

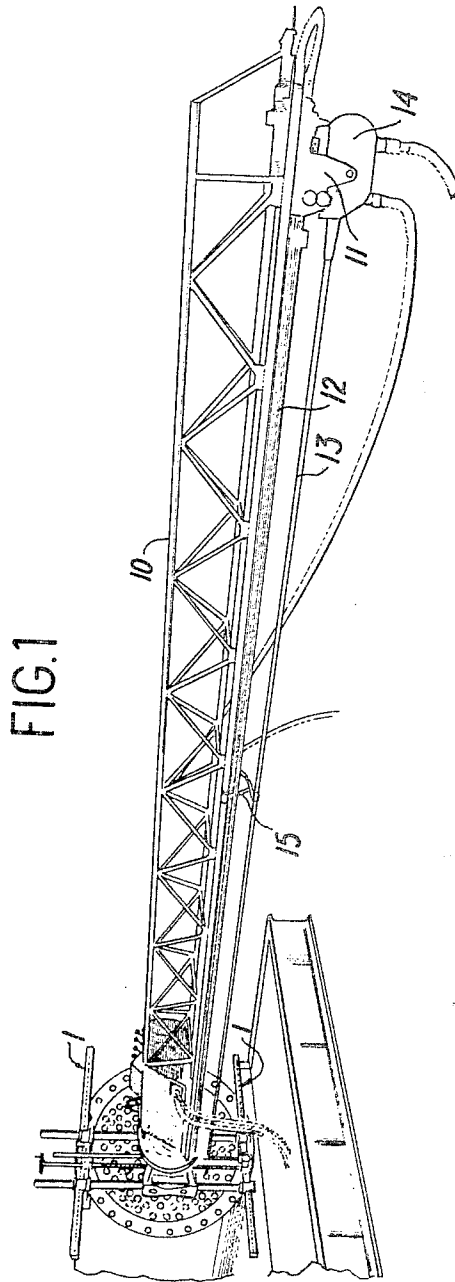
June 10, 1969

J. P. RICORDEAU ET AL  
APPLIANCE FOR CLEANING HORIZONTAL OR INCLINED DEVICES  
CONTAINING BUNDLES OF TUBES

3,448,477

Filed March 27, 1967

