

Dec. 9, 1969

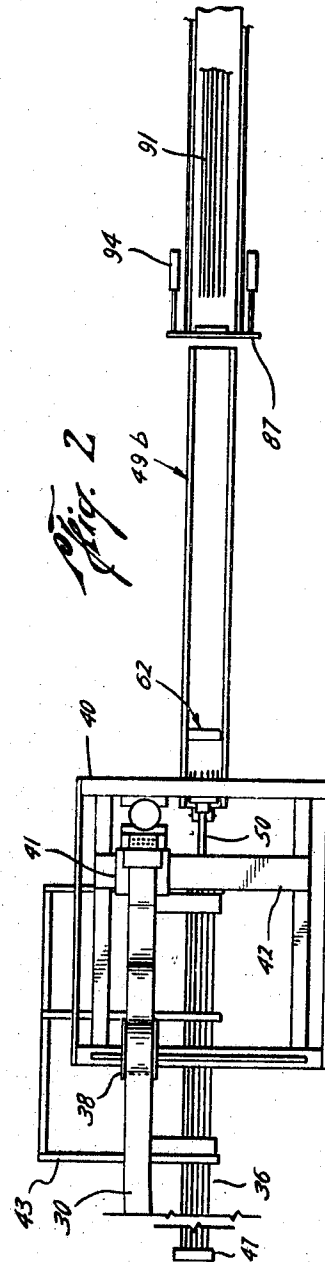
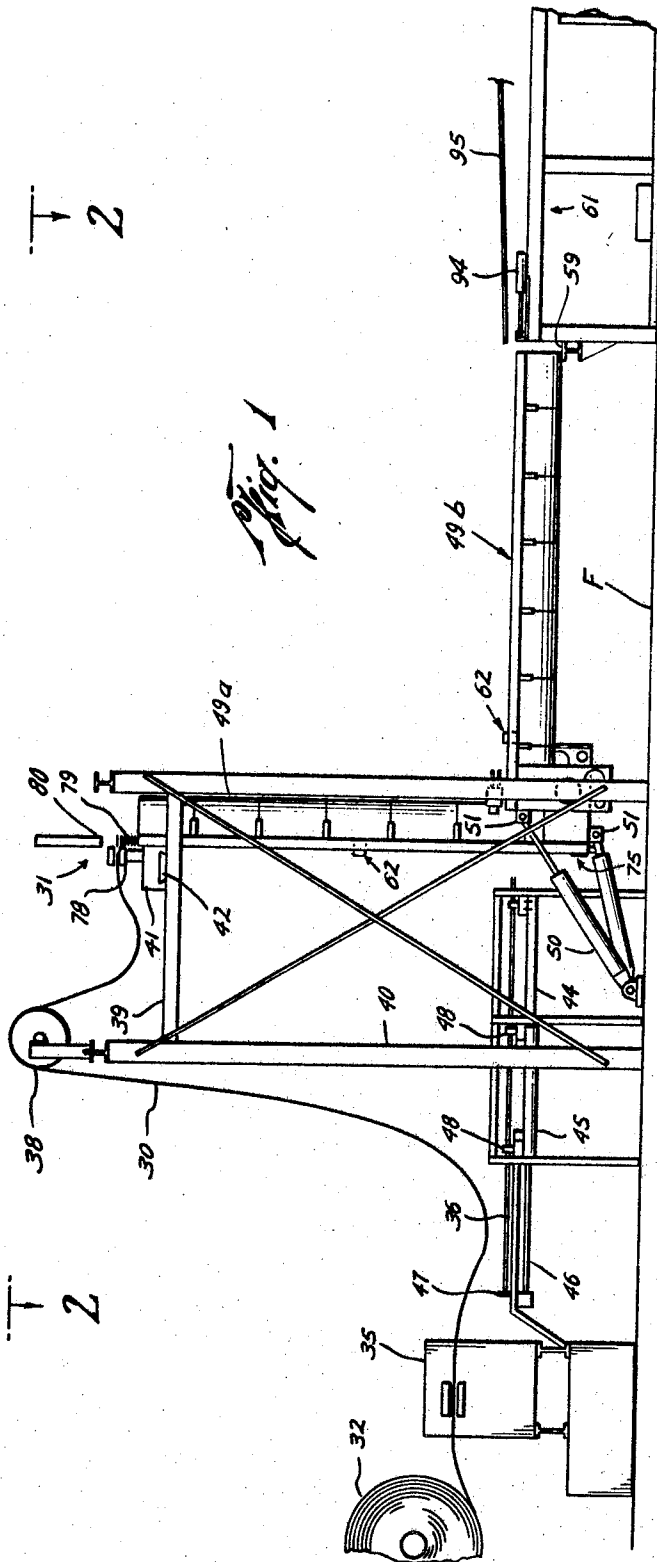
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3,482,299

MANUFACTURE OF PLATE FIN TUBE MODULES

Original Filed Feb. 7, 1966

7 Sheets-Sheet 1



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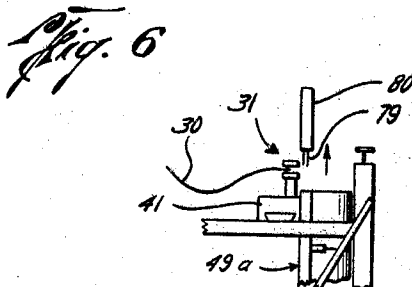
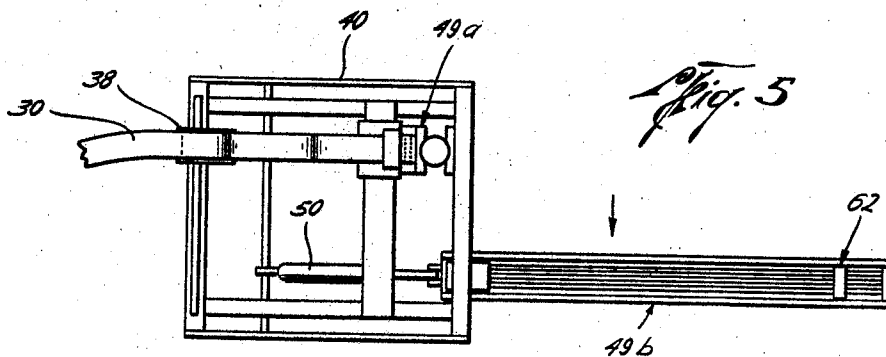
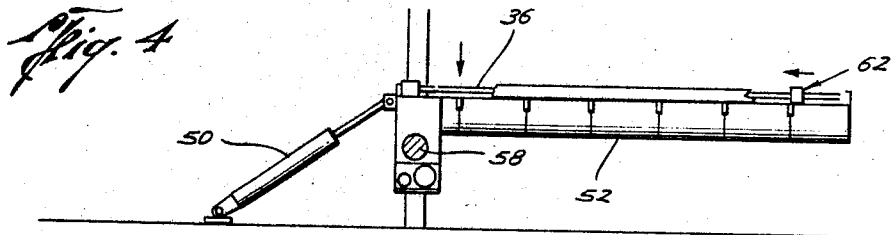
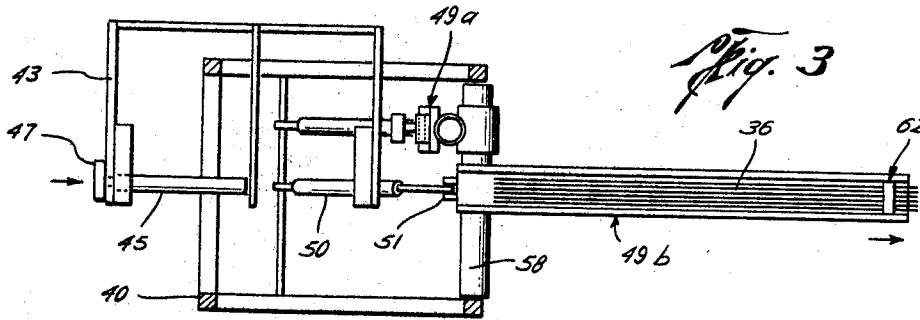
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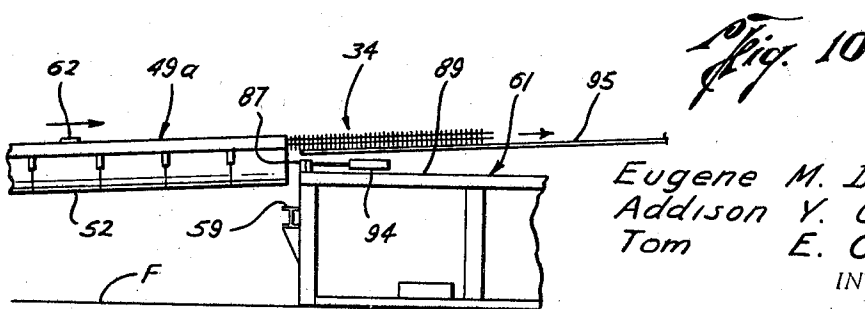
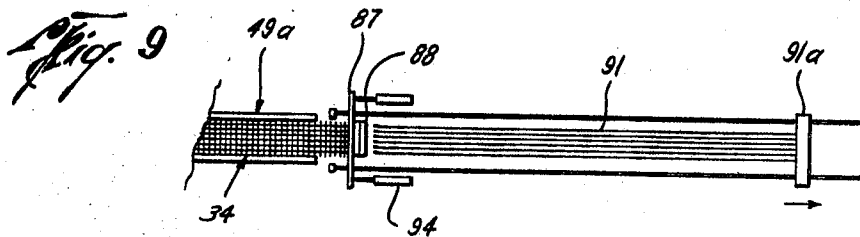
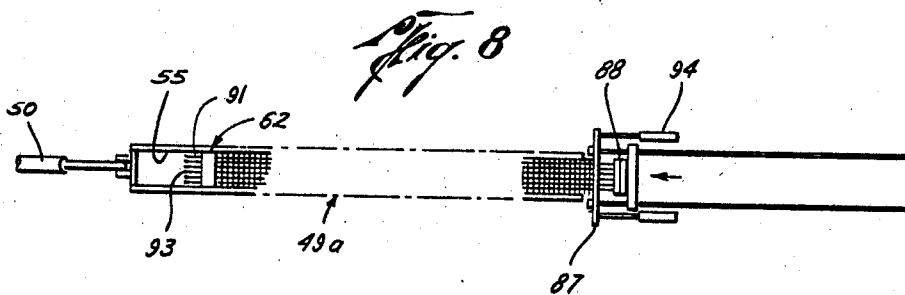
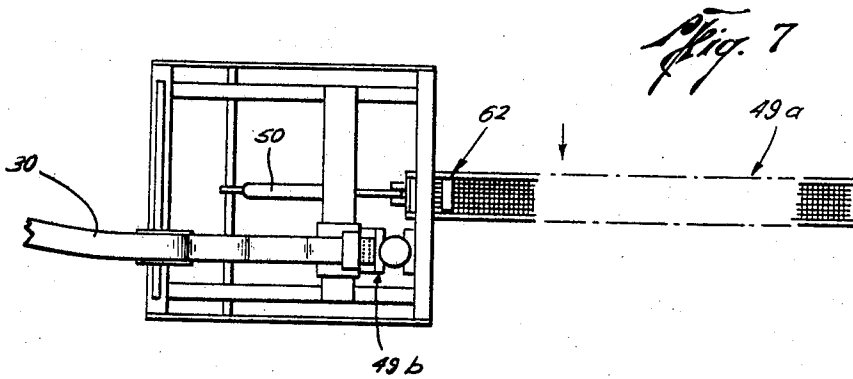
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Original Filed Feb. 7, 1966

