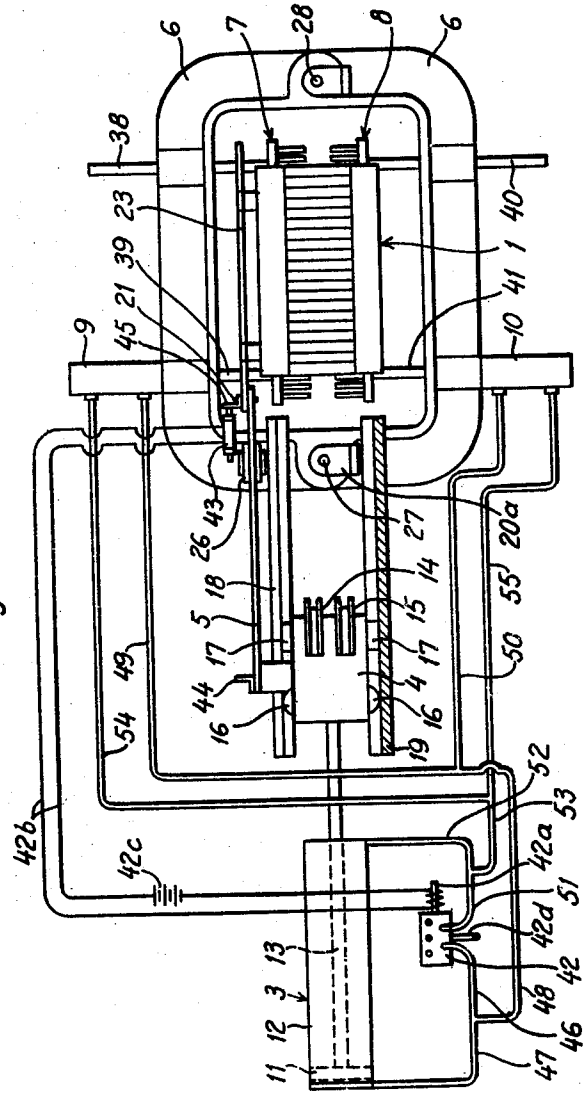
July 14, 1964 A. I. RÖNBECK 3,140,533

APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

Filed March 2, 1961 8 Sheets-Sheet 1

Fig. 1



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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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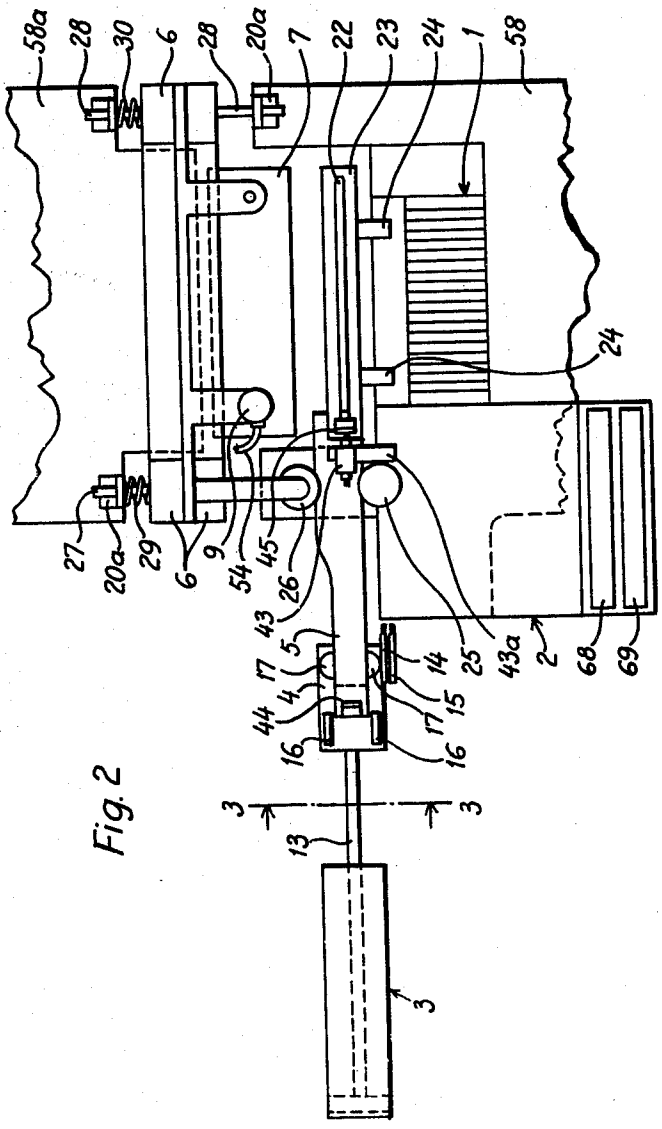

Fig. 2

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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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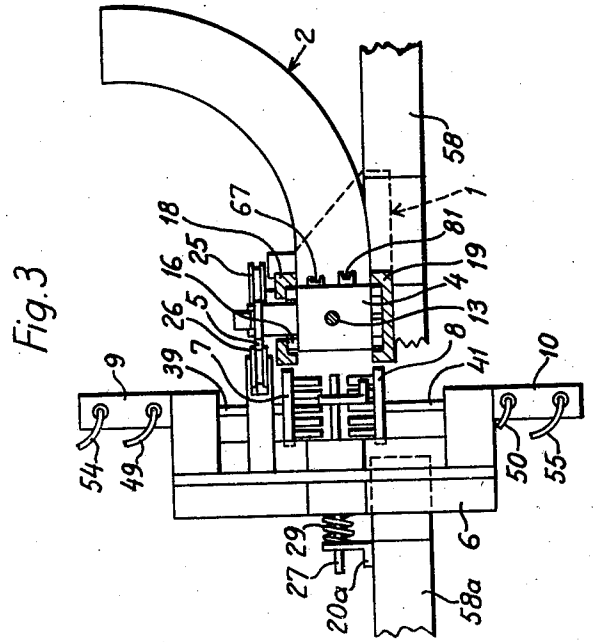
Fig. 3



