

Oct. 29, 1946.

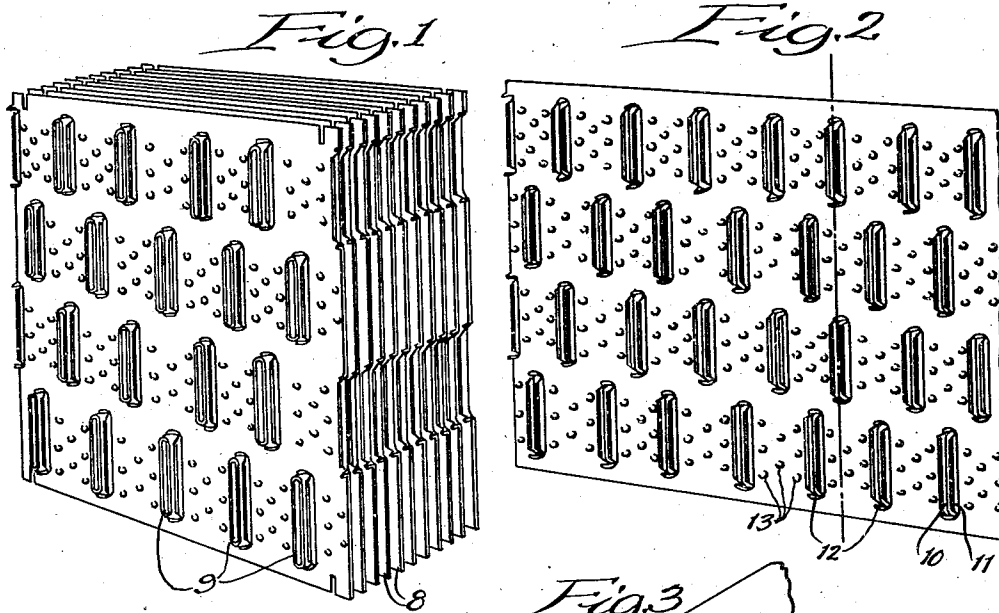
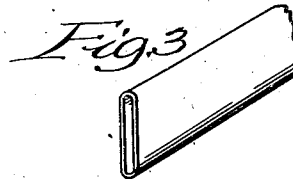
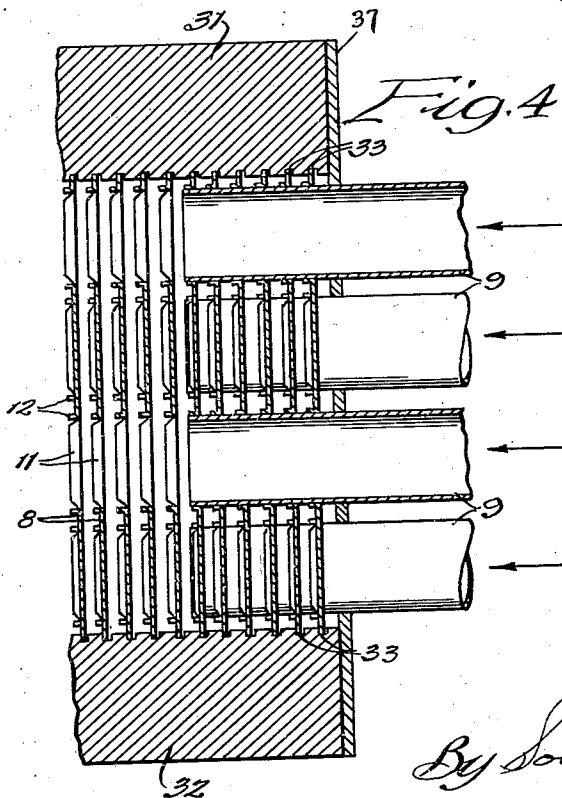
F. M. YOUNG

2,410,140

TUBE ASSEMBLY MACHINE FOR HEAT-EXCHANGE CORES

Filed April 23, 1945

4 Sheets-Sheet 1



*Inventor:*  
*Fred M. Young,*

*By Louis P. Anderson*  
*Attorneys.*

Oct. 29, 1946.