7 Sheets-Sheet 3



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Original Filed Feb. 7, 1966

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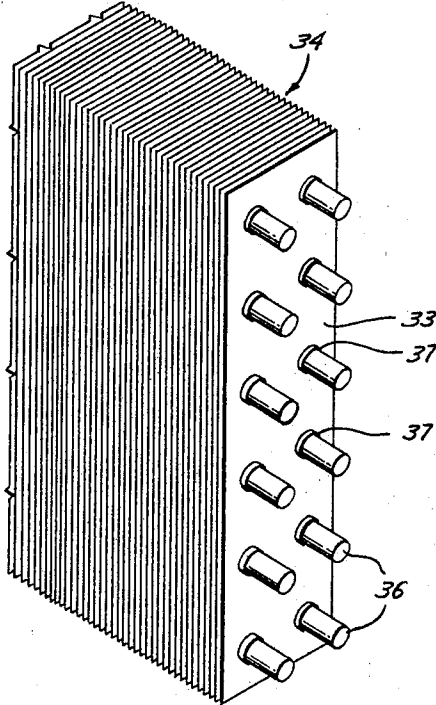


Fig. 11

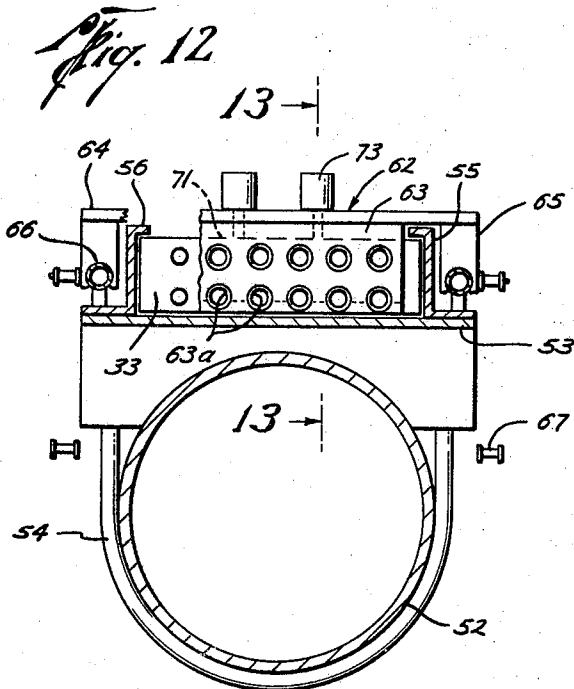


Fig. 12

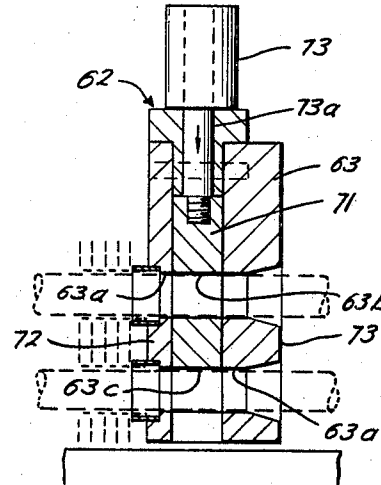


Fig. 13

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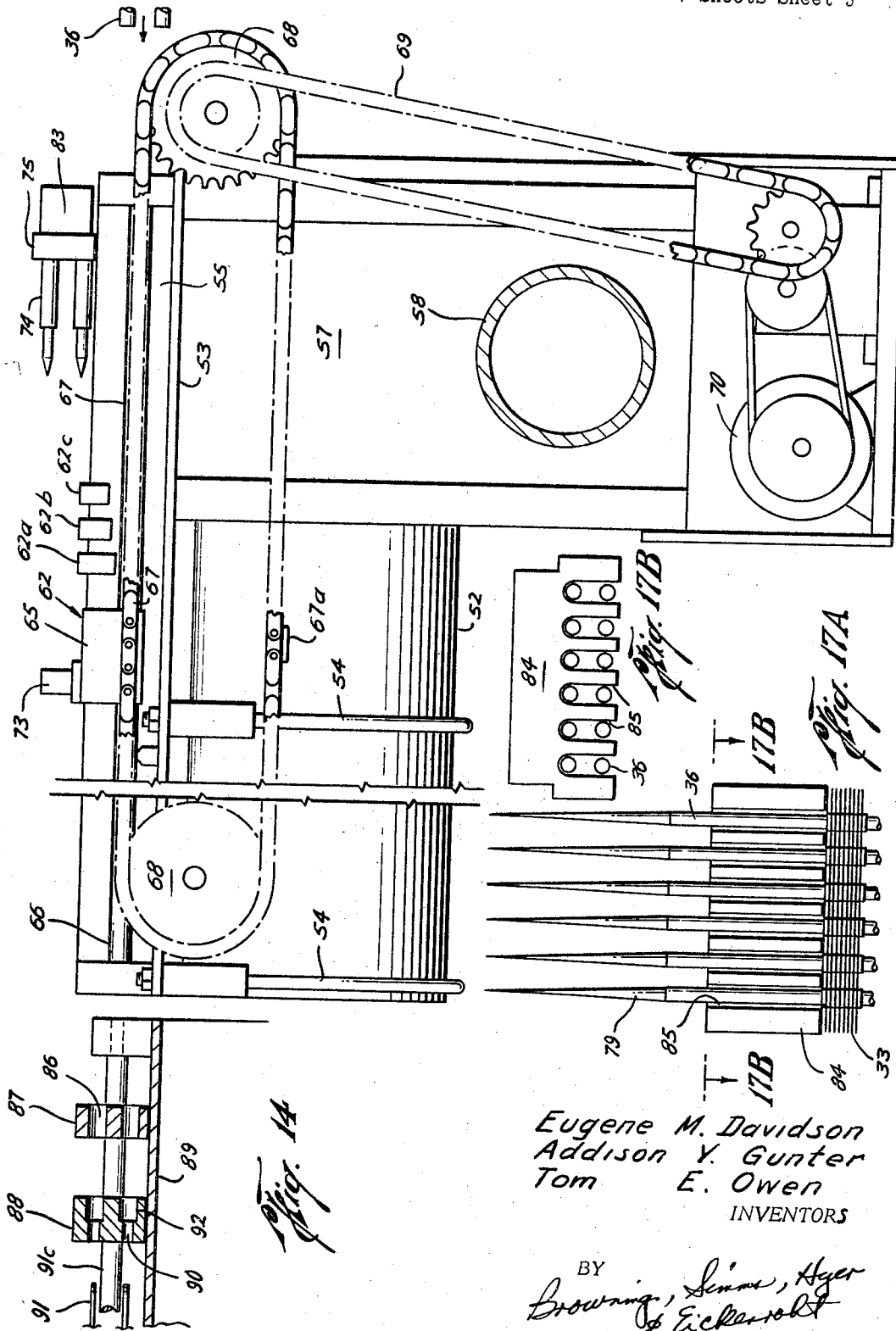
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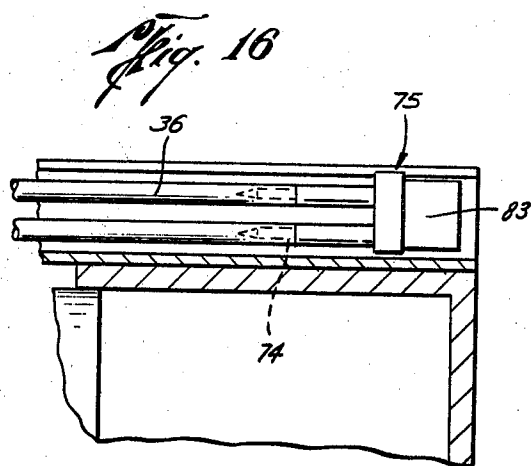
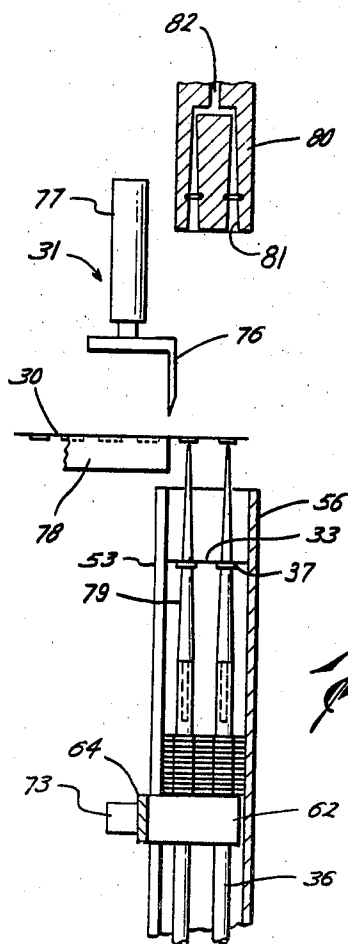
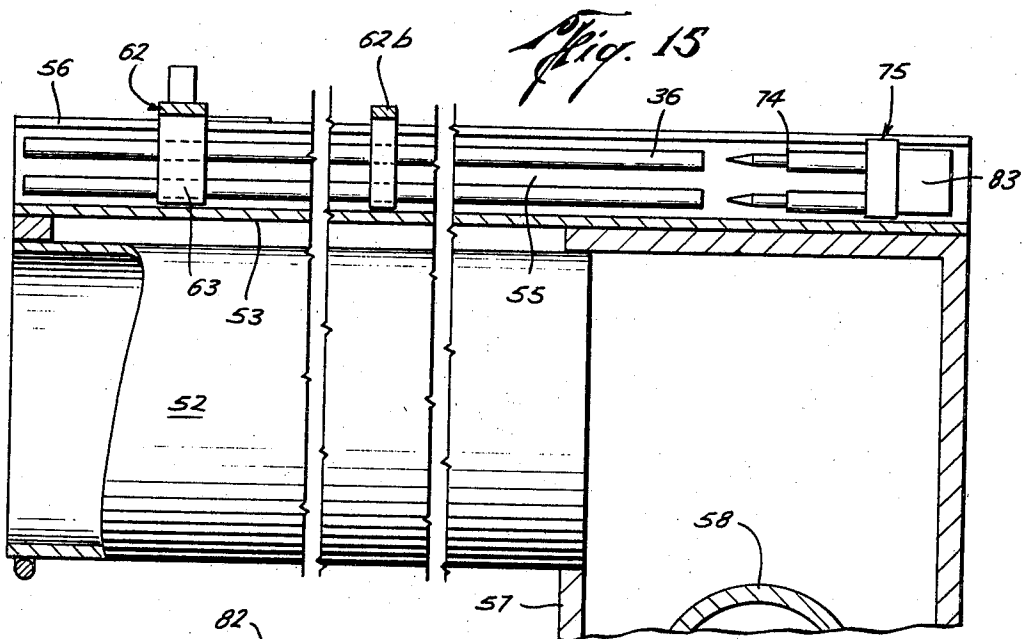
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3,482,299

