Oct. 11, 1927. 1,644,995

J. F. GRACE

TUBE CLEANER

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Fig. 1.

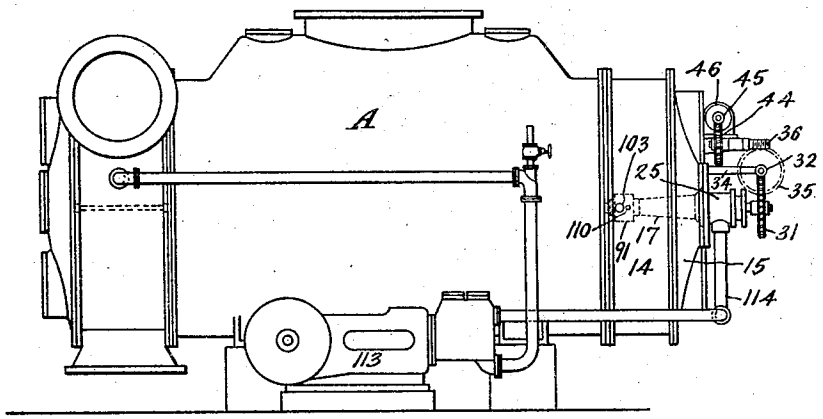


Fig. 2.

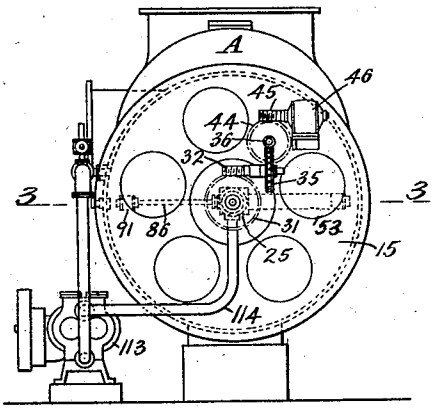
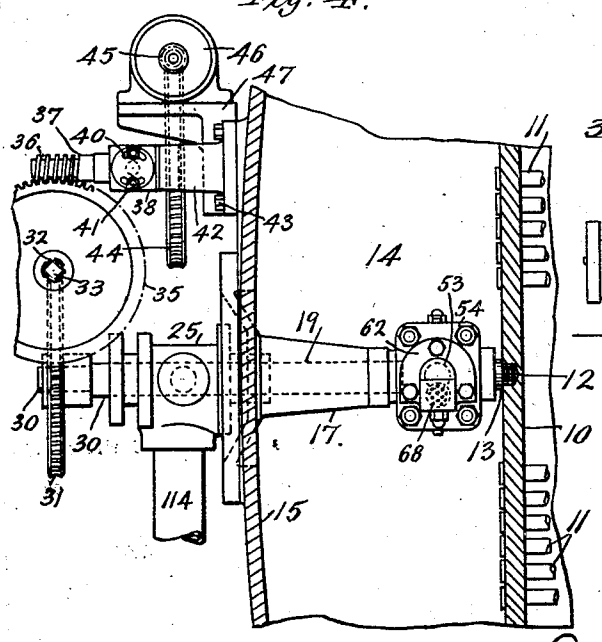


Fig. 4.