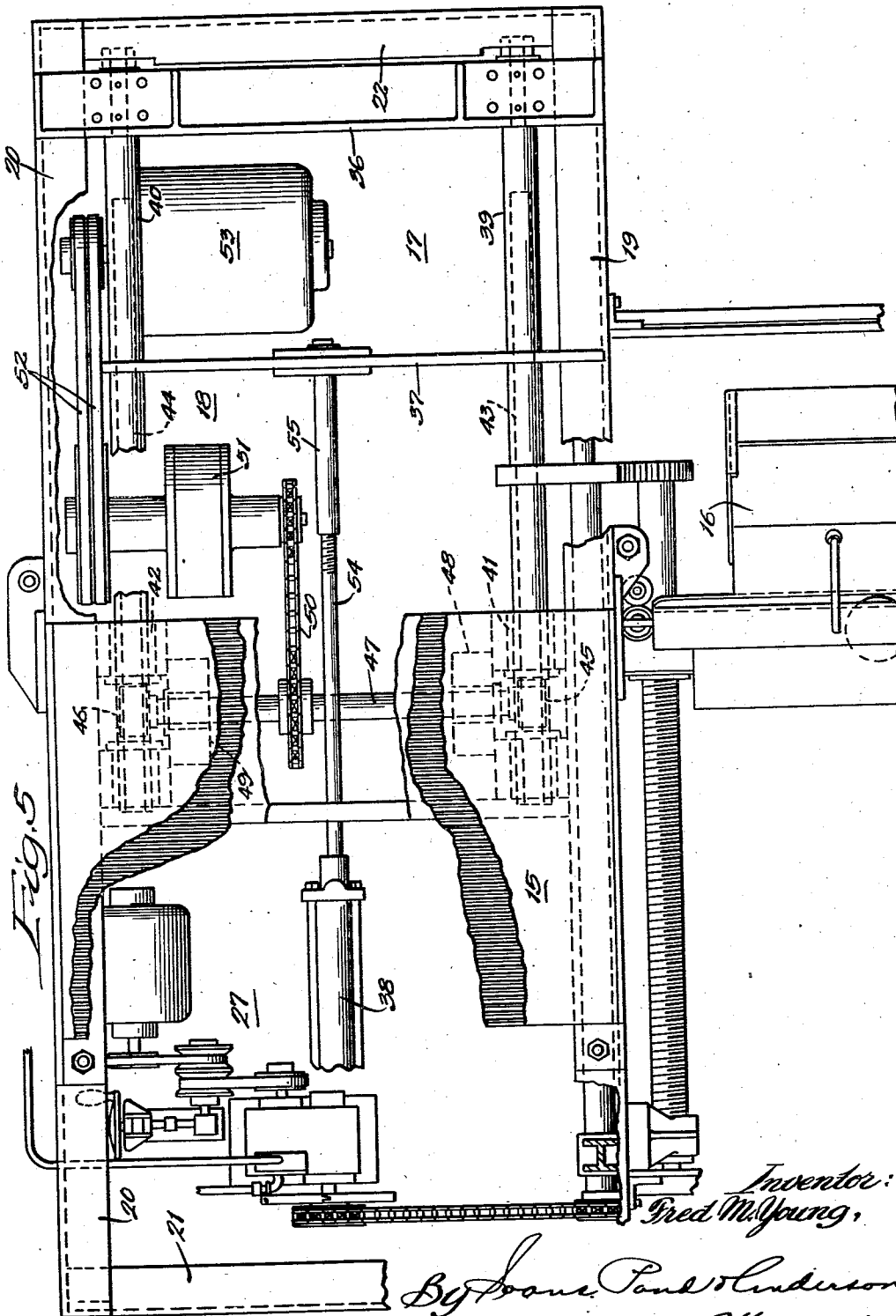
F. M. YOUNG

2,410,140

TUBE ASSEMBLY MACHINE FOR HEAT-EXCHANGE CORES

Filed April 23, 1945

4 Sheets-Sheet 2



Inventor:  
Fred M. Young,

By *Loane Paul Henderson*  
Attorneys.

Oct. 29, 1946.