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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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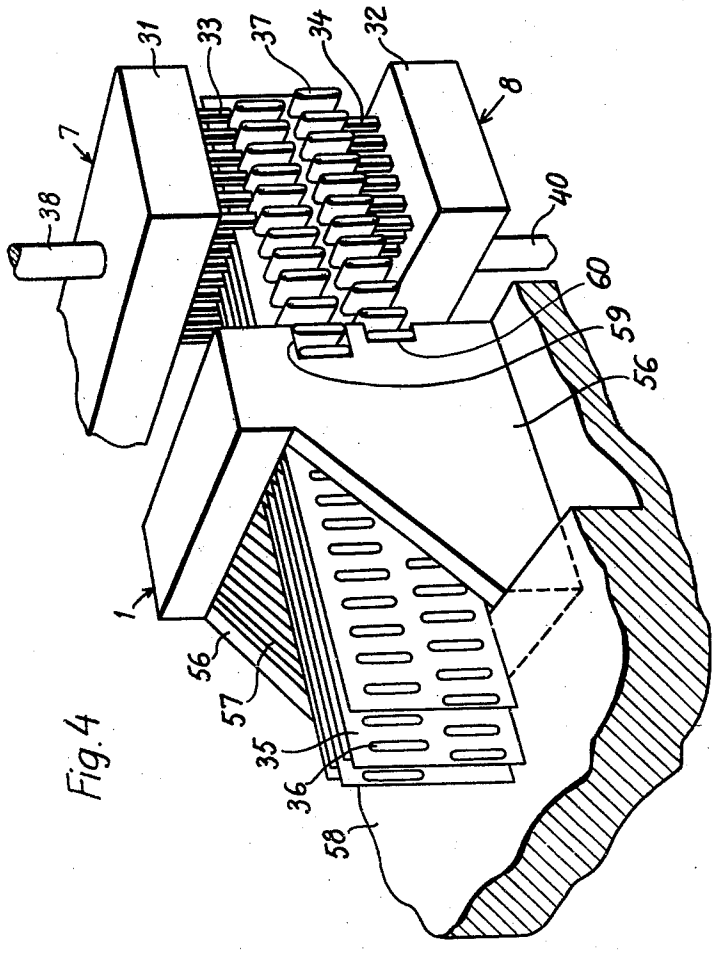

Fig. 4

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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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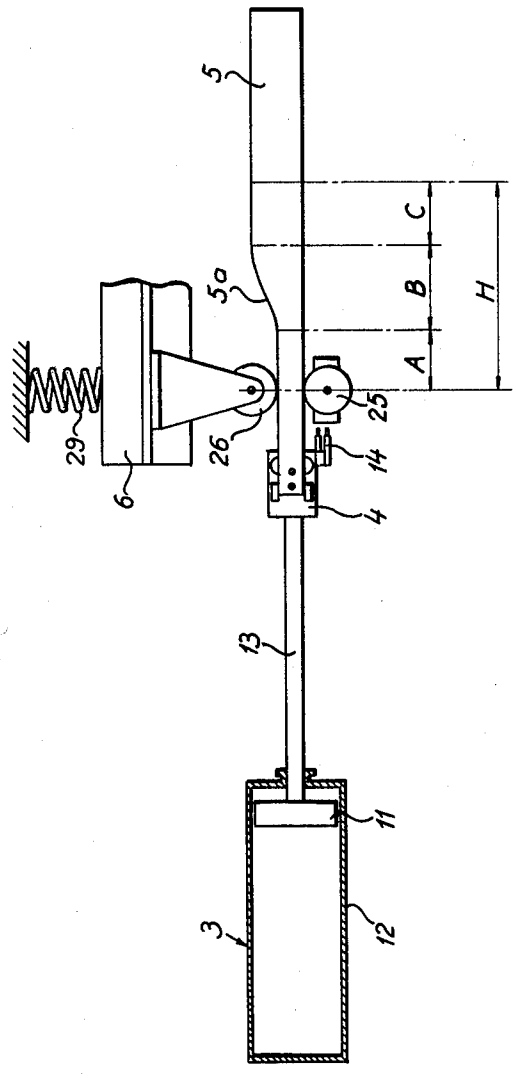

Fig. 5

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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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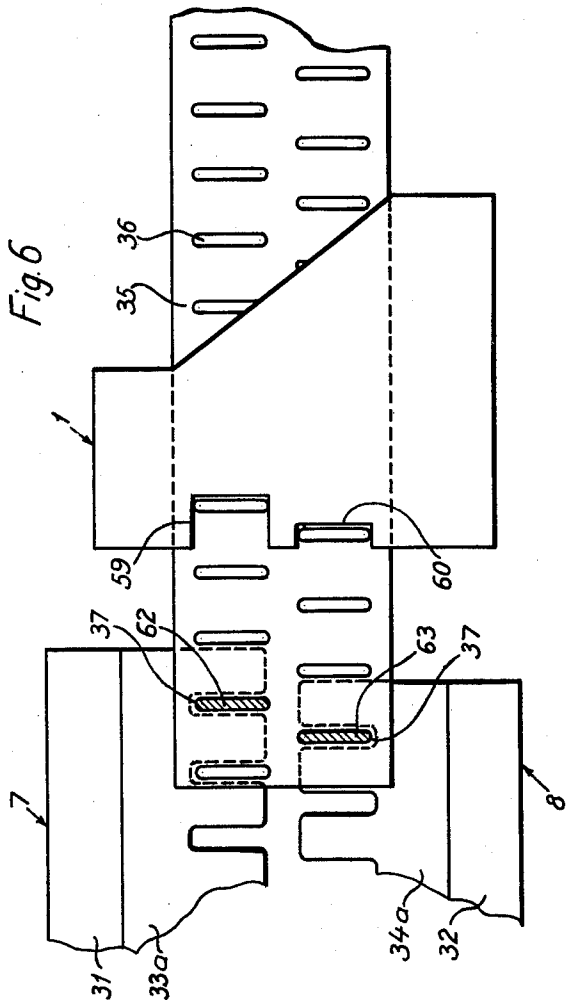
Fig. 6



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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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Fig. 8

