

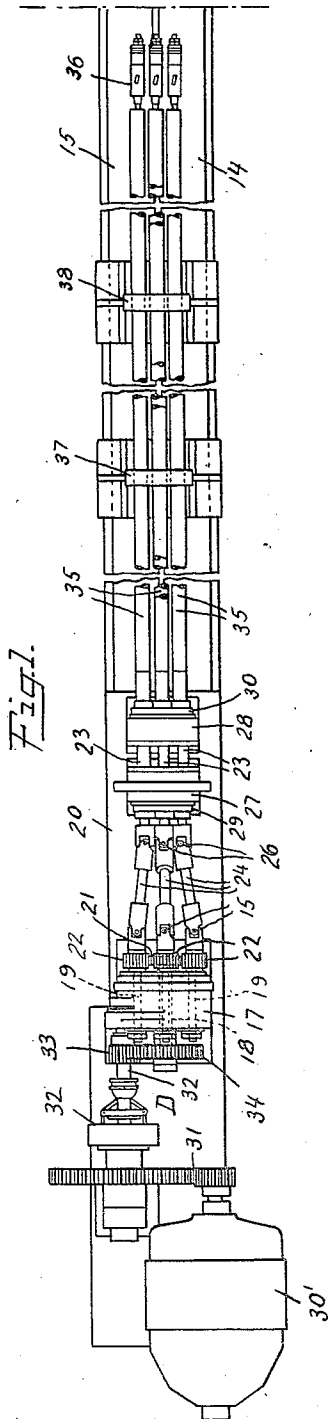
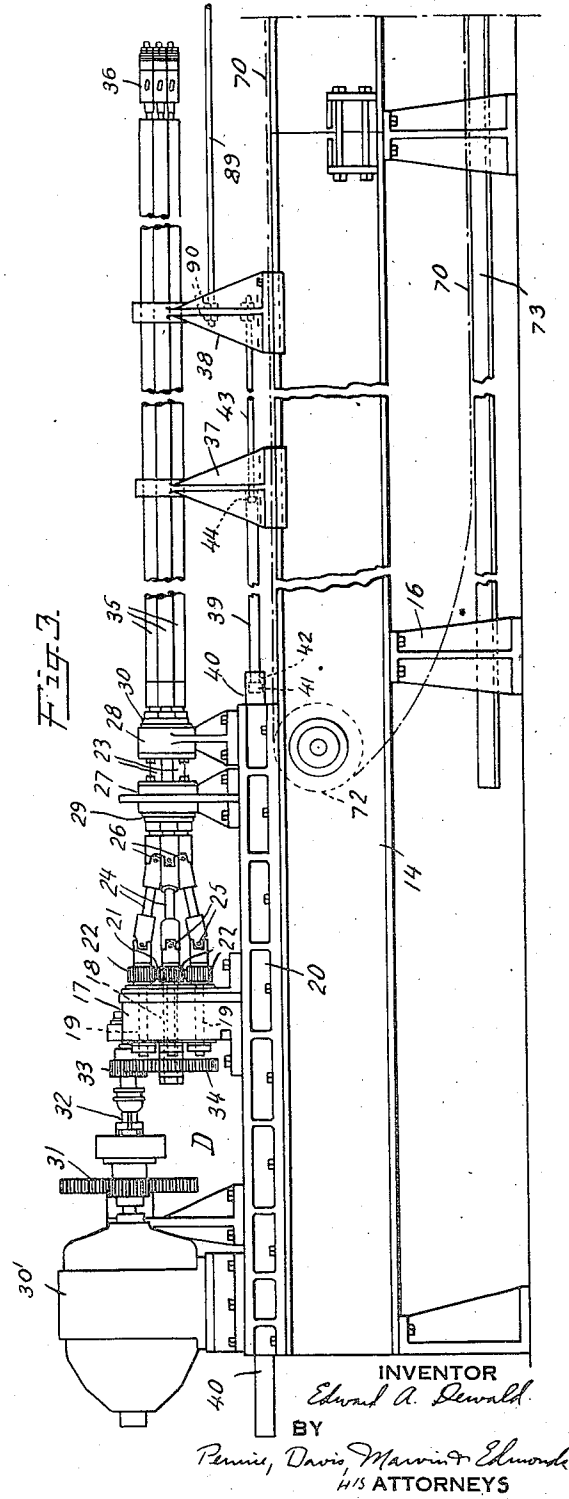
Jan. 15, 1935.

