April 18, 1939. J. D. LEAR 2,154,855

MACHINE FOR ASSEMBLING FINS AND TUBES

Filed Sept. 11, 1936 5 Sheets-Sheet 1

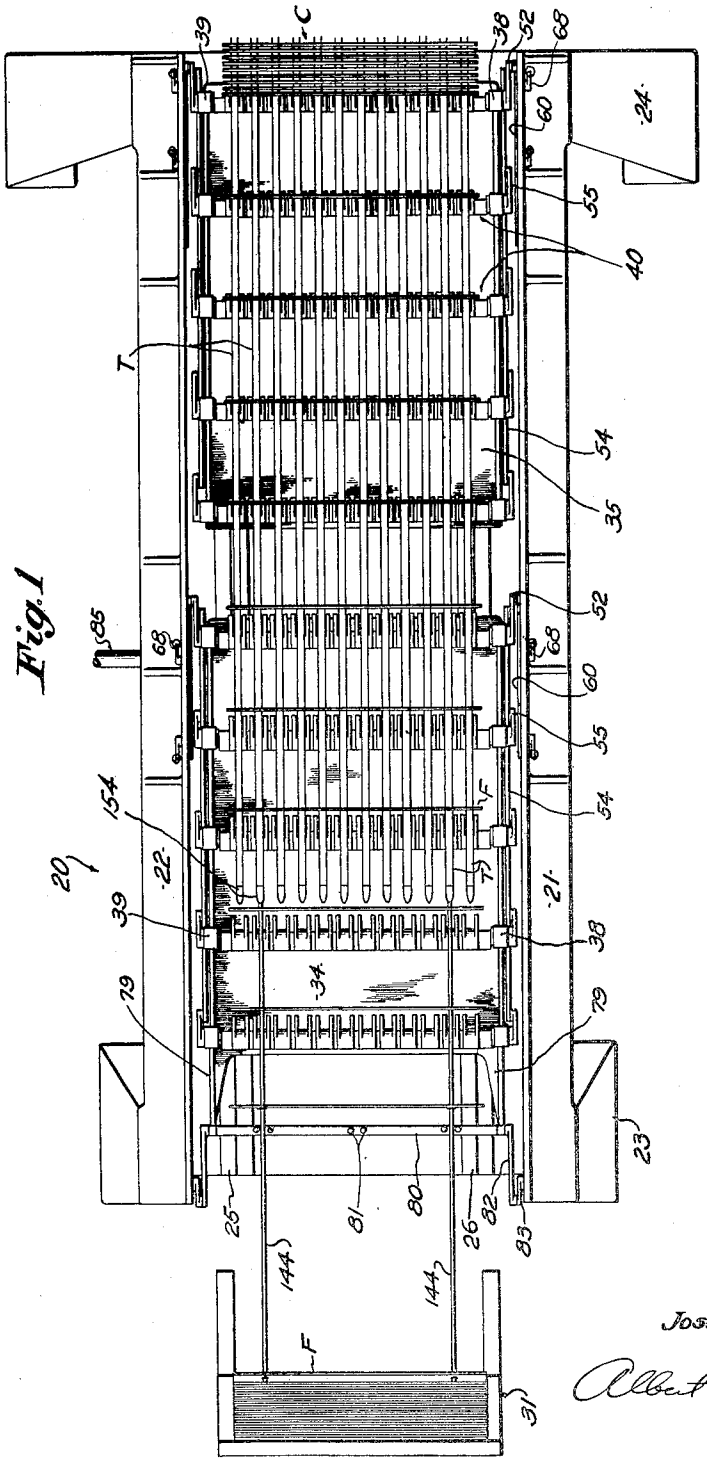



Fig. 1

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MACHINE FOR ASSEMBLING FINS AND TUBES

