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APPARATUS FOR CLEANING HEAT EXCHANGER TUBE BUNDLES

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Fig. 1.

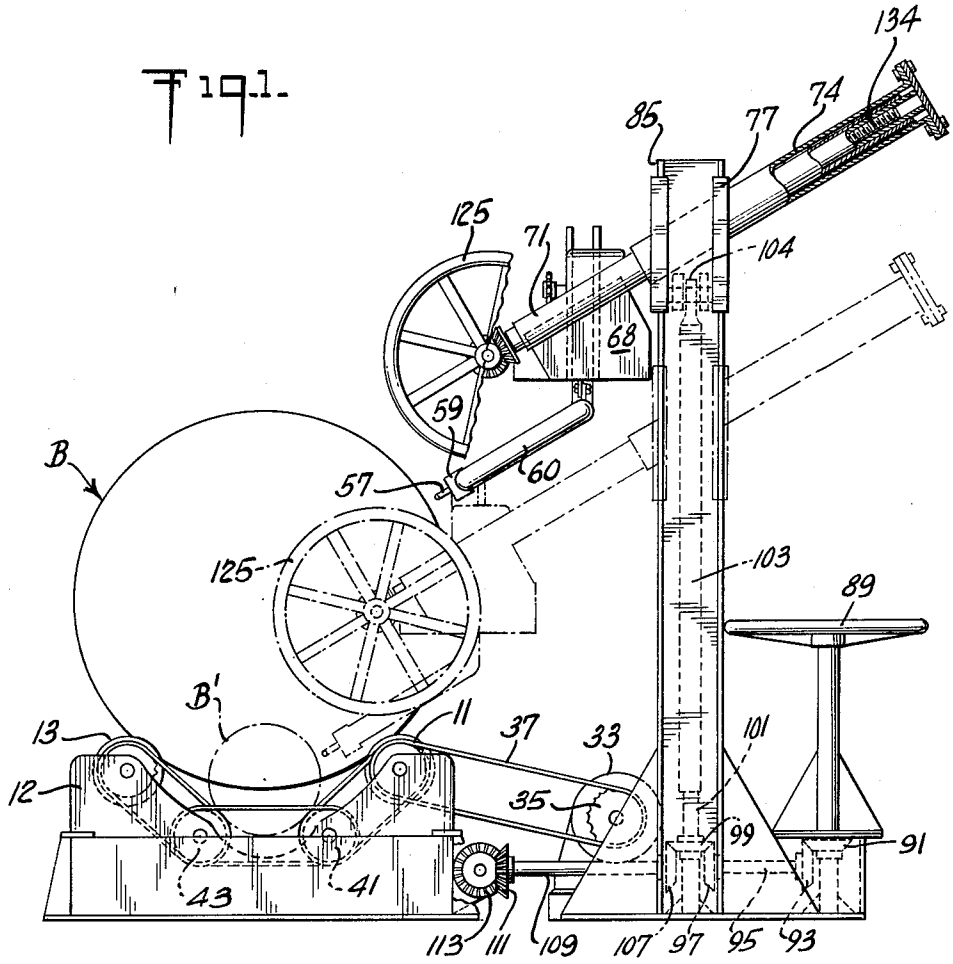

Fig. 7.