E. A. DEWALD

1,987,608

TUBE EXPANDING

Original Filed July 2, 1931 4 Sheets-Sheet 1



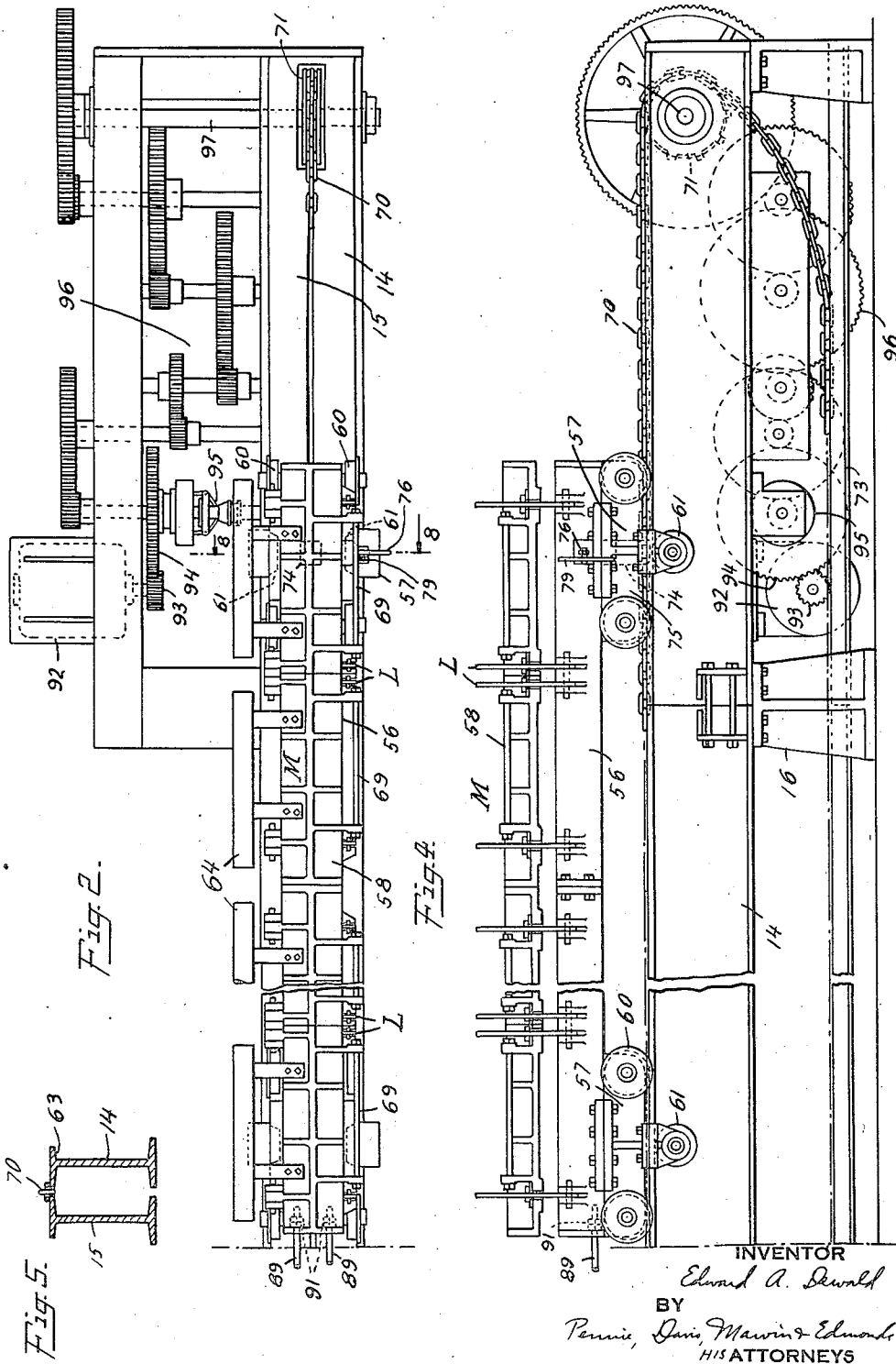
Jan. 15, 1935.