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By his Attorneys

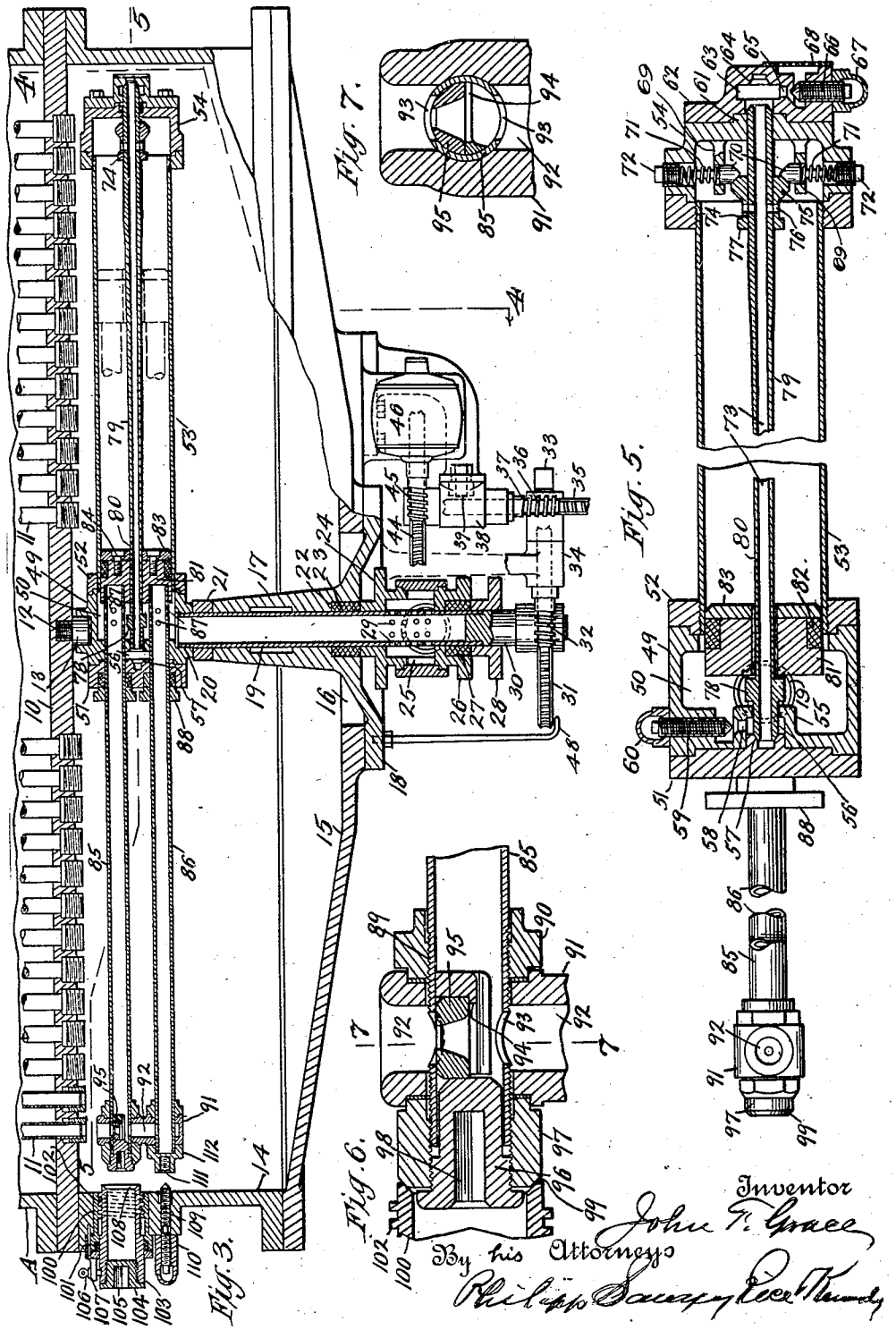
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TUBE CLEANER

