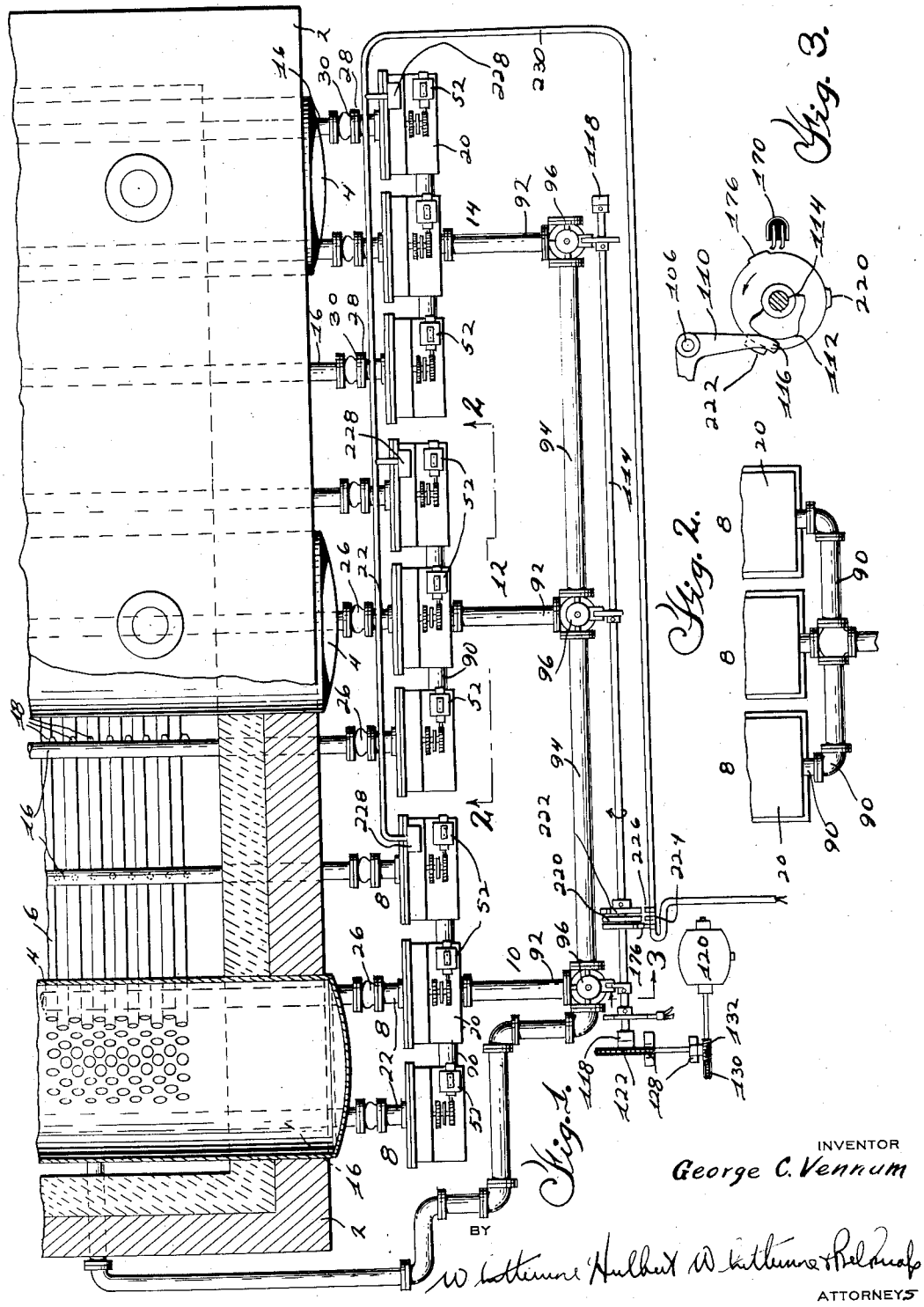
Feb. 19, 1935. G. C. VENNUM 1,991,968

BOILER TUBE CLEANING APPARATUS

Original Filed July 29, 1921 4 Sheets-Sheet 1



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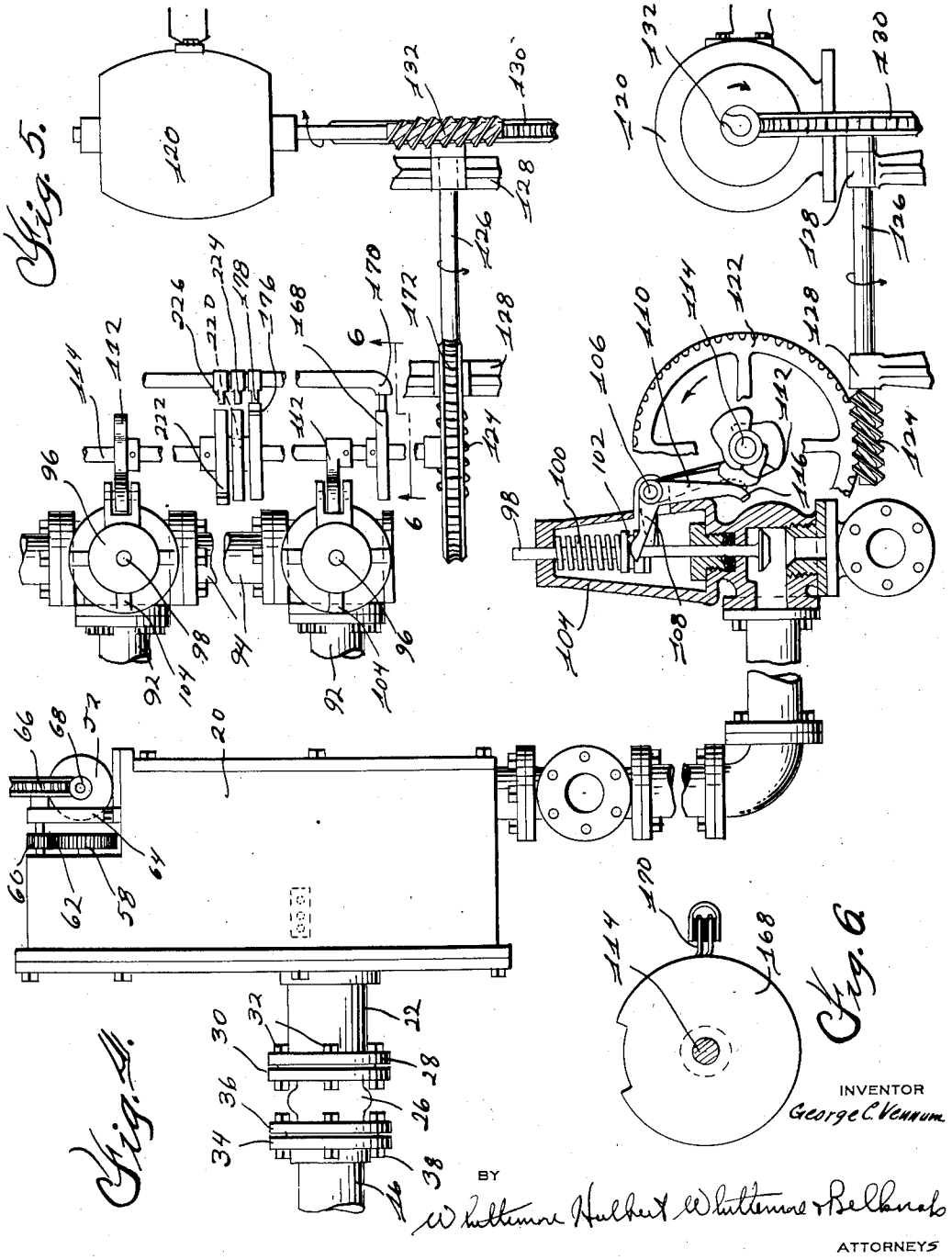