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Fig. 2

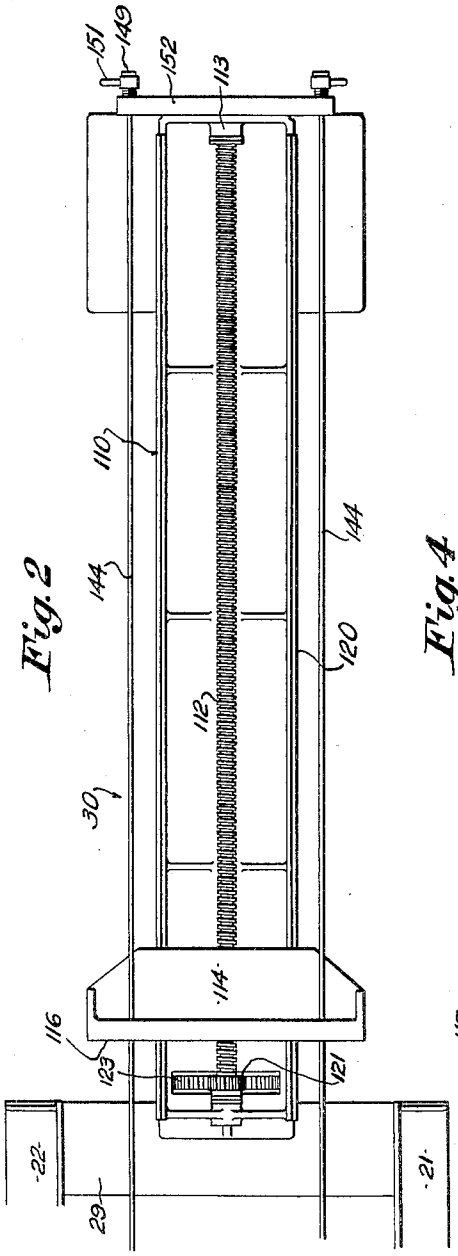
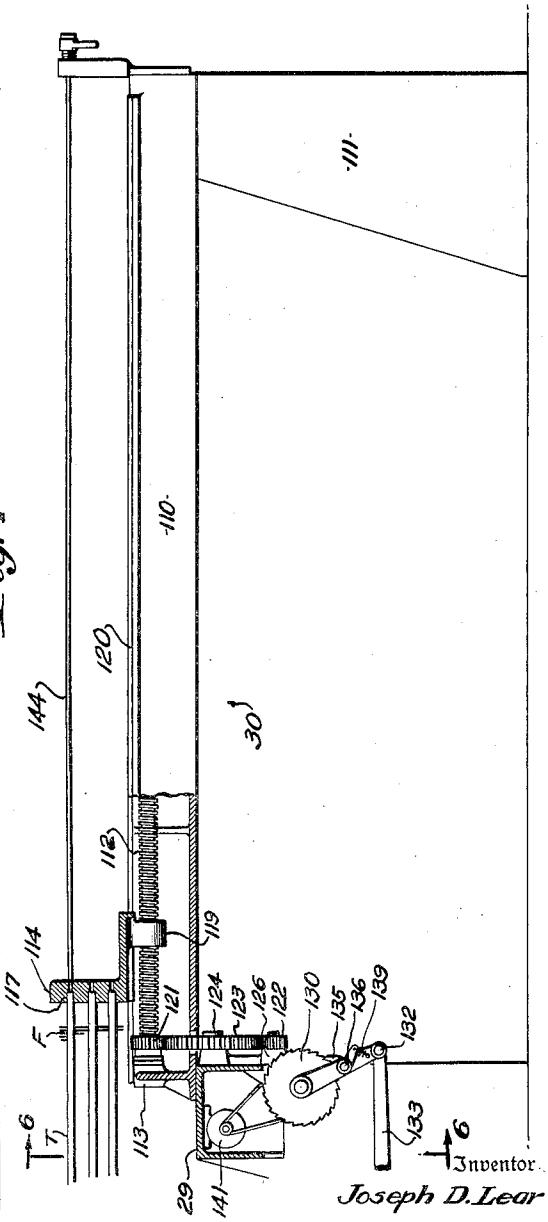



Fig. 4




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MACHINE FOR ASSEMBLING FINS AND TUBES

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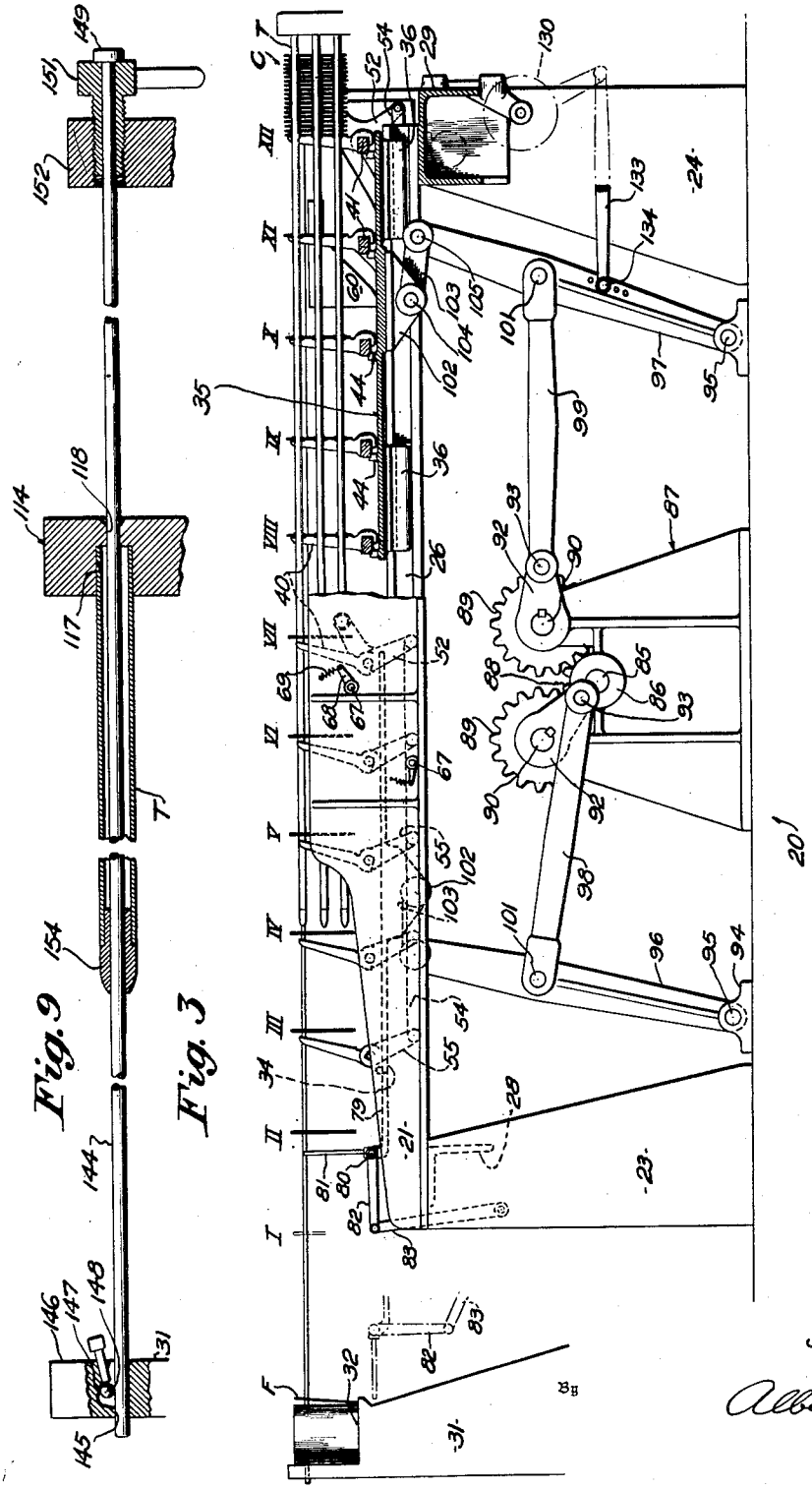


