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Riebe

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[54] **TUBE CLEANING APPARATUS**

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[52] **U.S. Cl.** ..... **134/56 R;** 134/167 C

[51] **Int. Cl.²** **B08B 3/02;** B08B 9/02

[58] **Field of Search** .. 134/22 C, 24 C, 56 R, 166 C, 134/167 C, 168 C, 169 C

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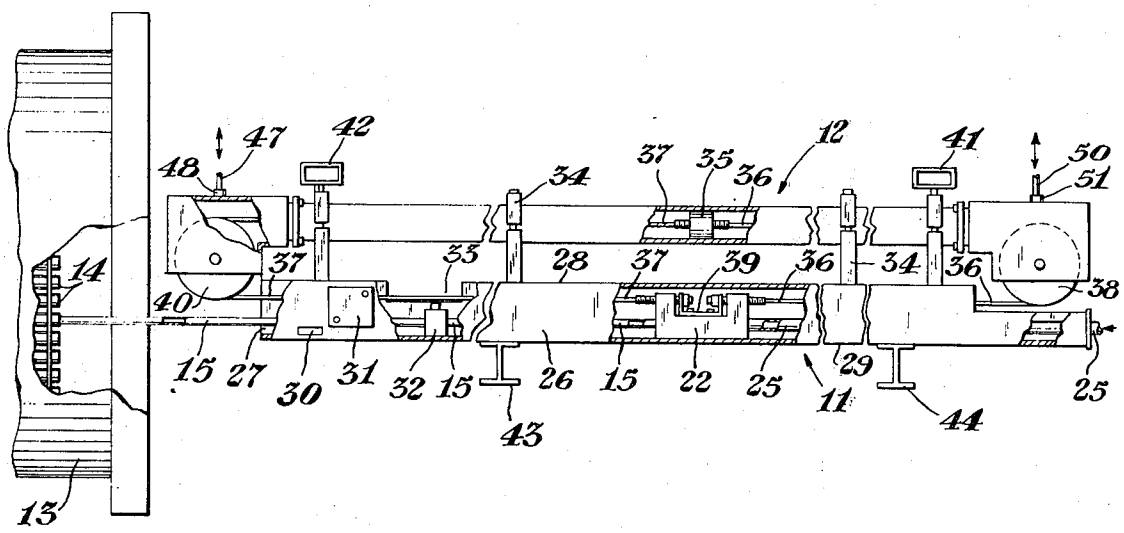
Primary Examiner—Robert L. Bleutge

Attorney, Agent, or Firm—V. Dean Clausen; William M. Yates

[57] **ABSTRACT**

An apparatus is disclosed which is particularly suitable for cleaning a tube bundle, such as those found in heat exchangers. In a preferred embodiment, a pair of tubular lances are fastened at the rear end into interconnecting channels of a manifold block. The manifold block and lances are completely enclosed within a hollow, squared beam, with the block being slidable in the beam. An air-operated cable cylinder is mounted on the beam above the block. Cable segments in the cylinder are attached to opposite sides of a piston and to opposite ends of the manifold block. Upon actuation of the cable cylinder by an air-operated valve, which is tripped by a follower at the front end of the lances, the manifold block is moved from a forward position to a retract position. In the forward position of the manifold block the lance tips are inserted in the tubes of the bundle and a high pressure water stream is directed through the manifold block and into each lance. The high force of the water stream which discharges from each lance loosens solid deposits which build up in the tube bundle.