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BOILER TUBE CLEANING APPARATUS

Original Filed July 29, 1921 4 Sheets-Sheet 3

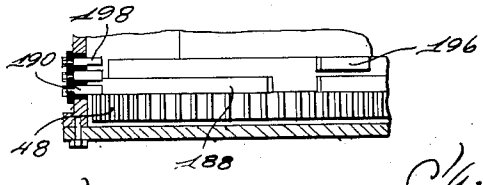


Fig. 11.

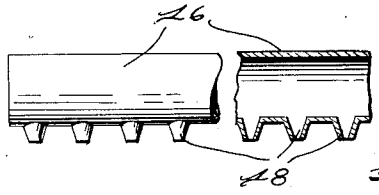


Fig. 8.

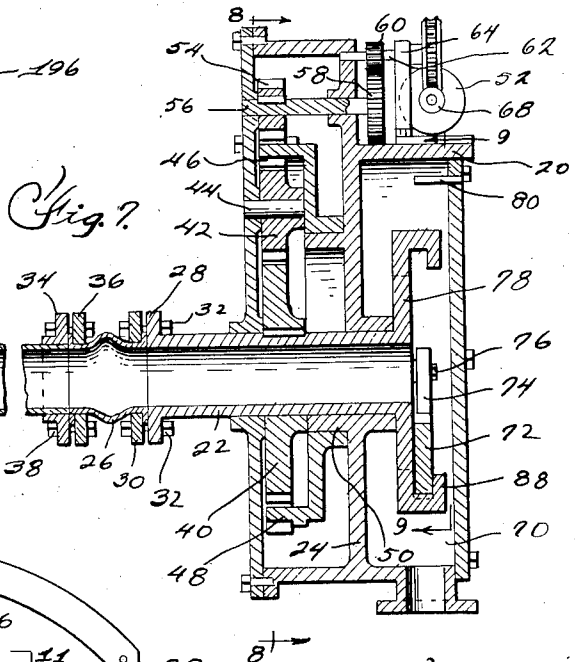
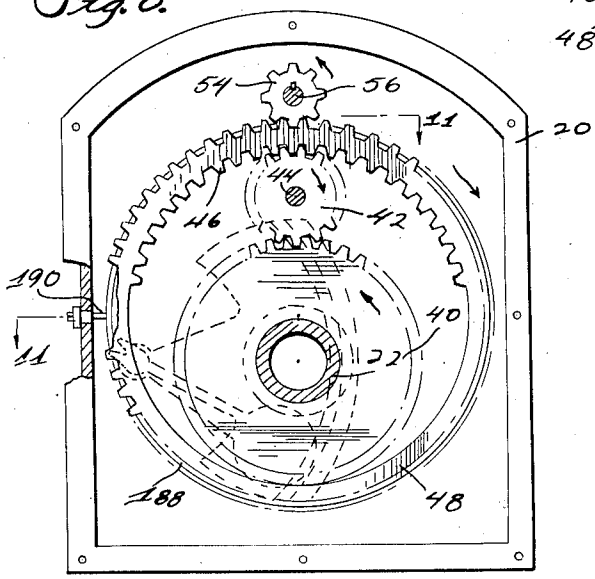