Fig. 9



Fig. 3

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MACHINE FOR ASSEMBLING FINS AND TUBES

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Fig. 5

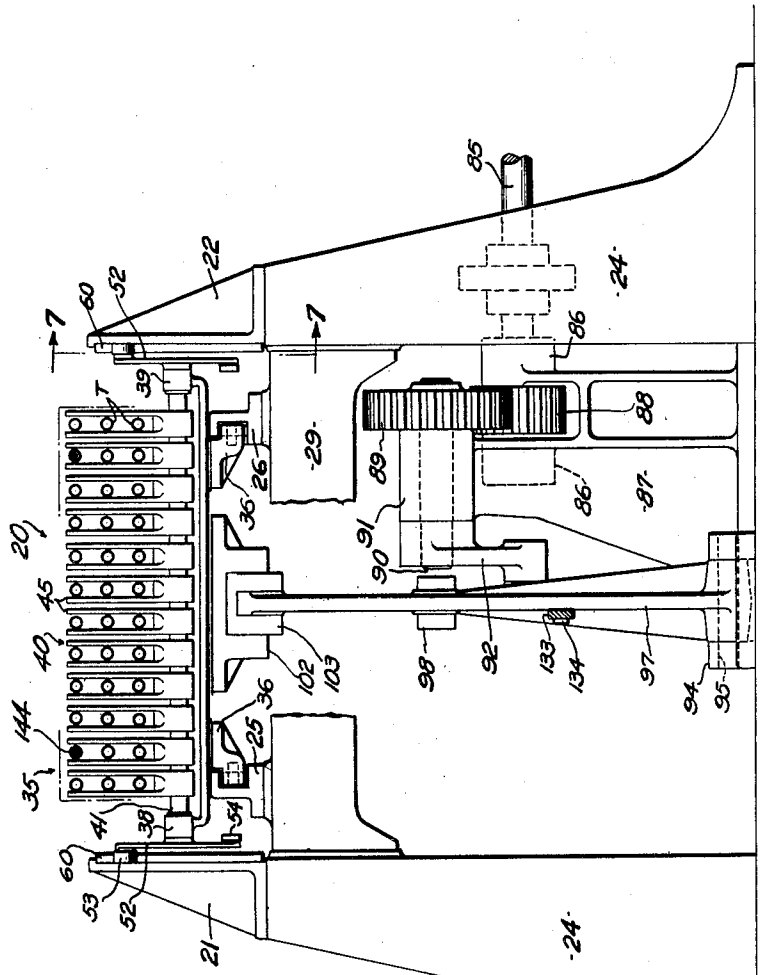
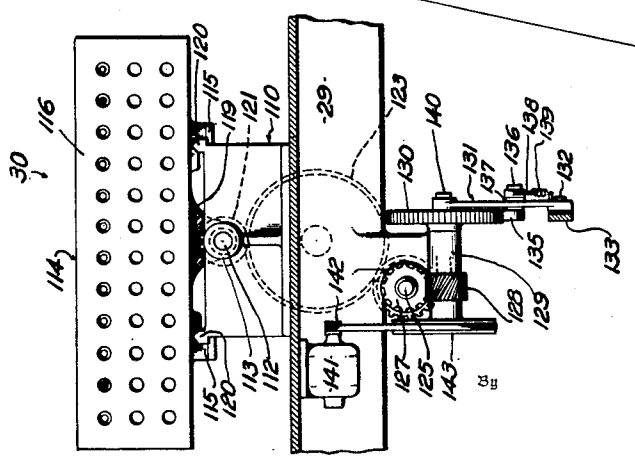