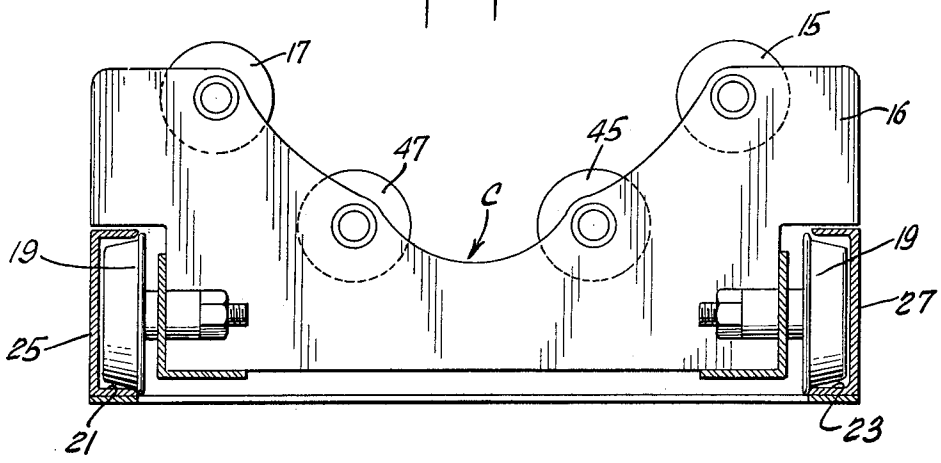

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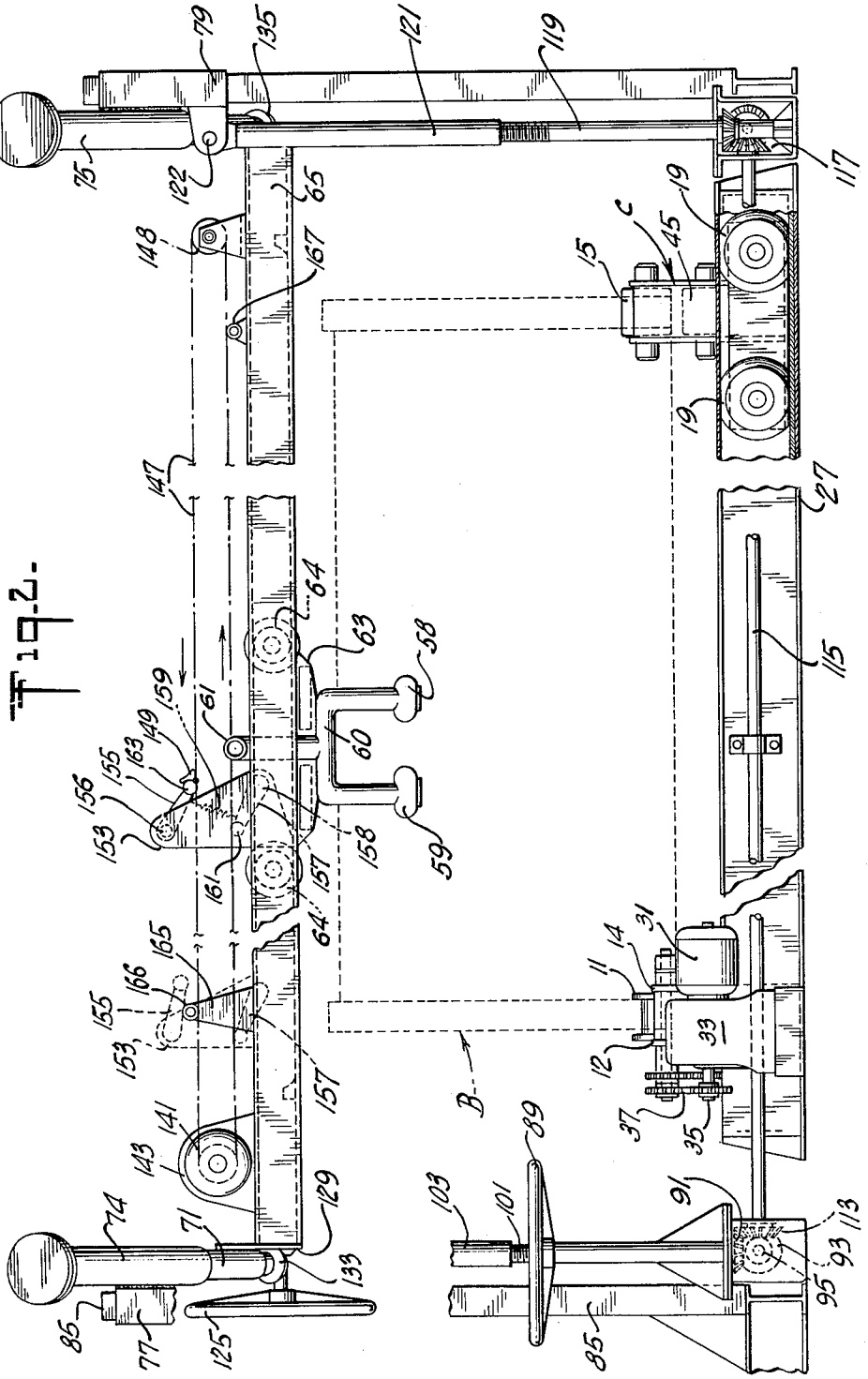
Fig. 2.