Fig. 7.



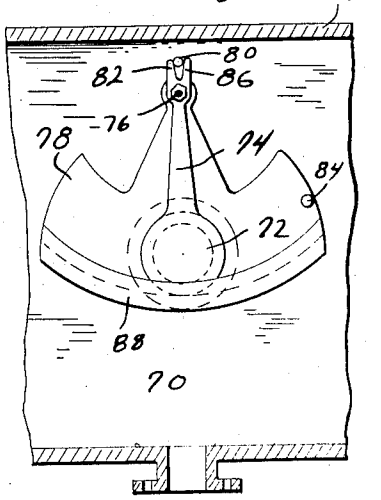


Fig. 10.

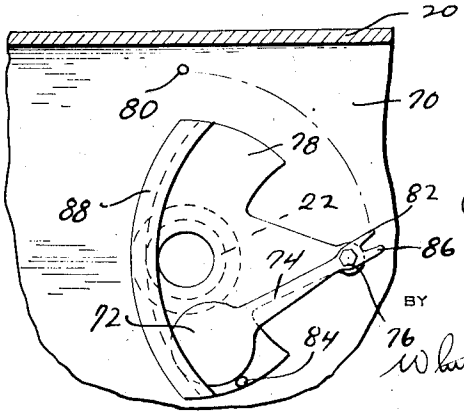


Fig. 9.

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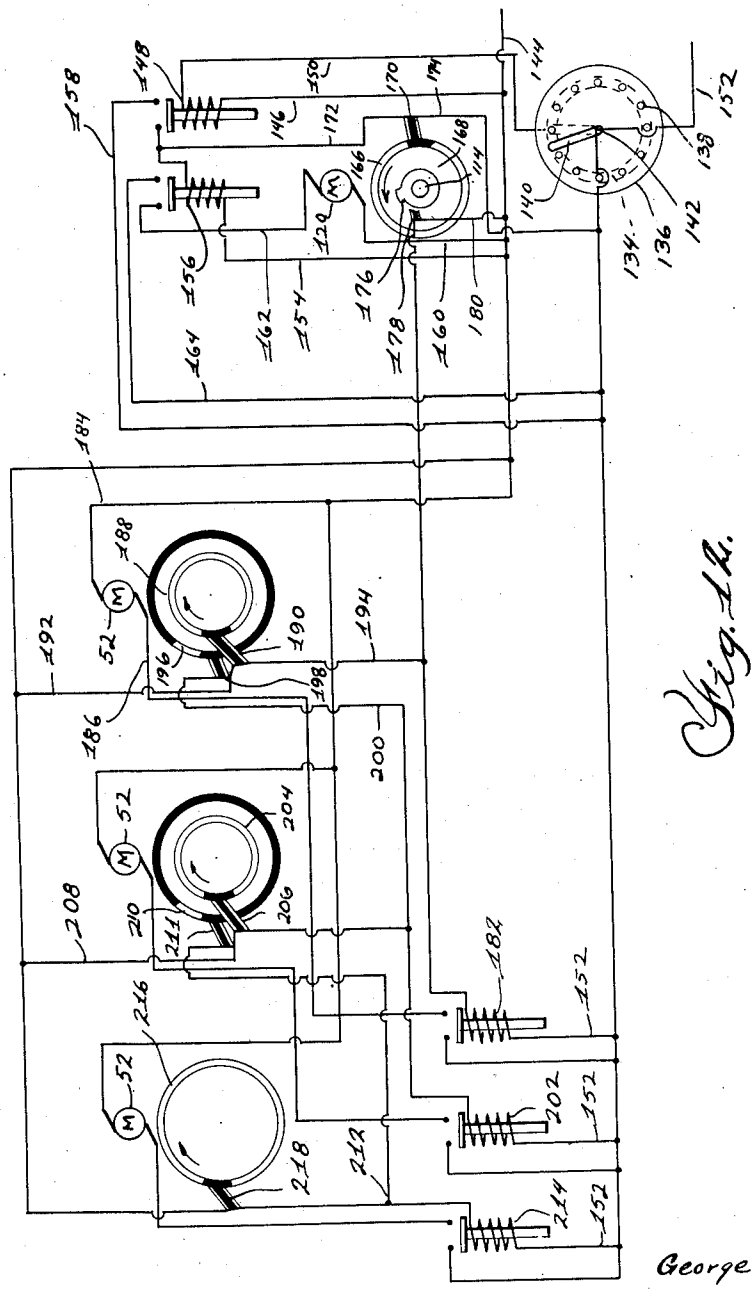

Fig. 12.