Fig. 6



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*Fig. 10*

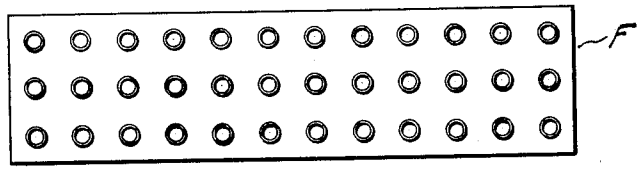



*Fig. 7*

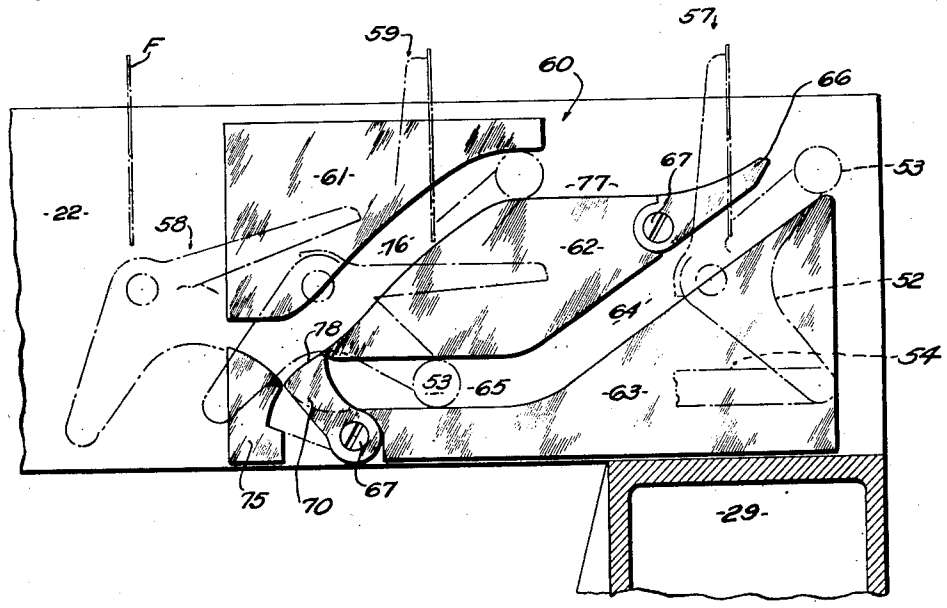
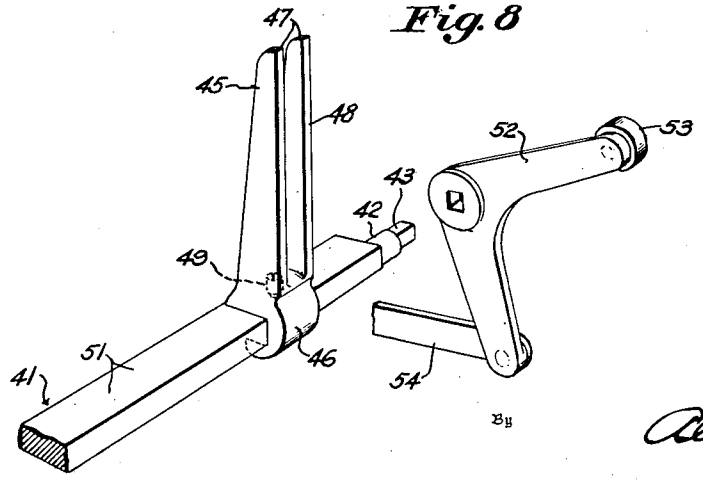



*Fig. 8*




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# UNITED STATES PATENT OFFICE

2,154,855

## MACHINE FOR ASSEMBLING FINS AND TUBES

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Application September 11, 1936, Serial No. 100,331

10 Claims. (Cl. 29—84)

This invention relates to machines for applying fins on and transversely of one or more tubes to create a cross fin structure useful for heat exchange purposes, and it has particular reference to a machine in which means are provided to effect such assembly in a rapid and economical fashion.

A useful structure in the heat exchange arts consists of a plurality of tubes which are connected to a number of transversely disposed heat radiating or absorbing metal fins more or less uniformly disposed along the length of such tubes. Heretofore, it has been customary to make these assemblies by means of fixtures or "nests", as they are termed in the art, and it has also been proposed to effect the desired assembly by means of machines in which a number of tubes, suitably mounted, receive the fins from a paddle mechanism moving lengthwise of the tube bank.

A serious difficulty with machines of this nature has been that their production capacity has been curtailed by such factors as running time, difficulty of setting up the work, and maintenance troubles, to such a degree as not to justify their use, particularly when compared to the economics of nest assembly. At the same time, the principle of holding the tubes and moving the fins into position over them is basically sound.

Accordingly, the present invention has as its major object the provision of an effective machine by means of which fins and tubes may be readily assembled. According to one of the principles of the present invention, means are provided to move a fin lengthwise of the tube by a fin-engaging member which contacts the fin during one phase of action, but is detached from the fin during another phase of action when it is moved to position to receive another fin.

In another aspect, the invention contemplates the simultaneous operation of a plurality of fin-engaging members which are given a reciprocatory motion with respect to the lengthwise disposal of the tubes, and which stand crossways of the tubes while the fins are being advanced therealong, but swing out of the path of the fins during the return action, so as not to interfere with the several fins already applied.

In another aspect, the invention contemplates the conjoint operation of two or more fin-engaging members, each of which serves to advance a fin throughout a limited length of the tube during its forward movement, and which, on its return stroke, moves under and to the rear of the fin just advanced by the adjacent member. To attain this end, the machine of the present invention is provided with means to give to the fin-engaging member an effective stroke greater than the mean distance between such members when in fin-engaging position.

In still another aspect, the invention provides means, not only applicable to the machine embodying the foregoing principles, but generally applicable to machines of this class, for supporting the tubes independently of the fin-engaging members during the operation of the latter.