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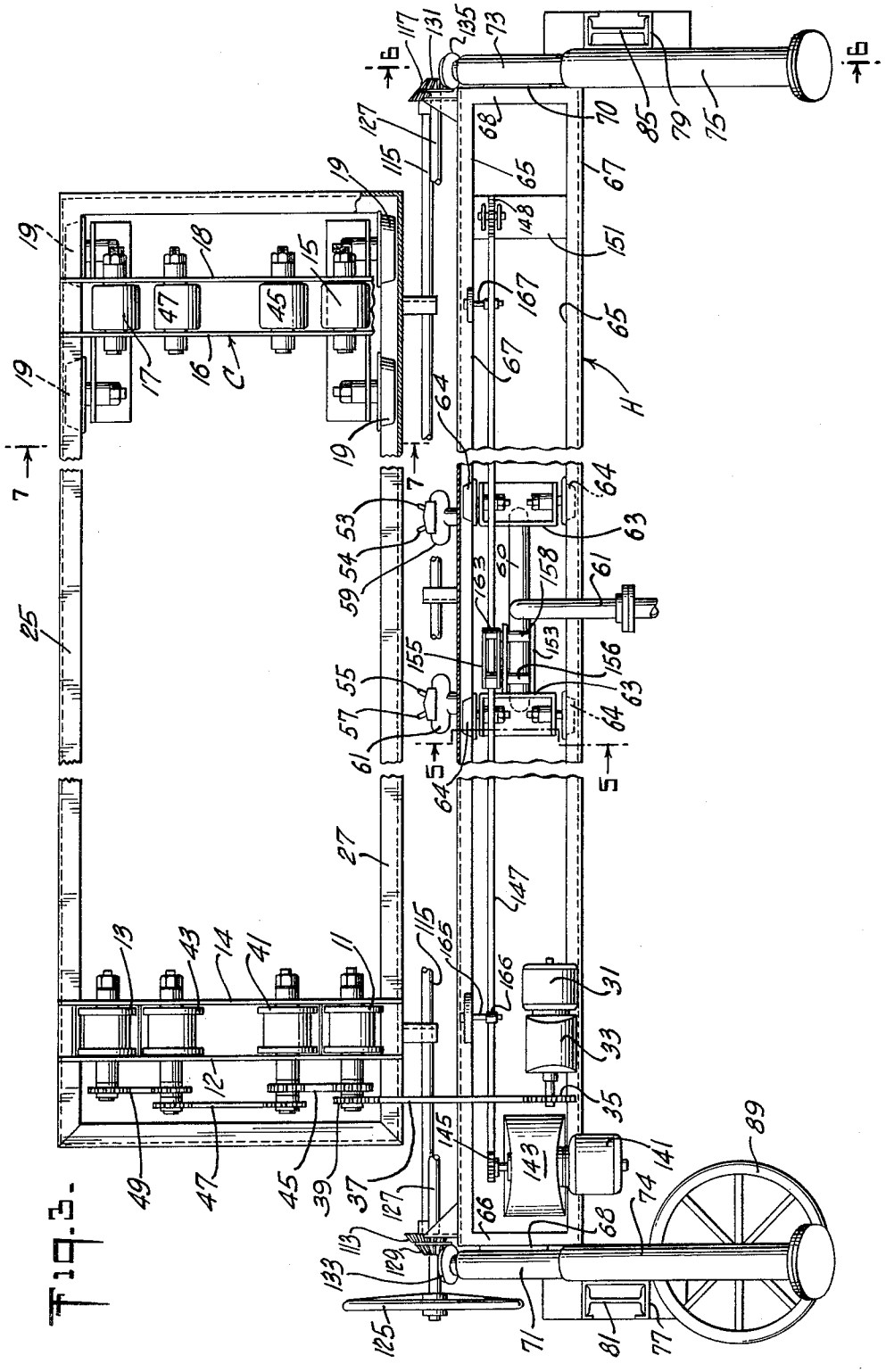

Fig. 3.

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Fig. 4.