Sheet 1 of 5



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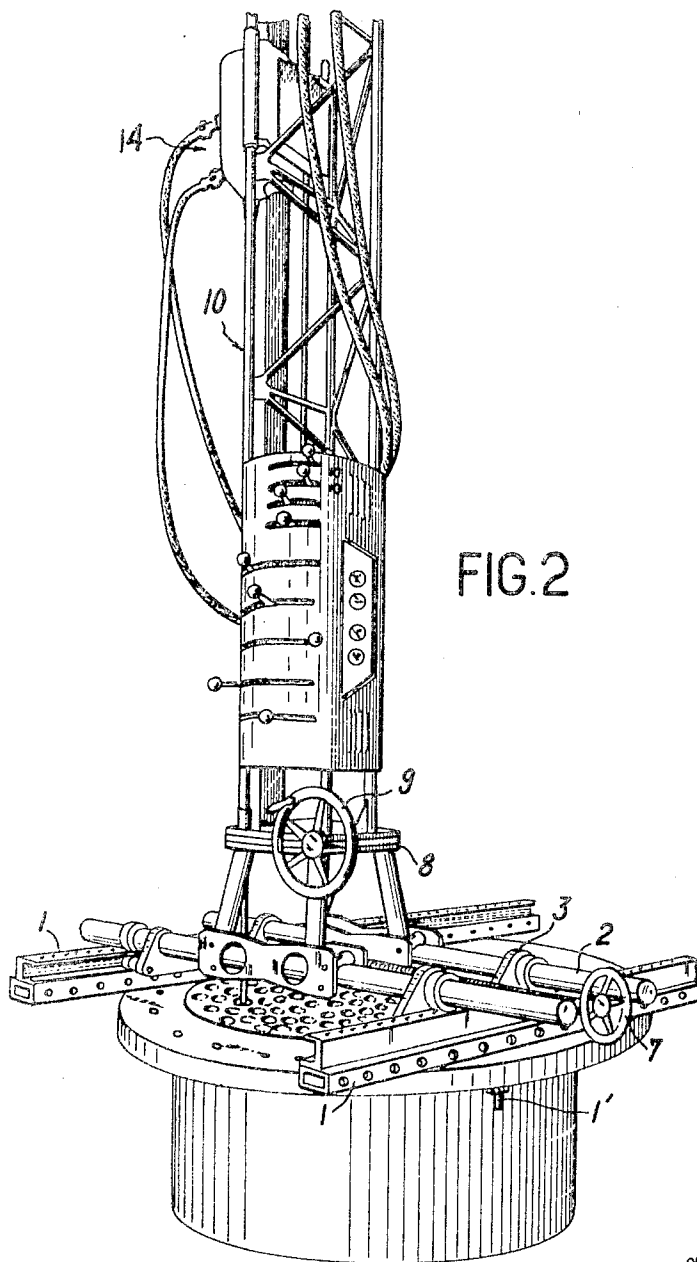
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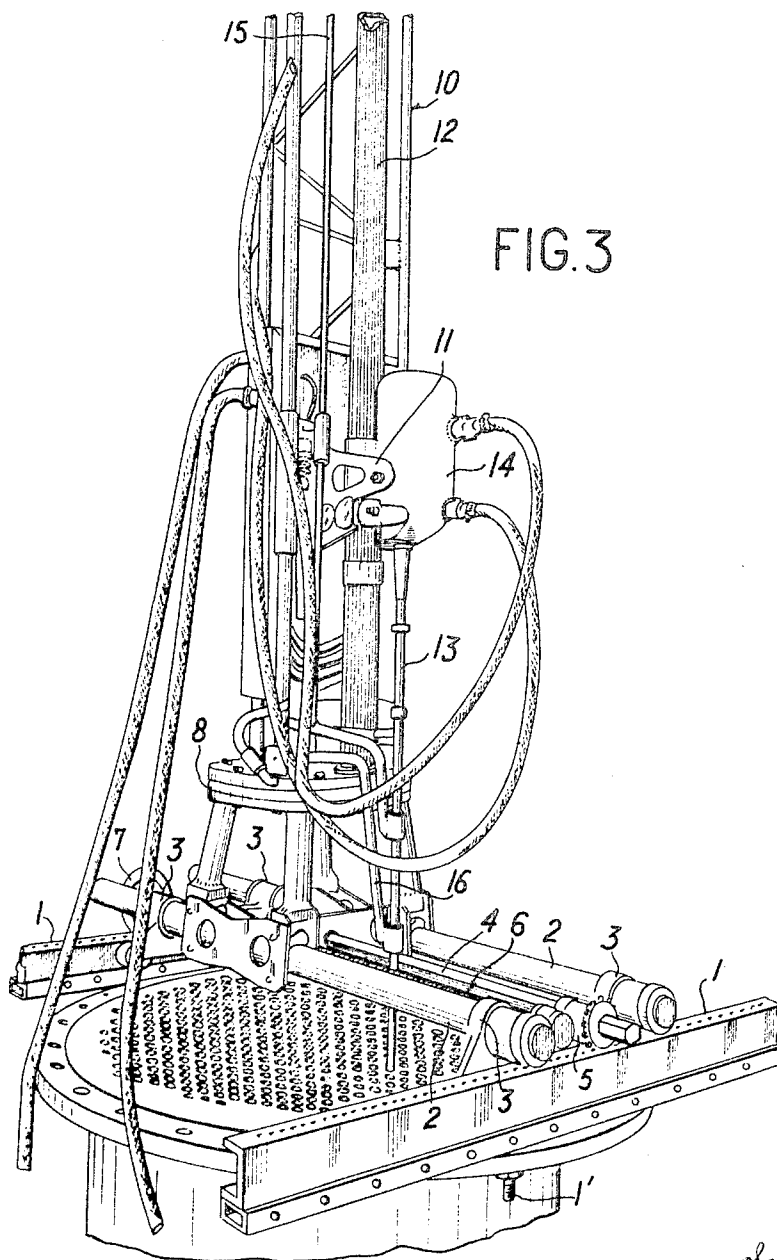