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BOILER TUBE CLEANING APPARATUS

George C. Vennum, Wilmington, Del., assignor to Diamond Power Specialty Corporation, Detroit, Mich., a corporation of Michigan

Original application July 29, 1921, Serial No. 488,454. Divided and this application July 3, 1931, Serial No. 548,670

16 Claims. (Cl. 122—392)

The present invention relates to steam blowing apparatus for cleaning the tubes of steam boilers, and more particularly to such apparatus for cleaning the tubes of steam boilers of the water tube type.

The principal object of the invention is to provide a novel and improved apparatus of this character which shall be automatic in operation.

With this object in view, the features of the invention consist in certain constructions, arrangements, and combinations of parts hereinafter described and claimed, the advantages of which will be obvious to those skilled in the art.

This application is a divisional of my copending application Ser. No. 488,454, filed July 29, 1921.

The several features of the invention will be clearly understood from the following description and accompanying drawings, in which:

Figure 1 is a plan view, partly in section, of a portion of a steam boiler, with an apparatus applied thereto embodying the features of the invention in their preferred form, certain parts of the apparatus being shown diagrammatically for the sake of clearness;

Figs. 2 and 3 are detail sectional elevations taken on the lines 2—2 and 3—3, respectively, of Fig. 1;

Fig. 4 is a side elevation, partly in section, of a portion of the apparatus;

Fig. 5 is a plan view of a portion of the parts of the apparatus illustrated in Fig. 4;

Fig. 6 is a detail sectional elevation taken on the line 6—6 of Fig. 5;

Fig. 7 is a vertical sectional view, partly in elevation, of a portion of the apparatus, illustrating particularly, a steam blowing nozzle, actuating mechanism therefor, and means including a valve for controlling the passage of steam to the nozzle;

Fig. 8 is a sectional elevation taken on the line 8—8 of Fig. 7;

Fig. 9 is a sectional elevation taken on the line 9—9 of Fig. 7, illustrating particularly the nozzle valve in open position;

Fig. 10 is a view similar to Fig. 9 but with the valve shown closed;

Fig. 11 is a sectional plan view taken on the line 11—11 of Fig. 8; and

Fig. 12 is a diagrammatical view of an electrical system for controlling the operations of certain parts of the apparatus.

The steam boiler illustrated in Fig. 1 of the drawings is of a common water tube type having a boiler wall 2 in which are mounted spaced cylindrical drums 4, from each of which leads a set of water tubes 6. The boiler tube cleaning apparatus as illustrated is provided with a series of steam blowing devices 8, which are arranged in three groups 10, 12 and 14, there being three steam blowing devices in each group. The three groups of steam blowing devices are arranged to severally operate on the three sets of boiler tubes. Each steam blowing device is provided with an elongated cylindrical cleaner element 16, which extends through and is adapted to oscillate in a horizontal aperture in the boiler wall 2 and the portion of the element extending within the boiler wall is provided with a series of discharge nipples 18 on one side. The steam blowing devices of each group are so arranged that the outer elements extend adjacent opposite sides of the associated section of boiler tubes, while the intermediate cleaner element extends approximately through the center of the section of boiler tubes. During the passage of steam through the elements, they are given an oscillating movement which insures that the jets of steam from the nipples 18 will act uniformly on all of the tubes of a section throughout their length. Each steam blowing device is also provided with a junction box 20 (Fig. 7) in which is contained mechanism for oscillating the cleaner element, and through a portion of which steam is supplied to the element. The mechanism for actuating the element comprises a tube 22 which extends through and is journalled in bearings in the rear wall of the junction box and in a vertical partition 24 within the junction box. The tube 22 is connected with the element through a flexible coupling 26 which comprises a flexible sleeve having a flange on one end which is clamped between a flange 28 formed on the rear end of the tube 22, and a clamping collar 30 which is secured to the flange 28 by bolts 32; and the other end of the flexible sleeve is provided with a flange that is clamped between a flanged collar 34 secured on the cleaner element and a clamping collar 36 which is secured to the flange collar 34 by bolts 38. The flexible coupling 26 permits the cleaner element to be displaced slightly out of alinement with the tube 22 and also allows the tube to be adjusted circumferentially, by loosening the clamping bolts 38, to vary the direction in which its line of discharge nipples is directed.

