United States Patent

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[15] **3,703,905**

[45] **Nov. 28, 1972**

[54] **HEAT EXCHANGER CLEANING SYSTEM**

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[22] Filed: **June 26, 1970**

[21] Appl. No.: **50,067**

[52] **U.S. Cl.** **134/144,** 134/152, 134/153

[51] **Int. Cl.**.....**B08b 3/02,** B08b 9/02

[58] **Field of Search**.....134/7, 25 A, 32, 33, 34, 152, 134/153, 123, 144

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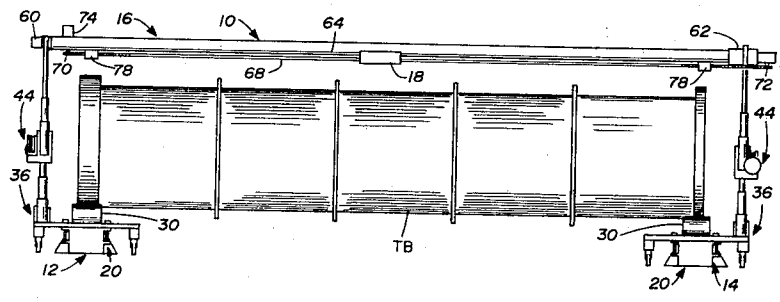
Primary Examiner—Robert L. Bleutge

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[57] **ABSTRACT**

A heat exchanger cleaning system includes a pair of dollies each comprising powered rollers for receiving and supporting a tube bundle and a boom pivoting assembly. A boom is supported on the pivoting assemblies for rotation about a tube bundle, and in turn supports a cleaning head that discharges cleaning material. In the use of the cleaning system, the distance between the dollies, the horizontal positions of the pivoting assemblies, the vertical position of the axis of rotation of the boom, and the distance from the axis to the boom are adjusted in accordance with a particular tube bundle configuration. Then, a tube bundle is mounted on rollers, the boom is rotated to successive positions arcuately of the tube bundle, and the cleaning head is moved back and forth along the boom. During its movement from position to position, the boom is pivoted about an axis extending longitudinally through it to optimize the angle at which cleaning material is discharged from the cleaning head.