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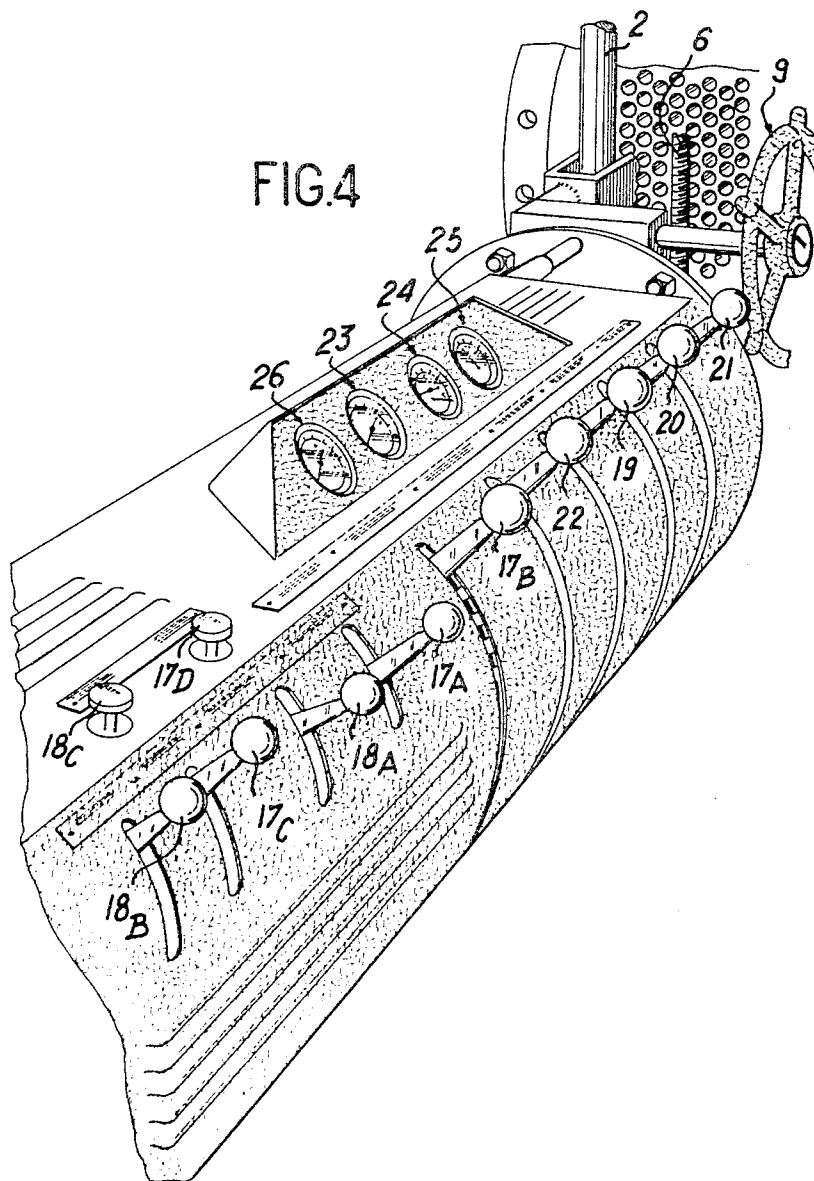
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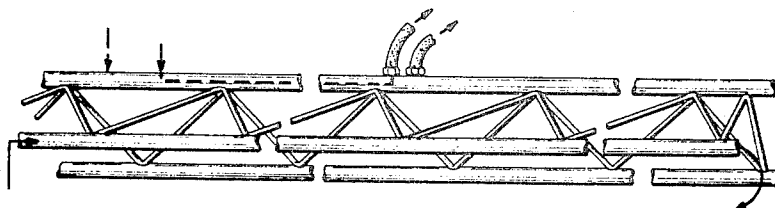