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1,987,608

TUBE EXPANDING

Original Filed July 2, 1931 4 Sheets-Sheet 2



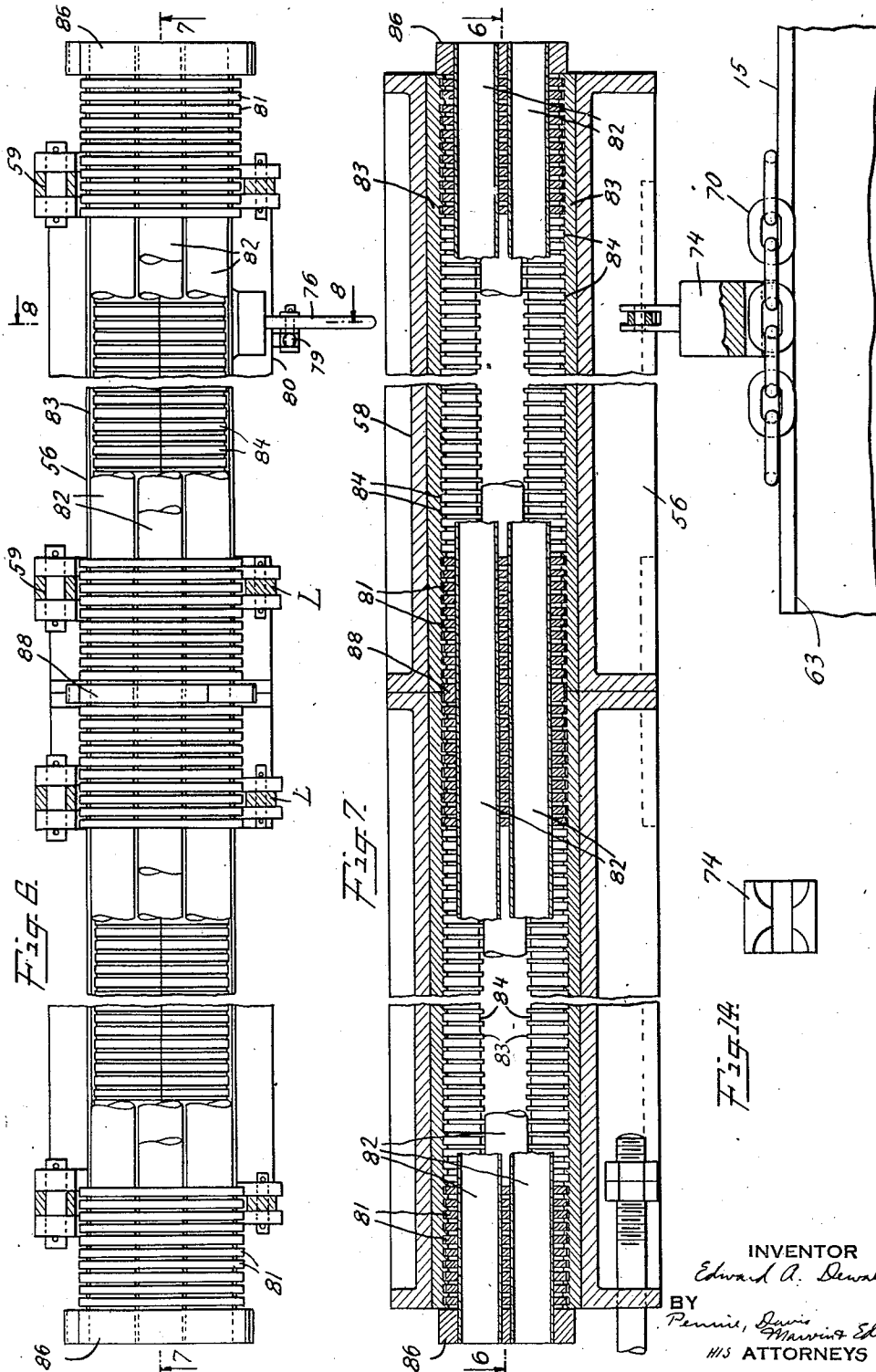
Jan. 15, 1935.