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TUBE CLEANER

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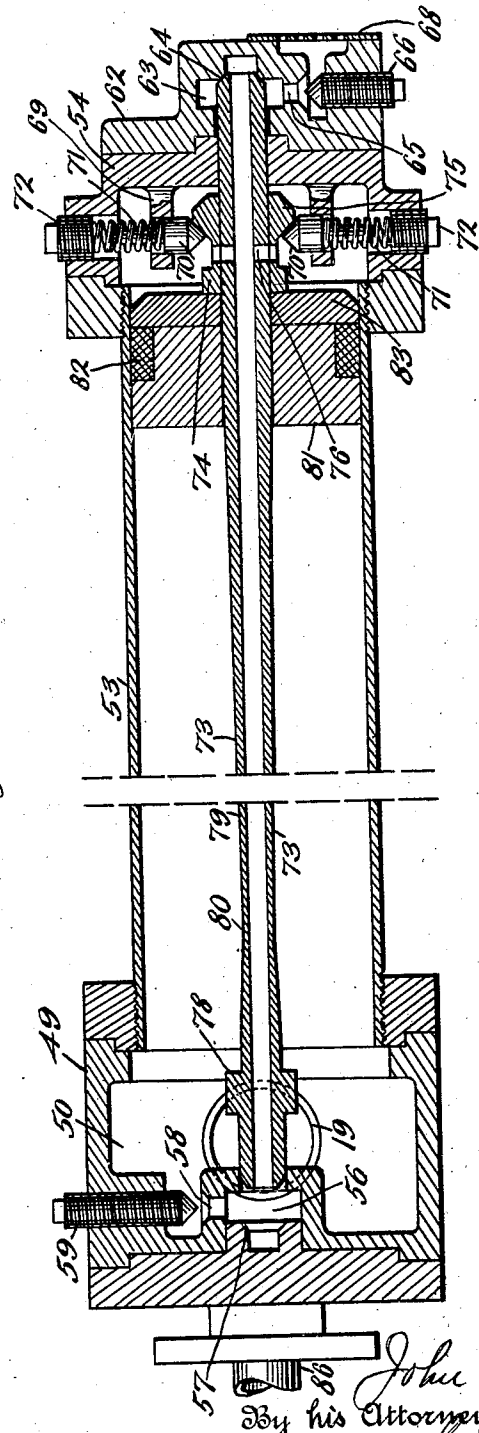


Fig. 8.

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UNITED STATES PATENT OFFICE.

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TUBE CLEANER.

Application filed February 1, 1921. Serial No. 441,553.

This invention relates to tube cleaners of the type used more especially for removing accumulation of sediment from the tubes of such apparatus as condensers though, of course, the invention may also be applied to boilers.

The urgent need of maintaining an unimpaired efficiency for the above-mentioned class of apparatus has resulted in the development of numerous devices of the hand operated universal movement type and also the rotating sweep arm types, in both of which a jet or jets of cleaning fluid such as water, air, steam, or the like are directed onto the tubes to remove deposits therefrom which reduce the heat transfer.

However, in all of the present devices for this purpose there are three important objections; firstly, the constant attendance of an operator is required; secondly, the operation of the devices is such that they do not insure uniform cleansing of each tube; and thirdly, the devices are not of such a character as to form an integral part of the condensers or the like and cannot be automatically operated continuously or intermittently while the condenser is in or out of use, as conditions may demand.

The present invention provides a tube cleaner which is automatic in its operation and does not require the attendance of an operator; it is of the rotating arm type, but the arm moves radially as well as rotatively, and such radial movement is of a gradually accelerating character whereby all of the tubes are subjected to a substantially uniform cleaning action regardless of whether they are approximate to or removed from the center of rotation of the arm; also, the tube cleaner is assembled as a permanent attachment to the condenser and may be operated while the condenser is in or out of service, and its operation may be continuous or intermittent.

A further feature is that the cleaning jet nozzles may be removed and replaced with ease from outside of the condenser, and even while the condenser is in operation.

In the drawings:

Figure 1 is a side elevation of a condenser embodying the invention.

Figure 2 is an end elevation of the tube cleaner applied to the condenser.

Figure 3 is a part horizontal section on the line 3—3 of Fig. 2.

Figure 4 is a sectional detail of a condenser taken on the line 4—4 of Fig. 3, showing a side elevation of the tube cleaner.

Figure 5 is an enlarged central section of the operating cylinder on the line 5—5 of Fig. 3.

Figure 6 is an enlarged detail view of a part of the apparatus.

Figure 7 is a section on line 7—7 of Fig. 6.

Figure 8 is an enlarged central section of the operating cylinder, similar to Figure 5 but with the parts reversed.

Referring now to the drawings:

The tube cleaner, as herein shown for the purpose of disclosing the invention, is applied to a condenser A of the surface type having the tube plates 10 mounting the tubes 11 in the usual manner, a screw stud 12 being positioned at the center of one of the plates 10 and having a bearing head 13 for a purpose to be presently set forth.

A ring head 14, at one end of the condenser A, carries a cover plate 15 having a central aperture 16 which admits a journal box 17 having a flange 18 abutting the cover plate 15, as shown, and projecting inwardly of the ring head 14.