5 Claims, 4 Drawing Figures



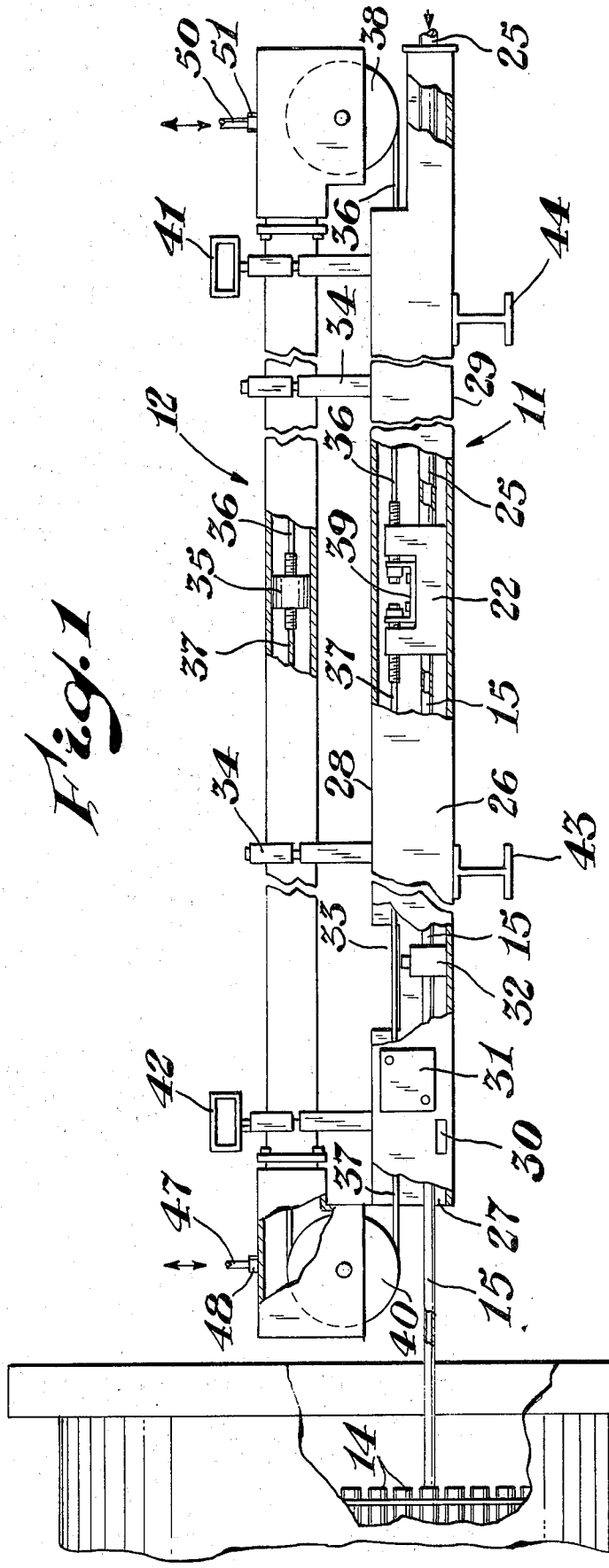

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Fig. 1

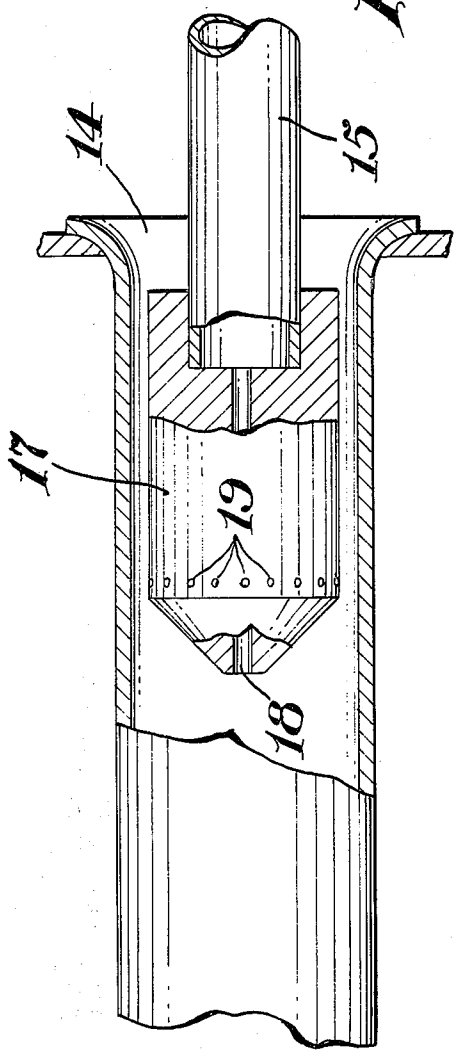

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Fig. 4

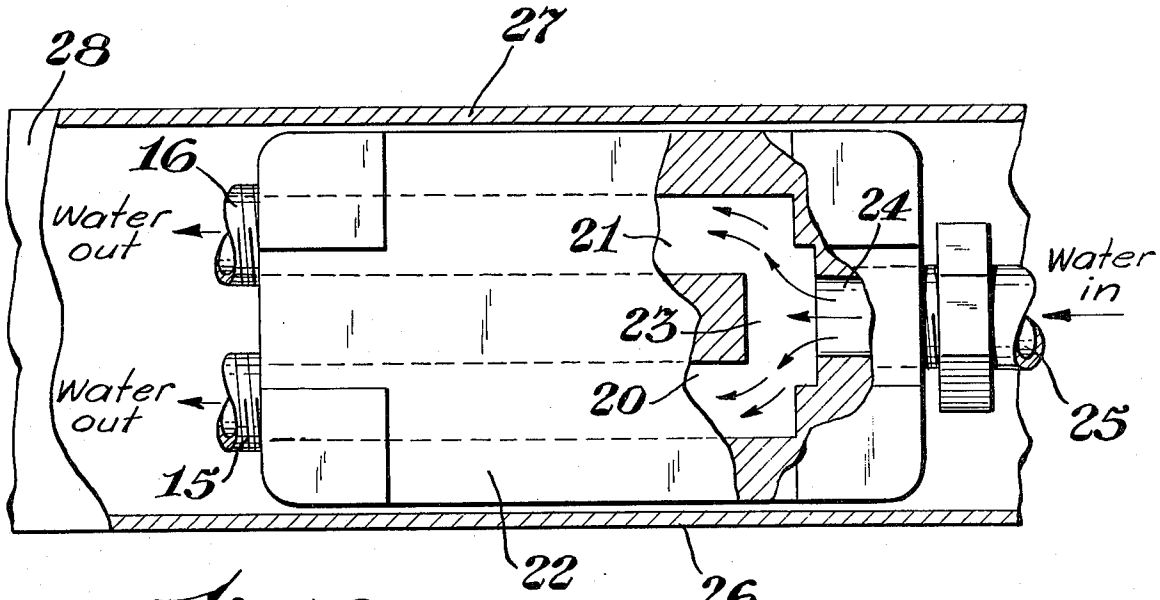

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Fig. 2

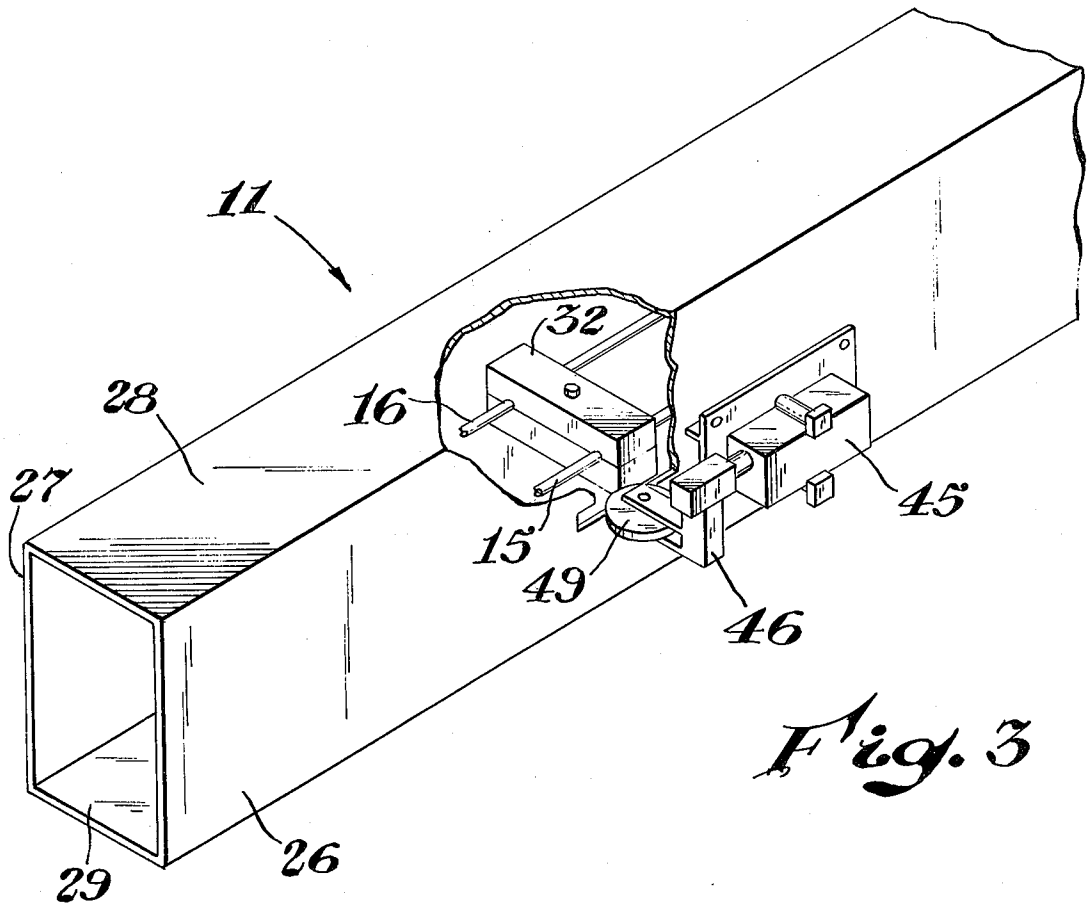

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Fig. 3

TUBE CLEANING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for cleaning a tube bundle. More specifically, the invention covers an apparatus utilizing one or more tubular lances through which fluid at high pressure is directed to clean the tubes in a tube bundle.

In many industrial operations liquids or slurries are heated by passing the material through the tube bundle of a furnace or heat exchanger. Over a period of time mineral deposits or other deposits