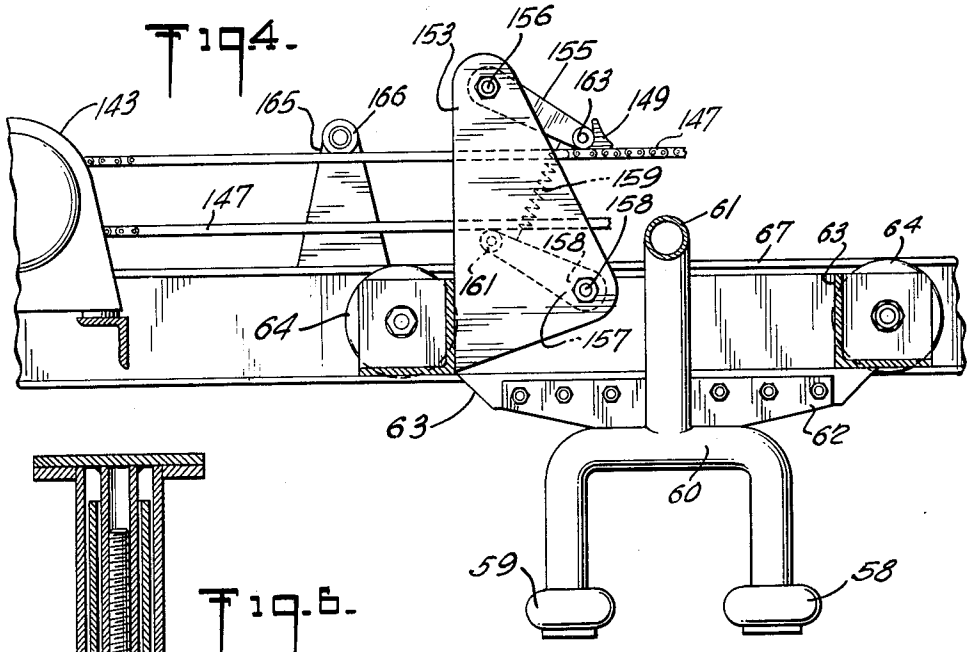


Fig. 6.

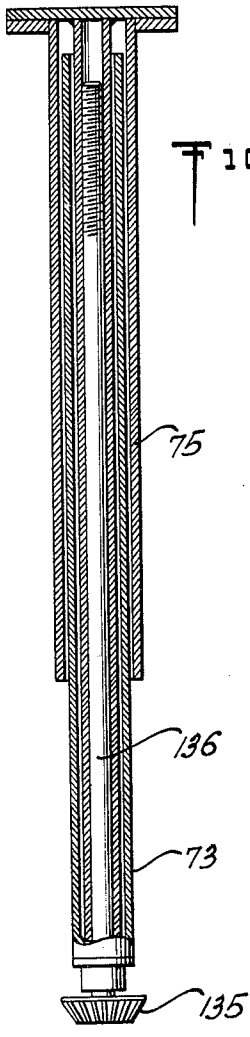
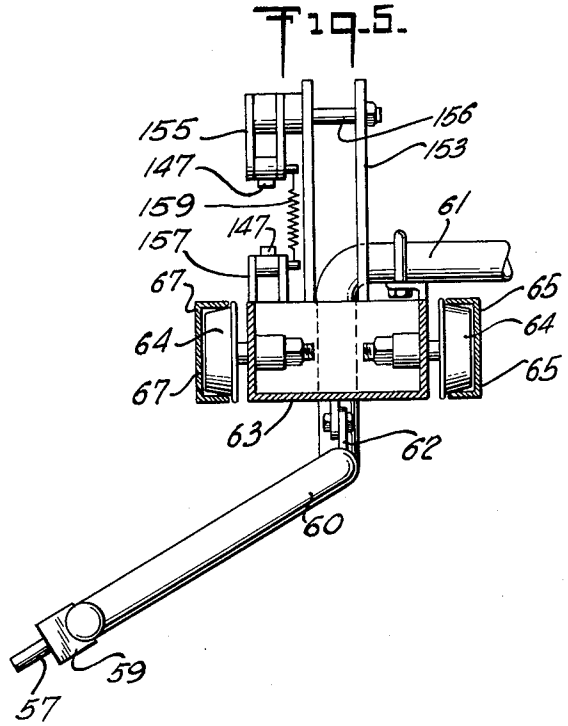


Fig. 5.