The journal box 17 mounts a hollow shaft 19 the inner end 20 of which projects beyond the end of the journal box and is threaded. A collar 21 fits loose on the inner end of said shaft 19.

The outer end of the journal box 17 is counterbored as at 22 to receive packing 23 which is compressed by a flanged gland member 24 which forms one end of an inlet T 25, the opposite end being closed by a flanged member 26 counterbored to receive the packing 27 compressed by the gland member 28. The portion of the hollow shaft 19 lying within the T 25 is perforate as indicated at 29 to admit fluid to the said hollow shaft 19, the outer end of said shaft being closed by a solid stub shaft 30 screwed into the end of the hollow shaft.

The stub shaft 30 carries a worm wheel

31 meshing with a worm 32 carried on a shaft 33 journaled in a bearing 34 supported on the cover plate 15; said shaft 33 carries at its other end a worm wheel 35 meshing with a worm 36 carried on a shaft 37 journaled in a bearing 38 swivelled at 39, the swivel movement being limited by arcuate slots 40 through which studs 41 on the swivelling part extend, the entire swivelling journal 39 being carried by an arm 42 fixed to the cover plate 15 by bolts 43. The shaft 37, on its remaining end carries a worm wheel 44 which is engaged by a worm 45 on the shaft of a driving motor 46 mounted on a base 47 projecting out from the cover plate 15.

From the foregoing description it will be apparent that the motor 46 drives the hollow shaft 19 but that the shaft 37 may be turned about pivot 39 so as to disengage worms 36 and 45 from worm wheels 35 and 44, respectively, whereupon worm wheel 31 may be rotated by hand to bring certain marks on said worm wheel 31, hereinafter referred to, into registration with a pointer 48.

The inner threaded end of the hollow shaft 19 carries a hub casting 49 having the chamber 50 closed by diametrically opposite heads 51 and 52, the former being the nozzle tube head and the latter the cylinder base.

The inner end of a cylinder 53 is screwed into the cylinder base head 52, while the outer end of said cylinder is closed by an outer cylinder head 54. In the hub casting 49, which is recessed for journaling on head 13 of stud 12, is a boss 55 having an inlet chamber 56 one side of which is closed by a valve seat 57 carried by the nozzle tube head 51. A port 58 is controlled by a screw plug 59 covered by a cap 60.

The outer cylinder head 54 carries a boss 61 which enters a counterbore in a cylinder head cap 62 having an outlet chamber 63 and a valve seat 64, the outlet port 65 being controlled by a screw plug 66 covered by a cap 67, a screen 68 serving to keep sediment and the like from entering the outlet port. Opposite lugs 69 carry the bevelled keepers 70 which are pressed inwardly by springs 71 held by screw plugs 72. A reciprocable tubular valve member 73 is mounted concentric with the cylinder 53 and each end is formed conical to seat on valve seats 57 and 64, respectively. The outer end of this tubular valve member 73 carries a spool-like tappet 74 having the conical portion 75 for holding engagement by the beveled keepers 70. Ports 76 through the spool-like tappet 74 and the tubular valve member 73 are provided. An abutment face 77 is also carried by the spool-like tappet 74. At the opposite end of the tubular valve member 73 is a tappet 78. Intermediate the ends the tubular valve member 73 is reduced in size as indicated by the numeral 79, this reduced portion being gradually tapered inward and preferably having its smallest diameter approximate the point 80.

Within the cylinder 53 and sliding on the tubular valve member 73 is a piston 81 having the packing 82 held by the piston head 83, said piston head being held to the piston body by screws 84. Tubular nozzle arms 85 and 86 are secured at one end in the piston body 81 and have openings or perforations 87 communicating with the chamber 50 so as to admit fluid to the said arms. These arms extend through glands 88 in the nozzle tube head 51 and at the outer end each arm is threaded as at 89 to receive a nut 90, said nuts forming stops for a casting 91 forming a discharge chamber 92 communicating with the interior of the nozzle arms by means of ports 93. Within the nozzle arm 85 and approximate the ports 93 is a web 94 which forms a support for a jet nozzle 95 slipped into the arm 85, as shown in Figure 7. This nozzle is retained in place by a plug 96 screwed into a nut 97 threaded onto the extremity of the nozzle tube 85 and bearing against the casting 91. The screw plug 96 is provided with a wrench socket 98. The outer side of the nut 97 is beveled off as indicated at 99 for a purpose to be hereinafter set forth.