The mechanism for oscillating each cleaner element comprises a gear 40 which is secured on the tube 22 adjacent the inner side of the rear wall of the junction box, which gear engages a pinion 42 journalled on a stud shaft 44 secured

to the rear wall of the junction box. The gear 40 and pinion 42 are adapted to be alternately engaged by an internal gear segment 46 formed on a gear wheel 48 which is arranged eccentrically of the tube 22 and journalled on a collar or flange 50 projecting from the partition 24. The internal gear segment 46 as shown extends slightly less than half way around the gear wheel 48. With this construction it will be apparent that during one revolution of the gear wheel 48 the gear segment 46 will first engage the pinion 44 to rotate the cleaner element a part of one revolution in one direction and then will disengage from the pinion 42 and engage the gear 40 to rotate the cleaner element a part of one revolution in the opposite direction to its initial position. The gear wheel 48 is driven through speed reducing gearing by an electric motor 52 mounted on the outside of the junction box. This gearing comprises a pinion 54 carried by a shaft 56 which extends through and is journalled in bearings in opposite walls of the junction box. A gear 58 is secured to the forward end of the shaft 56, which gear engages a pinion 60 carried by a shaft 62 having one end journalled in a bearing in a wall of the junction box and its other end projecting through a bearing in a bracket 64. A worm wheel 66 is secured to the projecting end of the shaft 62 and engages a worm 66 carried by the shaft of the motor 52.

Steam is applied to the cleaner element 16 through a steam chest 70 which is formed in the junction box by the partition 24. A valve 72 is provided for controlling communication between the cleaner element 16 and the steam chest 70, which valve closes communication between the element and the steam chest when the element is at rest and opens communication between the element and the steam chest when the element is oscillated. This valve is formed on the lower end of a depending lever 74 pivoted at 76 on a segmental arm 78 formed on the forward end of the tube 22, having its upper end forked. When the cleaner element is at rest the valve is held closed as shown in Fig. 10 by the engagement of the forked end of the valve lever with a pin 80 projecting inwardly from the forward wall of the junction box. At the start, however, of an oscillating movement of the cleaner element, a prong 82 of the forked end of the valve lever, by engagement with the stop pin 80, swings the lever in the direction to open the valve and the valve is held open by gravity during the remaining portion of the oscillating movement of the tube 22, this movement of the valve lever being limited by the engagement of the valve end thereof with a stop pin 84 carried by the segmental arm 78. Near the end of the return movement of the cleaner element, a prong 86 on the forked end of the valve lever 74 engages the pin 80 to swing the valve lever in a direction to close the valve the valve again being held closed by the engagement of the forked end of the valve lever with the pin 80. The valve is held in close sliding engagement with the face of the segmental arm 78, which face constitutes a valve seat, by a flange 88 formed on the arm engaging the outer face of the valve. The valve is in the form of a disk and is of slightly greater diameter than the axial bore of the tube 22. It will be apparent that because of the difference in leverage between the forked end and the valve end of the valve lever 74 the valve will be opened and closed quickly so that there will be very little loss of steam, and yet, because of the circular shape of the valve and valve opening, the start of the opening of the valve will be comparatively gradual which enables the steam to fill the cleaner element before the valve is open wide so that there is no danger of the admission of steam to the cleaner element causing injury to parts of the apparatus.

The steam chests 70 of each group of steam blowing devices are all connected by pipes 90 (Figs. 1 and 2) with a branch supply pipe 92, there being a separate branch supply pipe 92 for each group. As the steam chests 70 of each group are thus connected they may be considered as constituting a single steam supply chamber for each group of cleaner elements. The three branch supply pipes 92 lead from a main supply pipe 94, which, as shown, is connected with one of the boiler drums 4.

Communication is controlled between the branch pipes 92 and the main supply pipe 94 by valves 96, a valve being associated with each branch pipe. Each valve is provided with a valve stem 98 (Fig. 4) which is urged downwardly to close the valve by a spring 100 coiled about the stem and interposed between a collar 102 on the stem, and the top of a spider 104 through an aperture in which the valve stem extends and is guided.

The valves 96 are independently controlled by means of bell cranks pivoted at 106 on the spiders 104. Each bell crank is provided with a horizontally extending arm 108 arranged to engage the under side of the valve stem collar 102, and is further provided with a vertically extending arm 110, arranged to be engaged by a cam 112 carried by an elongated shaft 114, there being a separate cam for each bell crank and the three cams being equally spaced about the shaft 114. The shaft 114 is rotated in a counter-clockwise direction, as indicated by the arrow in Fig. 4, and each cam is so shaped that it acts positively on the associated bell crank to first crack or slightly open the valve to permit the steam to fill the pipes thereby avoiding shock, and then to quickly open the valve wide and hold it open through a predetermined period. Such cracking of the valve a sufficient length of time to enable the steam to fill the pipes before the valve is opened wide, is of considerable practical importance in an apparatus of this character, as serious damage would be likely to result to parts of the apparatus if the valve were opened wide in the first instance. The valve is opened wide immediately after a sufficient amount of steam has been admitted to fill the pipes so that there is very little if any loss of steam during the opening of the valve. The cam then permits the valve to close quickly so that there will be very little loss of steam, but to prevent the valve from pounding or closing with a shock the arm 110 of each bell crank has a curved extension 116 so formed as to drag across the receding face of the cam, thus slightly retarding the quick release of the cam at the end of its effective operation. The cam shaft 114 is journalled in bearings in brackets 118 and is driven by an electric motor 120 through speed reducing gearing. This gearing comprises a worm wheel 122 secured on one end of the cam shaft 114 which engages a worm 124 formed on one end of a countershaft 126. The shaft 126 extends through and is journalled in bearings in brackets 128, and the other end of the shaft carries a worm wheel 130 which engages a worm 132 formed on the shaft of the motor 120.