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APPARATUS FOR CLEANING HEAT EXCHANGER TUBE BUNDLES

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6 Claims. (Cl. 134—144)

The present invention relates to novel apparatus for cleaning heat exchanger tube bundles by discharging high velocity, high pressure fluid jets against a tube bundle to dislodge dirt accumulations.

In accordance with this invention, there is provided a novel cleaning apparatus which is adaptable and adjustable to the cleaning of bundles of various lengths and various diameters. An important feature of the invention is the provision of traveling jet nozzles which are reciprocated for cleaning the entire length of a bundle without the need for reciprocating the heavy bundle itself.

In its broader aspects our novel apparatus for cleaning a heat exchanger tube bundle comprises, in combination, a support for holding a tube bundle in a horizontal position, means for rotating the tube bundle on its support, jet means for discharging one or more high pressure high velocity jets of a cleaning fluid such as hot water transversely against the tube bundle as it rotates, and driving mechanism for moving the jet means longitudinally of a tube bundle for cleaning the bundle over its entire length. An important feature of the invention is the mechanism which coacts with the driving mechanism to reverse the direction of movement of the jet means at the end of each traverse longitudinally of the tube bundle thereby producing a reciprocating movement to assure complete cleaning of the bundle.

Another important feature is the adjusting mechanism for moving the jet means up and down at will, and for moving the jet means in a direction transversely of a tube bundle at will, whereby the jet means may be positioned the optimum distance from a tube bundle of any diameter. Still another important feature for adapting the apparatus to the cleaning of tube bundles of various lengths is the construction of the bundle support with a fixed set of driven rollers at one end and a movable set of idler rollers spaced lengthwise from the driven rollers, and movable toward and away from the latter in accordance with the length of the tube bundle. This latter adjustment feature is most advantageously coupled with a novel construction for adjusting the path of travel of the jet means so as to coincide with the length of a tube bundle.

The novel features of the invention will be described in more detail hereinafter with reference to the accompanying drawings wherein:

FIG. 1 is an end elevational view, parts being broken away and in section, of our novel apparatus for cleaning tube bundles;

FIG. 2 is a side elevational view of the novel apparatus as viewed from the right in FIG. 1;

FIG. 3 is a plan view of the novel apparatus;

FIG. 4 is a side elevational view on an enlarged scale of a detail of the apparatus shown in FIG. 2;

FIG. 5 is a cross-sectional view taken along the line 5—5 in FIG. 3;

FIG. 6 is a cross-sectional view taken along the line 6—6 in FIG. 3; and

FIG. 7 is a cross-sectional view taken along the line 7—7 in FIG. 3.

Referring to the drawings, there is shown a tube bundle B which is supported at one end on a pair of driven rollers 11 and 13 journalled between a pair of brackets 12 and 14 and supported at the other end on another pair of idler rollers 15 and 17 which are journalled between upstanding brackets 16 and 18 on a movable carriage C having flanged wheels 19 rolling on the lower flanges 21 and 23 of a pair of horizontal channel irons 25 and 27' forming the horizontal beams of the bundle support. The construction of the carriage C is such that it can easily be moved by hand along the beams to the proper position for receiving the tube sheet of a tube bundle.

Rotation of a tube bundle B is accomplished by an electric motor 31 which actuates a gear reduction unit 33 driving a sprocket 35 and chain 37. Chain 37 in turn drives a sprocket 39 on the shaft of roller 11 which in turn drives another pair of lower more closely spaced rollers 41 and 43, as well as roller 13, by interconnecting chains 45, 47 and 49 riding on similar sprockets on the ends of the shafts of these rollers.

As shown in FIG. 1, the support mechanism described above is adaptable not only for a large diameter bundle B, but also for a smaller diameter bundle B' which is supported by the lower and more closely spaced set of rollers 41 and 43 at one end, and by the corresponding axially aligned idler rollers 45 and 47 at the other end. No matter what size bundle is to be cleaned, its rotation is always accomplished with the same motor and the same driving interconnections.