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Original Filed Feb. 7, 1966

7 Sheets-Sheet 6



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3,482,299

MANUFACTURE OF PLATE FIN TUBE MODULES

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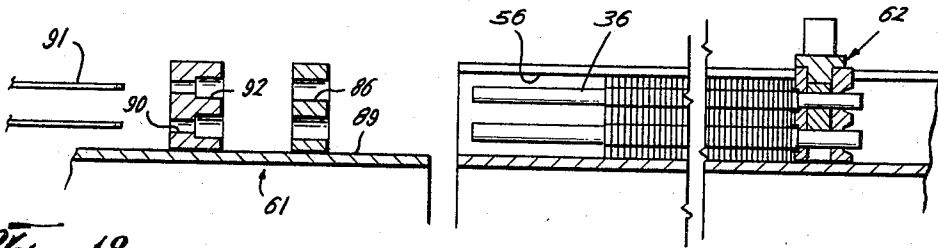


Fig. 18

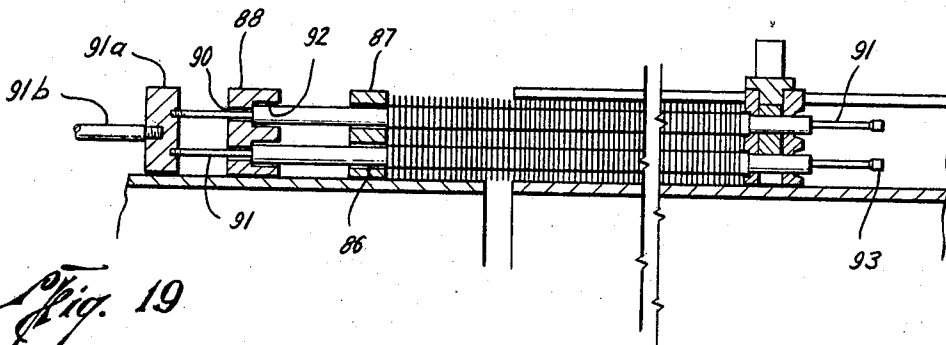


Fig. 19

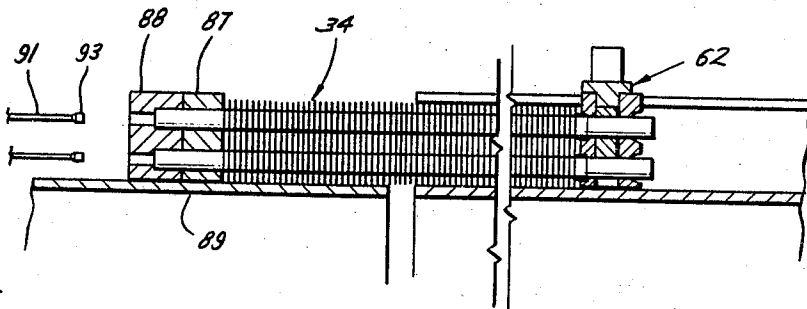


Fig. 20

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MANUFACTURE OF PLATE FIN TUBE MODULES

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Continuation of application Ser. No. 525,729, Feb. 7, 1966. This application Jan. 9, 1969, Ser. No. 796,271

Int. Cl. B21d 53/00; B23p 15/26

U.S. Cl. 29—157.3

30 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus and method for use in manufacturing plate fin tube modules wherein a beam is swingable between a generally horizontal position in which it is adapted to receive an assembly of tubes and support them in spaced apart side-by-side relation, and an inclined position to permit plate fins to be dropped freely over the upper ends of the tubes assembled thereon. The tubes are vibrated to assist the plate fins in moving downwardly along the tubes toward their lower ends so as to form a stack of fins of desired length. The tube receiving openings through the plate fins have hubs which face downwardly in the direction of movement of the fins relative to the tubes as the fins are fed over the upper ends of the tubes. A head on the beam has holes through it to receive the tubes and moves longitudinally of it to receive and position the tubes as they are assembled on the beam in its horizontal position and oppose movement of the fins along the tubes at a substantially greater rate than they are fed to the tubes, when the beam is inclined. When the fins are disposed along a desired length of the tubes and the beam is swung back to a horizontal position, the tubes are expanded to tightly engage the fins by means of a series of rods which are inserted through the tubes to receive expanding bullets on their ends and then drawn back through the tubes.

This is a continuation of Ser. No. 525,729, filed Feb. 7, 1966, now abandoned.

This invention relates to the manufacture of plate fin tube modules for use in air coolers or the like. More particularly, it relates to improved methods and apparatus for assembling a stack of the plate fins of a desired length about the tubes and then effecting a tight joint between the tubes and the plate fins.

As contemplated by his invention, a plate fin tube module comprises an assembly of four or more spaced apart, side-by-side tubes, about which the plate fins are tightly engaged over a substantial length of the assembly. As well known in the art, each plate fin is common to all the tubes so that it has holes therein corresponding in spacing and number to the tubes. Headers are connected to opposite ends of sections made up of one or more of the modules to form tube bundles for use in the air coolers.

These fins are held in closely spaced relation by any suitable means, which may comprise one or more protuberances on one or both of adjacent fins. Frequently, these spacers comprise hubs formed about each hole through the fin as the hubs provide a relatively wide surface with which the tubes may be joined. However, the holes may instead be formed through the plane surface of the plate. The remaining area of this surface may or may not be interrupted, as by means of louvers or the like.

It has heretofore been the practice, in the manufacture of this type of tube module, to first stack the plate fins and then insert the tubes through the holes in the fins. As a practical matter, this has required that usually only one and not more than a few tubes be inserted through

the aligned holes in the stack at any one time. Even then, difficulty is encountered in inserting each tube through the stack because of the usual lack of complete straightness in commercial tubes and the need for a close fit of the tube within the holes, particularly if the module is to have highly efficient heat transfer characteristics.