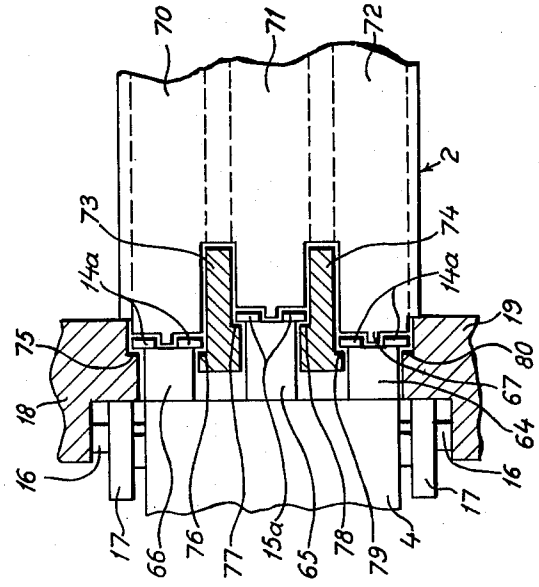
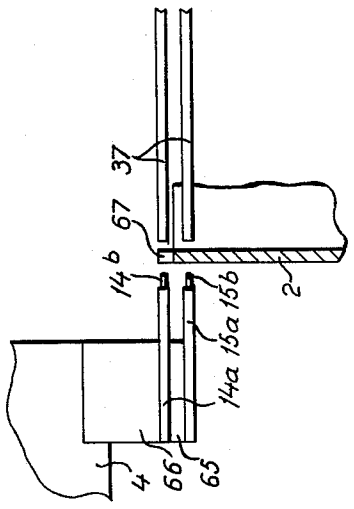


Fig. 7



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APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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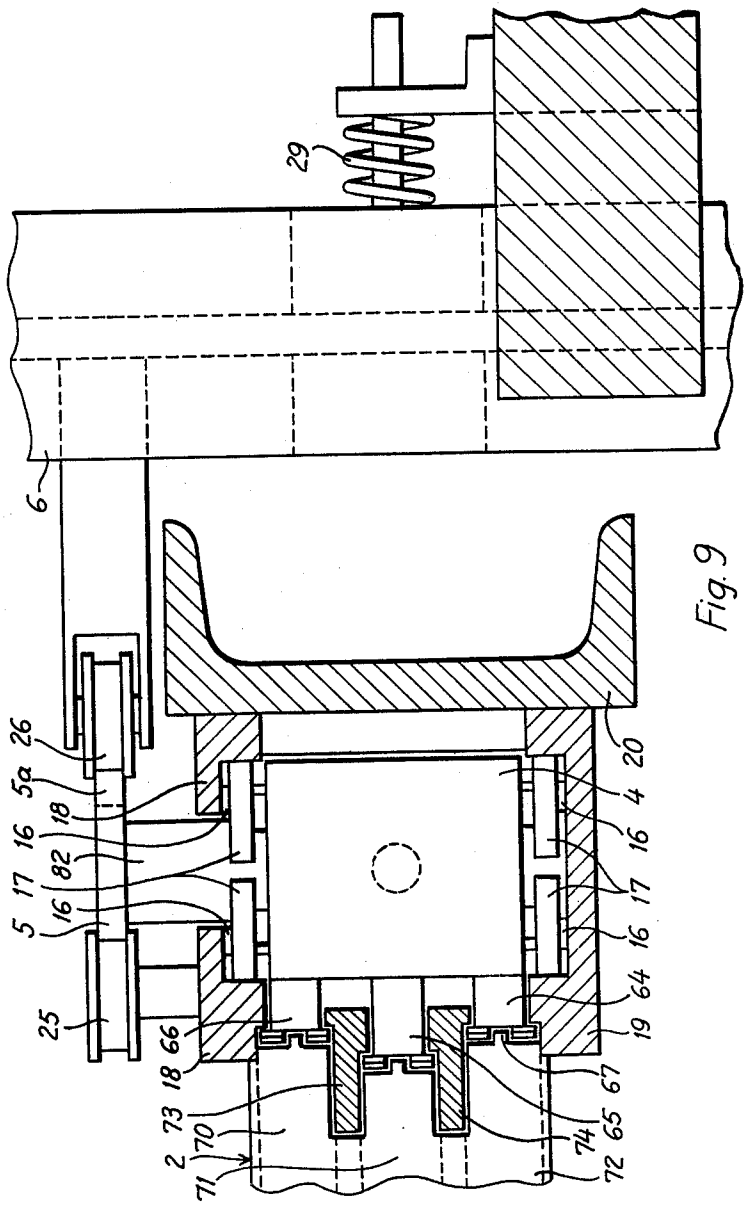

Fig. 9

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United States Patent Office 3,140,533 Patented July 14, 1964

3,140,533

APPARATUS FOR WEAVING FIN AND TUBE RADIATORS

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Filed Mar. 2, 1961, Ser. No. 92,962
Claims priority, application Sweden July 22, 1960
13 Claims. (Cl. 29—202)

This invention relates to the production of radiators, and the like, of the type having tubes extending through holes in a set of spaced fins. More particularly, the invention relates to a novel apparatus for assembling such radiators and similar units by what may be referred to as a weaving operation.

A fin-and-tube radiator comprises a pack of fins of thin metal which are parallel to but spaced from each other and provided with one or more rows of holes arranged in the longitudinal direction of the fins, these holes being located opposite each other and at equal distances from each other within the row, and tubes extending through the holes at right angles to the fins. A fin-and-tube radiator of this nature is the most essential part of an automobile radiator, for example, though a complete automobile radiator includes other complementary parts. The latter, however, do not pertain to the present invention and are therefore entirely omitted herein.

Fin-and-tube radiators are used principally as cooling units for the cooling water in cars. The water passes through the tubes while the fins serve as cooling fins by the passage along the fins of atmospheric air which takes heat from them.

Fin-and-tube radiators of this type have heretofore been manufactured more or less by hand. No really continuous manufacture of them is known. Their manufacture previously has been effected by using a fixture as a guiding and supporting device for a pack of fins arranged edgewise in parallel spaced relation to each other, the fins being of a length corresponding to the length of the fins in the intended fin-and-tube radiator. The fins are provided with one or more rows of holes with uniform spacing between the holes within each row. Fins of this design were inserted by hand into the fixture, one by one or many at a time, to align the holes of the fins opposite each other groupwise. Tubes were then introduced into these holes, likewise by hand, so that each tube extended through all the fins in the fixture. The tubes were in this case introduced one by one or a few at a time. All this work required much time, was costly, and was often complicated by the tubes being introduced obliquely so that the fins were damaged by bending or the edges of the holes were knocked out of shape, with the result that the whole pack of fins was discarded.

A certain automation in the introduction of the tubes is known. Machines have been provided which from a certain point push out one or more tubes at a time and insert them into the holes in the fins when the latter are arranged in a fixture in the manner indicated. In that case, the entire fixture with the fins has been displaced manually stepwise and crosswise in front of that point where the tubes were fed out, in order to permit the mechanical introduction of the tubes.