The actual cleaning of the tube bundle is accomplished by discharging extremely high velocity, high pressure jets of hot water from two pairs of nozzles 51, 53 and 55, 57 carried by headers 58 and 59 connected to a header 60 which is supplied by a pipe 61 adapted to be coupled to a supply hose for water. Header 60 is welded to a bracket 62 which in turn is mounted on a wheeled carriage 63 having four wheels 64 running on the inside lower flanges of a pair of parallel spaced channel irons 65 and 67 for movement in opposite directions. At their ends the channel irons are connected together by cross bars 66 and 68, thus forming a horizontal beam H.

The opposite ends of the beam are connected by end plates 68 and 70 to a pair of parallel downwardly and forwardly inclined arms 71 and 73 which are mounted within a pair of sleeves 74 and 75 in turn secured to a pair of upwardly and downwardly movable slides 77 and 79 engaging two vertical I-beam columns 81 and 85 for movement up and down thereon. All connections may be welded.

The position of the slides 77 and 79 is adjusted by rotating a single hand wheel 89 which actuates meshed bevel gears 91 and 93 to drive a horizontal shaft 95 having a bevel gear 97 which drives a bevel gear 99 on a vertical shaft 101 which is threaded within a coacting vertical sleeve 103 connected at its upper end at 104 to slide 77.

Corresponding vertical movement of slide 79 on the other column is accomplished by transmitting movement from bevel gear 99 to a bevel gear 107, a shaft 109, a bevel gear 111, a bevel gear 113 and a horizontal shaft 115 ex-

tending over to column 85. Shaft 115 transmits motion to the slide 79 by way of a bevel gear 117 and coacting gears and shafts corresponding to those at the other end of the apparatus to drive shaft 119 in sleeve 121 which is connected at its upper end at 122 to the slide 79.

The mechanism described above will accomplish the necessary vertical adjustment of the jet nozzles, but without a concurrent transverse adjustment the proper constant spacings of the nozzles from tube bundles of different diameters can not be obtained. This transverse adjustment is accomplished by rotating a hand wheel 125 which drives a shaft 127 having bevel gears 129 and 131 on its opposite ends coacting with bevel gears 133 and 135 carried by threaded shafts 134 and 136 within arms 71 and 73 which are threaded within the sleeves 74 and 75, whereby upon movement of the hand wheel 127 in one direction the arms are retracted into the sleeves, and upon movement of the hand wheel in the opposite direction the arms are withdrawn to a greater extent.

FIG. 1 shows the apparatus properly adjusted for cleaning a small tube bundle B', using the adjusting mechanism described above.

For reciprocating the carriage 63 back and forth along the horizontal beam H so as to direct fluid jets over the entire length of a tube bundle, there is provided a motor 141 driving a gear reducing unit 143 which is mounted on the beam and rotates a sprocket 145 driving a chain 147 which at the other end is mounted on an idler sprocket 148 on a cross bar 151. Chain 147 carries a projecting tooth 149 for engaging a cam 155 to drive the carriage toward the left in FIG. 2.

Engagement and disengagement of the driving mechanism from the carriage 63 involves an upwardly projecting bracket 153 welded to the carriage and carrying a cam arm 155 pivotally mounted on a laterally projecting shaft 156 near the upper end thereof above chain 147, and a second cam arm 157 similarly pivotally mounted on a shaft 158 near the lower end of bracket 153 below the chain 147. A coil spring 159 extends between the two cam arms for normally holding them in contact with the chain 147 by means of rollers 161 and 163. As the chain rotates the tooth 149 engages the roller 163 and drives the carriage 63 from right to left as viewed in FIG. 2. Near the end of its stroke the cam arm 155 is disengaged by an upstanding tripper 165 having a roller 166 which forces the cam arm to rise so that the tooth 149 is disengaged and movement of the carriage stops. Due to flexibility of the chain 147, tooth 149 passes under tripper 165, on around the drive sprocket 145, and then engages the lower cam arm 157 and reverses the movement of the carriage so that it travels from left to right as viewed in FIG. 2. Disengagement of tooth 149 is accomplished in a similar manner at the opposite end by means of a tripper 167 arranged below the chain 147 in position to engage cam arm 157 and move it downwardly out of engagement with the tooth which then passes over the tripper due to flexibility of the chain. Thereafter the cam arm 155 is again engaged by tooth 149 after it rounds idler sprocket 149, and movement of the carriage in the opposite direction commences.

