into said gun 30, in a manner well known in the art. Upon the admission of air pressure into the gun through said pipe 270 the cylinder 260 and gun proper 30 are moved downwardly to their lowermost position against the tension of spring 264 acting between flange 262 and said bracket 254. In this position the bit 248 is brought into operating relation with said rail 22 and in which position said gun 30 through the operation of its piston causes the bit 248 to hammer on said rail 22.

In the operation of the apparatus the air hammers 30 serve to deliver a series of rapid blows to the bars 22 and 24, which support respectively the plate electrodes 12 and the wire electrodes 14. Through such blows on bars 22 and 24 said electrodes 14 and 16 are shaken free of any dust which has settled and accumulated on them and which in excessive accumulations causes considerable trouble through weighting down the electrode apparatus, short circuiting them and reducing the efficiency of the precipitating apparatus by cutting down the high tension electrostatic effects necessary for effective precipitation.

The plate electrodes 12 are effectively jarred through their supporting bars or rail members 22 because the natural elasticity of the metal rails causes the transmission of the jarring vibrations to the plates which are thereby quickly shaken free of dust accumulations.

In a similar manner the wire electrodes 14 by being suspended to the bars 24 are effectively jarred through the jarring of said bars 24 whereby they likewise are freed of accumulations of dust.

Upon the application of air through the pipe 270 to the hammer 30, the hammer through the cooperation of piston 258 and cylinder 260 is moved against spring 264 into operating relation with said rail 22 in which position it delivers rapid blows to said rail through bit 248. Upon release of air pressure from pipe 270 the spring 264 operates to carry the hammer 30 and its bit 248 out of contact with the bar 22 which is connected to the high tension circuit and to such a distance therefrom as to preclude breakage of current therebetween.

For controlling the operation of the said air hammers 30 and 32, and said cylinders 42, 53, 54 and 55 for the operation of the dampers 36 and electric switches 19, 20 and 21 there is provided the manifold 60 which is connected to an air pressure source through the pipe 62 and which manifold is comprised of three principal parts, namely, the pressure chamber 64, the feed port chambers 65, 66, 67, 68, 69, 70, 71, and 72 which respectively connect to the damper opening side of cylinder 42, the chamber closing side of cylinder 42, the switch operating cylinder 53, the air hammers in the third bank of treater electrodes, the switch operating cylinder 54, the air hammers in the second bank of treater electrodes, the switch operating cylinder 55, and the air hammers in the first bank of treater electrodes, said air feed chambers 65 to 72 inclusive connect with said chamber 64 through the pocket valves 76, 78, 80, 82, 84, 86, 88 and 90 whose respective stems extend through the respective bottoms of said chambers and through the bottoms of corresponding discharge chambers 94, 96, 98, 100, 102, 104, 106, and 108 respectively and into contact with respective cams for their operation in a manner hereinafter fully described.

Between the bottom of said manifold 60 and a shoulder on each of said pocket valve stems there is mounted compression spring 110 which tends to keep its respective valve in closed position. Each of said chambers 65 to 72 inclusive connects with its corresponding discharge chamber through corresponding pocket valves 112, 113, 114, 115, 116, 117, 118 and 119 respectively, whose stems extend through the bottom of said manifold

60 and into contact with operating cams to be hereinafter fully described. A spring 120 is mounted between the bottom of said manifold and a shoulder on the end of each of said stems to hold the valves in the closed position. In operable relation with said pocket valve stems and mounted on the cam shaft 130 are cams 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, and 146, which engage the stems of the following respective pocket valves 76, 112, 78, 113, 80, 114, 82, 115, 84, 116, 86, 117, 88, 118, 90, 119. On one end of said cam shaft 30 is mounted the reduction gear 150 which cooperates with the worm 152 mounted on the shaft 154 of the electric motor 156. In the mains 160 of said electric motor 156 is mounted the time switch 162 which in a manner well known in the art is designed to close the circuit of said motor 156 at given intervals of time, for example, at intervals of one hour and to hold the circuit closed for a given period of time, for example, for one minute, during which the motor and its gears 150 and 152 are designed to rotate said shaft 130 and the cams thereon through one complete revolution.