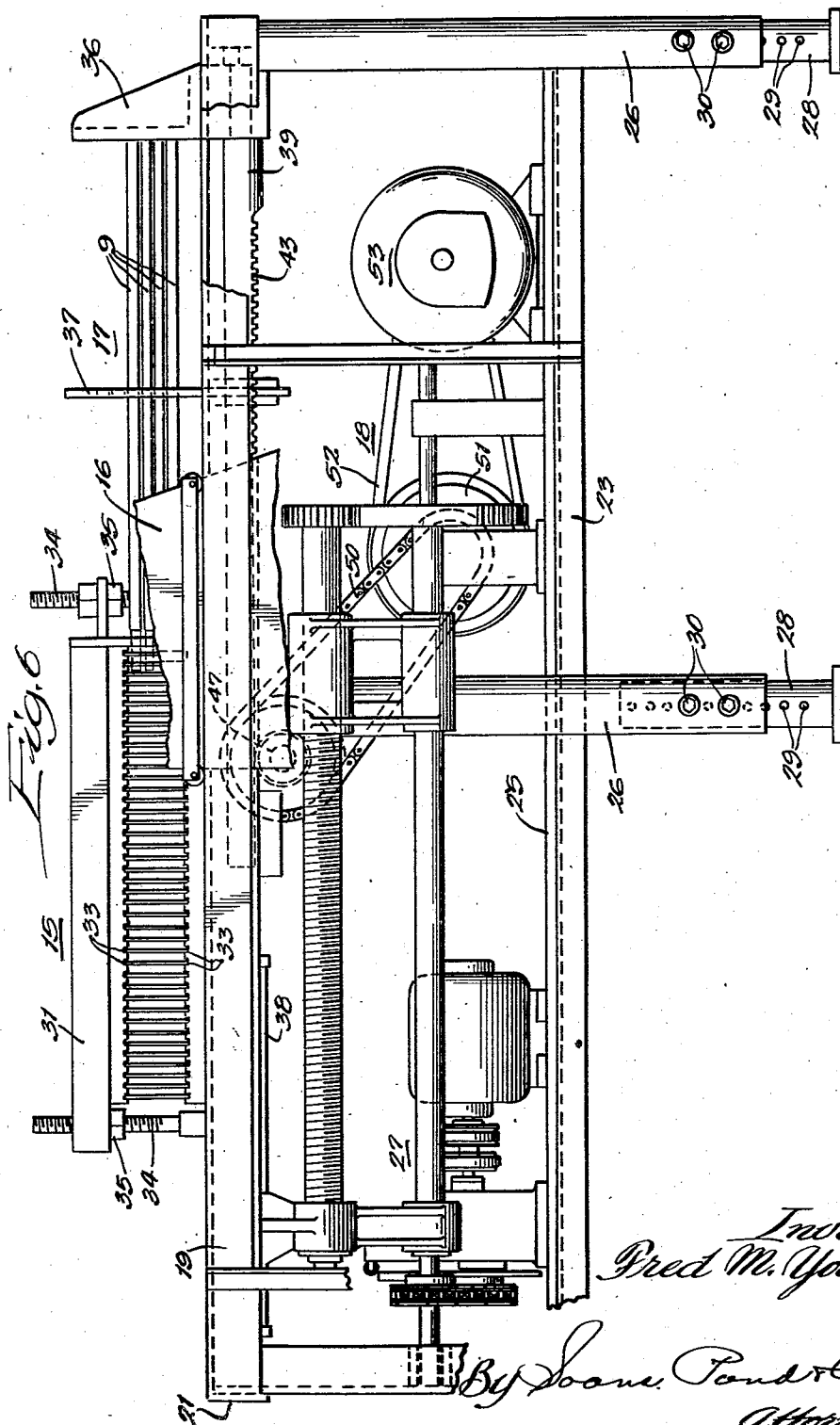
F. M. YOUNG

2,410,140

TUBE ASSEMBLY MACHINE FOR HEAT-EXCHANGE CORES

Filed April 23, 1945

4 Sheets-Sheet 3



Inventor:  
Fred M. Young,

By *Loane Pond Anderson*  
Attorneys

Oct. 29, 1946.