21 Claims, 7 Drawing Figures



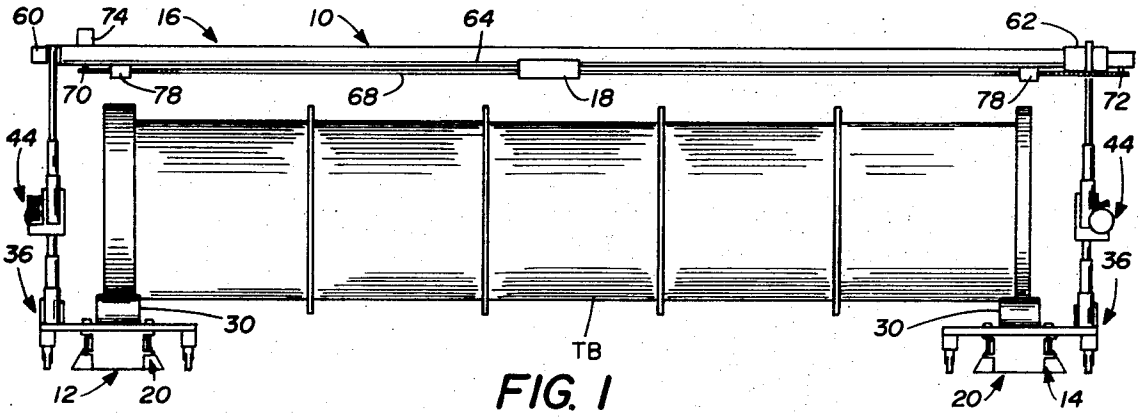


FIG. 1

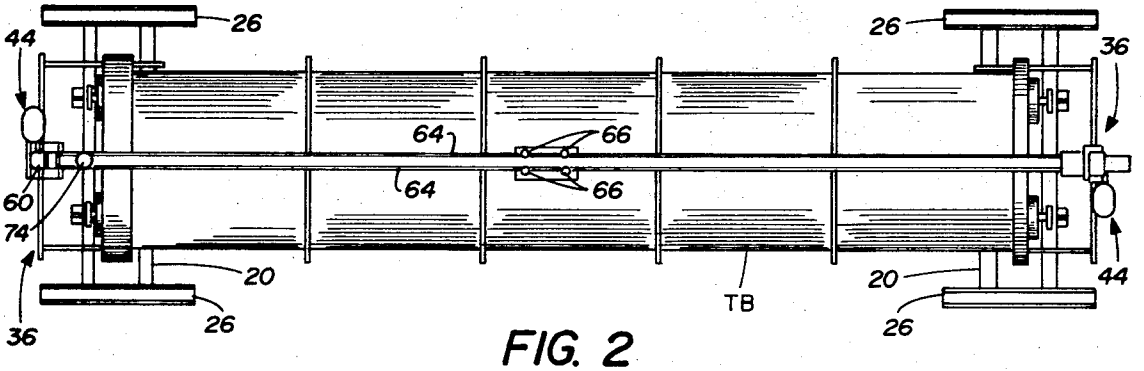


FIG. 2

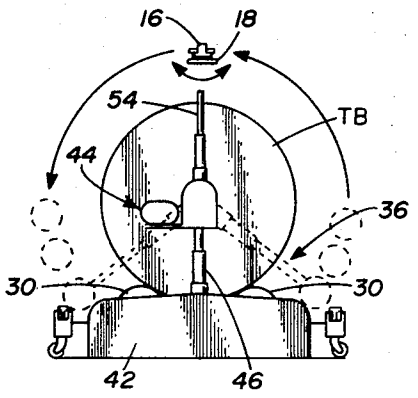


FIG. 3

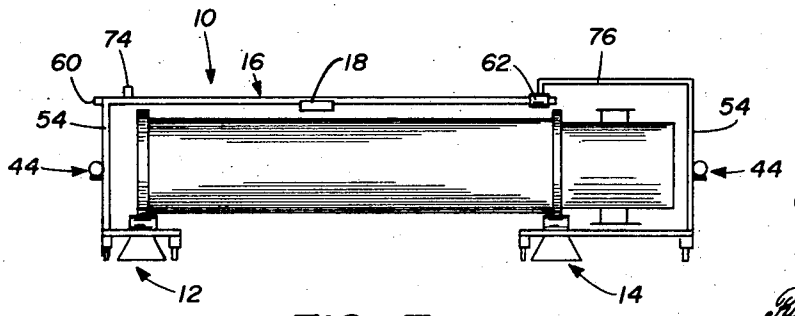


FIG. 7

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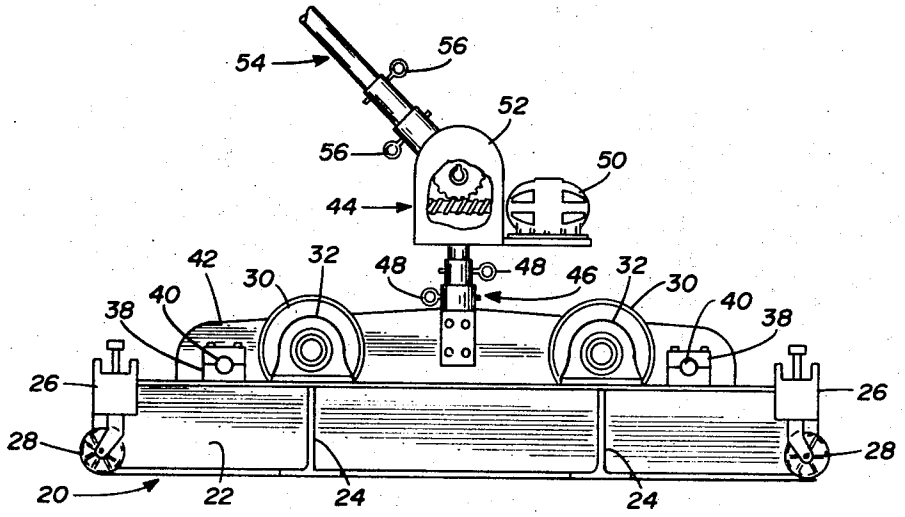