Other aspects of the invention will be made apparent from a description of a typical embodiment of the principles thereof, illustrated in the accompanying drawings, wherein:

Figs. 1 and 2 are related top views of the machine;

Figs. 3 and 4 are similarly related side views of the machine with portions shown in longitudinal section;

Fig. 5 is an enlarged end view of the fin applying unit;

Fig. 6 is an enlarged fragmentary section of the line 6—6 of Fig. 4, showing the tube positioning unit;

Fig. 7 is an enlarged section on the line 7—7 of Fig. 5;

Fig. 8 is a perspective view of one rocker shaft with a single platen positioned thereon;

Fig. 9 is an enlarged view of a supporting rod with the parts through which it projects being shown in section;

Fig. 10 is an enlarged front view of a fin.

In various views of the drawings there is shown in the process of assembly a cross fin coil C, which consists of parallel tube T and equally spaced transversely positioned fins F of rectilinear shape. In Fig. 10 a preferred type of fin is shown in detail, where it will be observed that it is formed with flanged apertures which are adapted resiliently to engage about the tubes T.

The assembling machine for the above mentioned coil consists of two principle units, a fin applying unit **20** which introduces fins onto the tubes in progressive order, and a tube positioning unit **30** which holds the tubes and additionally retreats upon the application of each fin to provide for the correct and uniform spacing of the fins.

### *Fin applying unit*

The applying unit **20** includes a machine frame consisting of spaced, longitudinally disposed rails **21**, **22** mounted on pairs of legs **23**, **24**, and parallel carriage slides **25**, **26** supported on cross members **28**, **29**. The cross members also serve to connect the pairs of legs. A feed table **31** is

disposed at the left hand end of this structure (Figs. 1 and 3) and it is formed with a platform 32 on which the fin supply is placed, and from which the fins are individually fed into the machine, as hereinafter described.

A pair of similar carriages 34 and 35 are provided with spaced pairs of depending slide bearings 36 (Fig. 5) which engage in the opposed carriage slides 25 and 26, and thus provide for free longitudinal sliding movement of the carriages along the machine frame. Bearings 38 and 39 are formed in spaced pairs on the upper surfaces of the carriages and each pair rotatably receives a rocker shaft 41 (Fig. 8) of a paddle 40 which is formed with suitable pintles 42 and projecting squared portions 43.

The body of each shaft 41 is rectangular in cross section and it is adapted to engage stop members 44 (Fig. 3) secured to the carriages, which limit the shaft's turning movement. A plurality of platens 45 (Fig. 8) are mounted on each shaft 41 and they are formed with notched hubs 46 which accurately fit the shaft, and vertical fingers 47, the front faces 48 of which assume a perpendicular position when the shaft is in engagement with the stop members 44. Each platen is secured to the shaft by a set-screw 49 which engages in one of the holes 51 provided in the shaft. It will be apparent that certain of the platens may be removed, or the spacing thereof may be varied to suit the dimensional characteristics of the coil being assembled; or, if the nature of the work does not demand this adjustable feature, the paddles 40 may be of an integral character.

The first rock shaft of each carriage receives a bell crank 52 on each of its squared portions 43. One arm of each crank is supplied with a cam roller 53 while the remaining arm is pivotally secured to the extremity of a connecting bar 54. Levers 55 are connected to the remaining rock shafts, and they are also connected to the bars 54, which thus unite the group of paddles on each carriage for common pivotal action.

*Paddle control cams*

Through a drive mechanism, which will be presently described, each carriage is reciprocated along the slides 25 and 26 in work and relief strokes through a distance slightly less than twice the paddle spacing.

Referring first to the carriage 35 (Fig. 3) it will be observed that it is at the end of its forward or work stroke, from which position it will retreat rearward. In Fig. 7, the translatory movement of the first paddle of this carriage is shown, where, as it moves from its forward position 57 to its rear position 58, it is caused to rock forward to a substantially horizontal position, while on its return or work stroke, it is restored rapidly to its vertical position, as indicated by the numeral 59.

A pair of control cams 60 are secured to the rails 21 and 22 in transverse alignment, and each cam is formed of sections 61, 62, 63 (Fig. 7). The sections 62 and 63 are formed to provide therebetween a downward sloping track 64 merging into a horizontal track 65. At the right hand extremity of the section 62, a hinged switch member 66 is secured to a stud 67 (Fig. 3) which projects through the adjacent rail and receives a lever 68 which is engaged by a spring 69. This spring constantly urges the stud and accompanying switch member in a counter-clockwise direction, so that the switch member will normally occupy a position where it, in effect, provides a continuation of the track 64.

It will now be apparent that as the carriage 35 retreats from position 57, the cam rollers 53 on the bell cranks 52 will engage in the tracks 64 and then the tracks 65, thus causing the unitary clockwise rotation of the five paddles of the carriage from a perpendicular to a substantially horizontal position.

Prior to the completion of the return stroke, the paddles are caused to start turning upward, through the medium of a second switch member 70, which forms an upwardly curved terminal for the track 65. This member is secured to a similar stud and lever system as devised for the switch member 66, and it is normally retained thereby in contact with the section 62 (Fig. 7).

As the cam roller 53 strikes the switch member 70, the latter member is forced downward against a stop member 75 which supports it as the cam roller travels up the incline thus provided. The roller finally comes to the end of its rearward movement where it is positioned beyond the extremity of the member 70 and between the stop member 75 and the section 61.

The cam sections 61 and 62 are formed to provide a track 76 therebetween, which extends upward and merges into a horizontal track 77 chiefly formed by the top surface of the section 62.