The electric controlling system illustrated in

Fig. 12 comprises a timing device associated with the electric motor 120 which throws the apparatus into operation at predetermined intervals, the apparatus being automatically thrown out of operation at the completion of a cycle of operations thereof, and each cycle of operations taking place during each rotation of the cam shaft 114. This timing device comprises a contact ring 134 arranged at one side of a stationary disk 136 and provided with pin contacts 138 extending through the disk which are adapted to be successively engaged by a switch arm 140 which is rotated at a predetermined slow speed about a center 142 by any suitable timing mechanism. Upon engagement of the switch arm 140 with one of the pin contacts 138 a circuit is closed through a conductor 144 leading from an electric source, a conductor 146, a relay 148, a conductor 150, contact ring 134, switch arm 140 and a return conductor 152 leading to the electric source. The closing of this circuit energizes the relay 148 to close a circuit through a conductor 154 connected with the lead 144, a relay 156 and a conductor 158 connected with the return conductor 152. The closing of this circuit in turn energizes the relay 156 to close a circuit through a conductor 160 connected with the lead 144, the cam shaft driving motor 120, the conductor 162 and a conductor 164 connected with the return conductor 152. Before the switch arm 140 has passed by this contact 138 these circuits have remained closed long enough to energize the motor 120 a sufficient length of time to cause the cam shaft 114 to be rotated a sufficient number of degrees to bring a split contact ring 166 on a disk 168 carried by the cam shaft 114 into contact with a brush 170. The brush 170 is provided with two metal contact strips, one of which is connected by a conductor 172 with the relay conductor 154, and the other of which is connected by a conductor 174 with the return conductor 152 so that a circuit containing the motor 120 is maintained closed by the engagement of the contact ring 166 with the brush 170 after the switch arm 140 passes by its pin contact, and this circuit remains closed until the space between the ends of the contact ring 166 is again brought into registry with the brush 170 which, of course, occurs substantially at the end of one rotation of the cam shaft 114. During such rotation of the cam shaft 114 a short ring contact 176 carried by the cam shaft 114 engages a brush 178. The brush 173 is provided with two metal contact strips, one of which is connected with the lead 144 through the conductor 180 and the other of which is connected through a relay 182 with the return conductor 152 so that a circuit is closed through this relay. This relay then acts to close a circuit through the electric motor 52 associated with the first one of the group of steam blowing devices 10, the circuit comprising a conductor 184 connecting the motor with the lead 144 and a conductor 186 leading through the relay 182 to the return conductor 152. Before the ring contact 176 passes by the brush 178 the circuit through the relay 182 is maintained closed to energize the motor 52 a sufficient length of time to bring a split contact ring 188 carried by the internal gear wheel 48 of the steam blowing device (Fig. 11) into contact with the brush 190. The brush 190 is provided with two metal contact strips, one of which is connected through a conductor 192 with the lead 144, and the other of which is connected through a lead 194 with the relay 182 so that a circuit is maintained closed through the relay 182 to maintain the motor 52 in operation after the ring contact 176 passes by the brush 178. This circuit remains closed until it is broken by the space between the ends of the split ring 188 again being brought into registry with the brush 190, which occurs near the end of one rotation of the internal gear wheel 48. Thus it will be apparent that the gear wheel of the first steam blowing device of the group 10 is rotated one revolution and then brought to rest and, as hereinbefore described, such rotation of this gear wheel imparts the desired oscillating movement to the associated steam blowing cleaner element 16.