Both the methods described above have the drawback that after all the tubes had been inserted through the holes in the fins, which are located in the fixture, it was necessary to disassemble the fixture to make it possible to remove the assembled fin-and-tube radiator from the fixture. Thereafter, it has necessary to assemble the fixture again and charge it with new fins before new tubes could be introduced. This also required much time and work and was costly.

The present invention has for its principal object to overcome the above-mentioned inconveniences in the manufacture of fin-and-tube radiators and to produce an apparatus by means of which it is possible automatically and continuously to introduce the tubes into bands of fins of any desired length which are fed step-by-step in the assembling operation, and to cut the fins with the introduced tubes to suitable lengths. This operation may be best characterized as a weaving of the fin-and-tube radiators in infinite lengths. In order to avoid the operations incident to restarting the weaving after a supply of fins has been used up, new bands of fins may be attached to the trailing ends of preceding fins during the weaving. In so doing, however, care should be taken that the joints formed by the attachment operation do not lie exactly opposite each other within a pack of fins but are displaced in relation to each other in the longitudinal direction of the fins. The weaving can thus be continued for an unlimited time, the result being a simple, cheap, rapid and expedient method of manufacturing fin-and-tube radiators.

In the manufacture of radiators with the new apparatus, a group of fins is advanced step-by-step in unison lengthwise through a guiding zone while supporting the fins in parallel spaced relation in the zone with the holes of the different fins forming sets each composed of holes aligned with each other transversely of the fins, this guiding zone having an inlet end for receiving the fins and an outlet end through which the fins are moved by the advancing steps. Each advancing step moves the fins lengthwise through a distance equal to the spacing of adjacent holes in a row of holes in a fin, and each advancing step is followed by a dwell period of the fins. The tubes are fed in succession to a positioning zone where each tube is held at one side of the group of fins while aligning this tube with a set of fin holes located at the outlet end of the guiding zone. The tube-feeding steps are effected in timed relation to the fin-advancing steps, and during each dwell period of the fins a tube is pushed endwise from the positioning zone into the set of aligned fin holes at the outlet end of the guiding zone. In this way, the operation may be carried out continuously so that an assembled radiator of infinite length is discharged from the outlet end of the fixture. Preferably, each step of advancing the fins in unison through the guiding zone is effected by simultaneously pressing, in the advancing direction, a plurality of tubes which have been pushed into corresponding hole sets of the fins at the outlet end of the guiding zone, thereby drawing the fins along this zone. Also, each tube-feeding step is preferably effected upon completion of a step of advancing the fins and is followed promptly by the corresponding tube-pushing step.

An apparatus made according to the invention comprises a fixture having an inlet end for receiving a group of fins and an outlet end, the fixture including means for guiding and supporting the fins in parallel spaced relation to each other during lengthwise movement of the fins through the fixture. The apparatus also includes mechanism for advancing the group of fins step-by-step lengthwise through the fixture from its inlet end to its outlet end, this mechanism being operable in each advancing step to advance the fins a distance equal to the spacing of adjacent holes in a row and with the holes of the different fins forming sets each composed of holes aligned with each other transversely of the fins. A holder is provided for positioning a tube at one side of the group of fins and in alignment with a set of aligned fin holes at the outlet end of the fixture, the holder including means for guiding such tube endwise toward the aligned set of fin holes.

A tube-pushing member is reciprocal transversely of the group of fins and is operable in a forward stroke to engage a tube in the holder and push the tube endwise along the holder into the aligned fin holes at the outlet end of the fixture. Means are provided for interconnecting the fin-advancing mechanism and the reciprocable tube-pushing member to move the latter member through its forward stroke during each dwell period in the step-by-step advance of the fins. To further automate the apparatus, it may also include a magazine adapted to hold a supply of tubes and operatively connected to the holder for delivering tubes thereto in succession.

The fixture means preferably include a plurality of separator plates interconnected in parallel spaced relation to form interspaces for passage of the respective fins, these plates having free edges located at the outlet end of the fixture and provided with aligned recesses with which a set of fin holes at the outlet end of the fixture is adapted to be aligned. These recesses are dimensioned to receive one of the tubes with a fairly close fit, whereby the edges of the recesses serve to guide the tube as it is pushed through the aligned fin holes from the tube holder.

In the preferred form of the new apparatus, the fin-advancing mechanism includes a first reciprocable element mounted for reciprocating movements in the direction of advance of the fins and in the reverse direction, means including a reciprocating driving member for reciprocating this first element, a second reciprocable element carried by the first element and having a part movable into and out of engagement with a tube extending transversely through fin portions which project from the outlet end of the fixture, and means under control of the reciprocating means for operating the second element to disengage its part from a tube upon completion of the movement of the first element in the advance direction and to engage this part with a next tube upon completion of the movement of the first element in the reverse direction. Thus, each movement of the first reciprocable element in the direction opposite to the advancing direction of the fins positions the second reciprocable element so that subsequent movement thereof engages this part with another tube which has been inserted through the fins at the outlet end of the fixture, whereby the next advance stroke of the first reciprocable element advances the fins through the fixture. The second reciprocable element may be a piston mounted in a cylinder on the first reciprocable element and carrying tube-engaging parts in the form of fingers adapted to engage a plurality of tubes simultaneously, and this cylinder may be operated by pressure fluid from a control valve which also controls the reciprocation of the driving member for the first reciprocable element. Preferably, the latter driving member is also a piston mounted in a separate cylinder in which it is reciprocated under control of the aforementioned valve which, in turn, is actuated by this piston at the end of each stroke thereof so as to reverse the direction of movement of the piston. The tube-pushing member may be operatively connected to the latter piston or reciprocating driving member so that the tube-pushing member is moved through its forward or working stroke each time the fin-advancing mechanism is retracted preparatory to the next advancing step.