In order to provide for renewing the jet nozzle 95 the ring head 14 carries a bushing 100 having the packing 101 and which receives the threaded end 102 of a bushing 103 closed at its outer end by a screw cap 104 having the wrench socket 105, said bushing 103 being retained against movement under ordinary conditions by a pin 106 extending through a lug 107 and entering the said bushing. The inner end of the bushing 103 is beveled as at 108 to engage the end of the nut 97 in a fluid tight manner. A screw plug 109 normally covered by a cap 110 is adapted to screw into a recess 111 in a cap nut 112 on the end of the nozzle arm 86.

When it is desired to remove the jet nozzle 95 the bearing 38 is swivelled so as to disengage the gears driving the tubular shaft 19 and the worm gear 31, which has been previously suitably marked, is rotated to a position wherein the pointer 48 indicates that the nozzle arms 85 and 86 align with the bushing 103 and plug 109 respectively. When this position of the mechanism has been attained the bushing 103 is screwed into engagement with the nut 97 and the screw plug 109 is screwed into the recess 111 thus holding the nozzle arms 85 and 86 in a set position; then the plug 104 is removed by means of a socket wrench inserted in the socket 105 and similarly the screw plug 96 is removed through the bushing 103 after which the jet nozzle 95 may be withdrawn by any convenient means such as a bent wire or the like and replaced by a new one. The

parts are then reassembled and the nozzle arms 85 and 86 released by restoring the bushing 103 and screw plug 109 to their former inoperative position. It will be noted that this removal and replacing of parts may be accomplished during the operation of the condenser with a minimum escape of fluid from the condenser and without the admission of air thereto.

Cleaning fluid, which may be hot or cold water, air or steam, is supplied under pressure to the T 25 by a suitable pump 113 delivering through pipe 114 connected thereto.

The operation is as follows: The nozzle 95 is rotated with nozzle arms 85, 86 and cylinder 53 by motor 46 which drives the hollow shaft 19 through worm wheels 44, 35, 31 and worms 45, 36, 32 co-operating therewith. Meanwhile the cleaning fluid, which is to be discharged through jet nozzle 95 into the condenser tubes 11 for a thorough cleaning thereof, passes from T 25 through hollow shaft 19 and chamber 50 to ports 87 and the nozzle arms 85, 86 for delivery to the nozzle 95.

During its rotary movement the nozzle 95 is moved radially by the pressure of the cleaning fluid under the control of the tubular valve member 73. With the parts in the position shown in Figure 5, the outer end of the cylinder 53 is closed to the inlet of fluid through chamber 56 by the engagement of the inner end of the tubular valve 73 with the valve seat 57 and is opened to discharge through ports 76, tubular valve 73, and discharge chamber 63 and port 65, so that the pressure of the cleaning fluid on the inner face of the piston 81 produces an outward movement of the piston 81 to draw nozzle arms 85, 86 and nozzle 95 inward toward the center of rotation.

The early part of this movement of piston 81 is slow due to the escape of fluid through the clearance space between the piston 81 and the tapered portion 79 of the tubular valve 73 but as the piston 81 moves outward this space is gradually contracted by the gradual increase in diameter of the tubular valve 73 so that the outward movement of the piston 81 is gradually accelerated as the length of the arc of rotation of the nozzle 95 is decreased. Near the end of its outward stroke the piston 81 engages face 77 of the tappet 74 for movement of the tubular valve 73 outward to close the discharge chamber 63 and port 65 by the engagement of the outer end of the tubular valve 73 with the valve seat 64, the valve 73 being retained in this position by the engagement of the beveled keepers 70 with the inner face of the conical portion 75 of the tappet 74.