FIG. 4

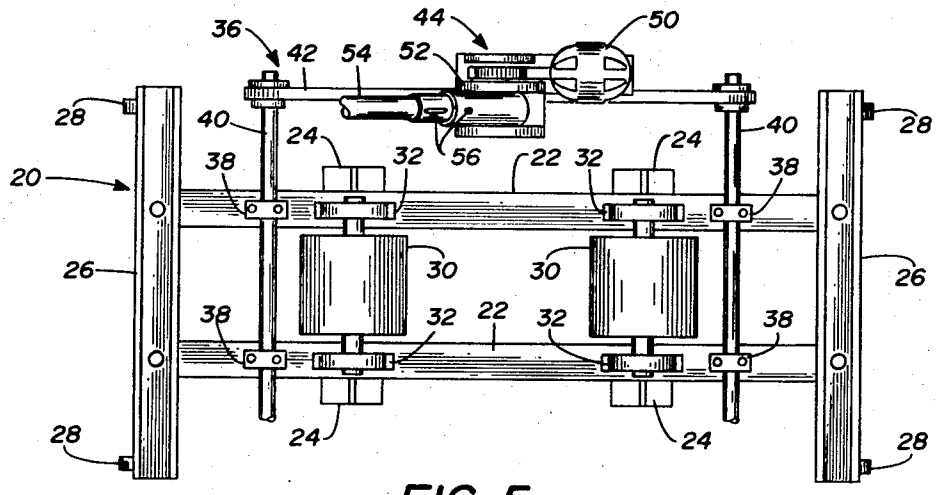


FIG. 5

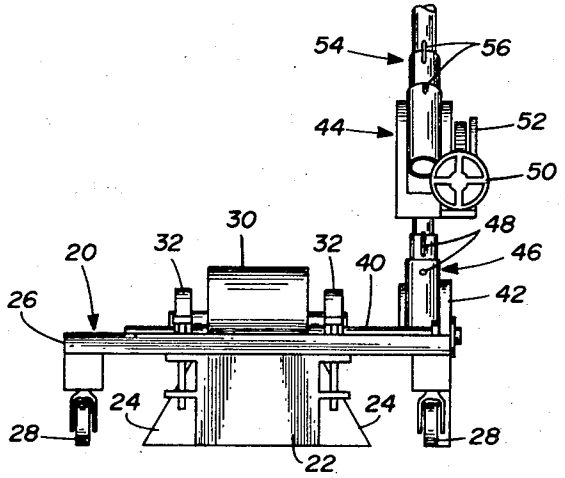


FIG. 6

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HEAT EXCHANGER CLEANING SYSTEM

BACKGROUND OF THE INVENTION

Heat exchangers are used throughout industry to transfer heat from one fluid to another. One type of heat exchanger includes a cylindrical outer shell, and a tube bundle positioned within the shell. In the use of this type of heat exchanger, one fluid is passed through the tubes from one end of the shell to another. Another fluid is passed through the central portion of the shell around the tubes to achieve heat transfer between the fluids.

The fluids passing through a heat exchanger are often corrosive in nature. Also, the fluids often contain dissolved solids. In either case, during the use of a heat exchanger, the tubes tend to become coated with materials that do not conduct heat readily. As this condition progresses, the efficiency of the heat exchanger is reduced, so that it eventually becomes necessary to clean the tubes of the heat exchanger.

This invention relates to a heat exchanger cleaning system, and more particularly to a system for cleaning the exterior walls of the tubes comprising a heat exchanger tube bundle. The system is both economical and efficient in operation and, accordingly, the use of the invention reduces both the cost and the downtime involved in a heat exchanger cleaning operation. The system is also advantageous in that it is adjustable in size and in operation, and is therefore adapted to the cleaning of virtually any tube bundle configuration.

SUMMARY OF THE INVENTION

In accordance with the preferred embodiment of the invention, a heat exchanger cleaning system includes a cleaning head that is moved both rotatably around and laterally along a cleaning station. More specifically, the system includes a pair of dollies that receive a heat exchanger tube bundle, and a boom that extends between the dollies. The boom supports the cleaning head for movement longitudinally of the tube bundle, and is in turn supported for arcuate movement about the tube bundle. The boom is further supported for rotation about an axis extending longitudinally through it, so that the cleaning head can be oriented in any desired direction. Preferably, the spacing between the dollies, the position of the axis of arcuate movement of the boom, and the distance from the boom to the axis of arcuate movement are adjustable, so that the heat exchanger cleaning system can accomodate tube bundles of various diameters and lengths.

DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be had by referring to the following Detailed Description when taken in conjunction with the drawings, wherein:

FIG. 1 is a side view of a heat exchanger cleaning system employing the invention;

FIG. 2 is a top view of the heat exchanger cleaning system shown in FIG. 1;

FIG. 3 is an end view of the heat exchanger cleaning system;

FIG. 4 is an enlarged end view of one of the dollies employed in the heat exchanger system;

FIG. 5 is a top view of the dolly shown in FIG. 4;

FIG. 6 is a side view of the dolly, and

FIG. 7 is a reduced side view of a modified version of the heat exchanger cleaning system shown in FIG. 1.

DETAILED DESCRIPTION

Referring now to the drawings, and particularly to FIGS. 1, 2, and 3 thereof, a heat exchanger cleaning system 10 employing the present invention is shown. The heat exchanger cleaning system 10 includes a pair of dollies 12 and 14 which receive and support a tube bundle TB to be cleaned. A boom 16 extends between the dollies 12 and 14 and supports a cleaning head 18.

In the use of the heat exchanger cleaning system 10, the boom 16 is moved arcuately of the tube bundle TB, and the cleaning head 18 is moved back and forth along the boom 16. During the movement of the cleaning head 18, cleaning material, which preferably comprises high pressure water or a mixture of sand and water, is sprayed from the cleaning head onto the tube bundle TB. The cleaning material dislodges foreign matter that has accumulated on and between the tubes comprising the tube bundle TB, and thereby cleans the exterior of the walls of the tubes.

Referring now to FIGS. 4, 5 and 6, the structural details of the dollies of the heat exchanger cleaning system 10 are shown. Each dolly includes a main frame 20 comprising a pair of beams 22 and a plurality of feet 24 extending laterally therefrom. The beams 22 extend to a pair of end beams 26 which in turn extend to a plurality of casters 28. The casters 28 and/or the end beams 26 are spring loaded relative to the beams 22, so that the dolly provides a solid foundation for a tube bundle, and yet is easily rolled from place to place.

The frame 20 supports a pair of hydraulically powered rollers 30 which are secured to the frame by a plurality of pillow blocks 32. The powered rollers 30 receive and support a tube bundle, and also rotate the tube bundle relative to the frame 20 whenever the latter function is required. The frame 20 also supports a boom pivoting assembly 36 which is secured to the frame by a plurality of clamps 38. The clamps 38 permit adjustment of the horizontal positioning of the boom pivoting assembly 36 relative to the powered rollers 30.

The boom pivoting assembly 36 includes a pair of rods 40 which extend from the clamps 38 to an end plate 42. A boom pivoting mechanism 44 is mounted on the end plate 42 by a telescoping support 46. The telescoping support 46 has a plurality of holes formed through it and is provided with a pair of retaining pins 48. The holes and the pins permit adjustment of the length of the telescoping support 46, which in turn determines the vertical positioning of the boom pivoting mechanism 44 relative to the powered rollers 30.

The boom pivoting mechanism 44 includes a hydraulic motor 50 and a worm gear type speed reducer 52. A telescoping arm 54 is connected to the output of the speed reducer 52. The arm 54 has a plurality of holes formed through it and is provided with a pair of retaining pins 56. The holes and the pins permit adjustment of the length of the telescoping arm 54.

Referring again to FIGS. 1, 2, and 3, a hydraulic motor 60 is supported on the distal end of the telescoping arm 54 of the dolly 12. One end of the boom 16 is detachably connected to the output of the hydraulic motor 60. The other end of the boom 16 is slidably supported in an adjustable swivel 62 mounted on the

telescoping arm 54 of the dolly 14. The motor 60 and the swivel 62 permit rotation of the boom 16 about an axis extending longitudinally through it. The swivel 62 further permits adjustment of the distance between the dollies 12 and 14.

The cleaning head 18 is supported on the boom 16 by the cooperation of tracks 64 mounted on the boom 16 and a plurality of wheels 66 mounted on the head 18. As is best shown in FIG. 1, a chain 68 extends between a sprocket 70 mounted at one end of the boom 16 and a sprocket 72 mounted at the other end. The chain 68 is connected to the cleaning head 18 and is driven through the sprocket 70 by a hydraulic motor 74 mounted on the boom 16. Thus, by operating the hydraulic motor 74, the head 18 is moved back and forth along the length of the boom 16.