FIG. 5

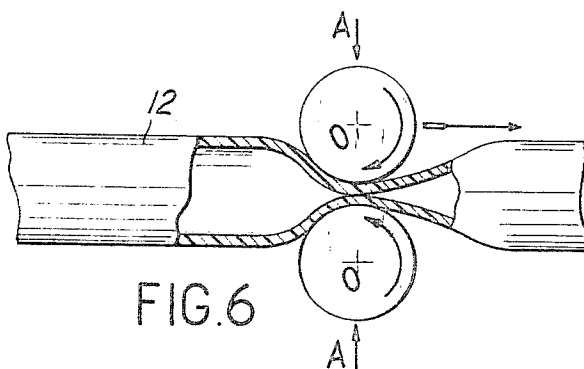


FIG. 6

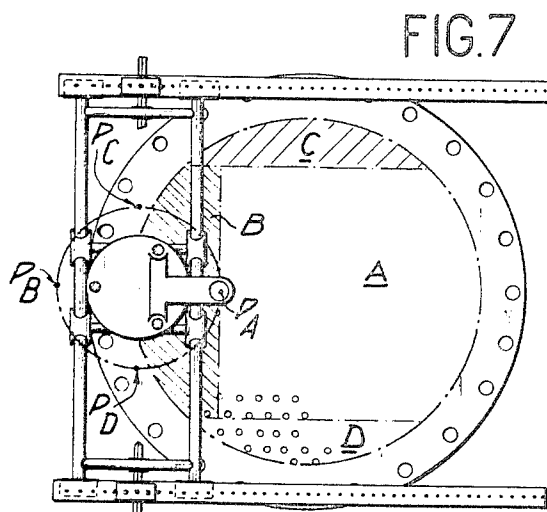


FIG. 7

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3,448,477

## APPLIANCE FOR CLEANING HORIZONTAL OR INCLINED DEVICES CONTAINING BUNDLES OF TUBES

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Filed Mar. 27, 1967, Ser. No. 626,109

Claims priority, application France, Nov. 2, 1966, 82,171

Int. Cl. F28g 1/00

U.S. Cl. 15—104.1

7 Claims

### ABSTRACT OF THE DISCLOSURE

Appliance for cleaning bundles of tubes in either horizontal or inclined position including a longitudinal unit carrying at least one cleaning tool with means for moving the unit longitudinally and for 360° rotation and for longitudinal movement of the tools; the latter means using compressed air in combination with a flexible pipe squeezed between two movable rollers.

The invention described in this application refers to an appliance for cleaning devices containing bundles of tubes, such as exchangers, condensers, reboilers and others; this appliance allows for cleaning of these tubular bundles to be carried out either in a horizontal or an inclined position.

In the majority of cases, where devices containing bundles of tubes are concerned, deposits of scale, tartar, sludge or other sediment are formed, these deposits being a nuisance, leading to a reduction in thermic exchange and to the tubes becoming blocked fairly rapidly.

Experiments have been made with various chemical processes involving dilution of the above-mentioned deposits by injecting certain products, notably acid in character, and these are still in use. These methods are expensive and inconvenient, as they require the machine to be cleaned to be out of action for a long time and the risk of rapid corrosion is present.

Various appliances have therefore been tried out; all of them incorporating a rotating tool, driven by a drilling type machine, which moves all the way along the tube.

Manual appliances have been in use for a long time; the disadvantages of these lie in the need for a considerable number of workers to be employed.

The use of certain of these appliances necessitates dismantling the device containing the bundle of tubes and positioning them on a cleaning bench. These operations are complicated and inconvenient as the device is consequently out of service for some considerable time, and many qualified workers are required.

With a recently introduced appliance, cleaning can be carried out very much quicker. This appliance is a boring type machine. Its disadvantage is that it cannot be used for cleaning a bundle of tubes in the vertical position, consequently either vertical appliances have to be placed in the horizontal position or the bundles of tubes have to be dismantled. In addition, when using this appliance, it is difficult to reach the tubes situated near the exchanger, as the appliance may be put out of balance, and this may even cause the appliance to fall, with risk of danger to the operator.

The invention described in this specification removes the disadvantages of previously used appliances, as it enables the exchangers to be cleaned in the horizontal, in the inclined position, or even in vertical. The present invention also makes it possible to have all the tubes of a bundle cleaned, including the peripheral tubes, without

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risk of throwing the appliance out of balance, hereby eliminating operations which may be dangerous to the workers.

Additionally, the invention described in this specification reduces the length of time required for cleaning the tubes referred to above, and enables the operations to be carried out by one man only, thus increasing the safety of these operations.

The appliance for cleaning the bundles of tubes, horizontal or inclined, according to the present invention, comprises a support carrying a longitudinal unit adapted for position change and holding at least one cleaning tool; the support mentioned above is so designed that it may also be moved in two orthogonal directions, perpendicular to the longitudinal axis of this unit.

The whole of the longitudinal unit is, preferably, fixed to the support in such a way that it can turn through an angle of 360° around its longitudinal centre line.

A desirable feature is to have the controls of the orthogonal movements also fixed onto the support.

The controls for rotating the whole longitudinal unit around the longitudinal axis could also be fixed to the support.

The support is of tubular or other construction, forming a mobile trolley, the movable components of which may be rollers, tubes, sliding links, wheels, gears, rack-and-pinion systems, slides, or any other equivalent.