from process fluids will accumulate in the tubes and clog the tube passageways. This requires periodic shut-downs to clean the tube bundle.

One of the usual cleaning methods involves a rodding of each tube by directing a fluid under high pressure through a long hollow rod which is forced into the tube. The outside diameter of the "lance" rod is slightly smaller than the inside diameter of the tube, to permit discharge of fluid and chips. Frequently, this cleaning operation is done manually. The manual procedure usually involves having one man near the tip of the lance to guide it into the tube and one or two men behind him to support the long thin lance to keep it from buckling.

There are major problems inherent in the hand lance method. For example, it is very difficult to keep the lance from buckling and bending while it is being guided into the tube. A more serious problem, however, is jet reaction from the high pressure stream. Since the fluid is forced through the lance at extremely high pressures (in excess of **6000** psi) the fluid discharge from the lance tip will frequently blow backward and strike the operators guiding the lance. Because of this feature the hand lance method is an extremely unsafe cleaning technique.

Various mechanical devices have also been used to clean tube bundles. A typical mechanical apparatus used for this purpose is described in U.S. Pat. No. **3,736,909.** In this apparatus the rear portion of the lances are supported in an elongated channel member which has an open top. The front end (operating end) of each lance is fed into the tube through a vertical separator plate positioned at the front end of the channel member. The drive means comprises a set of motor-driven friction rollers which engage the lances immediately behind the separator plate.