Near the end of this rotation of the internal gear wheel and its contact ring 188 means is provided for energizing the motor 52 associated with the next steam blowing device of the group 10. To this end the internal gear wheel just mentioned carries a short segmental contact ring 196 which, near the end of the rotation of the internal gear and the contact ring 188, is brought into engagement with a contact brush 198. This brush is provided with two metal contact strips, one of which is connected with the lead 144 through the conductor 192, and the other of which is connected through a conductor 200 and relay 202 with the return conductor 152 to complete a circuit through the relay 202. The relay then acts to close a circuit through the electric motor 52 associated with the next steam blowing device of the group 10 and before the contact 196 passes by the brush 198 a split ring contact 204 carried by the internal gear wheel 48 of this steam blowing device and corresponding to the ring contact 188 is brought into contact with a brush 206. The brush 206 is provided with two metal contact strips, one of which is connected through a conductor 208 with the main lead 144, and the other of which is connected through the relay 202 with the return conductor 152 so that the circuit of the motor of the second steam blowing device of the group 10 is held closed after the motor circuit of the first steam blowing device is opened. Near the end of one revolution of the internal gear 48 of the second steam blowing device the space between the ends of the contact ring 204 is brought into registry with the brush 206 to open the circuit of the relay 202 and thence to open the motor circuit of this steam blowing device. Just before the end of the operation of this steam blowing device, however, a short segmental contact ring 210 is brought into contact with a contact brush 211 to throw the last steam blowing device of the group into operation. The brush 211 is provided with two metal contact strips, one of which is connected through the conductor 208 with the lead 144, and the other of which is connected through the conductor 212 and a relay 214 with the return conductor 152 so that a circuit is closed at this time to energize the relay 214. This relay then acts to close a circuit through the motor 52 of the last steam blowing device of the group 10 and before the contact ring 210 passes by the brush 211 a split contact ring 216 carried by the internal gear wheel 48 of this steam blowing device is brought into contact with a brush 218. The brush 218 is provided with two metal contact strips, one of which is connected with the lead 144 and the other of which is connected with the relay 214 so that after the contacts 210 and 211 disengage the motor circuit associated with the last steam blowing device of the group 10 is maintained closed until the space between the ends of the contact ring 216 has

been brought into registry with the brush 218 at the completion of substantially one revolution of the internal gear wheel 48. Thus it will be apparent that upon the engagement of the contact 176 carried by the cam shaft 114 with the brush 178 that the steam blowing devices of the group 10 are successively operated, the supply valve 96 associated with this group of steam blowing devices being held open during this time.

In order to throw the group 12 of steam blowing devices into operation at the completion of the cycle of operations of the group 10, and in order to throw the group 14 into operation at the completion of the cycle of operations of the group 12, ring contacts 220 and 222 are carried by the cam shaft 114 which are connected with the electric motors 52 of the groups 12 and 14, respectively, in the same manner as the ring contact 176 is connected with the motors of the group 10, the ring contacts 220 and 222 engaging brushes 224 and 226, respectively, at the proper times. In Fig. 12 the electric connection between the group 10 of steam blowing devices and its contact ring 176 is illustrated but the electrical connections between the group 12 and 14 and their contact rings are not illustrated in this figure as such connections are obvious. In Fig. 1 boxes for enclosing the relays of the circuits associated with the groups of steam blowing devices are indicated at 228 and a cable conduit is indicated at 230 containing the electrical connections between the relays and the ring contacts 176, 220 and 222.

It will be apparent from the foregoing that the several groups of steam blowing devices are operated one after another and also that the steam blowing devices of each group are operated one after another, which insures that the operation of the apparatus will not interfere with the draft of the furnace and the steam supply will not be unduly drawn upon at one time. It will also be apparent that an automatically operated apparatus is provided which requires no attention on the part of an operator and which will operate efficiently with a minimum loss of steam irrespective of the size of the boiler or the number of sections of boiler tubes. During a cycle of operations of the apparatus all the sections of boiler tubes are acted upon uniformly throughout their extent and the soot is uniformly and effectively removed from the individual boiler tubes. The apparatus may be timed to operate at such intervals as may be necessary to maintain the boiler tubes substantially free from soot at all times.

While the features described above are well adapted for use in connection with the type of boiler illustrated in the drawings, it is to be understood that, except as defined in the claims, certain features of the invention are not limited to use with a boiler of this type, as they may be used in connection with various types of both water tube and fire tube boilers. It will be further apparent that the invention may be utilized in connection with a cleaner for various types of heat exchange apparatuses, and it is to be therefore understood that wherever the term "boiler" is used throughout the specification and claims, it is to be construed as meaning a fluid heater or heat exchange apparatus of any character, while the term "boiler cleaner" is to be construed as meaning a cleaner for any such apparatus.

What I claim as my invention is:

1. In a soot cleaning system, a plurality of blower elements, means for initially starting the actuation of one of said elements, and electrically actuated means operating independently of said first mentioned means but in timed relation to the actuation of said elements for successively actuating all of the remainder of said elements.

2. In a soot cleaning system, the combination of a plurality of groups of blower elements, valves for controlling the supply of cleaning fluid to said groups of blower elements, means for initially successively actuating the first element of each group and for successively actuating said valves, and means for successively actuating the remaining elements of each group from the first element of its respective group.

3. In a soot cleaning system, a plurality of blower units, a header for supplying cleaning fluid to all of said units, a valve for controlling the flow of cleaning fluid through said header, means for actuating said valve and for simultaneously starting the actuation of one of said blower units and means operating independently of said first mentioned means and controlled by the actuation of said units for successively actuating all of the remainder of said units.

4. In a soot cleaning system, a plurality of blower units, a valve for controlling the flow of cleaning fluid to all of said units, means for actuating said valve and for starting the actuation of one of said units, and means actuated by the unit thus actuated but operable independently of said first mentioned means for starting the actuation of another of said units upon the completion of the actuation of the unit initially started by said first mentioned means.