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1,987,608

TUBE EXPANDING

Original Filed July 2, 1931 4 Sheets-Sheet 3



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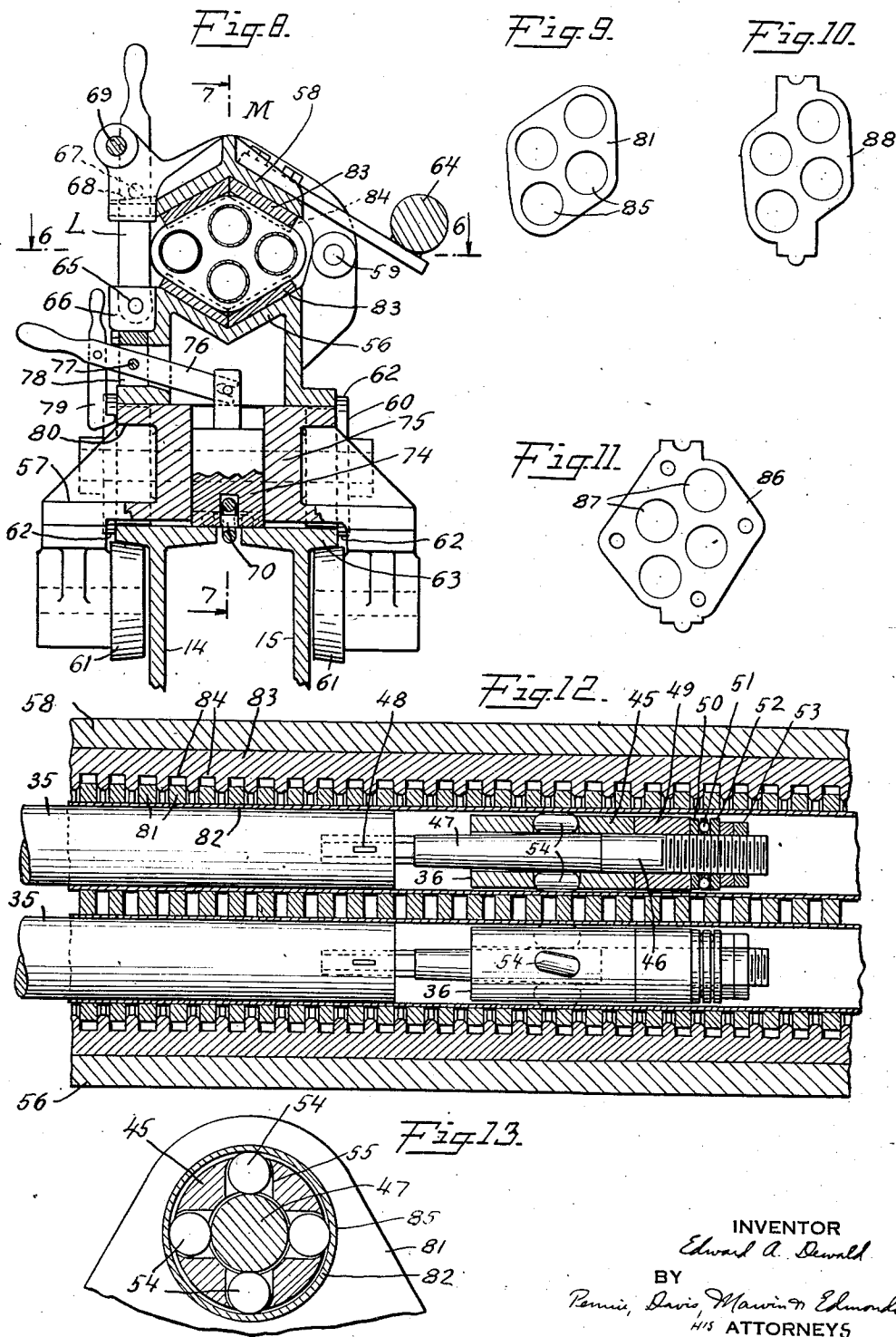
Jan. 15, 1935.

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1,987,608

TUBE EXPANDING

Original Filed July 2, 1931 4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

1,987,608

TUBE EXPANDING

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Application July 2, 1931, Serial No. 548,386
Renewed April 11, 1934

12 Claims. (Cl. 153—82)

This invention relates to an improved method of assembling a heat exchanger construction and further includes improved apparatus for carrying this method into effect.

5 In numerous industrial operations, it is desirable or essential that heat be efficiently transferred from a comparatively hot fluid to a fluid of lower temperature. One form of heat exchanger which has been found highly desirable
10 for such purposes comprises generally, a plurality of tubes or pipes for carrying the fluids of different temperature and a plurality of spaced or interengaging cross plates or fins for binding the tubes together in substantially parallel relationship, all of the tubes passing through openings in each plate or fin. A heat exchanger of this type
15 is described and claimed in the copending application of Joseph Price, Serial No. 495,205, filed November 12, 1930.

20 The assembly of a heat exchanger unit of the type described involves the rigid attachment of the cross plates or fins in intimate heat engaging contact with all of the tubes and, in many cases, the fastening of end flanges or heads to the opposite ends of the grouped tubes.

25 It is an object of the present invention to provide an improved method for assembling heat exchangers of the type in which a plurality of fins or plates are to be secured to one or more tubes or pipes, and more particularly, the method of the present invention has to do with the assembly
30 of a plurality of substantially parallel tubes or pipes with a plurality of closely spaced or interengaging plates or other heat conducting means surrounding all of the pipes of the group. It is a further object of the invention to provide improved apparatus for assembling heat exchanger units of the type described.

40 In general, the above and other objects of the invention are carried out by first arranging the fins or plates in the desired spaced or contacting relationship, then passing the tubes or pipes through aligned openings in the fins and finally expanding the tubes into intimate heat conductive contact and secure mechanical engagement
45 with the fins. When two or more tubes or pipes are employed in the unit being assembled, it is preferred to simultaneously expand all of such tubes into engagement with the fins whereby the warping or breakage of the fins or the loosening of the joints between the fins and the tubes due to the elongation of the tubes upon expansion is avoided.

50 The improved apparatus provided for carrying my improved method into effect comprises generally one or more clamping devices for holding the

5 fins in the desired relative positions while the tubes are expanded into engagement therewith, these devices being movably mounted whereby the expanding tools may be drawn through the tubes. Improved and simplified driving means are preferably provided for the fin clamping devices and I also prefer to employ improved means for driving the expanding tools and for supporting the
10 expanding tool driving shafts.