The support also incorporates means for orthogonal movement on which the movable components of the carriage may travel. For the orthogonal movement two pairs of perpendicular tracks are provided on which position changing may occur, each independent of the other. These tracks may be slots, rails, tubes or slides fixed onto a base.

This base, which forms part of the support, is preferably so constructed that it could be fixed onto the machine containing the bundles of tubes to be cleaned.

The longitudinal unit adapted for position change which holds at least one scraping tool comprises longitudinal components such as bars, section steel columns, tubes or other parts, arranged so that they form a polygon in a section perpendicular to the longitudinal axis. Cross-members maintain rigidity of this unit.

This longitudinal unit is fixed to the support. Means could be devised to ensure rotation of the unit in relation to the support around the longitudinal axis of the unit. Rotation may be by means of a rotating plate, a circular rail, a connection formed by a wheel and an endless screw, or any other known means. This means of rotation is placed between the longitudinal unit and the support.

The appliance also incorporates controls for longitudinal position-changing of the de-scaling tool or tools.

The controls for orthogonal movements of the support, as well as for the longitudinal movement of the cleaning tool or tools, are grouped on the control panel.

All the controls may be grouped on the control panel.

The tool or tools for de-scaling or scraping are connected with a motor; they may however be operated by any other known means. Raising and lowering these tools, and any other operation, may be out by hydraulic, pneumatic, electric, electro-magnetic, magnetic or any other means.

A variant of the installation using compressed air for changing the position of the cleaning tool lies in the use of a flexible pipe squeezed between two movable rollers tied in with the motor, each end of this piping being connected alternatively onto the compressed air conduits and air at atmospheric pressure, the connection being effected by the operational controls.

The appliance described in this patent specification offers the advantage of enabling the inside and the outer

surface of a bundle of tubes to be cleaned; the bundle of tubes are dismantled and placed on the cleaning bench, such as, for instance, in front of a fixed or mobile framework on which is assembled the whole cleaning appliance; this gives an appreciable saving in the number of working hours involved.

Further purposes and advantages of this invention will be best understood by reference to certain of its structural forms, which is by no means limitative, as illustrated by the drawings enclosed.

FIGURE 1: diagrammatic view of the appliance in horizontal working position.

FIGS. 2 and 3: diagrammatic views from two sides of the lower part of the appliance in vertical position.

FIG. 4 shows the control panel of the appliance.

FIG. 5 shows schematically the use of the tubes of the longitudinal unit, as a system of fluids.

FIG. 6 shows diagrammatically the flexible piping governing position changing of the cleaning tool head by increasing or reducing pressure, and the system of fixing the motor with which the head of the cleaning system is connected.

FIG. 7 shows diagrammatically the various positions of the cleaning tool axis possible during rotation of the longitudinal unit.

The appliance, as shown on the drawings enclosed, is fixed at 1' by means of a frame, either to the shell flange or to the circulation box, or to the tube plate of the machine containing the bundle of tubes to be cleaned.

This frame comprises two traveling tracks 1 the gauge of which is variable, and the length can be adapted to the diameter of the bundle of tubes to be cleaned. Part 8 of the structure taking the shape of a trolley moves along the traveling tracks 1. Spacing between the gear trains of the above-mentioned carriage can be altered by means of a system of spacing tubes 2 and fixing collars 3. Movement of the above mentioned carriage on the tracks can be obtained by means of a rack-and-pinion system. The gauge of this system is adjustable by means of a hexagonal shaft sliding inside a fitted sleeve 5. The rotation of the hexagonal shaft is controlled from the control panel.

Movement of this carriage in the orthogonal direction is obtained by a screw and nut type driving system 6. Movement of the nut along the screw is operated from the control panel, while movement of the screw in the nut is caused by the wheel 7.

The carriage 8 slides along the spacing tubes by means of rollers. A wheel-and-endless screw connection is provided at the upper part of the support allowing complete rotation of the longitudinal movement-and-holding unit around its longitudinal axis. Rotation is afforded by a series of ball bearings, and is controlled by a flywheel 9. It is obvious that this control can be obtained by pneumatic mechanical electro-magnetic or any other means.