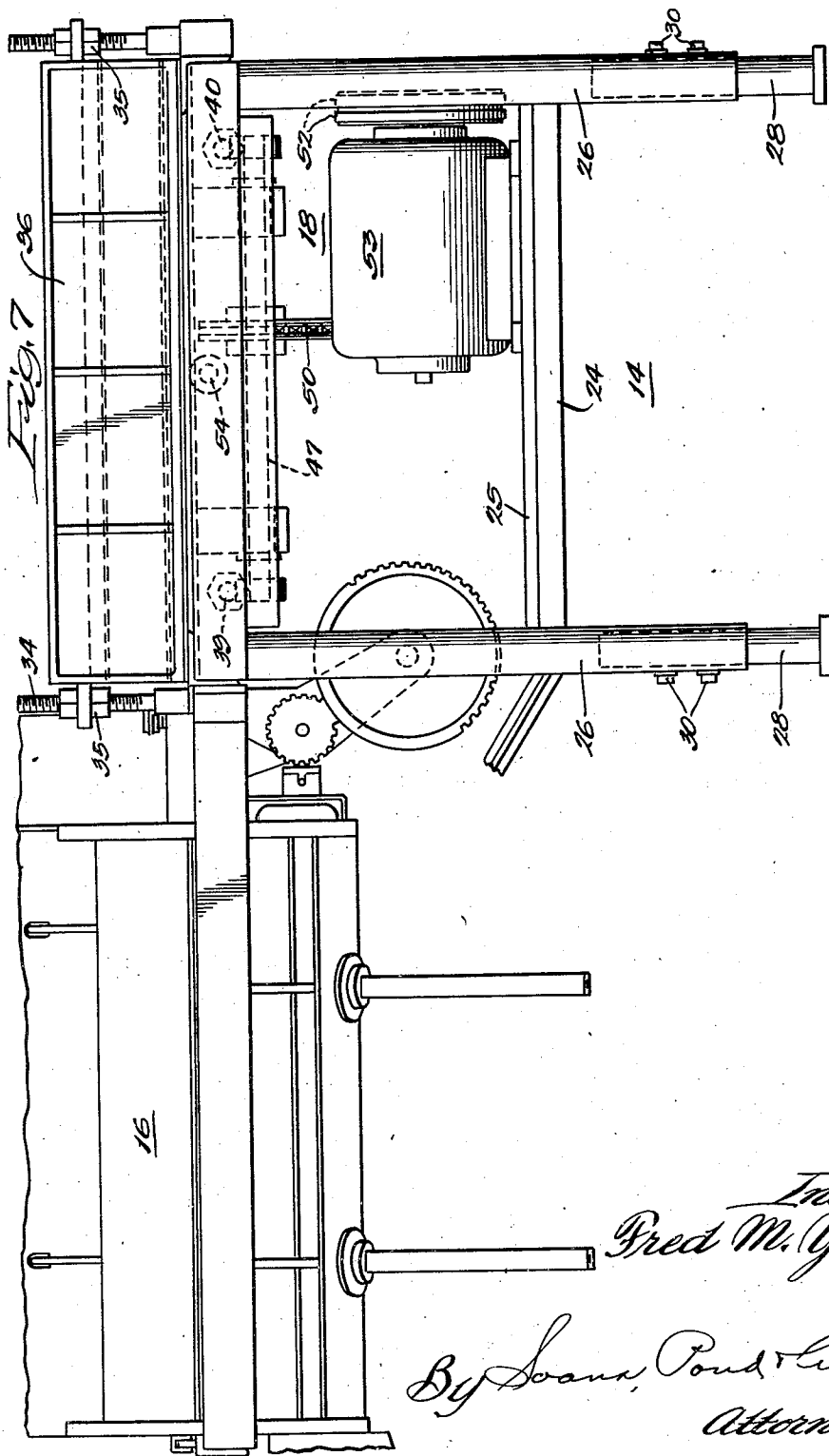
F. M. YOUNG

2,410,140

TUBE ASSEMBLY MACHINE FOR HEAT-EXCHANGE CORES

Filed April 23, 1945

4 Sheets-Sheet 4



*Inventor:*  
*Fred M. Young,*

*By* *Loane, Pond & Henderson*  
*Attorneys.*

## UNITED STATES PATENT OFFICE

2,410,140

TUBE ASSEMBLY MACHINE FOR  
HEAT-EXCHANGE CORESFred M. Young, Racine, Wis., assignor to Young  
Radiator Company, Racine, Wis., a corporation  
of Wisconsin

Application April 23, 1945, Serial No. 589,790

3 Claims. (Cl. 29—202)

1

This invention relates to a machine adapted to insert a plurality of tubes through the registering slots or holes in an assembly of laminae of the type which in the manufacture of heat-exchange equipment are generally known as "fins." Such an assembly of laminae and tubes constitutes, what is commonly called, a heat-exchange core. In such a core a predetermined number of these laminae or fins are arranged in closely-spaced parallel relationship for support on and in heat-dissipating contact with a plurality of these transverse tubes. The core is used with fluids of different temperature, one of which flows through said tubes and the other of which flows cross-wise of and around the tubes between the laminae. The heat from the fluid of the higher temperature is thereupon transferred to the fluid of the lower temperature.