For these reasons, it has not been practicable to insert tubes into very long stacks of plate fins in this manner. Thus, in the manufacture of relatively long tube bundles, it has been the practice to fabricate the bundles in separate relatively short lengths and then join them end-to-end.

A tight joint between each of the tubes and the fins may be effected in a number of ways, such as by galvanizing, soldering, or expansion of the tubes against the fins. In one method of expanding the tubes, an expander part or "bullet" is drawn through them. This may shorten the tubes, and thus have a tendency to buckle the stack of fins about the tubes and/or upset the desired spacing between the fins. Rather elaborate precautions have had to be taken to avoid these problems.

An object of this invention is to provide a method and apparatus which overcomes these and other difficulties encountered in the prior practices in that it does not require that the tubes be inserted through a stack of the plate fins, either individually or a few at a time, but instead enables the assembly of fins about relatively long lengths of tubes with a minimum of time and difficulty.

Another object is to provide an apparatus for accomplishing the above-described object which enables such modules to be manufactured on a substantially continuous production line, thereby accomplishing higher production rates at lower costs.

A further object is to provide such a method and apparatus which requires a minimum of moving parts, and, more particularly, which includes a single moving part which is useful in various stages of assembling the stack of plate fins over a desired length of the tubes.

A still further object is to provide such a method and apparatus in which such moving part is also useful in connection with expansion of the tubes into a tight fit with the fins.

Still another object is to provide a method and apparatus for expanding tubes into tight engagement with plate fins stacked thereabout in such a manner as to maintain the desired spacing between the plate fins and prevent the module from buckling as expander parts are drawn through the tubes.

These and other objects are accomplished by a method and apparatus in which an assembly of tubes is supported in spaced apart, side-by-side relation, and plate fins are fed over the ends of the supported tubes. In one novel aspect of the invention, particularly when the clearance between the tube and fin hole is small, the tubes and fins are caused to move relative to one another, preferably, by vibration of the tubes, to assist the advance of the fins toward the other ends of the tubes so as to form a stack of said fins of desired length. A single stack may extend for substantially the entire length of the tube assembly in the event the tube module is to be of the same length as the tubes. Alternatively, two or more stacks may be formed along the tubes, each being separated from another by a spacer inserted between the last fin of one stack and the first fin of the next. In this way, the spacers may later be removed to permit the stacks to be separated from one another to form separate, relatively short tube modules.

In another novel aspect of the invention, the advance of the fins is controlled by opposing their movement over the tubes at a substantially greater rate than they are fed to the tubes. In this manner, the fins are caused to stack

substantially parallel to one another and at a predetermined angle with respect to the tubes, which they might not do if free to move over the tubes at an uncontrolled rate. At the same time, this does not constitute a bottleneck in the assembly of the fins on the tubes, because it still permits the means for feeding the fins to operate at full capacity. This step may be found sufficient, without vibration of the tubes, when there is a relatively large clearance between the tubes and fins of the modules to be manufactured. In fact, this may be true even when the holes in the fins are formed through the hubs, if, as is preferred, the fins are fed to the tubes with the hubs facing the ends of the tubes, because it has been found that this will facilitate advance of the fins.

It is preferred that as the fins are fed over the ends thereof, the tubes be supported with one end above the other, or in other words, with one end at a higher elevation than the other. In this way, gravity may assist the movement of the fins downwardly over the tubes. In this event, the advance of the fins would be controlled by a support disposed beneath the stack and moved downwardly at substantially the same rate as the fins are fed to the tubes.

In the illustrated embodiment of this invention, there is a beam which may be swung between generally horizontal and inclined positions. In its generally horizontal position, the beam is adapted to receive an assembly of the tubes and support them in spaced apart, side-by-side relation for swinging with the beam to inclined position. In this latter position of the beam, the upper ends of the tube supported thereon are positioned to receive plate fins from fin feeding means near the upper end of the beam. In its broader aspects, this invention contemplates that a tight joint between the tubes and fins may then be effected in any well known manner. However, in accordance with the preferred practice of the invention, the beam is swung back to a generally horizontal position so as to dispose the tubes with the fins stacked thereabout in line with a series of rods insertible through the tubes and bullets adapted to be secured to the ends of the rods so that, upon retraction of the rods, the bullets are drawn through the tubes to expand them against the fins. At this time, the beam may be swung upwardly to dispose its one end adjacent the expanding means in a position to permit removal of the tube module or modules onto an in-line conveyer above such means. The beam may then be returned to its generally horizontal position so that additional tubes may be received and supported thereon preparatory to forming another module.

In its generally horizontal position, the beam is also in line with a means at its opposite end for assembling the tubes in the desired spaced apart, side-by-side relation. When so assembled, the tubes are moved longitudinally into supported position on the beam so that, as previously mentioned, the upper ends of the tubes are disposed to receive the fins from the fin feeding means. This latter means comprises a means mounted on a platform above the tube assembling means for shearing individual plate fins from a strip of fin material in position to drop freely over the upper ends of the tubes. This strip is supplied to the shearing means from a roll of same which has passed through a hole punching press substantially aligned with the beam, thereby providing its own means of conveyance between the plate fin supply and feed.

Preferably, there are two beams of the type described so that fins may be stacked on the tubes supported on one beam in its inclined position, while tubes are expanded and then removed and a new assembly of tubes is moved into supported position on the other beam in its horizontal position. For this purpose, each beam is shiftable from its position in-line with the tube assembly and tube expanding means to a laterally displaced position in which it may be swung between generally horizontal and inclined positions. The shearing means is laterally shiftable on the platform to permit it to feed fins onto the

upper ends of one or the other of the laterally displaced and inclined beams.

There is a head which is movable longitudinally of the beam and which has holes through it to receive the ends of the spaced apart, side-by-side tubes as the assembly of such tubes is moved longitudinally toward the beam. The head includes means for releasably clamping it about the tubes so that it may be moved to the end of the beam adjacent the tube assembly means to receive and clamp the ends of the tubes to permit the assembly to be moved toward the opposite end of the beam in order to draw its full length onto the beam. The beam is then swung upwardly to its inclined position, at which time the clamping means is released. Then, as the plate fins are fed onto the upper ends of the tubes and thus accumulate on the top side of the head, such head is gradually moved downwardly along the beam toward its lower end at approximately the rate of feed of the plate fins and until a stack of fins of desired length has been formed. As previously described, this stack may extend substantially the full length of the tubes, or, alternatively, two or more stacks of fins may be separated from one another by spacers inserted at suitable locations along the lengths of the tubes. In either case, the stacking of the fins will continue until the head has been lowered to substantially the lower end of the tubes.

This movable head is also useful in holding the lower ends of the tubes in supported position on the beam and in moving the tubes into position for receiving the expanding rods. For the first purpose, a second head is movable between a first position spaced from the beam and a second position adjacent the beam and in line with the tube ends. Upon gripping one end of the tube assembly, the first head moves toward the opposite end of the beam a sufficient distance to draw the opposite end of the tube assembly beyond the second position of the second head. In this manner, the second head can be moved to its second position adjacent the beam to dispose tube guide parts facing toward the opposite end of the beam, so that the first head may be moved back toward the opposite end of the beam so as to force the lower ends of the tubes into closely fitting relation with respect to the guide parts on the second head. Thus, as the beam is swung upwardly, the two heads support the tubes at their opposite ends. Then, as the first head moves downwardly upon feeding of the fins to the tubes, the portions of the tubes above the first head are supported by the plate fins thereabout.

Upon swinging of the beam back to its generally horizontal position, the first head will be adjacent the second head near the ends of the tubes opposite those ends confronting the expanding rods. Thus, the first head is again clamped about the tubes and moved back toward the expanding means to force the opposite ends of the tubes against a stop having holes through which the expanding rods may be moved. The rods are moved all the way through the tubes, bullets are mounted thereon, and the rods are retracted to draw such bullets through the tubes to expand them. In accordance with another novel aspect of this invention, there is a plate intermediate the stop and the ends of the tubes for engaging the plate fins about the tubes as the rods are drawn therethrough. More particularly, there is a means for yieldably urging this plate against the plate fins so as to prevent the desired spacing between the plate fins from being upset in the event the tubes shorten. Also there is a flange along each side of the beam for disposal over the opposite side edges of the fins about the tubes, which thereby prevents the module from buckling as the rods are drawn through the tubes.