5. In a soot cleaning system, a plurality of blower elements, a motor associated with each element for rotating the same, means for initially closing an electric circuit through one of said motors to actuate the same, and means associated with each motor and actuated by the motor which precedes it but operating independently of said first mentioned means for successively closing the circuits through the remaining motors associated with said units.

6. In a soot cleaning system, a plurality of rotatable blower elements, an electric motor associated with each blower element for rotating the same, means for momentarily closing an electric circuit through one of said motors, means operable upon the closing of the electric circuit through said motor to maintain said circuit closed during the rotation of the blower element associated with said motor through one revolution, means actuated by said blower element but operable independently of said first mentioned means upon completion of the rotation of said blower element through one revolution to momentarily close an electric circuit through the motor associated with another of said blower elements, and means operating upon the closing of the electric circuit through said last mentioned motor to maintain said circuit closed during the rotation of the blower element associated with said motor through a predetermined arc.

7. In a soot cleaning system, a pair of rotatable blower elements, an electric motor associated with each blower element for rotating the same, means for momentarily closing an electric circuit through the motor associated with one of said blower elements, means associated with said blower element for maintaining the circuit closed through said motor during rotation of the element through a predetermined arc, means as-

sociated with said blower element for momentarily closing the circuit through the motor associated with the second blower element, and means associated with the second element for maintaining the circuit closed through the motor associated with said element during rotation of the said second element through a predetermined arc.

8. In a soot cleaning system, a plurality of groups of blower elements, a main cleaning fluid supply header, a branch header for supplying cleaning fluid from said main header to each group of blower elements, a valve for controlling the flow of cleaning fluid through each branch header, means for initially successively starting the actuation of the first element of each group, and means for successively actuating the said valves in synchronism with the starting of the actuation of the first element of each group.

9. In a soot cleaning system, a plurality of groups of blower elements, a main cleaning fluid supply header, a plurality of branch headers, one branch header connecting each group of blower elements to said main header, a valve associated with each branch header for controlling the flow of cleaning fluid therethrough, means for successively actuating said valves for successively supplying cleaning fluid to said groups of blower elements, means for successively initially starting the actuation of the first element of each group, said last mentioned means operating in synchronism with the actuation of the valve controlling the flow of cleaning fluid to the group, and means associated with each element and actuated by the element which precedes it for successively starting the actuation of the several elements of each group after the starting of the actuation of the first element of each group.

10. In a soot cleaning system, a plurality of blower elements, a valve for controlling the flow of cleaning fluid to all of said blower elements, means for initially starting the actuation of one of said blower elements, a second means operating independently of the first mentioned means but in timed relation thereto for successively actuating all of the remainder of said elements, a shaft for controlling the operation of said valve and said starting means, and means for starting the rotation of said shaft and for stopping the rotation thereof after the shaft has rotated through 360°.

11. In a soot cleaning system, a plurality of blower elements, a valve for controlling the flow of cleaning fluid to all of said blower elements, means including a rotatable shaft for controlling the actuation of said valve and for starting the actuation of said blower elements, an electric motor for rotating said shaft, means for momentarily closing an electric circuit through said motor, and a contact member rotatable with said shaft and operable to maintain the electric circuit closed through said motor during rotation of the shaft through 360°.

12. In a soot cleaning system, a plurality of groups of blower elements, means for successively initially starting the actuation of one of said elements of each group, and electrically actuated means operating independently of the first mentioned means and controlled by the elements of its respective group for successively actuating all of the remainder of said elements of each group.

13. In a soot cleaning system, a plurality of blower units, a valve for controlling the flow of cleaning fluid to all of said units, a rotatable shaft, a cam on said shaft for actuating said valve, means on said shaft for starting the actuation of one of said blower units, and means associated with each unit and actuated by the unit which precedes it but operable independently of said shaft for successively actuating all of the remainder of said blower units.

14. In a soot cleaning system, a plurality of rotatable blower units, means for initially starting the actuation of one of said units, and a second means operating independently of said first mentioned means and controlled by the actuation of said units for successively actuating all of the remainder of said units.

15. In a soot cleaning system, a plurality of rotatable blower units, a power device associated with each of said units to rotate the same, means for initially starting the actuation of one of said power devices, a second means independent of the starting means providing for the continued movement of said power device to move the blower unit a predetermined amount, and a further means for actuating the power device associated with a second unit in timed relation to the movement of said first mentioned blower unit.

16. In a soot cleaning system a plurality of rotatable blower units, an electric motor associated with each of said units to rotate the same, means for momentarily completing a circuit to one of said motors to rotate the same, means independent of said first mentioned means to complete a second circuit to said motor, said second circuit providing that the motor continues to operate after the breaking of said first circuit and said second named circuit closing means being so arranged as to open the circuit to the motor and terminate its operation after it has moved the blower element a predetermined amount, and a further circuit closing means operating in timed relation to the movement of said blower element to complete a circuit to a second motor to rotate a second blower element of the system.

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