The greatest disadvantage of this apparatus is the safety factor. Since the major portion of each lance is supported in the open channel member behind the drive rollers and the motor, the lances are not guarded by a protective shield. In such a structure, therefore, even a "pinhole" leak in the lance may result in injury to the operators from the force of the high pressure stream.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for cleaning a tube bundle. One or more tubular lance members are enclosed in a hollow, squared beam. The front end of each lance is adapted to fit into a tube in the bundle and the rear end of each lance connects into one side of a manifold block which is slidable in the beam. A fluid inlet line connects into the opposite side of the manifold block. The inlet line communicates

with the rear end of each lance through interconnecting channels in the manifold block.

A drive means is mounted on the beam and is operatively connected to the manifold block. In operation, a fluid, such as water, is forced at high pressure from the inlet line through the manifold block and into the lances. Operation of the drive means moves the manifold block to a forward position to insert the lances into the tubes, and to a retract position in which the lances are withdrawn from the tubes. A follower member is mounted on the forward end of the lances ahead of the manifold block. During forward travel of the lances within the beam the follower strikes a stroke limiting member mounted on the beam. The stroke limiting device, which is operatively connected to the drive means, actuates the drive means to move the manifold block from the forward position to the retract position.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view, partly in section, of a preferred form of a tube cleaning apparatus according to this invention. This figure also includes a fragmentary view of a tube bundle and it shows the position of a lance as inserted in the tube bundle during the cleaning operation.

FIG. **2** is a plan view, partly in section, of the manifold block component of this apparatus.

FIG. **3** is a fragmentary view, in perspective, which illustrates a stroke limiting valve and a follower member which actuates the valve, as components of the present invention.

FIG. **4** is a detail view, mostly in section, which illustrates a nozzle tip on the cleaning lance and the position of the nozzle tip in the tube bundle.

DESCRIPTION OF A PREFERRED EMBODIMENT

In the drawing, referring particularly to FIG. **1,** the numeral **10** generally designates one embodiment of the tube cleaning apparatus of this invention. A basic component of apparatus **10** is a hollow, elongate beam indicated generally by numeral **11.** Mounted on beam **11** is a cable cylinder, indicated generally by numeral **12.** In preferred form the beam **11** is a hollow metal beam having a square cross section. The fragmentary view at the left side of FIG. **1** illustrates the outer shell **13** and the tube bundle **14** of a typical shell and tube heat exchanger.

Means for cleaning the tubes **14** is provided by one or more tubular lance members which are enclosed within the hollow beam **11.** In actual practice, it is preferred to use two lance members, as indicated at **15** and **16.** Only one lance member **15** is shown in the side elevation view of FIG. **1** and the detail view of FIG. **4.** Both the lances **15** and **16,** however, are shown in FIGS. **2** and **3.**

The front end of each lance is adapted for inserting the lance into a tube **14** of the tube bundle. Specifically, a spray nozzle **17,** is fastened to the tip of each lance. The nozzle **17** includes a central orifice **18** and peripheral channels **19,** which intercept with orifice **18.** This construction provides a good spray pattern for cleaning of the tube bundle with a fluid, usually water, which is forced through the lance under high pressure.

Reference is made to FIG. **2.** The rear end of each lance **15** and **16** connects into lengthwise flow channels **20** and **21** in a manifold block **22.** Within the body of manifold block **22** the channels **20** and **21** connect into

a crosswise channel 23. Channel 23 in turn communicates with an inlet channel 24. A cleaning fluid, such as water, is directed into manifold block 22 from an inlet line 25, which has one end connected into the inlet channel 24. The opposite end of inlet line 25 connects into a supply line or other source for the water (not shown). The manifold block 22 thus provides a distribution header which diverts fluid flow from a single line into both the lances 15 and 16.