The parts are now in the position shown in Figure 8 and the inward movement of the piston 81 for moving the nozzle 95 outward is accomplished by differential piston pressure. The cleaning fluid now passes through port 58, chamber 56, tubular valve 73, and ports 76 to the outer face of the piston 81. The inner face of the piston 81 presents considerably less surface to the pressure of the cleaning fluid than the outer face thereof due to the nozzle arms 85, 86 secured to the inner face thereof, as clearly shown in Figure 3, so that the pressure of the fluid in the outer end of the chamber 53 co-operating with the larger surface of the outer face of the piston 81 forces the piston inward. During this stroke of the piston 81, its speed is gradually retarded as it moves over the tapered portion 79 of the valve 73 to compensate for the gradually increasing lengths of the arcs to be covered by the nozzle 95 as it approaches the outer-most limit of its motion. At the end of its inward movement the piston 81 engages tappet 78 to shift the tubular valve 73 to the position shown in Figure 5 for the outward movement of the piston which has already been described.

The fluid by-passed through the clearance space between the piston 81 and the tubular valve 73 on the outward movement of the piston 81 also acts to cushion this movement of the piston during the latter part of its stroke.

While, in the foregoing disclosure, electric driving means has been shown for the tubular shaft 19, nevertheless it is obvious that other means may be employed for this purpose. Also, other devices than that herein shown may be used for moving the nozzle arms 85 and 86.

I claim:

1. In combination with a condenser having a series of tubes, a rotating nozzle arm for delivering a cleaning fluid jet endwise of said tubes, and pressure operated means for reciprocating said arm radially to direct said jet on tubes remote from and approximate to the center of rotation of said arm.

2. In combination with a condenser having a series of tubes, a rotating nozzle arm for delivering a cleaning fluid jet endwise of said tubes, and means actuated by the cleaning fluid for reciprocating said arm radially while rotating to direct said jet on tubes remote from and approximate to the center of rotation of said arm.

3. In combination with a condenser having a series of tubes, a rotating nozzle arm for delivering a cleaning fluid jet endwise of said tubes, means for moving said arm radially to direct said jet on tubes remote from and approximate to the center of rotation of said arm, and means for accelerating the inward and retarding the outward movements of said arm.

4. In combination with a condenser having a series of tubes, a nozzle arm arranged to rotate continuously in a single direction for delivering a cleaning fluid jet endwise of

said tubes, and pressure operated means for reciprocating said arm radially while rotating to direct said jet on tubes remote from and approximate to the center of rotation of said arm.

5. In combination with a condenser having a series of tubes, a condenser head adjacent said tubes and carrying a rotating nozzle arm for delivering a fluid jet endwise of said tubes, a cylinder, a piston in said cylinder connected with said arm, and means for admitting fluid to the cylinder for moving said piston to impart radial movement to the nozzle arm.

6. In combination with a condenser having a series of tubes, a condenser head adjacent said tubes and carrying a rotating nozzle arm for delivering a fluid jet endwise of said tubes, a cylinder, a piston in said cylinder connected with said arm, and valve means admitting fluid to the cylinder for moving said piston to impart radial movement to said nozzle arm and including means for graduating the rate of movement of said arm.

7. In combination with a condenser having a series of tubes, a condenser head having a hollow rotating shaft, a hub carried by said shaft and mounting a radially disposed cylinder, a piston in said cylinder, a nozzle arm forming the piston rod of said piston and carrying a nozzle for delivering a cleaning fluid jet to said tubes, and means for supplying pressure fluid to said cylinder and nozzle.

8. In combination with a condenser having a series of tubes, a condenser head having a hollow rotating shaft, a hub carried by said shaft and mounting a radially disposed cylinder, a piston in said cylinder, a nozzle arm forming the piston rod of said piston and carrying a nozzle for delivering a cleaning fluid jet to said tubes, and valve means for admitting fluid to said cylinder and graduating the rate of movement of the piston in said cylinder.

9. In combination with a condenser having a series of tubes, a condenser head, a rotating arm mounted within said head, a removable nozzle carried by said arm for delivering a cleaning fluid jet endwise of said tubes, and means carried by said head and cooperating with said arm to enable replacement of said nozzle without discontinuing operation of the condenser.