With the cam roller in the last described position, it will be apparent that the switch member 70 will be free to be restored to its upper position, where its outer surface 78 will provide a continuation of the track 76. During the beginning of the forward stroke of the carriage, the roller 53 will engage the surface 78 and be deflected into the track 76 for a sharp ascending movement, wherein the paddles will be rapidly restored to a vertical position and retained in such position for the balance of the forward or work stroke.

Near the termination of the work stroke, the roller 53 will engage and depress the switch member 66, and, after the roller has passed, the switch will be restored to its normal elevated position, where it is prepared to guide the roller into the track 64 on the subsequent rearward stroke.

As indicated in Figs. 1 and 3, a second set of cams 60 is provided for causing an identical movement of the paddles of the rear carriage 34. This carriage, as will hereafter be apparent, is given a stroke of the same length as the first carriage.

*Feed paddle*

A pair of spaced bearing brackets 79 are secured to the rear end of the carriage 34, and they rotatably receive a rock shaft 80, to which are secured a plurality of fin-engaging fingers or rods 81. Levers 82 are secured to the shaft 80, and their extremities are pivotally secured to extremities of links 83, the remaining ends of which are pivotally connected to the legs 23. This structure provides an extra paddle on the carriage 34, which, as the carriage retreats, is caused to tilt rearward, as indicated in dotted lines in Fig. 3.

*Drive mechanism*

A main drive shaft 85 (Figs. 3 and 5) connected to a suitable source of power (not shown) is mounted in bearings 86 of a pedestal 87, and it operates an attached pinion 88 which meshes with similar gears 89. The gears are keyed to countershafts 90 which are journalled in bearings 91 of the pedestal 87, and they in turn carry cranks 92 having similarly located crank pins 93.

Floor bearings 94 are disposed in spaced relation on each side of the pedestal 87, and they receive pins 95 which project through the lower ends of the levers 96 and 97. Connecting rods 98 and 99 have common extremities connected to the crank pins 93, and their remaining extremities connected to mid-portions of the levers 96 and 97 respectively by studs 101.

The carriages 34 and 35 have depending bearings 102 secured thereto, and they are each pivotally connected to one end of a link 103 by a pin 104. The remaining ends of the links are connected to the upper terminals of the levers 96 and 97 by pins 105 to complete the lever system.

In the operation of the lever system, it will be apparent that the levers 96 and 97 will be similarly reciprocated by their cranks and transmit a reciprocatory action to their respective carriages 34 and 35 through the link connection 103. It will be noted that although the carriages are provided with identical strokes, they are caused to operate slightly out of phase with each other, due to the mismatched positioning of the cranks 92. Although obviously the carriages could be united and be operated by a single lever system, it is preferred to split the paddle group into two or more parts to stagger the load impacts, and for other reasons which will be hereinafter set forth.

*Tube positioning unit*

This unit is provided with a hollow base 110 which is mounted on legs 111 at its right hand extremity, and on the cross member 29 at its remaining extremity (Figs. 2, 4, 6). A screw 112 is longitudinally disposed in the base, and it is mounted in bearings 113 therein. A tube supporting head 114 is formed with slide bearings 115 which engage slide rails 120 formed on the base. The vertical face 116 of the head 114 is formed with spaced sockets 117 for receiving the extremities of the tubes T. Small holes 118 are drilled in the rear of the sockets to permit passage of guide rods which will be described later.

The supporting head is formed with a depending projection 119 which is tapped to engage the screw 112. The screw is driven in timed relation to the movement of the carriage 35 through a driving mechanism consisting of a gear 121 secured to the screw and operated by a gear 122 through the medium of a connecting gear 123, the latter gear being mounted on the cross member 29 by a stud 124. The gear 122 is secured to a shaft 125 which projects through its bearing 126 to receive a helical gear 127. A transversely positioned gear 128 meshes with the gear 127, and it is secured to a shaft 140 which protrudes through bearing 129 and receives a ratchet 130. A lever 131 is pivotally mounted on the shaft 140, and its extremity is connected by a stud 132 to a link 133, which in turn is pivotally connected to the drive lever 97 of the carriage 35 (Fig. 3) by a stud 134.

A pawl 135 adapted to engage the ratchet 130 is secured to a stud 136 mounted in a bearing 137 in the lever 133. A lever 138 is secured to the stud, and it is engaged by a compression spring 139 which retains the pawl in engagement with the ratchet.

During the forward movement of the carriage lever 97, it will be observed that the pawl 145 engages the ratchet 130 and causes its partial rotation. This action is transmitted through the associated gear train and finally causes the partial rotation of the screw 112 and a consequent retreating movement of the head 114 along the rails 120. Thus, during each forward stroke of the carriage 35, the head 114 retreats simultaneously a short distance, and such movement of the head determines the spacing between adjacent fins.

The head may be positioned at any desired starting location along the rails 120 by disconnecting the pawl 135 and operating a small positioning motor 141 (Figs. 4 and 6) which is secured to the cross rail 29. The motor operates a pulley 142 which is connected by a belt to a pulley 143 secured to the shaft 140, and through this connection with the gear train, the motor may be controlled to drive the screw 112 for adjustable movement of the head.