For a better understanding of the invention, reference may be had to the accompanying drawings in which

FIG. 1 is a side elevational view, partly schematic, of a preferred form of the new apparatus, with the tube magazine, tube holder and parts of the frame removed;

FIG. 2 is a plan view of the apparatus illustrated in FIG. 1, showing the tube magazine but omitting the pressure fluid lines, control valve and guideways for the end piece of the main piston rod;

FIG. 3 is an end view of the apparatus, including the tube magazine and the guideways for the end piece, as seen from the left on line 3—3 in FIG. 2;

FIG. 4 is a perspective view of the fin-guiding fixture,

showing a group of fins therein and also showing parts of the fin-advancing mechanism engageable with tubes inserted through the fins at the outlet end of the fixture;

FIG. 5 is a schematic plan view of the reciprocating driving member for operating the fin-advancing mechanism and actuating the tube-pushing member;

FIG. 6 is a detail view in elevation showing a modified form of the tube-engaging means of the fin-advancing mechanism in position for the next step of advancing the fins through the fixture, which is also shown;

FIG. 7 is a schematic plan view showing tube-pushing members connected to the reciprocating driving member and positioned for pushing corresponding tubes endwise from the tube magazine;

FIG. 8 is an elevational view, partly in section, as seen from the left in FIG. 2, showing part of the magazine for the tubes and adjacent parts of the tube holders and the end piece of the piston rod or reciprocating drive member, the arrangement here shown being adapted for simultaneous insertion of three tubes into the pack of fins, and

FIG. 9 is a vertical sectional view of the arrangement illustrated in FIG. 8 but on a reduced scale and as seen in the opposite direction, showing also how the end piece is connected to the cam rail which acts on rollers for displacement of a reciprocable element of the fin-advancing mechanism.

In FIGS. 1, 2 and 3, reference numeral **1** designates the fixture for the fins, **2** the magazine for the tubes, and **3** the reciprocating driving means for an end piece **4** and a cam rail **5**. A reciprocable element of the fin-advancing mechanism is shown at **6**, which carries upper and lower gripping means **7** and **8** whose motion up and down is effected by actuators in the form of cylinders **9** and **10**.

The driving means **3** comprise a compressed-air operated piston **11** slidable in a cylinder **12** and having a piston rod **13**. The end piece **4** is secured to the piston rod and has fixed thereto two tube-pushing members **14** and **15** as well as the cam rail **5**. The end piece **4** is provided with a number of rollers **16**, **16** and **17**, **17** arranged in pairs in the end piece so as to guide it on all sides when it is driven forward and backward by the piston **11**, these rollers bearing against stationary guideways **18** and **19** which are secured to the machine frame **20** (FIG. 9). One end of the cam rail **5** is secured to the end piece **4**, and the other end of this rail carries a pin **21** located in and guided by a groove **22** in a guide rail **23** which is secured by arms **24** to the fixture **1** and thus to the frame.

The cam rail **5** cooperates with two rollers **25** and **26**. Roller **25** is rotatable about a stationary pivot secured to the frame through guideway **18** (FIGS. 3 and 9). Roller **26** is rotatable about a pivot secured to reciprocable element **6** of the fin-advancing mechanism. When the cam rail **5** moves forward and backward between the rollers **25** and **26**, it will reciprocate the element **6** on rods **27** and **28** in coaction with springs **29** and **30**. The rods **27** and **28** are fixed to frame brackets **20***a* and extend parallel to the direction of travel of the fins through fixture **1**.

The gripping means **7** and **8** are alike and comprise plates **31** and **32**, respectively (FIG. 4), of which the former has downwardly directed teeth **33** and the latter upwardly directed teeth **34**. These teeth mesh between the fins **35** and between tubes **37** inserted in the holes **36** in the fins at the outlet end of the fiixture **1**. The plates **31** and **32** are secured to and guided vertically by vertical rods **38**, **39** and **40**, **41**, respectively, which are slidable up and down in corresponding guide holes in the reciprocable element **6**. The rods **39** and **41** form piston rods for pistons in the cylinders **9** and **10**, respectively, which are air-operated and at fixed intervals of time carry the tube-engaging or gripping means **7** and **8** toward and away from each other.

The pistons in cylinders **9**, **10** and **12** are driven by compressed air from a control valve **42** of the well known

type having a slide valve movable between two positions, this valve being biased toward one position in any suitable manner and movable to the other position by a solenoid 42*a*. The latter is operatively connected through wiring 42*b* and current source 42*c* to a limit switch 43 functioning as a toggle switch. This switch is secured to a stationary bracket 43*a* (FIG. 2) and is actuated alternately by detents 44 and 45 on cam rail 5. As shown in FIGS. 1 and 2, the detent 45 has just snapped switch 43 to its closed position to energize solenoid 42*a* and thereby actuate valve 42 to one of its positions in which compressed air from supply line 42*d* is led into the pipes 46, 47, 48, 49 and 50, while air is led off to the atmosphere from the pipes 51, 52, 53, 54 and 55. This causes piston 11 to move a stroke length to the right (FIG. 1) and the pistons in the cylinders 9 and 10 to move a stroke length upward and downward, respectively. When the cam rail 5, upon movement of the piston 11 to the right, reaches the position in which stop 44 actuates the limit switch 43 to open it, the resulting deenergizing of solenoid 42*a* causes the control valve 42 to return to its biased position in which compressed air enters the pipes 51–55 while the pipes 46–50 are emptied of air to the atmosphere, all the pistons thus reversing their directions of motion. This procedure is repeated until the air supply to the control valve 42 is shut off by means of a valve (not shown) in supply line 42*d*, whereupon the apparatus stops.

Details of the fixture 1 and the gripping means 7 and 8 are shown in FIG. 4. The fixture 1 consists of a frame 56 in which a series of vertical spacer plates 57 are secured for supporting and guiding the fins 35. When starting the operation, the fins rest edgeways on a table 58 of the frame and are inserted by hand into the adjacent inlet end of the fixture between its plates 57 until the leading edges of the fins project far enough from the outlet end of the fixture so that it is possible to insert some tubes 37 through corresponding sets of aligned holes 36 in the group of parallel spaced fins. The fixture frame 56 and the plates 57 have free edges at the outlet end of the fixture 1, and these free edges are formed with recesses 59 and 60 which are open toward the gripping means 7–8 and have the same height as the fin holes 36. The recesses 59 are deeper than recesses 60 because of the staggering of the holes in the two rows of holes 36 in the fins. The fins are adjusted so that the bottoms of the recesses or grooves 59 are aligned with a set of holes in the upper rows of holes 36 in the respective fins, whereby the bottoms of recesses or grooves 60 are in alignment with a set of holes in the lower rows of holes in the respective fins. Thus, when inserting tubes 37 endwise into the respective two sets of aligned fin holes 36, the tubes are guided by the edges of the recesses 59–60 and these edges also serve to support the edges of the fin holes. After two tubes 57 have been inserted into the group of fins transversely thereof as described, the fins are advanced lengthwise in the fixture 1 to bring the next two sets of aligned fin holes 36 into alignment with the respective recesses 59 and 60, whereby two more tubes 37 can be inserted similarly in the latter hole sets. Enough tubes are thus inserted into the pack of fins so that the gripping means 7–8 when moved toward each other can mesh with their teeth between the fins and between a series of tubes, whereupon the apparatus is ready for continuous operation. As the fins (which may be about 15 meters long) are consumed during their stepwise advance through the fixture, they may be elongated by being connected at their trailing ends to new fins in any suitable manner. However, the joints between the fins should be staggered within the pack of fins so that they will not be aligned with each other transversely of the pack, which would weaken the pack.