In describing the invention in detail, reference will be made to the accompanying drawings, in which:

Figure 1 is a plan view of one-half of a machine embodying the invention and capable of performing the method of the invention;

15 Fig. 2 is a plan view of the other half of the machine shown in Fig. 1;

Fig. 3 is an elevation of the half of the machine shown in Fig. 1;

20 Fig. 4 is an elevation of the half of the machine shown in Fig. 2;

Fig. 5 is a sectional view of a portion of the machine frame showing the relation of the magazine propelling chain thereto;

25 Fig. 6 is a sectional view of the magazine together with a heat exchanger unit therein, this view being taken along the lines 6—6 of Figs. 7 and 8;

30 Fig. 7 is a sectional view of the magazine taken along the lines 7—7 of Figs. 6 and 8;

Fig. 8 is a partial sectional view of the machine taken along the lines 8—8 of Figs. 2 and 6;

35 Figs. 9, 10 and 11 are respectively end views of the tube fins, the supporting flanges and the end flanges of one form of heat exchanger unit which may be assembled by my improved method and apparatus;

40 Fig. 12 is an enlarged sectional view of a heat exchanger in the process of assembly showing the details of the expanders;

Fig. 13 is a sectional view of one of the expanders in operation within a tube; and

45 Fig. 14 is a bottom plan view of the chain engaging dog on the magazine.

Referring to the drawings, the machine disclosed to illustrate the invention comprises generally a frame or track formed of two parallel I-beams 14 and 15, a driving mechanism D attached to the driving end of the frame and a magazine or carriage M mounted on the frame
50 and movable thereon toward and away from the driving mechanism. The frame 14—15 may be carried on suitable supports 16.

The driving mechanism D shown includes a base 20 fixed on the frame members 14 and 15.

A driving gear bracket or head 17 carrying a central driving shaft 18 and four driven shafts 19 symmetrically disposed about the driving shaft is centrally secured to the base 20. A gear wheel 21 on the driving shaft 18 engages four pinions 22 respectively fixed to the four driven shafts 19. The four driven shafts 19 are respectively connected with four more closely adjacent shafts 23 through the stub shafts 24 and universal joints 25 and 26. The shafts 23 are carried in the spindle brackets 27 and 28, and suitable thrust bearings 29 and 30 are preferably provided on the opposite sides of the spindle brackets to take up the thrust imposed on the shaft during the tube expanding operation. The driving shaft 18 may be rotated by any suitable means, and as shown, an electric motor 30' is provided for this purpose and is connected to the shaft 18 through a gear train 31, a clutch 32 and the pinion 33 and gear 34.

Four expander drive shafts 35 are respectively coupled to the four shafts 23, and four expanders 36 are respectively coupled to the ends of the drive shafts. The drive shafts 35 are of considerable length and are preferably supported at two or more points by suitable means such as the steady rests 37 and 38 in which the shafts 35 are rotatably journaled. The steady rests 37 and 38 are mounted to slide longitudinally of the shafts 35 on the frame 14-15. The movement of the steady rest 37 away from the driving mechanism D is limited by suitable means such as one or more hollow tubes 39 having one end fixed to the steady rest 37 and the other end slidably carried in a hollow tube 40 of larger diameter which is fixed to and extends through the driving mechanism base 20. The tube 39 is provided with an enlarged head 41 and a constricted portion 42 at the mouth of the tube 40 engages this head when the tube 39 has been withdrawn to the maximum desired extent from the tube 40. In this manner, the sliding movement of the steady rest 37 away from the driving mechanism D is limited to a predetermined amount.

The movement of the steady rest 38 away from the rest 37 is limited by the rods 43 which are fixed to the rest 38 and which slidably engage openings in the rest 37. Nuts 44 or other means are fixed to the ends of the rods 43 beyond the rest 37 to limit the withdrawal of the rods from the rest 37.

The expanders 36 may take various forms, but are preferably of an improved construction shown in detail in Figs. 12 and 13. Each expander comprises a cylindrical casing 45 surrounding and carried by a mandrel 46 having a conical portion 47. The mandrel 46 is secured to the end of the expander drive shaft 35 by a suitable connection 48. A cylindrical collar 49 surrounds the mandrel 46 and engages the outer end of the casing 45 and a thrust bearing 50, which may include anti-friction means such as the ball race 51, is disposed between the outer end of the collar 49 and the washer 52. Lock nuts 53 or equivalent adjustable stop means are fixed to the outer end of the mandrel 46 in engagement with the washer 52. A plurality of expanding rollers 54 are carried in circumferentially spaced relation by the casing 45. In the disclosed embodiment, four equally spaced rollers 54 are used, each being rotatably carried in an opening 55 in the casing 45 and retained therein by the inturned outer edges of the opening as clearly shown in Fig. 13. The rollers are set diagonally to have a lead, that

is, each roller is disposed at an angle to an element of the cylindrical casing 45 whereby the expander is advanced through a tube by the spiral path of travel of the rollers along the interior of the tubes as the expander is rotated. Rotary motion is transmitted from the mandrel 46 to the casing 45 by the rollers 54 which rotate as planetary pinions between the mandrel and the inner surface of the tubes. It will be clear that the degree of expansion effected may be variably adjusted by moving the lock nuts 53 along the mandrel 46 and so changing the point on the tapered portion 47 at which the rollers 54 come into contact with the mandrel.