In the use of the heat exchanger cleaning system 10, the various components of the system are adjusted to form a cleaning station adapted to a particular tube bundle configuration. That is, the dollies 12 and 14 are manipulated toward or away from each other to locate the powered rollers 30 in tube bundle receiving positions, the boom pivoting assemblies 36 are adjusted by means of the clamps 38 until they clear the ends of the tube bundle, the lengths of the telescoping supports 46 are adjusted to position the boom pivoting mechanisms 44 approximately in alignment with the axis of the tube bundle, and the lengths of the telescoping arms 54 are adjusted to permit movement of the boom 16 arcuately about the tube bundle. As is best shown in FIG. 7, tube bundles having large end flanges can be accomodated in the heat exchanger cleaning system 10 by connecting an extension 76 between the adjustable swivel 62 and the telescoping arm 54 of the dolly 14. After the various components of the system 10 are adjusted relative to each other, a tube bundle is positioned on the powered rollers 30 of the dollies 12 and 14, and the system 10 is operated to clean the tube bundle.

The heat exchanger cleaning system 10 is preferably operated by actuating the boom pivoting mechanisms 44 to position the boom 16 in alignment with a first portion of a tube bundle. In the case of a tube bundle having angularly extending tubes, the pivoting mechanisms 44 are actuated independently to skew the boom 16 relative to the axis of the tube bundle. When the boom 16 is properly positioned, the hydraulic motor 74 is operated to move the cleaning head 18 back and forth along the tube bundle, and cleaning material is discharged from the cleaning head 18 to clean the tubes of the tube bundle comprising the first portion.

When the first portion of the tube bundle has been thoroughly cleaned, the boom pivoting mechanisms 44 are actuated to position the boom in alignment with a second portion of the tube bundle, and the cleaning head 18 is actuated to clean the second portion. Depending on the orientation of the tubes in a particular tube bundle, for example, if some of the tubes are positioned along a flat face, the hydraulic motor 60 is actuated during the movement of the boom to properly align the discharge of the cleaning head 18. As is best shown in FIG. 3, the step by step movement of the boom 16 is continued until the boom 16 has been rotated as far as possible about the tube bundle, typically about 340°. The powered rollers 30 of the dollies 12 and 14 are then actuated to rotate the tube bundle relative to the dollies 12 and 14, whereupon the remainder of the tube bundle is cleaned.

In accordance with the preferred embodiment of the invention, the operation of the cleaning head 18 is automatically controlled. This may be accomplished by conventional techniques, such as by controlling the direction of operation of the motor 74 through a pair of limit switches 78 mounted on the boom 16 at points corresponding to the length of the tube bundle, or by placing the direction of operation of the motor 74 under the control of the timer apparatus. Of course, the control of the movement of the head 18 may also be accomplished manually, if desired.

The use of the heat exchanger cleaning system illustrated in the drawings results in several advantages over the prior art. For example, because the positioning of the various component parts of the heat exchanger cleaning system is adjustable, the system accomodates virtually any tube bundle configuration. Second, because the boom of the heat exchanger cleaning system is pivoted around a tube bundle, the system is adapted to clean tube bundles that cannot be rotated due to laterally extending flanges. Third, because the boom is mounted for rotation about an axis extending through it, the cleaning head can be manipulated to discharge cleaning material at an optimum angle relative to a particular tube bundle. Fourth, by operating the boom pivoting assemblies independently, the boom can be oriented to clean tube bundles having angularly extending tubes. Fifth, after a tube bundle has been cleaned and raised from the dollies by jacks, the apparatus can be moved by the dollies to another tube bundle without disassembly. Sixth, since the dollies can be moved under a tube bundle that has been raised by jacks, a crane or other hoisting apparatus is not required. Seventh, because of its modular construction and because of the use of spring loaded dollies, the present heat exchanger system is adapted for rapid disassembly and for transportation in a light truck to a particular cleaning site.