In the drawings, wherein like reference characters are used throughout to designate like parts;

FIG. 1 is an elevational view of the above-described apparatus, and showing one beam raised to a vertical position to receive plate fins over the upper ends of tubes supported thereon and the other beam in its generally horizontal

zontal position preparatory to receiving an assembly of spaced apart, side-by-side tubes from the tube assembly means at its left end;

FIG. 2 is a plan view of most of the apparatus shown in FIG. 1;

FIG. 3 is a horizontal sectional view of the apparatus, taken along a line above the tube assembly means and horizontal beam, and upon moving of the assembly of tubes onto the horizontal beam through shifting of the first head thereon;

FIG. 4 is a vertical sectional view of the horizontal beam shown in FIG. 3, but in which the second head thereon has been lowered into position adjacent the beam and the first head has been shifted back to move the ends of the tubes into tight fitting relation with respect to guide parts of the second head;

FIG. 5 is a plan view of the apparatus shown in FIGS. 3 and 4, but after shifting of the generally horizontal beam to its laterally displaced position;

FIG. 6 is an elevational view of the platform and plate fin feeding means mounted thereon, together with the upper end of the vertically disposed beam, upon lifting of guide pins from the upper ends of the tubes supported on the beam;

FIG. 7 is another plan view similar to FIG. 5, but upon lowering of the upright beam to its generally horizontal position and lateral displacement thereof to the in-line position, as well as upon swinging of the generally horizontal, laterally displaced beam upwardly to a vertical position;

FIG. 8 is a horizontal sectional view showing the horizontal beam of FIG. 7, together with the left-hand end of the means for expanding the tubes, and upon shifting of the tubes with the stack of plate fins disposed thereabout toward the expanding means and insertion of the rods of the expanding means through the tubes;

FIG. 9 is a view similar to FIG. 8, but after the rods have been drawn through the tubes so as to expand the same outwardly against the plate fins;

FIG. 10 is an elevational view of the apparatus shown in FIGS. 8 and 9, but upon lifting of the right-hand end of the beam an amount sufficient to permit the tube module to be moved by the first head from the beam onto a conveyer above the expanding means;

FIG. 11 is a perspective view of a tube module formed in accordance with the present invention;

FIG. 12 is a cross-sectional view of one of the beams, with tubes with plate fins disposed thereabout on the left-hand side thereof and with the tubes removed from the right-hand side thereof to show a portion of the first head;

FIG. 13 is a cross-sectional view of the clamping means on the head shown in FIG. 12, on an enlarged scale and as seen along broken line 13—13;

FIG. 14 is a broken, elevational view of the beam shown in FIG. 13, together with the end of the expander means adjacent one end thereof and the end of a tube assembly adjacent the other end thereof;

FIG. 15 is a vertical cross sectional view of the right-hand end of the beam shown in FIG. 14, with an assembly of tubes moved onto the beam and into a position to dispose their ends for close fitting relation with guide parts on the second head upon lowering of the second head into its position adjacent the beam;

FIG. 16 is a view of part of the apparatus shown in FIG. 15, and showing the ends of the tubes moved to the right into tight fitting relation with respect to the guide parts on the second head;

FIG. 17 is a vertical sectional view of the upper end of one of the beams in its vertical position, the plate fin shearing means mounted on the platform, and the means for raising and lowering guide pins with respect to the upper ends of the tubes supported on the beam, and during stacking of the plate fins upon the movable head on the beam;

FIG. 17A is an elevational view of the upper ends of the tubes, as seen from the left-hand side of FIG. 17, upon lowering of the movable head to a position in which a stack of desired length has been formed thereabove and during insertion of a spacer at the upper end of the stack;

FIG. 17B is a cross-sectional view of the tubes, as seen along broken line 17B—17B of FIG. 17A;

FIG. 18 is a vertical sectional view of the adjacent ends of a generally horizontal beam and the expander means, upon retraction of the expanding rods to their normal position;

FIG. 19 is a view similar to FIG. 18, but upon movement of the tubes with plate fins stacked thereabout toward the expanding means to receive the rods through the tubes; and

FIG. 20 is a view similar to FIGS. 18 and 19, but upon drawing of the rods through the tubes so as to expand the tubes against the plates.

With reference now to the details of the above-described drawings, and particularly FIG. 1, a strip 30 of plate fin material is supplied to the plate fin feeding means 31 from a roll 32. The width of this strip corresponds to the width of the plate fin to be formed, and thus to the vertical dimension of the plate fins 33 of the tube module 34 shown in FIG. 11.

A press 35 is mounted on the floor F relatively near the roll 32 so as to receive the strip therefrom and form the openings therein for receiving tubes 36 in the finished module 34. More particularly, in the embodiment shown in FIG. 11, the press stamps hubs 37 which surround the openings through the strip.

The material is usually of relatively thin gauge, and thus flexible intermediate the press and fin feeding means 31. Thus, it extends from the press 35 onto a guide roller 38 and then to the feeding means 31, where the strip is then sheared to the desired width for forming individual plate fins 33 having the lateral dimension shown in FIG. 11. The rate at which the strip is formed, and thus the plate fins are fed from the means 31, is controlled by the capacity of the press 35.

The guide rollers 38 as well as the plate fin feeding means 31 are mounted upon a platform 39 supported by a framework 40 extending upwardly from the floor F. The feed means 31 is movable between positions laterally displaced to opposite sides of a generally central position along the platform 39. In this manner, such plate fin feeding means can be disposed near the upper ends of tubes mounted on either of the two beams to be described.

Thus, the base 41 of the feed means is movable along a guide part 42 extending across the platform 39. The base of the guide roller 38 is also shiftable laterally over the platform in any suitable manner to permit it to be disposed in line with the feed means. The flexible strip 30 bends the required amount intermediate the guide roller 38 and the press 35, so that this arrangement does not require that the heavy press 35 be moved from its fixed position.

A supply of the tubes 36 may be stored upon a table 43 on the floor F for assembly onto a rack 44 along one side of the table and generally beneath a central portion of the framework 40. This rack comprises spaced apart supports for intermediate portions of one or more rows of tubes. In this case, of course, there would be two rows of six tubes, each spaced apart in the manner shown in FIG. 11.

As shown diagrammatically in FIGS. 1, 2 and 3, a cylinder 45 mounted longitudinally beneath the rack has a piston rod 46 extending from one end thereof toward the press 35. When the rod is extended, a pusher 47 on its end is positioned to engage the left-hand ends of the tubes 36 assembled on the rack. Thus, upon retraction of the piston rod 46, the pusher 47 moves the right-hand end of the assembled tubes from the position shown in FIGS. 1 and 2 into a position on the horizontal beam in which they may be gripped by the longitudinally movable first

head on such beam and then drawn by such head full upon the beam.

Obviously, other means may be employed for assembling the tubes in the desired spaced apart, side-by-side relation and then moving them when so assembled onto the horizontal beam. For that matter, the tubes may be assembled on the beam by hand. However, as previously mentioned and as will be described in detail to follow, the longitudinally shiftable first head on each beam makes it possible to mechanize this operation in conjunction with any suitable means for assembling the tube in spaced apart, side-by-side relation at the left-hand end of the beam.

There are two beams 49a and 49b, the first of these being shown in FIGS. 1 to 5 in its vertical position and the second being shown in these figures in its horizontal position. As previously described, when horizontal, each beam is shiftable between a position in line with the tube assembly and a laterally displaced position. Thus, in FIGS. 1 to 3, the upright beam 49a has first been moved to its laterally displaced position so as to dispose the upper ends of the tubes 36 supported thereon in position to receive plate fins being fed from the similarly displaced means 31 on the platform 39. On the other hand, the horizontal beam 49b is in its in-line position preparatory to receiving an assembly of tubes 36 from the rack 44 at the left-hand side of the beam.

When the plate fins have been stacked on the tubes supported on beam 49a and tubes have been assembled in supported position on beam 49b, the latter is moved to its laterally displaced position and then swung upwardly to its vertical position and the beam 49a is swung downwardly to its horizontal position and then moved laterally to an in-line position. These reversed positions of the beams are illustrated in FIG. 7. The feed means 31 is shifted laterally of the platform so as to begin the stacking of plate fins on the supported tubes of the beam 49b. During this time, the tubes on beam 49a are expanded against the plate fins thereabout and the completed tube bundle removed from the beam, as shown in FIGS. 8 to 10. As plate fins continue to be stacked on the tubes supported on beam 48b, additional tubes are assembled and moved into supported positions on the beam 49a.

Each beam is swung between its horizontal and vertical positions by means of a fluid actuator 50 having a cylinder anchored to the floor F and a piston rod connected at its free end to a bracket 51 on the left end of the beam, which becomes its lower end as the beam is raised. Thus, as can be seen from FIG. 1, one actuator is retracted to raise the beam 49a to which it is connected and the other is extended to permit the beam 49b to which it is connected to assume its horizontal position. Obviously, the lateral shifting of the beams between in-line and laterally displaced positions requires a pivotal connection (not shown) of the ends of the actuator 50 to the floor F and bracket 51.

Each of the beams 49a and 49b comprises a large pipe 52 having an open-ended guideway for the assembly of tubes, both with and without plate fins thereabout. As best shown in FIGS. 12, 14 and 15, this guideway includes a deck 53 mounted along the length of the pipe 52 by means of a series of spaced-apart straps 54 surrounding the underside of the pipe. Side members 55 are mounted on the top side of the deck 53 and spaced apart a distance to receive rather closely the opposite sides of the plate fins when disposed about the tubes, and the upper ends of the side members 55 are bent inwardly to form flanges 56 for confining the upper edges of the plate fins. (See the left-hand side of FIG. 12.) More particularly, the deck and side members extend along the top of the pipe in the horizontal position of the beam, and on the side thereof facing the framework 40 in the vertical position of the beam.

The end of each pipe has a base 57 extending across and downwardly from its end adjacent the tube assembly.

The lower end of this base 57 provides a journal surrounding a shaft 58 extending across and supported from the framework 40. Thus, the centerline of the shaft 58 forms a pivot about which each beam is swung between its horizontal and vertical positions. In the horizontal position of each beam, its end opposite the shaft 58 rests upon a shoulder 59 formed on the end of tube expanding means 61 disposed in line with the beam, and thus in line with the tube assembling means. In the vertical position of each beam, the guideway engages against the front side of the base 41 of the feed means 31, as shown in FIGS. 1 and 2.