The magazine M which carries the structure to be assembled comprises a general trough-shaped lower member 56 carried by two or more trucks 57 and one or more covers or upper members 58 hingedly secured to the lower member 56 by the hinges 59. The member 56 may be sectionalized, and it is generally preferred to form the covers 58 in a plurality of separably movable sections although it is entirely feasible to use a single integral or sectional cover if desired. Each truck 57 is provided with spaced pairs of wheels or rollers 60 resting upon the upper surfaces of the frame beams 14 and 15, and an intermediate pair of wheels or rollers 61 engaging the undersurfaces of the upper flanges 63 on the frame beams, as clearly shown in Fig. 8. The upper rollers 60 are provided with flanges 62 which engage the outer edges of the beam flanges 63 and so guide the trucks.

The hinged magazine covers 58 are preferably provided with suitable counterweights 64 to assist the operators in opening the magazine. The covers 58 are further provided with suitable latching mechanisms for clamping them down on the fins of the exchanger units to be assembled. As best shown in Figs. 2, 4 and 8, a plurality of latching levers L are provided for this purpose, each lever being pivotally connected at 65 to a lug 66 on the lower member 56 of the magazine. A cross pin 67 is fixed transversely on each lever L and is disposed to come into clamping engagement with a wedge shape surface 68 on the magazine cover 58 when the lever L is forced into a vertical position as shown in Fig. 8. Each lever L passes into a slot in the edge of one of the covers 58 when moved to the locking position. Suitable bar-shaped handles 69 are preferably provided on the covers 58 between the latching levers L.

Suitable means are preferably provided on the interior surfaces of the magazine member 56 and its covers 58 for supporting, in the desired relation, the fins or heat conductive plates 81 to be attached to the tubes 82 of the heat exchanger unit. The disclosed embodiment of the apparatus is designed to attach spaced heat conductive plates 81 to the tubes 82 and accordingly, a plurality of notched bars 83 is fixed to the interior surfaces of the lower magazine member 56 and its covers 58. The notches 84 in the bars 83 are disposed in substantial vertical alignment and are of sufficient width to retain the plates 81 as shown in Figs. 2, 8 and 12. The plates 81 employed may take various forms, and in the disclosed embodiment, are substantially diamond shaped with rounded corners, four symmetrically disposed tube openings 85 being provided in each plate as shown in Fig. 9. Suitable end flanges 86 having four symmetrically spaced openings 87 therethrough are preferably attached to the ends of the tubes 82 and one of such

flanges is shown in detail in Fig. 11. If desired, enlarged supporting plates 88 may be disposed at spaced points along the tubes 82, and one such plate is shown in Fig. 8.

5 The magazine M is preferably propelled by means of an endless chain 70, the upper span of which is carried by the upper flanges of the frame beams 14 and 15, as shown in Figs. 4 and 8. The chain 70 passes over the sprockets 71 and 72 adjacent the opposite ends of the machine, and the lower span of the chain is returned along the supporting track 73. As shown in Figs. 2, 4, 5 and 8, the chain 70 is arranged with its alternate links in a substantially vertical plane and extending between the upper flanges of the beams 14 and 15, the intermediate links resting upon and sliding along the upper surfaces of the beam flanges.

20 The magazine M may be detachably connected to the chain 70 by any suitable means. In the disclosed embodiment, a chain engaging dog 74 is vertically slidably carried in a central position in the frame 75 of the magazine truck 57. The dog 74 may be lifted out of engagement with the chain 70 by means of a manually operable lever 76 pivoted at 77 in an opening 78 through the lower member 56 of the magazine. A latch 79 is pivotally connected to the lever 76 and is disposed to come into latching engagement with the under-surface of the flange 80 on the frame 75, whereby the dog 74 may be retained in its lifted or disengaged position. The chain engaging lower end of the dog 74 is shaped to have a locking engagement with the chain links as shown in Fig. 14.