*The guide structure*

A number of rods 144 are engaged through the holes 118 in the head 114, and thence through the tubes and beyond the end of the fin applying unit (Figs. 1, 2, and 9) where their extremities are engaged in holes 145 provided in the vertical wall 146 of the feed platform 32. Ball clutches are formed within these holes through an angular wall structure 147 and inserted balls 148. Thus, while the rods may be readily inserted, they may not be withdrawn unless tension is relieved and a suitable instrument inserted to move the balls rearward. The opposite ends of the rods are formed with heads 149 which abut nuts 151, which are screwed into a bracket 152 secured to the extremity of the base 120. In Fig. 9 it will be observed that short mandrels 154 are slipped over the rods and engaged in the tube extremities to guide the fins upon the tubes.

It will be understood that during the process of loading the machine for operation, the rods are placed under considerable tension by turning the nuts 151. During the subsequent application of the fins on the tubes, the rods serve not only as guide means for the manual feeding of the fins from the platform 32, but as a suspension means for the united tubes and fins to prevent their sagging and interfering with the paddles 40.

*General operation*

When the machine is started, the operator, positioned at the feed table 31, slides fins along the rods 144 in timed relation to the retreat or rearward movement of the carriage 34. Thus, when the feed paddle is in the position indicated in dotted lines in Fig. 3, the operator positions a fin at the location indicated by the numeral I. On the return or work stroke of the carriage 34, the feed paddle is rotated into engagement with the fin and it is simultaneously carried forward with the carriage to slide the fin forward to position II.

Following the course of this particular fin, it will be observed that on the next return stroke of the carriage 34, the last paddle 40 thereof is tipped forward so that it passes under this fin. Upon the subsequent return stroke, this paddle quickly assumes a vertical position, due to the controlling action of the cams 60 (Fig. 7) and engages and moves the fin forward to position III, where on the next cycle it is engaged by the adjacent paddle and similarly advanced to position IV.

Thus each paddle 40 engages the fin and advances it to a position where it may be engaged by an adjacent paddle. As this step-by-step action continues, the fin is forced over the mandrels 154 and along the tubes in the direction of the carriage 35, the paddles 40 of which even-

tually engage this fin and convey it to the final position XII.

During each reciprocation of the carriages, a fin is fed to station I, so that a succession of fins follow the above-described fin along the tubes.

As previously described, when the carriages move forward, the head 114 is caused to retreat simultaneously along the screw 112. Thus, after a fin is advanced to position XII, it may be considered fixed to the tubes and accompanying head, and, upon the next work stroke of the carriage 35 the head 114, tubes T, and this particular fin retreat a short distance to the right, so that the subsequent fin arriving at station XII is spaced therefrom.

This progressive retreat of the tubes and attached mandrels continues until a coil of the proper length is built up. It will be noted that upon completion of an extremely long coil, the head 114 would be positioned near the right hand end of its frame, as shown in Fig. 4, while the tube extremities and mandrels would be positioned between stations XI and XII (Fig. 3).

From the foregoing description, it will be observed that the present invention provides a fin and tube assembling machine which is simple in construction and which may be operated with great rapidity, whereby the desired structures may be manufactured economically. It will be observed that the invention includes a number of novel and useful features. Among these may be briefly mentioned the provision of the fin-engaging members which are given a reciprocatory movement along the tube bank, in such fashion as to press the fins towards their "home" position in the advancing phase of operation, and to remove themselves from the partial assembly during the retreating phase to a position behind the fin advanced by the preceding member. Each member thus transmits its fin over to the next member, thus providing a rapid sequential movement of the fins from their supply stack toward the final position on the tubes themselves.

It will be observed that while this action takes place, the tubes are progressively moved rearwardly or away from the paddles, so that each fin has its own home position at a uniform distance from the adjacent fins. This tube action, it will be noted, takes place as the fins themselves are advanced, and hence the pressure, caused by the fins sliding over the tubes, is transmitted to the tube head, to keep the tubes firmly seated therein.

It will also be seen that the tubes and fins are generally supported on the rods 144 in such manner that they are independent of the fin-applying mechanism, and, by placing these rods under a suitable tension, the deformation or bending caused by the weight thereof is minimized to a point where the slight sagging of the assembly is insufficient to cause misalignment or otherwise interfere with the desired operation.

The foregoing and other advantages will be apparent to those skilled in the art, who will also appreciate that various modifications and adaptations may be made in the illustrated embodiment of the invention, without departure from the scope thereof as set forth in the following claims.

I claim:

1. A machine for applying fins transversely of tubes comprising means to support the tubes, a plurality of fin engaging members, means for imparting to said members reciprocatory movement lengthwise of said tubes, means for maintaining said members in fin-engaging position during the advancing phase of said reciprocatory movement to move fins along said tubes, means for diverting said members away from said tubes and the fins disposed thereon during the retreating phase of said movement, and means for restoring said fin engaging members to fin engaging position at the end of said retreating phase, said means being so proportioned with respect to each other as to restore said members to fin engaging position after said members have retreated a distance greater than the distance between said members, whereby each member successively advances the fin advanced by an adjacent member during a preceding cycle of reciprocation.

2. The combination with a machine for applying fins transversely of tubes and including means to move fins lengthwise of the tubes, of means for supporting said tubes independently of said fin moving means, said supporting means comprising rods extending through said tubes and beyond the ends thereof, supports for said rods at the ends thereof, and means for placing said rods under tension between said supports, whereby said tensioned rods may support said tubes and fins disposed thereon in resistance to the gravity load created by the mass thereof.