A head 62, which has previously been referred to as the "first" head, is movable longitudinally along each beam between a position near the end thereof facing the tube assembly means and a position near the end thereof facing the tube expanding means. As best shown in FIGS. 12 and 14, this head 62 comprises a flat body 63 having holes 63a therethrough corresponding in number and spacing to the tubes 36 in the finished tube bundle 34. This body is supported for reciprocation in the guideway by means of a bar 64 extending across the tops of the side members, as shown in FIG. 12. More particularly, legs 65 extend downwardly from opposite ends of the bar 64 and on the outside of the side members 55 for sliding along rods 66 extending longitudinally of the side members and supported upon the outwardly extending flanges thereof mounted above deck 53. Thus, as will be clear from FIG. 12, this permits the body 63 to move freely within the guideway with its lower edge spaced slightly above the top side of the deck 53, and the lower side of supporting bar 64 spaced above the flange 56 on each side member 55.

The first head 62 is reciprocated longitudinally of the beam by means of endless chains 67 mounted on sprockets 68 at each side of the beam. Thus, the upper run of each chain 67 is connected to the outer side of a leg 65 extending from supporting bar 64 so that the head 62 is caused to move with this portion of the chain along the length of the beam. The sprocket 68 at the right-hand end of the chain 67 is driven by another endless chain 69 which in turn is driven by any suitable power means, such as the reversible motor 70 supported on the lower end of the base 57 of the beam.

As previously mentioned, the first head 62 is moved toward the end of the beam adjacent the tube supporting means (the right-hand end as shown in FIG. 14) so as to receive the end of the assembly of tubes 36 through the holes 63a. When the head 62 has been so moved, the pusher 47 is actuated by means of the cylinder and piston 45, 46 so as to push the adjacent ends of the assembly of tubes 36 onto the end of the beam and then through the holes in the head 62. At this time, the head 62 is clamped about the tubes received through its holes so that, upon movement of the head toward the opposite end of the beam, the opposite end of the assembly can be drawn onto the beam. At this time, of course, the actuator for the tube assembly means may be reversed to return the pusher 47 to the position shown in FIGS. 1 and 2.

As shown in FIG. 13, this means for clamping the head 62 about the tubes 36 comprises an inner plate 71 sandwiched between outer plates 72 and 73 for vertical reciprocation therebetween. More particularly, each of the outer plates 72 and 73 has aligned portions of the holes 63a formed therein, and the inner plate 72 has a hole 63b formed therein for alignment in one position with the upper holes 63a of the plates 72 and 73 and an arcuate portion 63c at its lower end for alignment in such one position with the lower holes 63a in the plates 72 and 73. The ends of openings 63a in plate 73 are flared outwardly to facilitate insertion of tubes 36 (shown in phantom) from left to right. The plates 72 and 73 are bolted together, the bolt heads being flush with the

outside of plate 72 so as not to interfere with stacking of plate fins 33 (also shown in phantom).

Upon downward movement of the plate 71 relative to the plates 72 and 73, the upper ends of the holes 63b and arcuate portions 63c will tightly engage against the portions of the tubes received so as to grip them for movement with the head 62. This reciprocation of the inner plate 71 is imparted thereto in any suitable manner such as a solenoid within housing 73 connected by stem 73a to the upper end of the plate 71.

As has also been described heretofore, when clamped by the head 62, the opposite ends of the tubes are drawn by the head onto the beam to dispose them beyond the position in which they are to be supported on the beam. Thus, with reference again to FIGS. 14 and 15, the tubes 36 are drawn toward the end of the beam adjacent the tube expanding means 61 so as to dispose the ends of the tubes to the left of guide parts 74 upon the head 75, which has been heretofore described as the "second" head. As previously mentioned, this second head 75 is moved in any suitable manner between a position spaced from the beam, as shown in FIG. 14, and a position in which its guide parts 74 are disposed within the guideway on the beams, as shown in FIG. 16. In the former position, the head 75 and its guide parts 74 are out of the way of the assembly of tubes 36 as such tubes are initially pushed onto the end of the beam and then drawn onto the beam. However, when drawn beyond their normally supported positions, the ends of the tubes are out of the way of the second head 75, so that it may move downwardly to the position of FIGS. 15 and 16.

In this latter position, the guide parts 74 are aligned with the ends of the tubes 36, so that, upon shifting of the head 62 back to the right as shown in FIGS. 14 to 16, such ends of the tubes are caused to fit tightly over the guide parts 74. More particularly, the tubes move over the reduced ends of the guide parts until they engage annular shoulders on such parts, thereby spacing the tube ends from the head 75.

As the first head 62 draws the tube assembly onto the beam, as well as during its return movement to move the ends of the tubes 36 onto the second head 75, the first head is, of course, disposed near the left-hand end of the beam, as shown in FIGS. 14 to 16. Since these tubes may be of considerable length, intermediate heads 62a, 62b and 62c are mounted on the beam for movement longitudinally thereof and provided with openings therethrough (not shown) aligned with the openings 63a of the head 62. Since these intermediate heads merely provide supports for intermediate portions of the tubes, they need not have means thereon for clamping about the tubes.

Furthermore, in order that they may be spaced apart along the length of the beam at the desired distances from one another as well as from the heads 62 and 75, each such intermediate head is caused to be picked up and moved to the desired position by a part on the chain 67 as the chain is actuated to move the head 62 toward the end of the beam adjacent the tube expanding means. A part 67a for engaging and so placing the intermediate head 62a is shown in FIG. 14 as being attached to the lower run of the endless chain 67. As will be appreciated from FIG. 14, as the head 62 is moved to the left from its position shown in FIG. 14, the part 67a will be brought into a position to engage the head 62a and move it to a position along the length of the beam and spaced to the right of the beam 62. Similar parts (not shown) are provided upon trailing portions along intermediate portions of the beam.

Upon shifting of the first head 62 back toward the tube assembly means so as to force the ends of the tubes 36 over the guide parts 74, as shown in FIG. 16, the assembly of tubes will be supported at opposite ends by the heads 62 and 75 and along intermediate portions

thereof by means of the heads 62a, 62b and 62c. When the beam on which the tubes are supported is swung upwardly to the vertical position, the head 62 will be spaced downwardly somewhat from the ends of the tubes 36. Thus, as shown in FIG. 17, the ends of the tubes are free, when the beam is so raised, to receive the plate fins thereover. It may be desired to relocate the head 62 relative to the ends of the tubes 36, although generally speaking the head will still be disposed relatively near these ends of the tubes as the plate fin feeding operation begins.

This plate fin feeding means 31 is shown diagrammatically in FIG. 17 to include a cutter 76 vertically reciprocable above the strip 30 by means of an actuator 77. More particularly, the strip is supported on an anvil 78 having an outer edge substantially beneath the cutting edge 76 as it moves downwardly in its cutting stroke. This mechanism is, of course, coordinated with the travel of the strip 30 so as to shear off plates of the desired lateral dimension.

As shown in FIG. 17, the open upper end of the guideway of the beam is beneath the plate fin as it is sheared from the strip 30, so that the fin will fall freely through the guideway onto the upper ends of the tubes 36. As also shown in FIG. 17, the upper ends of these tubes 36 are spaced downwardly somewhat therefrom the upper end of this guideway, and, in order to insure free and easy movement of each of the plate fin 33 downwardly over the upper ends of the tubes 36, guide pins 79 are mounted in the upper ends of the tubes. These pins taper downwardly from upper pointed ends to a diameter at their lower ends which is substantially equal to the outer diameter of the tubes 36, thereby providing a smooth transition from the guide pins onto the tubes. As previously mentioned, it has also been found that the fins will slide down easier when the hubs 37 thereon project downwardly, as shown in FIG. 17.

The upper pointed ends of these pins extend to just beneath the openings through the hubs 37 of the plate fins as the fins are sheared from the strip 30. As shown in FIG. 17, each fin will move freely down over the guide pins 79 and within the guideway of the beam until it moves over the upper ends of the tubes and then along such tubes onto the top surface of the head 62. Since the head 62 is initially located beneath the upper ends of the tubes 36, a stack of the plate fins 33 can be formed above the head 62 before the head begins to move downwardly. However, before this stack reaches the upper ends of the tubes, the head 62 is caused to move gradually downwardly.

More particularly, the head is moved at approximately the same rate as the plate fin feeding means so as not to interfere with the downward descent of the stack of plate fins. At the same time, this support for the stack prevents the lowermost plate fins from moving downwardly too rapidly along the tubes and thus cocking into a position which would interfere with the orderly formation of the stacks.

As shown in FIG. 17, the guide pins 79 may be lowered into and removed from the positions shown in FIG. 17 by means of a vertically reciprocal head 80 having holes 81 in its lower end adapted to fit closely over the upper ends of the pins 79. The upper ends of these holes connect with a passageway 82 which may be connected to any suitable source of pressure fluid. Thus, the pins may be held in the holes 81 by a pressure differential thereacross to permit them to be moved vertically between the position shown in FIG. 17 and the position thereabove. When lowered into the position shown in FIG. 17, the pins may be released and permitted to remain in guiding position a reversal of the pressure differential. Obviously, however, other suitable means may be provided for this purpose; and, in fact, the guide pins may be mounted and removed by hand.