35 As shown in Figs. 2, 3 and 4, the steady rest 38 is connected to the magazine M by means of two rods 89 which may be fixed to the rest 38 by the nuts 90, and these rods pass loosely through openings in the end of the lower member 56 of the magazine, the nuts 91 being fixed to the ends of the rods to limit the withdrawal thereof from the openings in the magazine. With the disclosed arrangement of the steady rest connecting means, it will be seen that when the magazine M is moved to its extreme forward position adjacent the drive end of the machine, the two steady rests 37 and 38 will be pushed up close to the spindle bracket 28 and as the magazine moves back away from the drive mechanism D, the steady rest 38 will remain stationary until the magazine has moved a distance corresponding to the length of the rods 89. As the movement of the magazine continues, the rest 38 will be moved with the magazine and after the magazine and rest 38 have been moved a distance equal to the length of the rods 43, the rest 37 will be moved with the magazine and the rest 38. With this arrangement, the steady rests 37 and 38 are properly spaced along the drive shafts 35 as the magazine moves along the machine frame.

60 The propelling chain 70 may be driven by any suitable means such as a motor 92 or other prime mover. As shown in Fig. 2, the motor 92 is connected through a pinion 93, a gear 94, a friction clutch 95 and a speed reducing gear train 96 to the shaft 97 to which the chain engaging sprocket 71 is fixed.

70 In the operation of the disclosed embodiment of my invention, the magazine M is first moved to the back end of the machine and the required number of fins or plates 81 (and supporting plates 88 if desired) is placed along the notched bars 83 of the lower member 56, the notches 84 in the bars 83 serving to space the fins at the desired pitch. If desired, the notches 84

on the bars 83 may be omitted and the fins 81 spaced solidly in the magazine M. The cover members 58 of the magazine are then closed down on the fins 81, but the covers are not as yet clamped into place. The tubes 82 are next pushed through the aligned openings 85 in the fins 81 from the back end of the machine and the cover 58 is tightly clamped down on the fins 81 by means of the levers L. The end flanges 86 or other heads may then be slipped on the projecting ends of the tubes and then clamped to the opposite ends of the magazine M. The magazine M with the fin and tube structure thus assembled therein is then pushed toward the driving end of the machine, the expanders 36 and their drive shafts 35 passing respectively through the tubes 82 until the expanders 36 extend through the back ends of the tubes. The expanders 36 are then adjusted by means of the nuts 53 to insure the proper setting of the rollers 54 thereof whereby the required expansion of the tubes may be obtained. The driving motors 30' and 92 are then started, the friction clutches 32 and 95 are thrown in and the dog 74 is dropped into engagement with the propelling chain 70.

25 The motor 30' rotates the expanders 36 through the shafts 35 and the above described driving mechanism, and due to the lead of the rollers 54, the expanders 36 tend to advance themselves through the tubes 82. The movement of the finned tube structure over the expanders is further insured by the chain 70 which propels the magazine M backward along the machine and thus draws the tubes 82 over the expanders. A fluid lubricating compound is preferably pumped through the tubes 82 during the expanding operation, this fluid filling the tubes and acting both to lubricate the expanders 36 and to carry away the heat generated by the expanding operation. The steady rests 37 and 38 prevent the sagging of the drive shafts 35 and avoid the whipping of these shafts during operation. The expanding operation is preferably continuous until the expanders 36 have passed through the entire length of the structure. After the expanders 36 have passed entirely through the tubes 82, the clutches 32 and 95 are disengaged, the magazine covers 58 are swung back and the assembled structure is removed from the magazine. When the completed unit is removed therefrom, the magazine M is in a position at the back end of the machine and may be loaded with the elements of another heat exchanger unit while in this position.

55 The method of the present invention presents certain advantageous features. The radial expansion of a tube results in an increase in its length, and accordingly, if several tubes were successively expanded into one set of fins or other cross members, the expansion of the tubes would tend to warp the fins, weaken the bond between the fins and the tubes or break or injure the magazine or some other part of the expanding machine. By expanding all of the tubes simultaneously as taught by the present invention, the longitudinal growth of the several tubes is simultaneous, the bond between the tubes and the fins once established is not disturbed and the tendency of the structure to warp during assembly or subsequently is effectively eliminated.

70 Although the invention has been disclosed in connection with but one form of apparatus constituting an embodiment thereof, it will be understood that the scope of the invention is not limited to the particular construction disclosed but in-

cludes all such modifications thereof as fall within the terms of the appended claims. Also, the method of the invention is not limited to the particular steps noted. Thus, for example, it may in certain cases be desirable to expand the tubes into bonding engagement with the fins only, or with the fins and one end flange or head in one operation and to subsequently secure the other end flange or head to the tubes by another expanding operation or otherwise, and this procedure is within the scope of the invention as defined in the appended claims.

I claim:

1. In a device of the character described, a magazine for carrying a finned tube structure comprising an elongated lower member having a plurality of fin receiving depressions therein spaced longitudinally thereof, a cover member movably connected to said lower member and having a plurality of fin receiving depressions therein opposite the fin receiving depressions in said lower member and means for securing said cover member to said lower member whereby a plurality of fins may be clamped between said members in said depressions.