Although specific embodiments of the invention have been illustrated in the drawings and described herein, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of rearrangement, modification and substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. A heat exchanger cleaning system comprising:
means forming a heat exchanger cleaning station;
a cleaning head, and
means for automatically moving the head linearly along a plurality of paths each extending in a predetermined angular relationship to and located at arcuately spaced points around the axis of a tube bundle positioned at the cleaning station.

2. The heat exchanger cleaning system according to claim 1 wherein the head moving means includes a boom extending along the cleaning station and means for supporting the cleaning head on the boom and for moving the head linearly along the boom.

3. The heat exchanger cleaning system according to claim 2 wherein the head moving means further includes a pair of arms for supporting the boom and

means for rotating the arms about an axis extending through the cleaning station and thereby moving the head arcuately relative to the cleaning station.

4. The heat exchanger cleaning system according to claim 3 further including means for rotating the boom relative to the arms and thereby maintaining an optimum angular relationship between the cleaning head and the cleaning station.

5. The heat exchanger cleaning system according to claim 3 further including means for varying the lengths of the arms and means for varying the position of the axis of the rotation of the arms.

6. A heat exchanger cleaning system comprising:

mutually independently positionable means each for receiving and supporting one end of a heat exchanger tube bundle;

a pair of arms each extending from one of the receiving and supporting means;

means for rotating the arms relative to the receiving and supporting means;

a boom extending between the arms, and

means for discharging heat exchanger cleaning material from the boom.

7. The heat exchanger cleaning system according to claim 6 wherein each of the arms include means for varying the distance between receiving and supporting means and the boom.

8. The heat exchanger cleaning system according to claim 6 further including means for varying the vertical position of the axis of rotation of the arms.

9. The heat exchanger cleaning system according to claim 6 wherein the means for rotating the arms includes rotating mechanisms mounted on the receiving and supporting means and further including means for varying the vertical positioning of the rotating mechanisms.

10. The heat exchanger cleaning system according to claim 8 wherein each arm rotating mechanism comprises a motor and a worm gear type speed reducer.

11. The heat exchanger cleaning system according to claim 6 further including means on the receiving and supporting means for rotating tube bundles with respect thereto.

12. The heat exchanger cleaning system according to claim 6 wherein the rotating means further comprises means for skewing the boom relative to a tube bundle.

13. A heat exchanger cleaning system comprising:

a tube bundle supporting dolly;

a pivoting mechanism mounted on the dolly;

an arm extending from the pivoting mechanism and supported thereby for pivotal movement about an axis extending through a tube bundle supported on the dolly;

a boom supported on the arm and extending generally perpendicularly with respect thereto;

a cleaning material discharge head mounted on the boom; and

means for moving the head on the boom toward and away from the arm.

14. The heat exchanger cleaning system according to claim 13 wherein the dolly further comprises wheels and spring loaded means for facilitating movement of the dolly on the wheels when it is unloaded and for preventing movement of the dolly on the wheels when it is loaded.

15. The heat exchanger cleaning system according to claim 13 wherein the dolly includes at least one powered roller for rotating tube bundles with respect to the dolly.

16. The heat exchanger cleaning system according to claim 13 wherein the pivoting mechanism includes a motor and a worm gear type speed reducer mounted on the dolly for vertical movement with respect thereto.

17. The heat exchanger cleaning system according to claim 13 further including means for adjusting the vertical distance between the dolly and the pivoting mechanism.

18. The heat exchanger cleaning system according to claim 13 further including means for adjusting the length of the arm.

19. The heat exchanger cleaning system according to claim 13 further including means for moving the head longitudinally of the boom.

20. The heat exchanger cleaning system according to claim 19 wherein the moving means comprises a motor and a drive chain coupled between the motor and the head.

21. A system for cleaning a heat exchanger having a predetermined exterior contour comprising:

a pair of independently positionable dollies for receiving and supporting the opposite ends of the heat exchanger;

an elongated boom having opposite ends supported by the dollies, said boom extending between the dollies parallel to the heat exchanger;

means for positioning the boom at points located at intervals along a path extending parallel to the exterior contour of the heat exchanger;

a cleaning fluid discharge head supported on the boom for movement there along parallel to the heat exchanger;

means for moving the head back and forth along the boom while the boom is positioned at each of the points; and

means for simultaneously discharging cleaning fluid from the head and thereby cleaning the heat exchanger.

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