The fixture 1 is disclosed in further detail in my U.S. application Serial No. 837,612, filed September 2, 1959, now Patent No. 3,067,994, granted December 11, 1962, of which this application is a continuation-in-part.

I have shown schematically in FIG. 5 how the cam rail 5 is driven forward and backward by the driving means 3 and thus, in coaction with the spring 29, reciprocates the fin-advancing element 6 which supports the tube-gripping means 7–8. In the position shown, the piston 11 has just completed a stroke of operation to the right and the feeding or advancing element 6 is at this moment in its most retracted position nearest the fixture. The tube-pushing members 14 and 15 have just completed the insertion of two tubes 37 into corresponding sets of aligned fin holes 36 at the open grooves 59–60 in the outlet end of fixture 1. The piston 11 is thus ready for its return movement under control of the limit switch 43. The stroke length of the return movement is designated by H. During the first part A of the return movement, the feed element 6 remains in its retracted position. During the second part B of the return movement, the cam 5*a* acts upon the roller 26 and displaces the feed element 6 against the action of the spring 29, that is in the advance direction away from fixture 1. During the last part C of the return movement, the feed element 6 remains in its advanced position where it is farthest from the fixture. At the end of this return movement of piston 11, the limit switch 43 is actuated by detent 45 to reverse the piston movement, whereupon nothing happens during the distance C of the piston advance but only during the distance B when spring 29 moves the feed element 6 back again to its retracted position nearest the fixture 1, where it remains while the piston moves through the distance A. The procedure is then repeated. For each complete forward and backward movement of the piston 11, a corresponding retraction and advance of the feed element 6 takes place, although the element 6 by the action of the cam rail 5 pauses for a while in its end positions before it changes direction of movement.

During reciprocation of the piston 11 by the air pressure under control of valve 42 and switch 43, the pistons in the cylinders 9 and 10 are also reciprocated by the same air pressure and raise and lower the tube-engaging parts 7 and 8 so that the latter, supported by the feeding element 6, move toward and then away from each other. The movements of these tube engaging parts or gripping means are thus coordinated with the movements of the piston 11 so that when the piston 11 in its return stroke moves the distance A to the left in FIG. 5, the pistons in the cylinders 9 and 10 move toward each other and carry the gripping means 7 and 8 toward each other. As a result, by the time the piston 11 has completed the distance A, the teeth 33–34 of the gripping means are fully meshed between the fins and tubes in the pack of fins projecting from the outlet end of the fixture 1. As the piston 11 is displaced the distance B to the left in FIG. 5, the feed element 6 is advanced from the fixture and advances the pack of fins a corresponding distance through the fixture, since the gripping means are now engaged with a series of tubes extending through the pack of fins transversely thereof. When the piston 11 moves the remaining distance C, the gripping means remain in this engaged position. The pack of fins has now been advanced through the fixture a distance corresponding to the spacing of adjacent holes in a row of holes 36 in the fins.

This return stroke of piston 11 is completed when detent 45 actuates limit switch 43 to shift valve 42 and thereby reverse the air line connections to cylinders 9, 10 and 12, whereupon piston 11 reverses its direction and moves through distance C (FIG. 5) in its advance stroke while the pistons in the cylinders 9 and 10 withdraw the gripping means 7–8 away from each other and out of engagement with the tubes in the pack of fins, this disengagement of the gripping means being completed when the piston 11 has traversed the distance C. As piston 11 then advances through distance B, the feed element 6 is retracted toward fixture 1 by pressure from spring 29,

with the gripping means 7–8 in their withdrawn positions where they remain while the piston 11 completes the last part of its advance movement through the distance A. Detent 44 then actuates limit switch 43 to reverse the piston movements, and the procedure is repeated.

In FIG. 6, the fixture 1 is shown with the fins 35 and the gripping means 7 and 8 engaged with tubes 37 in the pack of fins. The teeth 33*a* and 34*a* as there shown are of somewhat different design than in the other figures. As shown in FIG. 6, the tubes first inserted in the fins are provided with metal inserts 62 and 63. The purpose of these inserts is to reinforce the tubes at the start of a weaving operation so that they stand the pull from the gripping means 7–8 during the first steps of advancing the pack of fins through the fixture 1, that is, before it becomes possible to insert a sufficient number of tubes which the gripping means can embrace, at which time the inserts 62–63 are removed.

The apparatus shown in FIGS. 1–6 is adapted for insertion of two rows of tubes in the pack of fins. The number of tube rows may be one, two, three, or more. In FIGS. 8 and 9, I have shown an arrangement for insertion of three rows of tubes, but in other respects the construction is the same as previously described.

As appears from FIGS. 7 and 8, the tube pushing members 14*a*–15*a* are secured to projections 64, 65 and 66 extending from the end piece 4. Each tube-pushing member consists of two parallel rails or prongs (such as 14*a*—14*a*) spaced from each other and each of which terminates at its forward end in a point 14*b* which is received in the adjacent end of a corresponding tube 37 during the tube-pushing operation. The rails 14*a*–15*a* because of their length remain in front of the magazine outlet and prevent the tubes therein from falling forward into tube-pushing positions before the tube-pushing members have had time to effect their return movement in preparation for pushing the next tubes. A detent 67 projects from the wall of the magazine 2 into the groove between the rails of each pushing member 14*a*–15*a*. These detents 67 retain the lowermost tubes in the magazine so that they are not moved from the magazine by friction against the tube-pushing members during the return movements of the latter. There is only one such detent 67 in each groove, and it is located on the side of the magazine which faces the driving means 3.