The operation of the dust precipitating apparatus, and the shutters in the gas conduit and of the electric switches in the high tension circuits of the three banks of precipitator electrodes is designed to take place within this given interval of one minute or any other predetermined interval, and in the following order of operation.

During the normal operation of the precipitators the dampers 36 are open, the electric switches 19, 20 and 21 are closed, the air hammers 30 and 32 are inactive, and all of the pocket valves are in a closed position being so held by their respective springs 110 or 120, the cams of said shaft 130 being in a proper position to permit such closure of said pocket valves. Upon rotation of said shaft 130 cam 133 operates said pocket valve 78 to allow air under pressure to pass from the pressure chamber 64 to chamber 66 and a suitable conduit into the top side of said cylinder 42 whereupon said piston 42 is actuated to close said dampers 36. As the movement is continued valve 112 is opened to permit movement of air from the bottom side of cylinder 42 out through its conduit and through pressure chamber 65 into exhaust chamber 94. The cam 143 then opens pocket valve 88 to apply air pressure to cylinder 55 which actuates to open switch 21. After the opening of said switch 21, cam 145 opens valve 90 and applies air pressure to the air hammers 30 and 32 of the first bank of electrodes for shaking dust from electrodes 12 and 14 of that bank. Cam 145 then permits the corresponding spring 110 to close said valve 90 and stop the operation of said first bank of air hammers. Cam 146 at this time opens valve 119 to permit the escape of the air trapped under pressure to the chamber 108 whereupon said hammers 30 and 32 return to their normal position at a predetermined distance from said electrodes. Said valve 119 remains open until valve 90 is again closed. At this time cam 143 permits the closure of said valve 88 by its corresponding spring 110 whereupon the spring 56 in cylinder 55 closes said electric switch 21 and renders the first bank of precipitating electrodes again operative. Cam 144, then opens valve 118 to allow the pressure to be relieved from said cylinder 55 and this valve remains open until valve 88 is again open.

In like manner valve 84 is opened to allow air pressure to cylinder 54 to open switch 20, whereupon valve 86 is opened to allow air pressure to the air hammers 30 and 32 of the second bank of electrodes from the chamber 70.

In like manner cams 135, 136, 137, 138, operating valves 80, 82, 114 and 115 open switch 19 to operate hammers 30, 32 of the first bank of electrodes and to again close said switch 19, valves 114 and 115 remaining open until their corresponding valves 80 and 82 are again opened.

At this point cam 133 permits the closure of valve 78 by its spring 110 and valve 113 is opened by its cam 134. Cam 131 now opens valve 76 and valve 112 is closed by its corresponding spring 120 through permission of its cam 132. Air pressure now being applied to the bottom side of piston 40 it is moved upwardly and said dampers 36 are again opened. During this movement of piston 40 exhaust from the upper part of cylinder 42 is permitted through its conduit and through chamber 66 and valve 113 to the exhaust chamber 96, said valve 113 remaining open until valve 78 is again open. At this point the cam shaft completes its revolution and cam 131 permits the spring 110 to close the valve 76 leaving the dampers 36 open and at this time said valve 112 is opened and left open being closed again only when said valve 76 is again opened.

Said time switch 162 at this point now breaks electric circuit with motor 156 whereupon said shaft 130 and its cam are left at the end of the cycle of operation. Switches 19, 20, and 21 are now all closed, damper 36 is open, air hammers 32 of each of the banks have been moved away from its electrodes and the electrostatic precipitating action of dust from gas passing through conduit 10 continues until operation of the jarring apparatus is again commenced at the end of the predetermined interval.

While I have shown and described and have pointed out in the annexed claims certain novel features of my invention, it will be understood that various omissions, sub-

stitutions and changes in the forms and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of my invention.