2. In a device of the character described, a magazine for carrying a finned tube structure comprising an elongated lower member having a plurality of longitudinally spaced transverse fin receiving depressions therein, a cover member hingedly secured to said lower member and having a plurality of longitudinally spaced transverse fin receiving depressions therein opposite the fin receiving depressions in said lower member, and means for clamping said cover member to said lower member whereby a plurality of spaced fins may be clamped between said members in said depressions.

3. In apparatus of the character described, an elongated frame, a plurality of drive shafts extending longitudinally of said frame, driving means adjacent one end of said frame for rotating said drive shafts, an expander connected to each of said shafts at the end thereof remote from said driving means, a magazine for carrying a heat exchanger unit, means for mounting said magazine to move along said frame whereby said drive shafts may be passed through said heat exchanger unit and means for moving said magazine along said frame away from said driving means whereby said expanders may be passed through the tubes of the heat exchanger unit.

4. In apparatus of the character described, an elongated frame, a plurality of drive shafts extending longitudinally of said frame, driving means adjacent one end of said frame for rotating said drive shafts, an expander connected to each of said shafts at the end thereof remote from said driving means, a magazine for carrying a heat exchanger unit, means for mounting said magazine to move along said frame, at least one support for said drive shafts movably mounted on said frame between said driving means and said magazine, means for moving said magazine along said frame away from said driving means whereby said expanders may be moved with respect to the heat exchanger unit in said magazine and means connecting said drive shaft support to said magazine whereby said support may be propelled along said drive shafts by the movement of said magazine.

5. In apparatus of the character described, an elongated frame, a plurality of drive shafts extending longitudinally of said frame, driving means adjacent one end of said frame for rotating

said drive shafts, an expander connected to each of said shafts at the end thereof remote from said driving means, a magazine for carrying a heat exchanger unit, means for mounting said magazine to move along said frame whereby said drive shafts may be passed through said heat exchanger unit, a propelling chain movably mounted on said frame adjacent said magazine, means for propelling said chain and means for releasably connecting said magazine to said chain.

6. The method of assembling a heat exchanger of the type described which comprises arranging a plurality of plates each having at least two openings therethrough in parallel relationship with the openings in alignment, passing a tube through each of the sets of aligned openings in said plates, clamping each of the said plates edgewise to hold the same firmly in position on the tubes and then expanding all of said tubes progressively throughout their length whereby said tubes are bonded in firm engagement with the plates.

7. The method of assembling a heat exchanger unit of the type described which comprises forming four openings in each of a plurality of plates with the openings in each plate arranged so that a line joining their centers forms a polygon, passing each of four separate tubes through corresponding openings in said plates and simultaneously expanding all of said tubes into rigid engagement with the edges of said openings.

8. In apparatus of the character described, a magazine for carrying a finned tube structure, comprising an elongated lower member having a plurality of fin receiving depressions therein spaced longitudinally thereof, a cover member comprising a plurality of sections each movably connected to said lower member and having a plurality of fin receiving depressions therein opposite the fin receiving depressions in said lower member, and means for securing said sections to said lower member whereby a plurality of fins may be clamped between said members in said depressions.

9. In apparatus of the character described, a magazine for carrying a finned tube structure, comprising an elongated lower member having a plurality of fin receiving depressions therein spaced longitudinally thereof, a cover member hingedly secured to said lower member and having a plurality of longitudinally spaced transverse fin receiving depressions therein opposite the fin receiving depressions in said lower member, a counterweight associated with said cover member to facilitate opening the magazine, and means for clamping said cover member to said lower member whereby a plurality of spaced fins may be clamped between said members in said depressions.

10. In apparatus of the character described, a magazine for carrying a finned tube structure, comprising an elongated lower member having a plurality of longitudinally spaced transverse fin receiving depressions therein, a cover member hingedly secured to said lower member and having a plurality of longitudinally spaced transverse fin receiving depressions therein opposite the fin receiving depressions in said lower member, and means for clamping said cover member to said lower member, said clamping means comprising a lever pivoted to said lower member and cooperating with said cover member.

11. In apparatus of the character described, a magazine for carrying a finned tube structure,

comprising an elongated lower member having a plurality of longitudinally spaced transverse fin receiving depressions therein, a cover member hingedly secured to said lower member and having a plurality of longitudinally spaced transverse fin receiving depressions therein opposite the fin receiving depressions in said lower member, a counterweight mounted on said cover member and a latching lever for clamping said cover member to said lower member, said latching lever being connected to said lower member and cooperating with said cover member.

12. The method of assembling a heat exchanger of the type described which comprises passing at least two tubes through aligned spaced openings in a plurality of transverse plates, passing one end of said tubes into spaced openings in an end flange, simultaneously expanding all of said tubes progressively throughout their length into bonding engagement with the openings in said plates and said end flange, and thereafter passing the other end of said tubes into spaced openings in a second end flange and securing said second end flange to said tubes.

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