The square configuration of beam 11 is defined by side walls 26 and 27, a top wall 28 and bottom wall 29. At the front end of beam 11 in side wall 26 is a small rectangular opening 30. Positioned next to opening 30 is a support plate 31, which is fastened to side wall 26. Opening 30 and plate 31 provide means for mounting a stroke limiting valve and an actuator lever on beam 11. The valve and lever members are described later in this specification.

At the forward end of lances 15 and 16, the lances are clamped together and supported by a follower block 32. The block 32, which is best shown in FIGS. 1 and 3, slides along the bottom wall 29 of beam 11 during the forward advance of lances 15 and 16. This sequence is explained more fully later in this description. Next to the support plate 31 is an access opening 33 in beam 11.

Only that part of opening 33 which cuts into the side wall 27 is shown (See FIG. 1). When apparatus 10 is in operating position the opening 33 is closed by a removable cover (not shown). The access opening 33 provides a convenient means for replacing those parts enclosed by the beam 11, such as the lances 15 and 16, and the manifold block 22.

Cable cylinder 12 is mounted on beam 11 with support blocks 34. Specifically, the upper half of the block fits around cylinder 12 and is fastened to the base of the block, which is attached to top wall 28 of beam 11. The cable cylinder provides a drive means for advancing the lances 15 and 16 into the tube bundle 14 and for retracting the lances from the tubes during the cleaning operation. Cylinder 12 includes a slidable piston 35 and cable segments 36 and 37. One end of cable 36 is attached to one side of piston 35 and the cable feeds through a pulley 38.

The opposite end of cable 36 connects into a stud which fastens into an angle bracket 39, the bracket being mounted on the upper surface of manifold block 22. Similarly, one end of cable 37 is attached to the opposite side of piston 35 and the cable feeds through pulley 40. The opposite end of cable 37 connects into a similar stud member, which also fastens into angle bracket 39. A preferred form of the drive means is a commercially available tool sold under the name Tol-O-Matic. The cylinder may be operated hydraulically or pneumatically with appropriate fluids.

The present cleaning apparatus has certain features which make it convenient to transport the device from one job site to another. One of these features is a pair of handles 41 and 42 which attach to the support brackets 34 at opposite ends of beam 11. The handles 41 and 42 enable the operators to carry the apparatus 10 to a truck or other vehicle and to support the device on the vehicle during transport to the next job. Another feature is a pair of I-beam members 43 and 44, which are fastened crosswise to the bottom wall 29 of beam 11. Members 43 and 44 provide supporting feet so the apparatus 10 can be set down on a surface, such as the ground, without damaging the apparatus or contaminating it with foreign matter.

A typical cleaning operation will now be described to illustrate the practice of the invention. In operating position the device 10 is positioned directly in front of the tube bundle 14. At the front end of beam 11, immediately ahead of support foot 43, the beam is seated on the cross member of an A frame structure (not shown). The mechanical design of the A frame structure permits up and down movement and lateral movement of the apparatus 10 to enable proper centering of the lances 15 and 16 in tubes 14.

The A frame structure is also rigidly fastened to the shell 13 of the tube bundle (not shown). This is done to lessen the recoil of the lances from the tube bundle during the cleaning operation. The rear or outboard end of beam 11 is supported by a hook and chain fastener from the cross bar of a sawhorse type frame (not shown). This structure allows a free swinging movement of the rear end of the apparatus and permits good vertical and horizontal adjustment.

When the apparatus 10 is in operating position, a main control console is positioned a short distance away. Basically, the console is a system of valves and other mechanical devices which enable the operator to operate and control the cable cylinder 12. In the retract position the front end of lances 15 and 16 are positioned in beam 11 such that the follower member 32 is behind the stroke limiting valve 45 and actuator lever 46. The operator first initiates water flow through the inlet line 25, manifold block 22 and into lances 15 and 16. This is done with a portable, hand-operated valve or a foot-operated control valve positioned near the control console.