I claim:

1. In combination with a bank of electrodes of a high tension dust precipitating apparatus of the usual type, a switch in the circuit thereof, means for delivering a series of rapid blows to the electrodes thereof for shaking accumulated dust therefrom, and automatic means for successively opening said switch, rendering operative said blow delivering means, rendering inoperative said blow delivering means, and for again closing said electric switch.

2. In combination with a plurality of banks of electrodes of a high tension precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, automatic means for successively opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, again closing said electric switch, and for regulating the switch and blow delivering means of each of said banks in the above given order one bank after the other.

3. In combination with a plurality of banks of electrodes of a high tension precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, automatic means for successively opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, again closing said electric switch, for regulating the switch and blow delivering means of each of said banks in the above given order one bank after the other, and for leaving all the jarring apparatus inoperative and all the switches closed after a complete cycle of operation of the apparatus of the series of banks.

4. In combination with a fume conduit, a damper operable for opening and closing said conduit, a bank of electrodes of a high tension precipitating apparatus of the usual type, a switch in the circuit thereof, means for delivering a series of rapid blows to said electrodes for shaking accumulated dust therefrom, and automatic means for successively closing said damper, opening said switch, rendering operative said blow delivering means, for rendering inoperative said blow delivering means, for again closing said electric switch, and for opening said damper.

5. In combination with a bank of electrodes of a high tension precipitating apparatus having two sets of electrodes one of which sets is insulated and the other grounded, a switch in the circuit of the insulated electrodes, means for each set of said electrodes delivering a series of rapid blows thereto for shaking accumulated dust therefrom, and automatic means for successively opening said switch, rendering operative said blow delivering means, rendering inoperative said blow delivering means, and for again closing said electric switch.

6. In combination with a plurality of banks of electrodes of a high tension dust precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, and automatic means for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

7. In combination with a plurality of banks of electrodes of a high tension dust precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom and automatic means operative at predetermined intervals for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

8. In combination with a plurality of banks of electrodes of a high tension dust precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, the blow delivering means of one of said banks having means operative automatically upon the rendering operative and inoperative of the blow delivering means to move it into and out of operative relation to its respective electrodes, and automatic means for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

9. In combination with a plurality of banks of electrodes of a high tension electric precipitating apparatus of the usual type, a switch in the circuit of each bank, means

for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, the blow delivering means of one of said banks having means operative automatically upon the rendering operative and inoperative of the blow delivering means to move it into and out of operative relation to its respective electrodes, and automatic means operative at predetermined intervals for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

10. In combination with a plurality of banks of electrodes of a high tension electric precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, the blow delivering means of one of said banks having means operative automatically upon the rendering operative and inoperative of the blow delivering means to move it into and out of operative relation to its respective electrodes, and automatic means comprising a source of air pressure, a set of valves in a piping system thereof, cams for operating said valves, means for operating said cams, a time clock for controlling said operating means, and pressure operated means connected to said valves and respectively to said switches and said blow delivering means for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

11. In combination with a plurality of banks of electrodes of a high tension electric precipitating apparatus of the usual type, a switch in the circuit of each bank, means for delivering a series of rapid blows to the electrodes of each of said banks for shaking accumulated dust therefrom, the blow delivering means of one of said banks having means operative automatically upon the rendering operative and inoperative of the blow delivering means to move it into and out of operative relation to its respective electrodes, and automatic means comprising a source of air pressure, a set of valves in a piping system thereof, cams for operating said valves, means for operating said cams, a time clock for controlling said operating means, and pressure operated means connected to said valves and respectively to said switches and said blow delivering means operative at predetermined intervals for controlling the apparatus on each of said banks successively in the following manner and order, opening the switch of a given bank, rendering operative the blow delivering means thereof, rendering inoperative said blow delivering means, and closing the electric switch of said bank.

In testimony whereof I have hereunto set my hand.

GORDON B. FORBES.