In order to adapt the stroke of carriage 63 to the length of any size tube bundle, the tripper 167 is adjustably mounted on the beam H in any suitable manner, as by bolts extending through holes in the channel iron 67. When a tube bundle shorter than the bundle B is to be cleaned, the tripper 167 is removed from the beam, placed in its new position farther to the left as seen in FIG. 2, and then secured by the bolt. The new position, of course, will coincide with the position of the carriage C supporting the end of the tube bundle, as described hereinabove.

Obviously, many other modifications and variations of the invention may be made without departing from the spirit and scope thereof and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. Apparatus for cleaning heat exchanger tube bundles comprising, in combination, a support for a horizontal tube bundle; means for rotating said tube bundle on said support; jet means for discharging at least one high pressure, high velocity jet of cleaning fluid transversely against said tube bundle; driving mechanism for moving said jet means longitudinally of said tube bundle for cleaning said tube bundle over the entire length thereof; and reversing mechanism coacting with said driving mechanism for reversing the direction of movement of said jet means at the end of each movement longitudinally of said tube bundle said reversing mechanism comprising pairs of cooperating cams and trippers carried by said jet means and said support, respectively, said cams being engaged with said driving mechanism, said trippers being spaced lengthwise of said support, whereby at the end of each movement of said jet means one of said trippers engages one of said cams which disengages said cam from said driving mechanism and engages the other cam with said driving mechanism for driving said jet means in the opposite direction.

2. Apparatus for cleaning heat exchanger tube bundles comprising, in combination, a support for a horizontal tube bundle; means for rotating said tube bundle on said support; jet means for discharging at least one high pressure, high velocity jet of cleaning fluid transversely against said tube bundle; driving mechanism for moving said jet means longitudinally of said support for cleaning said tube bundle over the entire length thereof; and mechanism operable at will for moving said jet means transversely toward and away from said support to accommodate said apparatus to various diameters of tube bundles, said last named mechanism comprising column means, a horizontal beam mounted on said column means, said jet means being carried by and movable along said beam, and mechanism coacting with said column means and said beam for moving said beam toward and away from said column means transversely of said support.

3. Apparatus for cleaning heat exchanger tube bundles comprising, in combination, a support for a horizontal tube bundle comprising a first set of fixed rollers in position for supporting one end of said tube bundle, a wheeled carriage mounted for movement in a direction longitudinally of said support toward and away from said fixed rollers, and a second set of rollers on said carriage, whereby said support can be adjusted at will to receive tube bundles of different lengths; means for rotating said tube bundle on said support; jet means for discharging at least one high pressure, high velocity jet of cleaning fluid transversely against said tube bundle; and driving mechanism for moving said jet means longitudinally of said support for cleaning said tube bundle over the entire length thereof.

4. Apparatus for cleaning heat exchanger tube bundles comprising, in combination, a support for a horizontal tube bundle comprising a first pair of horizontally spaced driven rollers, a second pair of horizontally spaced idler rollers spaced longitudinally from and axially aligned with said first pair, a third pair of driven rollers adjacent said first pair, spaced horizontally from one another by a greater distance than said first pair and located at a higher level than said first pair; and a fourth pair of idler rollers adjacent said second pair and axially aligned with said third pair; means for rotating said tube bundle on said support comprising mechanism connecting all of said first and third pairs of driven rollers together for rotation in the same direction; and driving mechanism drivingly connected to one of the rollers of said first and third pairs; jet means for discharging at least one high pressure, high velocity jet of cleaning fluid transversely against said tube bundle; and driving mechanism for moving said jet means longitudinally of said support for cleaning said tube bundle over the entire length thereof.

5. Apparatus in accordance with claim 3, also comprising reversing mechanism coacting with said driving mech-

anism for reversing the direction of movement of said jet means at the end of each movement longitudinally of said tube bundle, and means for adjusting said reversing mechanism to increase or decrease the distance moved by said jet means to coincide with the distance between said sets of rollers.

6. Apparatus in accordance with claim 1, also comprising mechanism operable at will for moving said jet means in a direction having both vertical and horizontal components to accommodate said apparatus to various diameters of tube bundles.

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