As previously mentioned, the downward movement of the plate fins over the tubes 36 due to gravity is aug-

mented, preferably by a vibration of the tubes. For this purpose, a vibrator 83 of suitable construction mounted on the base of the second head 75 may include suitable means for reciprocating the second head 75 in a direction generally parallel to the length of the tubes 36. The frequency and extent of these vibrations will, of course, be determined by operating conditions, all of which will be apparent to one skilled in the art. It may be found, for example, that these vibrations need only be of such lower frequency that a mechanical vibrator of the type indicated in 83 is unnecessary, and that instead the operator may merely deliver blows to the second head 75 at desired intervals. Also, of course, a mechanical vibrator may be located other than as shown, although the mounting of same upon the second head 75 is preferred for obvious reasons.

As previously mentioned, in the event the tube module to be formed is of substantially the same length as the beam, the stack of plate fins will be formed over substantially the entire length of the tubes 36. At the conclusion of this plate fin stacking operation, the head 62 will, of course, be disposed near the lower end of the beam above the intermediate heads and the second head 75. Thus, as it moves downwardly, head 62 will engage head 62a, which will in turn engage 62b, which will in turn engage 62c. The total thickness of heads 62-62c is somewhat greater than the length of the enlarged portions of the guide parts 74, so that the lower end of the fin stack will terminate above the lower ends of tubes 36.

However, in the event that two or more tube modules are to be formed along the lengths of the tubes 36, spacers 84 may be inserted intermediate stacks formed on the tubes by placement about the tubes 36 during the stacking process. Thus, as shown in FIGS. 17A and 17B, the spacer comprises a block having slots 85 formed therein for passing laterally over the upper ends of the tubes 36 above the uppermost plate fin of the stack supported above the head 62. The stacking operation is then continued to form one or more additional stacks above the spacer 84. Obviously, additional spacers may be used in the event more than two stacks, and thus more than two tube modules, are to be formed. These spacers are relatively thick from top to bottom so as to provide sufficient unfinned lengths of tubes intermediate adjacent stacks to permit their attachment to headers.

As previously described, and as shown in FIGS. 3 and 4, when the desired length of plate fins has been stacked along the tubes supported on the vertical beam 49A, an assembly of tubes 36 will have been received and supported in spaced apart, side-by-side relation upon the horizontal beam 49B. At this time, the horizontal beam 49B is moved from its in-line position to its laterally displaced position, as shown in FIG. 5, and swung upwardly to its vertical position, as shown in FIG. 7. Upon raising of the guide pins 79 from the upper ends of the tubes 36 supported thereon, as illustrated by the arrow in FIG. 6, vertical beam 49A is swung downwardly to its horizontal position and then moved laterally into its in-line position, as shown in FIG. 7. As also shown in FIG. 7, the feed means 31 and the guide roller 38 for the strip 30 leading to the feed means are moved laterally over to positions for feeding plate fins onto the upper ends of the tubes supported by the now vertical beam 49B.

As previously described, and as shown in FIGS. 7 and 18, the first head 62 on the now horizontal beam 49A is disposed near the ends of the tubes adjacent the tube assembling means (to the left in FIG. 7 and to the right in FIG. 18). More particularly, the head will be disposed at least close to the first plate fin to be formed at the lower end of the stack of fins shown in FIGS. 7 and 18. At this time, the head 62 is clamped about these ends of the tubes and moved toward the opposite end of the beam so as to in turn move the opposite ends of the tubes toward the tube expanding means 61.

As best shown in FIG. 19, the head continues to move until the unfinned ends of the tubes extend beyond the end of the beams adjacent the expanding means, through holes 86 in a plate 87, and into abutment with a stop 88. As shown in FIGS. 18 and 19, both plate 87 and the stop 88 are mounted on the top of a table 89 of the tube expanding means, the stop 88 being fixed to the plate and the plate 87 being longitudinally reciprocal over the plate, for reasons to be described hereinafter.

The stop 88 has holes 90 therethrough aligned with the holes 86 in plate 87 and adapted to receive rods 91 carried above the table 89 for longitudinal reciprocation with respect thereto. For this purpose, the ends of the rods furthest from the beam may be connected to a head 91a connected by a rod 91b to a prime mover (not shown), and the head and rods may be guidably supported for reciprocation by means of guide rods 91c extending along opposite sides of the table 89. The holes 86 and 90, as well as the rods 91, correspond in number and are axially aligned with the tubes 36. These holes are counterbored at 92 on their ends facing the tubes 36, so that the ends of the tubes move into abutment with the reduced portions of the openings 90. With the ends of the tubes so located, the rods 91 are advanced, from left to right, as shown in FIGS. 18 and 20, so as to extend through the tubes and out their opposite ends.

With the rods 91 inserted through the tubes, expander parts in the form of bullets 93 are secured to their free ends so that, upon retraction of the rods to the position illustrated in FIG. 20, such bullets will be drawn through the tubes 36 to expand same tightly against the hubs of the plate fins surrounding them. As the bullets are so drawn through the tubes, the partially formed tube module is prevented from buckling by means of the previously described flanges 56 of the guideway which extend over portions of the upper edges of the plate fins.

As shown in FIG. 19, the plate 87 is spaced to the right of the stop 88 a distance corresponding to the unfinned lengths of the ends of the tubes 36 engaged against the stop. Thus, when the tube ends are engaged against the stop, the corresponding end of the stack of plate fins about the tubes will be engaged against the plate 87. As illustrated diagrammatically in FIGS. 8 and 9, this plate is connected to a fluid actuator 94 at each side of the tube expanding means 61. This actuator, which includes the usual cylinder having a rod extending therefrom and connected to a side of the plate 87, provides a yieldable force normally urging the plate 87 to its position spaced to the right of the stop 88, as shown in FIGS. 18 and 19. However, as the bullets 93 are drawn through the tubes, the expansion of the tubes may cause them to shorten from end to end, which, in turn, requires that the left-hand end of the stack move toward the left-hand ends of the tubes.

The first head 62 is clamped about the opposite ends of the tubes during substantially all of the expanding operation. Obviously this clamp must be released as the bullets 93 are drawn through the portion of the tubes surrounded by the head 62. However, when the bullets have been drawn this far, the head 62 is again clamped about the ends of the tubes. Thus, this yieldable plate 87 resists this leftward movement of the end of the stack with sufficient force to maintain the desired spacing between the plate fins, as established by their hubs. Upon completion of the drawing process, the left-hand side of this plate 87 will have moved into engagement with the right-hand side of the stop 88.

At this time, the head 62 is moved back toward the right, as shown in FIGS. 18 to 20, to draw the left-hand end of the now formed tube module 34 back onto the beam. As shown in FIG. 10, the beam may then be swung about its pivot a sufficient distance to bring the guideway thereon into alignment with a conveyor 95 extending in line with and above the tube expanding means 61. The

direction of movement of the head 62 may then be reversed again so as to move the end of the tube module adjacent the tube expanding means onto the conveyer 95 a sufficient distance to permit the frictional engagement between the conveyer and module to pull the module along with the conveyer. This, of course, requires that the head 62 be released from clamping position about the trailing end of the tube module. Then, upon swinging of the beam downwardly to its horizontal position, it is again ready to receive another assembly of tubes.

After this further assembly of tubes has been drawn onto the horizontal beam, and then supported thereon in the manner previously described, the desired length of plate fins will have been stacked upon the vertical beam. At this time, the beams may be shifted in the manner previously described so as to permit the new tubes to be surrounded with plate fins and the tubes having plate fins disposed thereabout to be expanded into tight engagement therewith.

Obviously, the tube module 34 shown in FIG. 11 is for illustrative purposes only. Thus, although in this particular module the tubes 36 are arranged "in line"—i.e., in planes perpendicular to one another—such tubes may be instead arranged in staggered relationship. In either case, a tube module of the type contemplated by this invention ordinarily includes four or more tubes which are spaced apart in side-by-side relation and which have a plurality of plate fins common to them in one, three, or more rows, rather than in the two rows indicated. Also, of course, there may be more or less than the six tubes to a row. Still further, and as previously mentioned, the plate fins may or may not have hubs, in which latter case they may be spaced from one another by means of interruptions, such as louvres, in the area of the fins about the holes.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

We claim:

1. In a method of manufacturing plate fin tube modules, the steps of supporting an assembly of tubes in spaced apart, side-by-side relation and with one end thereof above the other, feeding plate fins over the upper ends of the assembled tubes, and causing vibration between the tubes and fins thereon to cause the plate fins to move downwardly along the tubes, solely in response to gravity and such vibration, toward the other ends thereof so as to form a stack of said fins of a desired length.

2. A method of the character defined in claim 1, the further step of controlling the advance of the fins by opposing their movement along the tubes at a substantially greater rate than they are fed to the tubes.

3. A method of the character defined in claim 1, the further step of freely dropping the plate fins onto the upper ends of the assembled tubes to feed them thereover.

4. A method of the character defined in claim 1, wherein the plate fins have openings through hubs which face toward the direction of movement of the fins relative to the tubes as said hubs are fed over the ends of the tubes.

5. A method of the character defined in claim 3, the further step of separating the plate fins into at least two stacks as they are fed over the ends of the supported tubes.

6. A method of the character defined in claim 1, wherein the feeding of said plate fins over the ends of the tubes is continued until the stack extends over substantially the entire length of the tubes.

7. In a method of manufacturing plate fin tube modules, the steps of supporting an assembly of tubes in spaced apart, side-by-side relation with one end thereof above the other, dropping plate fins freely over the upper ends of the assembled tubes, and controlling the downward movement of the fins along the tubes to prevent them from moving toward the other ends of the tubes at a substantially greater rate than they are fed onto the upper ends of the tubes.