10. In combination with a condenser having a series of tubes, a condenser head, a hollow shaft mounted within said head, means for driving said shaft rotatively, an arm connected to said shaft at right angles thereto, a removable jet nozzle carried by said arm, and means in said head for permitting removal of the nozzle therethrough during the operation of said condenser.

11. In combination with a condenser having a series of tubes, a condenser head mounting a hollow shaft, means for driving said shaft rotatively, an arm connected to said shaft at right angles thereto, a removable jet nozzle carried by said arm, means in said head for permitting removal of the nozzle therethrough without affecting the operation of said condenser, and means for disengaging said driving means to permit movement of said arm to a jet nozzle removing position.

12. In combination with a condenser having a series of tubes, a condenser head mounting a hollow shaft, means for driving said shaft rotatively, an arm connected to said shaft at right angles thereto, a removable jet nozzle carried by said arm, and bushing means in said head for engaging said arm to hold the same and forming therewith a valve through which said nozzle may be removed without substantial escape of fluid from the condenser, or entrance of air thereto.

13. In combination with a condenser having a series of tubes, a nozzle arm for delivering a cleaning fluid jet endwise of said tubes, motor driven means for rotating said arm, and pressure operated means for reciprocating said arm radially to direct said jet on tubes remote from and approximate to the center of rotation of said arm.

14. In combination with a condenser having a series of tubes, a condenser head adjacent said tubes and carrying a nozzle arm for delivering a fluid jet endwise of said tubes, a cylinder, a piston in said cylinder connected with said arm, and means for moving the nozzle arm radially by delivering fluid against one side of the piston and returning the nozzle arm by differential pressure on the piston.

15. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft, a radially disposed cylinder mounted on the shaft, a piston in the cylinder, a nozzle arm for delivering cleaning fluid to said tubes and connected to the piston, a hollow valve member extending through the cylinder and piston, and ports controlled by the hollow valve member for movement of the piston.

16. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft, a radially disposed cylinder mounted on said shaft, a piston in said cylinder, a nozzle arm for delivering cleaning fluid to said tubes and connected to said piston, ports at opposite ends of the cylinder, and a hollow valve member extending through said piston and co-operating with said ports for controlling the movement of the piston, the hollow valve member having a tapered portion arranged

to retard the inward movement of the piston and accelerate the outward movement thereof.

17. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft for the supply of fluid, a radially disposed cylinder mounted at one end on the shaft and in open communication therewith, a piston in the cylinder, a nozzle arm for delivering cleaning fluid to the tubes and connected to said piston, a hollow valve member extending through the cylinder and piston, and ports controlled by the hollow valve member for delivery of fluid to and from the outer end of the cylinder.

18. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft for the supply of fluid, a radially disposed cylinder mounted in open communication at one end on the shaft, a piston in the cylinder, a nozzle arm for delivering cleaning fluid to the tubes and connected to said piston, ports at opposite ends of the cylinder, a hollow valve member extending through the piston and controlling said ports for the delivery of fluid to and from the outer end of the cylinder and needle valves regulating the inlet to one of said ports and the outlet from the other of said ports.

19. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft, a radially disposed cylinder mounted on said shaft, a piston in said cylinder, a nozzle arm for delivering cleaning fluid to the tubes and connected to the piston, ports at opposite ends of the cylinder, a hollow valve member extending through the piston and co-operating with said ports for controlling the movement of the piston, and tappets engaged by the piston near the ends of its stroke for shifting the hollow valve member.

20. In combination with a condenser having a series of tubes, a condenser head having a rotating hollow shaft, a radially disposed cylinder mounted on said shaft, a piston in said cylinder, a nozzle arm for delivering cleaning fluid to the tubes and connected to the piston, ports at opposite ends of the cylinder, a hollow valve member extending through the piston and co-operating with said ports for controlling the movement of the piston, tappets engaged by the piston near the ends of its stroke for shifting the hollow valve member, and spring means preventing movement of the hollow valve member except on engagement of the piston with one or the other of the tappets.

In testimony whereof, I have hereunto set my hand.

JOHN F. GRACE.