3. A machine for assembling cross fin coils, comprising a frame, a carriage mounted on the frame for sliding movement, a furcated fin engaging paddle disposed transversely of the carriage and pivotally mounted thereon, drive means for reciprocating said carriage along said frame, a head slidably mounted on the frame adjacent one extremity of the carriage, means on the head for supporting one end of a tube with the remaining portion projecting over said carriage, means for rotating the paddle to an upright position to engage a fin during movement of the carriage toward the head, the furcation of the paddle during this movement receiving said tube therebetween, cooperating means for rotating the paddle to a substantially horizontal position during the opposite movement of the carriage, and means operated in timed relation to said drive means for moving said head and accompanying tube away from said carriage.

4. A machine for assembling cross fin coils, comprising a frame, a head slidably mounted on the frame, said head being formed to support one end of a tube, a fin receiving carriage, drive means for moving said carriage toward said head to force the fin on the tube, a rod extending through the tube and head and having a fin supply positioned thereon, and mounting means independent of the carriage and head for retaining said rods under tension to provide a support for the fins and tube.

5. In an assembling machine for cross fin coils consisting of a tube and transverse perforate fins, the combination of a frame, a head mounted on the frame and formed to support one end of the tube, a rod extending through the perforations of the fins and said tubes, means for supporting opposite ends of the rod including tensioning means for retaining the rod taut as a support for the tubes and fins, and fin applying means mounted on the frame and movable to engage and force a fin along the tube, drive means for the fin applying means, and cooperating means operating in timed relation thereto for moving said head and accompanying tube progressively toward one end of the frame.

6. A machine for assembling cross fin coils, comprising a frame, a carriage mounted on the

frame for sliding movement, a furcated fin engaging paddle, disposed transversely of the carriage and pivotally mounted thereon, drive means for reciprocating said carriage on said frame, a head sildably mounted on the frame adjacent one extremity of the carriage, means on the head for supporting one end of a tube, with the remaining portion of the tube disposed over the carriage and between the furcations of the paddle, a rod extending through said tube and having a fin supply positioned thereon adjacent the opposite end of the carriage, means independent of the carriage and head for retaining said rod under tension to provide a support for the fins and tube, and means operated in timed relation with said drive means for moving the head and accompanying tube away from said carriage.

7. An assembling machine for cross fin coils comprising a frame, a carriage mounted in said frame for sliding movement, a plurality of transversely disposed spaced paddles pivotally mounted on the carriage, said paddles having furcated body portions, drive means for reciprocating the carriage in alternating work and return strokes, a head mounted for sliding movement on the frame adjacent to said carriage, means operating in timed relation to said drive means for moving said head away from said carriage, means on the head for supporting the ends of a plurality of tubes with the tubes projecting therefrom and through the furcations in said paddles, means for retaining said paddles in a vertical position during the work stroke of the carriage whereby the paddles engage and force the fins along the tubes toward said head, and means engaging the paddles on the return stroke to cause them to swing to a substantially horizontal position while passing under fins applied during the preceding work stroke.

8. A machine for assembling cross fin coils comprising a frame, a carriage mounted on the frame for sliding movement, drive means for reciprocating said carriage on said frame, receiving rods positioned over said frame and said carriage and adapted to receive a fin supply, said fins being adapted to be slid individually along the rods toward one end of the carriage, a plurality of transversely disposed spaced paddles having furcated body portions pivotally mounted on the carriage, control means for the paddles for moving them to a horizontal position beneath said rods and fins during movement of the carriage toward the fin supply, and means for restoring said paddles to a perpendicular position and into engagement with the fins during the opposite movement of the carriage, a head slidably mounted on the frame adjacent the opposite end of the carriage, means on the head for supporting common ends of a plurality of tubes with the remaining portions of the tubes disposed over the carriage and between the paddle furcations in the path of the fins being carried thereby, certain of said tubes receiving said rods therein, and means operated in timed relation with said drive means for moving said head and accompanying tubes away from said carriage.

9. An assembling machine for cross fin coils comprising a frame, a plurality of carriages mounted on the frame for sliding movement and disposed adjacent to each other, a furcated paddle pivotally mounted on each carriage, reciprocating drive means, a connection between the drive means and each carriage whereby each carriage is provided with a similar reciprocating movement, said connections and drive means being organized so that the carriages arrive at the end of their strokes in sequential order, a head mounted for sliding movement on the frame adjacent to the carriages, means on the head for supporting one end of a tube with the remainder of the tube extending over the carriages and between the furcations of the paddles thereof, means for retaining the paddles in a perpendicular fin engaging position on the carriages during movement of the respective carriages toward said head, cooperating means for rotating the paddles to a horizontal position during the opposite movement of the carriages, and means operating in timed relation to said drive means for moving the head and accompanying tube toward one end of the frame.

10. A machine for assembling cross fin coils comprising a frame, a carriage mounted on the frame for sliding movement, drive means for reciprocating the carriage along the frame, a paddle on the carriage comprising a shaft pivotally mounted thereon and a plurality of furcated members adjustably secured to said shaft, a head mounted on the frame adjacent one extremity of the carriage, means on the head for supporting one end of a tube with the remaining portion projecting over said carriage, means for rotating the paddle to an upright position to engage a fin during movement of the carriage toward the head, the furcations of the paddle member during this movement receiving the tube therebetween, and cooperating means for rotating said paddle to a substantially horizontal position during the opposite movement of the carriage.

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