8. A method of the character defined in claim 7, the further step of causing vibration between the tubes and fins thereon to assist the plate fins moving downwardly along the tubes toward the other ends thereof so as to form a stack of said fins of a desired length.

9. A method of the character defined in claim 7, wherein the plate fins have openings through hubs which face toward the direction of movement of the fins relative to the tubes as said hubs are fed over the ends of the tubes.

10. In a method of manufacturing plate fin tube modules, the steps of assembling tubes in spaced apart, side-by-side relation, moving the tube assembly longitudinally onto and supporting it from a generally horizontal beam, swinging the beam into an inclined position to dispose one end of the tube assembly above the other, feeding plate fins over the upper ends of the assembled tubes, vibrating the tubes to assist movement of the plate fins downwardly therealong toward the lower end of the assembly so as to form a stack of said fins of desired length, and then swinging the beam back to a generally horizontal position.

11. In a method of manufacturing plate fin tube modules, the steps of supporting an assembly of spaced-apart, side-by-side tubes longitudinally on a generally horizontal beam, swinging the beam into an inclined position to dispose one end of the tube assembly above the other, feeding plate fins over the upper ends of the assembled tubes, vibrating the tubes to assist movement of the plate fins downwardly therealong toward the lower end of the assembly so as to form a stack of said fins of desired length, swinging the beam back to a generally horizontal position, inserting rods through the tubes while said tube assembly is supported on the generally horizontal beam, and then drawing parts on the rods through said tubes to expand them against the plate fins.

12. In a method of manufacturing plate fin tube modules, wherein there is provided a beam having a head movable longitudinally therealong, said head having holes therethrough to receive an assembly of spaced apart, side-by-side tubes and means for releasably clamping the head about the tubes, the steps of locating the head toward one end of the beam, moving the tubes at one end of the assembly through the holes in the head, clamping the head about the tubes and moving the head toward the other end of the beam to draw the opposite end of the assembly onto the beam, releasing the head from about the tubes at the one end of the assembly, feeding plate fins onto the tubes at said one end of the assembly to cause them to move therealong into engagement with said head, and gradually moving the head along the tubes toward the one end of the beam at approximately the rate of feed of the plate fins until a stack of said fins of desired length is formed.

13. In a method of the character defined in claim 12, the further steps of drawing the tube assembly onto the beam while the beam is disposed in a generally horizontal position, and raising the beam to an inclined position prior to feeding the plate fins onto the tubes at said one end of the tube assembly, so that the head supports the stack as it moves downwardly along the tubes.

14. In a method of manufacturing plate fin tube modules, wherein there is provided a beam having a first head movable longitudinally therealong and a second head

movable between a position spaced from the beam and a position on the beam near one end of the beam, said first head having holes therethrough to receive an assembly of spaced apart, side-by-side tubes and means for releasably clamping the head about the tubes, and said second head having guide parts thereon for closely fitting the ends of said tubes, the steps of locating the second head in its position spaced from the beam and the first head toward the one end of the beam, moving the tubes at one end of the assembly through the holes in the first head, clamping the first head about the tubes and moving the first head toward the other end of the beam to draw the opposite end of the assembly onto the beam, moving the second head to its position on the beam, and moving said first head while clamped to the tubes along the beam back toward said one end thereof to force the tubes at the opposite end of the assembly into close fitting relation with respect to the guide parts of said second head.

15. In a method of the character defined in claim 14, the further steps of releasing the first head from about the tubes at the one end of the assembly, feeding plate fins onto the tubes at said one end of the assembly to cause them to move therealong into engagement with said head, and gradually moving the first head along the beam toward the one end thereof at approximately the rate of feed of the plate fins until a stack of said fins of desired length is formed.

16. In a method of the character defined in claim 15, the further steps of clamping the first head about the tubes and moving the first head back toward the other end of the beam and into engagement with a stop to dispose the tubes at said one end of the assembly in position to receive the ends of longitudinally reciprocable rods, inserting the rods entirely through the tubes and securing expander parts to the ends of the rods, and pulling said rods through the tubes to expand the tubes against the plate fins.

17. In a method of the character defined in claim 16, the further step of exerting a yieldable force against the end of the stack adjacent said one end of the assembly as the rods are pulled through the tubes.

18. Apparatus for use in manufacturing plate fin tube modules, comprising a beam, means at one end of the beam for swinging it between generally horizontal and inclined positions, means on the beam to support tubes in spaced apart, side-by-side relation, a platform near the upper end of the beam in its inclined position, means on the platform for feeding plate fins to the upper ends of the tubes supported on the inclined beam so as to form a stack of said fins of a desired length, and means at the other end of the beam in its generally horizontal position for inserting rods through the tubes supported thereon and drawing parts on the rods back through the tubes to expand said tubes against the plate fins.

19. Apparatus of the character defined in claim 18, wherein the plate fin feeding means comprises means for shearing fins from a strip of fin material in a position to fall freely over the upper ends of the tubes.

20. Apparatus of the character defined in claim 19, including pins removably insertable into the upper ends of the tubes for guiding the fins as they are fed onto the tubes.

21. Apparatus for use in manufacturing plate fin tube modules, comprising a beam, a first head for holding one end of an assembly of tubes in spaced apart, side-by-side relation, a second head for surrounding the tubes and movable longitudinally along the beam between positions near the one end and the opposite end of the assembly, means for swinging the beam between a generally horizontal position and an inclined position in which the opposite end of the assembly is above the one end thereof to receive plate fins fed onto the tubes at said one end, means for vibrating the assembled tubes to cause the fins to move downwardly therealong, and means for moving the first head longitudinally of the beam so as to support the fins as they stack on the tubes

and prevent them from moving downwardly therealong at substantially a greater rate than they are fed onto the tubes.

22. Apparatus of the character defined in claim 21, including means for feeding the plate fins over the upper ends of the tubes.

23. Apparatus of the character defined in claim 21, wherein said vibrating means is attached to the first head.

24. Apparatus for use in manufacturing plate fin tube modules, comprising a beam, a first head on the beam having holes therethrough to receive one end of an assembly of spaced apart, side-by-side tubes as the assembly is moved longitudinally onto one end of the beam, a second head having guide parts extending therefrom, means for moving the second head between a first position spaced from the beam to permit the one end of the assembly to be moved onto the beam and through the holes in said first head and a second position in which its guide parts are disposed adjacent the one end of the beam and extend toward the other end thereof, means on the first head for releasably clamping about the tubes received through the holes therein, and means for moving the first head longitudinally along the beam so that, when clamped about the one end of the assembly, it may draw the assembly toward the other end of the beam to dispose the other end of the assembly beyond the second position of the guide parts on the second head, said guide parts being axially aligned with said tubes in said second position thereof, whereby the first head may be moved back toward the one end of the beam to force the tube ends into a close fit with said guide parts.

25. Apparatus of the character defined in claim 24, including means for swinging the beam between a generally horizontal position and an inclined position in which the other end of the assembly is above the one end thereof in position to receive plate fins thereover, and the first head may be moved downwardly along the inclined beam at such a rate as to support the fins as they are stacked thereon and prevent their downward movement at a rate substantially greater than they are fed.

26. Apparatus of the character defined in claim 24, including additional heads movable longitudinally along the beam intermediate the first head and the one end of the beam and having holes therethrough to receive portions of the tubes intermediate the first and second heads.

27. Apparatus for use in manufacturing plate fin tube modules, comprising a beam for supporting an assembly of longitudinally extending tubes having a stack of plate fins about an intermediate portion thereof, a head mounted on the beam and having holes therethrough to receive the ends of tubes on one end of the stack, means including a plurality of rods mounted at one end of the beam for movement longitudinally with respect to the beam, a stop having holes therein through which the rods may be advanced upon movement in one direction, means on the head for releasably clamping about the tube ends received therethrough, means for moving the head along the beam so as to move the opposite ends of the tubes against the stop and into position to permit the rods to be inserted through said tubes, means on the ends of the rods to receive parts which may be pulled through the tubes to expand the tubes tightly against the plate fins, a plate having holes therethrough to receive the opposite ends of the tubes intermediate the stop and the end of the stack opposite the end of the stack engaged by the head, and fluid pressure means urging the plate against said end of the stack as said expander parts are drawn through the tubes.

28. Apparatus of the character defined in claim 27, wherein there are flanges extending longitudinally along opposite sides of the beam above the stack to prevent excessive bending of the stack during expansion of the tubes,

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29. Apparatus for use in manufacturing plate fin tube modules, comprises a platform, a pair of beams each for supporting an assembly of tubes and movable between a generally horizontal position to receive the tubes and an inclined position to dispose the upper ends of the tubes near the platform, means for forming tube receiving openings in a strip of metal and continuously feeding the strip to the platform, means on the platform for receiving the strip of metal and shearing plate fins therefrom, means for disposing each beam to its inclined position while the other beam is in its generally horizontal position, and means for shifting the shearing means between positions on the platform for delivering the fins to the upper ends of the tubes on the inclined beam.

30. Apparatus of the character defined in claim 29, including means for shifting each beam, when in its generally horizontal position, laterally between a common central position and a position to one side of the central position in which it may move to and from its inclined position, means aligned with one end of each beam when in the central position for moving an assembly of tubes onto it, and means aligned with the other end of each beam when in the central position for expanding tubes assembled thereon against the fins received about such tubes.

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U.S. Cl. X.R.

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