The longitudinal movement-and-holding unit for at least one cleaning tool comprises three parallel spacing tubes 10. These tubes may also be used for piping fluids, water and air, as shown in FIG. 5. This arrangement ensures guidance of the cleaning tool head 11 exterior to the tubes 10 defining the longitudinal unit, so that the tool 11 slides along two tubes and along a flexible tube 12 squeezed between two movable rollers connected to the cleaning tool head (FIGURE 6), position change being effected by subjecting one part of the tube to pressure while no pressure is exerted on the other part. The rollers move under the pressure of the motive fluid. This reverse movement is made possible by applying pressure to the end which has been subjected to atmospheric pressure and by subjecting to atmospheric pressure the end which has been under pressure. Compressed air is used as the motive fluid, but any other suitable motive fluid can be used. The cleaning tool head contains end-of-travel shock absorbers.

The cleaning tool head 11 is so arranged that it can slide along tubing 12 and on to the movement-and-holding unit, and rotates at least one borer 13, at the end of

which a tool may be fitted, for instance, a cutter, brush etc. This cleaning-tool head 11 comprises a motor 14, for instance, an air compressor with a reducing valve, for injecting water under pressure into the borer and into the tool in order to evacuate the refuse. Obviously, any other type of cleaning tool head can be used.

If the tube to be cleaned is extra long, as is usually the case, it is necessary to guide the cleaning borer at an intermediate point in order to avoid flexure or whipping. This is achieved by the guide 15, which is capable of sliding along the longitudinal movement-and-holding unit. Movement of this guide 15 is actuated from a certain position of the cleaning tool head. A second guide 16, situated near the tubular plates, facilitates correct positioning of the tool inside the tube to be cleaned. This guide can also slide on the longitudinal unit referred to above, thus ensuring rotation of the unit around its longitudinal axis.

The control panel comprises a set of controls 17A, 17B, 17C, 17D, corresponding to the movement of the rack-and-pinion system for movement of the carriage in one direction.

Shaft 4 is driven by pawls catching a ratchet, one way or the other. The following operating controls are provided:

control 17A for admission of air into the operating double action type pneumatic jack, actuating one of the pawls; three positions are possible: (forward—neutral—reverse);

control 17B for adjusting the jack movement; this gives variable forward movement and thus the possibility of adjusting this movement, once and for all, to the tubular pitch of the exchanger;

control 17C for reversing the direction of the movement, this involving changing the pawl actuating the ratchet; this is achieved by means of cables connected with the pawls;

pushbutton 17D which regulates the air escape flow volume from the operating jack, with consequent adjustment of movement speed.

Movement of the screw-nut system (following a path perpendicular to the previous one) is controlled according to the same principle, except for the extent of the movement which is not variable. Here the following operating controls are available:

control 18A admits air onto the pneumatic operating jack, double action type, actuating the pawl; three positions are possible (forward—neutral—reverse);

control 18B reverses the movement, by means of cables (ropes) connected to the pawls;

pushbutton 18C regulates the air-flow volume from the operating jack, with consequent adjustment of the movement speed.

In addition, this operating control panel comprises a control 19 for water intake under pressure to the borer and to the cleaning tool. It also comprises a control 20 for air intake to the cleaning tool head motor, a control 21 for reversing the intake of compressed air into the flexible tube 12, ensuring movement of the cleaning head, and a control 22 for connecting the other end of the flexible tube to the outside air supply. Automation could, of course, be applied to these controls, to the whole system or to part of it. Four pressure gauges, 23, 24, 25, 26 give respective readings for: (1) general air supply, (2) water supply, (3) air on the side of the flexible tube compressed, and (4) air on the side of the flexible tube subjected to atmospheric pressure.

Operation of the appliance is as follows. After having fixed the appliance frame on to e.g. the shell flange of the apparatus the bundle of tubes of which have to be cleaned, the cleaning tool is placed in the centre line of one of the tubes of the nest. This is achieved by means of operating controls 17A, B, C, D, and 18A, B, C. Then by actuating control 21 compressed air is supplied into the flex-