The magazine as appears from FIG. 3, curves downward toward the path of end piece 4. When the apparatus is to insert two rows of tubes in the fins, as in FIGS. 1–6, the magazine 2 has two parallel channels 68–69 for the tubes, the upper or entrance ends of these channels being shown in FIG. 2. As shown in FIGS. 8 and 9, the magazine has three channels 70, 71 and 72. These channels open at their lower ends toward the stationary guideways 18–19 and toward parts 73 and 74 which are also stationary and secured to the frame in any suitable manner. The guideways 18 and 19 and the parts 73 and 74 form stops 75, 76, 77, 78, 79 and 80 against which the lowermost tubes in the channels 70, 71 and 72 lie in contact. The tubes are also guided laterally by these guideways and parts, which thus form tube holders for holding these lowermost tubes in alignment with respective sets of aligned fin holes and for guiding the tubes when pushed endwise into such holes. The channels of the magazines are filled by hand with tubes, and the tubes are fed by gravity down to the bottoms of the channels. In FIG. 3 is shown the hole 81 (in the wall of the magazine) through which the end of the lowermost tube would appear if it were illustrated. Through hole 81 the corresponding tube-pushing member 15 passes so that its points 15*b* engage an aligned tube at opposite sides of the detent 67, thereby pushing the tube out of the magazine and directly into the aligned holes in the pack of fins which are situated at the outlet end of the fixture 1.

As shown in FIG. 9, the cam rail 5 through an arm 82 is secured to the end piece 4. The latter is guided at its top, bottom and sides by means of the guide rollers 16—16 and 17—17 which are arranged in pairs on the end piece and roll along the stationary guideways 18–19.

The apparatus is prepared for operation by filling the magazine 2 with tubes and manually inserting the first tubes 37 in the leading end portion of the pack of fins extending through fixture 1, as previously described, so that the gripping means 7–8 can engage these first tubes and feed the pack of fins stepwise out of the fixture. Compressed air is then supplied through pipe 42*d* to the control valve 42, which starts the apparatus in operation. Assuming that its starts from the position in FIGS. 1–3, the piston 11 is advanced (displaced to the right). Each tube pusher 14–15 thus engages the adjacent end of an aligned tube in the tube holder 18, 19, 73, 74 at the outlet end of the magazine and pushes the tube endwise into the aligned holes in the fins, which holes at this moment are situated in alignment with the open grooves 59 or 60 in the fixture. The feeding element 6 at the start of this advance stroke of piston 11 is in its advanced position most remote from the fixture, with the gripping means in engagement with the pack of fins. During the first part C of the advance movement of the piston 11, the gripping means 7–8 are moved away from each other and out of engagement with the pack of fins. During the second part B of the advance movement of the piston 11, the feeding element 6 is retracted (with the disengaged gripping means 7–8) toward the fixture, and during the last part A of the advance movement of the piston 11 the feeding element 6 will remain in its retracted position with the gripping means disengaged. This advance stroke of piston 11 is terminated when detent 44 actuates the limit switch 43 and reverses the control valve 42 so that the compressed air drives the piston 11 back in its return direction.

During the return stroke of piston 11, the tube pushers 14–15 slide along the lowermost tubes in the channels of the magazine 2, and prevent the tubes from falling forward to their tube-pushing positions. They take the latter positions only after the tube-pushing members 14–15 have cleared the lower channel openings of the magazine for the tubes. At the same time as the piston 11 effects its return movement, the gripping means 7–8 and reciprocable element 6 are operated to advance the fins one step through fixture 1. That is, during the first part A of the return movement of piston 11, the pistons in the cylinders 9, 10 carry the gripping means 7–8 toward each other into engagement with the pack of fins while the feeding element 6 remains in its retracted position nearest the fixture. When the piston 11 effects its return movement B, the cam rail 5 advances the feeding element 6 (together with the gripping means engaging the pack of fins) from the fixture whereby the pack of fins is advanced through the fixture a distance corresponding to the spacing of adjacent holes in a row of fin holes. When the piston 11 effects the last part C of its return movement, the feeding element 6 remains in its advanced position most remote from the fixture and with the gripping means in engagement with the pack of fins. When the detent 45 now actuates the limit switch 43, the control valve 42 for the compressed air is reversed again and the procedure is repeated, thereby weaving infinite lengths of tube-and-fin radiators. These lengths may be cut to suitable pieces by means of a cutting roller (not shown) located in the path of advance of the fins from the gripping means, the cutter being fed transversely of the fins during a period when the pack of fins is in a position of repose.

As will be apparent from the foregoing, the apparatus has mechanism for advancing the fins step-by-step lengthwise through fixture 1, this mechanism as illustrated including tube-engaging parts 7–8, cylinder means 9–10 for moving these parts into and out of engagement with a tube extending through the fins, and means 3–6 for moving the parts 7–8 (while engaged with said tube) in the direc-

tion to advance the fins, the means 3–6 moving these parts in the opposite direction upon their disengagement from the tube. Also, the end piece 4 and projections 64–66 (FIG. 8) form means interconnecting the fin-advancing mechanism and each reciprocable tube-pushing member 14–15 to move the latter through its forward or working stroke during each dwell period in the step-by-step advance of the fins. The reciprocable tube-advancing element 6 is reciprocated by means 3, 29 and 42–55 including the reciprocating driving member 11, 4, 5; and the tube-engaging parts 7–8 form reciprocable elements operable by cylinder means 9–10 under control of the reciprocating means 3 and 42–55.

I claim:

1. Apparatus for weaving fin-and-tube radiators of the type having spaced parallel fins and also having tubes extending transversely of the fins through aligned holes therein, each fin having its holes spaced uniformly along a row extending lengthwise of the fin, the apparatus comprising a fixture having an inlet end for receiving a group of fins and an outlet end, the fixture including means for guiding and supporting the fins in parallel spaced relation to each other during lengthwise movement of the fins through the fixture, mechanism for advancing the group of fins step-by-step lengthwise through the fixture from said inlet end to said outlet end, said mechanism being operable in each advancing step to advance said group a distance equal to the spacing of adjacent holes in a row and with the holes of the different fins forming sets each composed of holes aligned with each other transversely of the fins, a holder for positioning a tube at one side of said group and with the tube in alignment with one of said hole sets at the outlet end of the fixture, the holder including means for guiding said tube endwise toward the aligned holes of said one set, a tube-pushing member reciprocable transversely of said group and operable in a forward stroke to engage a tube in the holder and push said tube endwise along said guiding means into the holes of said one set, and means interconnecting said advancing mechanism and the reciprocable tube-pushing member to move said member through its forward stroke during each dwell period in said step-by-step advance of the fins.

2. Apparatus according to claim 1, comprising also a magazine adapted to hold a supply of tubes and operatively connected to said holder for delivering tubes thereto in succession.

3. Apparatus according to claim 1, in which said fixture means include a plurality of separator plates interconnected in parallel spaced relation to form interspaces for passage of the respective fins, said plates having free edges at the outlet end of the fixture, said free edges having recesses with which said one hole set at the outlet end of the fixture is adapted to be aligned.