After water flow is commenced the lances 15 and 16 are advanced forward into tubes 14. Forward movement of the lances is effected by air flow from the control console through an air line 47 and fitting 48, which pushes against the forward side of piston 35 (the left side in FIG. 1). In actual operation the air flow through cylinder 12 pushes the piston 35 toward the right, so that cable 37 pulls manifold block 22 forward in beam 11 and pushes the lances into the tube bundle. In the forward travel of the lances 15 and 16 the follower member 32 will strike a rotatable wheel 49 and force actuator lever 46 outwardly.

Movement of actuator lever 46 actuates valve 45 which, in turn, operates another air valve in the control console, activation of the air valve in the control console cuts off air to line 47 and simultaneously directs air into cylinder 12 through an air line 50 and fitting 51. The air directed through fitting 51 thus pushes against the back side of piston 35 (right side of FIG. 1). In this sequence piston 35 is forced toward the left and cable 36 will pull the manifold block 22 backward in beam 11, thus withdrawing the lances 15 and 16 from the tube bundle 14.

Various features of the present invention make it a significant improvement over the prior tube cleaning devices. For example, the present device is a very light weight tool in that all structural members are fabricated of aluminum. This tool has the advantage that it requires only one operator. Another advantage is that the tool does not present a safety hazard to the operator. One of the safety features is that the operator can conduct the cleaning operation from the control con-

sole, which is located several feet away from the tube bundle during cleaning.

Another safety feature is that the lances, the manifold block, and the water inlet hose are completely enclosed during the cleaning operation. For example, this tool has been operated safely using fluid pressure up to **10,000** psi. Another advantage of this tool is the cable cylinder drive. This type of drive structure enables the lances to be moved a full stroke by moving the piston **35** in cylinder **12** the same distance. This is possible because the driver is mounted in the same plane as the lances and it has the same frame length as the beam structure.

The invention claimed is:

1. An apparatus for cleaning the tubes of a tube bundle, which includes the combination of:

a hollow, elongate beam;

at least one tubular lance member which is enclosed by the hollow beam;

the lance having a front end adapted for inserting the lance into a tube, the lance having a rear end which is connected into one of the interconnecting channels of a manifold member, and the lance defining a conduit for carrying a liquid stream from the manifold into the tube;

the manifold member defining a block which is enclosed by the hollow beam and which is slidable within the beam, the manifold including several interconnected channels within the block which are adapted for carrying a liquid stream through the block and into the lance;

a liquid inlet line which has one end connected into a liquid source, which has an opposite end that is positioned within the hollow beam, and which is connected into one of the interconnecting channels of the manifold block;

a drive means which is mounted on the hollow beam, and which is operatively connected to the manifold block, the drive means being adapted for moving the manifold block to a forward position in which the front end of the lance is inserted into the tube, and to a retract position in which the front end of the lance is withdrawn from the tube;

a stroke limiting means which is mounted on the elongate beam, which is operatively connected to the drive means, and which is adapted to actuate the drive means to move the manifold block from the forward position to the retract position;

a follower means which is enclosed by the hollow beam, which is slidable within the beam, which is mounted on the lance member ahead of the manifold block, and which is adapted to contact the stroke limiting means when the manifold block reaches the forward position, to thereby actuate the stroke limiting means.

2. The apparatus of claim **1** in which the drive means is an air-operated cable cylinder, the cylinder including cable segments in which one end of each segment is attached to opposite sides of a piston positioned within the cylinder and the other end of each cable segment is attached to opposite ends of a bracket member which is mounted on the manifold block.

3. The apparatus of claim **1** which includes at least two tubular lance members, the lance members being positioned in side-by-side relation and being enclosed by the hollow beam, each lance having a front end adapted for inserting the lance into a tube, each hance having a rear end which connects into one of the interconnecting channels of the manifold block, and each lance defining a conduit for carrying a liquid stream from the manifold block into the tube.

4. The apparatus of claim **1** in which the hollow beam has a square cross section.

5. The apparatus of claim **1** in which the stroke limiting means is an air-operated valve which actuates the piston member of the cable cylinder.

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