ible tube 12, thus causing longitudinal movement of the cleaning head and penetration of the borer into the tube; the other end of the tube is subjected to atmospheric air pressure by control 22, the aperture of the latter governing the movement speed of the cleaning tool head. Controls 20 and 19 drive air supply to the motor and water under pressure to the borer and to the cleaning tool. The latter rotates around its axis. Then, by changing the position of control 21 the borer is withdrawn, the supply of air and water under pressure may be cut off by means of controls 20 and 19. In fact, transferring the cleaning tool from one tube into another is carried out without stopping either the rotating movement of the bit or the water supply, on the contrary, the flow of water helps to center the borer in the tube to be cleaned, and avoids any possible waste of time caused by manipulating the controls. The carriage is then moved along one of the two position-changing axes by operating lever 17A, thus advancing to another tube in the same row. Cleaning is carried out by re-starting the operations described above for cleaning the previous tube. In this way, all the tubes in the same row are cleaned. Then the tubes in the following row are dealt with by moving the carriage in a direction perpendicular to the direction selected previously; this is done by operating lever 18A. The cleaning operation for the new row of tubes starts. Flywheel 9 ensures rotation of the movement-and-holding unit along the longitudinal axis. In this way it is possible to reach all the tubes of the exchanger tube plate, because the cleaning tool occupies an eccentric position in relation to the centre line of the longitudinal unit. FIGURE 7 shows the positions  $P_A$ ,  $P_B$ ,  $P_C$ ,  $P_D$  in which the axis of the cleaning tool should be placed to ensure correct working in the respective zones A, B, C and D of the nest of tubes.

Flywheel 9 may be advantageously replaced by an automatic device, operated by compressed air, or any other similar means.

The appliance is provided with a seat for the operator.

It is obvious that this invention is in no way limited to the example described; it is to be understood that the invention is susceptible to variation, modification, and change within the spirit and scope of the above disclosed embodiments.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A device for cleaning horizontal or vertical tube bundles comprising:

a longitudinal unit adapted for position change and for holding at least one cleaning tool, said longitudinal unit being adapted in use to extend parallel to the tubes to be cleaned;

support means for said longitudinal unit comprising a first pair of parallel tracks, means to attach said tracks adjacent the tubes to be cleaned perpendicular to the axes thereof, a second set of parallel tracks perpendicular to the axes of said tubes to be cleaned and to said first pair of tracks and adapted to move along said first pair of tracks, and means to provide rotation of said longitudinal unit about an axis parallel to the axes of said tubes to be cleaned, said means to provide rotation carrying said longitudinal unit and being carried by said second pair of tracks and being adapted to move along said second pair of tracks;

at least one cleaning tool carried by said longitudinal unit and adapted to move in a direction parallel to the axis of said longitudinal unit into said tubes to be cleaned;

means to independently move said longitudinal unit in two orthogonal directions along said tracks and in a rotary manner about its longitudinal axis for positioning said cleaning tool prior to movement of said tool into said tube; and

means to move said tool parallel to the axis of said longitudinal unit and into and out of said tube for cleaning thereof.

2. A device in accordance with claim 1 wherein said cleaning tool is mounted on said longitudinal unit exterior thereto.

3. A device in accordance with claim 2 wherein said longitudinal unit comprises three parallel spacing tubes defining a triangular cross-sectional area therebetween, said exterior mounting of said cleaning tool placing it outside said triangular cross-sectional area, and said cleaning tool being supported for movement along two of said tubes.

4. A device in accordance with claim 1 wherein said means to move said cleaning tool comprises a flexible tube along said longitudinal unit, means for providing fluid pressure to either end of said flexible tube while venting the other end thereof, and roller means carrying said cleaning tool along said flexible tube, said roller means pinching said flexible tube closed so that fluid pressure in one end of said flexible tube causes rotation of said roller means along said flexible tube thereby moving said cleaning tool.

5. A device in accordance with claim 4 wherein said cleaning tool is mounted on said longitudinal unit exterior thereto.

6. A device in accordance with claim 4 wherein said longitudinal unit comprises three parallel spacing tubes defining a triangular cross-sectional area therebetween, said exterior mounting of said cleaning tool placing it outside said triangular cross-sectional area, and said cleaning tool being supported for movement along two of said tubes.

7. A device in accordance with claim 1 wherein said longitudinal unit comprises three parallel spacing tubes defining a triangular cross-sectional area therebetween, a plurality of said cleaning tools being mounted on said longitudinal unit exterior of said triangular cross-sectional area, said cleaning tools being supported for movement along two of said tubes; said means to move said cleaning tools comprising a flexible tube running along said two of said tubes supporting said cleaning tools, said means to move said cleaning tools further comprising means providing fluid pressure to either end of said flexible tube while venting the other end thereof, and roller means provided on said cleaning tools for carrying said tools along said flexible tube, said roller means pinching said flexible tube closed so that fluid pressure in one end of said flexible tube causes rotation of said roller means along said flexible tube thereby moving said cleaning tools.

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ROBERT W. MICHELL, *Primary Examiner*.

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