4. Apparatus according to claim 1, in which said advancing mechanism includes a tube-engaging part, means for moving said part into and out of engagement with a tube extending transversely through fin portions which project from said outlet end of the fixture, and means for moving said part while engaged with said tube in the direction to advance the fins, said last means being movable in the opposite direction upon disengagement of said part from said tube, whereby said part is positioned for engagement with another tube extending through the fins.

5. Apparatus according to claim 1, in which said advancing mechanism includes a first reciprocable element mounted for reciprocating movements in the direction of said advance and in the opposite direction, means including a reciprocating driving member for reciprocating said first element, a second reciprocable element carried by said first element and having a part movable into and out of engagement with a tube extending transversely through fin portions which project from the outlet end of the fixture, and means under control of said reciprocating means for operating the second element to engage said part with said tube upon completion of the movement of the first element in said opposite direction and to disengage the part from said tube upon completion of the movement of said first element in said advance direction, said interconnecting means including a connection between said tube-pushing member and said reciprocating driving member.

6. Apparatus according to claim 1, comprising also a magazine operatively connected to said holder for delivering tubes thereto in succession, the magazine having a channel adapted to hold a supply of the tubes extending in adjacent relation parallel to the direction of said forward stroke of the tube-pushing member, the channel extending downwardly toward said holder and having adjacent thereto an outlet through which the tubes are movable one-by-one into the holder by gravity, said holder including surfaces engageable with a tube from the magazine to hold an adjacent tube in the magazine against movement through said outlet while positioning said tube from the magazine in said alignment with said one hole set and in the path of the forward stroke of the tube-pushing member.

7. Apparatus according to claim 1, in which said advancing mechanism includes a first reciprocable element mounted for reciprocating movements in the direction of said advance and in the opposite direction, means including a reciprocating driving member for reciprocating said first element, a second reciprocable element carried by said first element and having a part movable into and out of engagement with a tube extending transversely through fin portions which project from the outlet end of the fixture, and means under control of said reciprocating means for operating the second element to engage said part with said tube upon completion of the movement of the first element in said opposite direction and to disengage the part from said tube upon completion of the movement of said first element in said advance direction.

8. Apparatus according to claim 7, in which said means for reciprocating said first element also include a spring for moving said first element in said opposite direction and a cam connected to the driving member for moving said first element in said advance direction against the spring.

9. Apparatus for weaving fin-and-tube radiators of the type having spaced parallel fins and also having tubes extending transversely of the fins through aligned holes therein, each fin having its holes spaced uniformly along a row extending lengthwise of the fin, the apparatus comprising a fixture having an inlet end for receiving a group of fins and an outlet end, the fixture including means for guiding and supporting the fins in parallel spaced relation to each other during lengthwise movement of the fins through the fixture, said fixture means including a plurality of separator plates interconnected in parallel spaced relation to form interspaces for passage of the respective fins, said plates having free edges at the outlet end of the fixture, said free edges having recesses aligned with each other transversely of the plates and with which a set of holes in the respective fins is adapted to be aligned transversely of the fins, a reciprocating driving member movable parallel to the direction of alignment of said recesses and holes, a first element mounted for reciprocating movements parallel to said lengthwise movement of the fins through the fixture, a second element mounted on said first element for movements relative thereto into and out of engagement with a tube extending transversely through fin portions which project from said outlet end of the fixture, a first actuating means operable by said driving member for reciprocating said first element through a distance equal to the spacing of adjacent holes in said row, said first actuating means providing a dwell period of said first element after each stroke thereof, a second actuating means operable by said driving member for moving the second element into engagement with said tube in

the dwell period following completion of said first element's stroke in a retracting direction from said outlet end to said inlet end of the fixture, whereby said first element's next stroke in an advancing direction advances the fins through the fixture toward its outlet end, the second actuating means being operable by said driving members to disengage the second element from said tube in the dwell period following completion of said stroke of the first element in said advancing direction, whereby the first element's next stroke in the retracting direction positions the second element for movement into engagement with another tube extending transversely through the fins, a holder for positioning a tube at one side of the fixture in alignment with said recesses and with a set of said holes at the outlet end of the fixture, the holder including surfaces for guiding said last tube endwise toward said aligned set of holes, and a tube-pushing member connected to said driving member for reciprocating movements therewith and operable in a forward stroke of said driving member to engage a tube in the holder and push said tube endwise along the holder and into said aligned set of holes, said forward stroke of the driving member also acting through said first actuating means to move said first reciprocable members in its retracting direction.

10. Apparatus according to claim 9, in which said second actuating means include a limit switch and stops on the driving member for operating the limit switch.

11. Apparatus according to claim 9, in which said reciprocating driving member is a piston rod, the apparatus comprising also a cylinder, a piston slidable in the cylinder and connected to said rod, a pressure fluid line, a control valve connected to said line and cylinder and operable alternately to connect said line to one end of the cylinder while venting the other end of the cylinder and to connect said line to said other end of the cylinder while venting said one end of the cylinder, thereby reciprocating the piston and rod, a limit switch operable by the rod at the end of each stroke thereof, and an operating connection between the switch and valve for operating the valve to effect said reciprocation of the piston and rod.

12. Apparatus according to claim 11, in which said second actuating means include a second cylinder mounted on said first reciprocable element, a second piston movable in said second cylinder and connected to said second element, and pipe means connecting the second cylinder to the control valve and through which said valve also reciprocates the second piston.

13. Apparatus for use in the production of a tube-and-fin radiator of the type having spaced parallel fins and also having tubes extending transversely of the fins through aligned holes therein, each fin having said holes thereof spaced uniformly along a row extending lengthwise of the fin, said apparatus comprising a fixture forming a guiding zone having an inlet end for receiving the fins and an outlet end through which the fins are movable from said zone, said fixture including means for guiding and supporting a plurality of said fins simultaneously in parallel spaced relation to each other during lengthwise movement of the fins from said inlet end to said outlet end of the guiding zone, the fins being advanceable lengthwise as a group step-by-step in unison through said fixture through a distance equal to the spacing of adjacent holes in a said row and while maintaining said holes in sets each composed of holes aligned with each other transversely of the fins, and means forming a positioning zone including a holder for positioning a said tube at one side of said group with the tube in alignment with one of said hole sets at the outlet end of the fixture, the holder including guide means for guiding said tube endwise toward the aligned holes of said one set, whereby said tube is movable endwise along said last guide means into the holes of said one set.

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