These laminae or fins are comparatively thin, having a thickness of around .004. Generally they are hemmed along their lateral edges for the purpose of reinforcement. Moreover, the slots or holes for the tubes are struck up from the metal so as to form perimetral flanges around the holes adapted to increase the area of contact between the fins and tubes and thereby accelerate the transfer of heat between the tubes and the fins. The length and width of these laminae or fins vary, depending upon the size of the heat-exchange core to be formed therewith.

Preparatory to inserting the tubes through the assembly of fins, to make up such a heat-exchange core, a predetermined number of laminae or fins are assembled in a jig by means of a laminae-assembling machine similar to that disclosed in co-pending application, Serial No. 593,671, filed May 14, 1945. The assembly of fins is effected in such a way that the slots or holes are brought into alinement to permit the subsequent forcing of the tubes through the registering slots or holes.

Heretofore it has been necessary to assemble the laminae or fins in a jig by hand and to subsequently press the tubes, one at a time, through the registering slots or holes in the assembled fins. As dexterous as men have become at the task of assembling fins and inserting the tubes by hand, it is a slow and consequently expensive method compared with what is possible with a mechanical assembling of these parts.

The main objects of this invention, therefore, are to provide a machine for effecting the semi-automatic insertion of the tubes into a previously-assembled bank of laminae or fins to complete the formation of a heat-exchange core; to pro-

2

vide a machine of this kind wherein, after a predetermined number of laminae or fins have been first assembled in a jig, a selected number of transverse tubes are subsequently and simultaneously pressed into interfitting relationship with the jig-held laminae; to provide improved means for bracing the tubes against buckling during the initial pressing thereof into said interfitting relationship with said assembled laminae; to provide improved mechanism for advancing said tube-pressing means and returning it to its initial position preparatory to pressing a subsequent charge of tubes into a bank of assembled laminae; and to provide a machine of this kind which is especially suitable for cooperative association with a laminae- or fin-assembling machine of the character shown in my co-pending application hereinbefore identified.

In the accompanying drawings,

Fig. 1 is a perspective view of a section of a heat-exchange core, the tubes of which have been inserted into a bank of assembled fins by means of a machine constructed in accordance with this invention;

Fig. 2 is a perspective view of a fragment of one of the thin metal sheets, or laminae, which constitute the heat-dissipating fins of the core;

Fig. 3 is a perspective view of a portion of one of the tubes used in securing the laminae or fins in the assembled relationship, as shown in Fig. 1;

Fig. 4 is an enlarged fragmentary sectional view of the assembly jig with a number of laminae or fins in place and a number of tubes the ends of which have been inserted into the registering slots in the laminae;

Fig. 5 is a top plan view of a tube-inserting machine constructed in accordance with this invention, portions being broken away so as to more clearly illustrate operative parts of the machine;

Fig. 6 is a side elevation of the machine with practically all of the laminae-assembling mechanism omitted in order to more clearly show the structure which is involved in this tube-assembling machine;

Fig. 7 is an end-elevation of the complete core-assembling machine, the details of the laminae-assembling mechanism being omitted.

A machine constructed in accordance with this invention, and that disclosed in the previously-identified co-pending application, greatly facilitates the assembly of heat-exchange cores of the type shown in Fig. 1 and required for various kinds of heat exchange equipment. As therein shown, the heat-exchange core comprises, a plurality of parallel laminae or fins 8 supported on

3

a plurality of parallel tubes 9. When such a section is associated with suitable headers connecting the opposite ends of the tubes 9 and with plates (not shown) attached on two sides of the assembled fins 8, a fluid of one temperature will flow through the tubes 9 and a fluid of a higher or lower temperature will flow transversely of and around said tubes 9 between the laminae 8. The heat of the fluid with the higher temperature, thereupon, will be transferred to the fluid of the lower temperature.

A lamina 8, as more fully appears in Fig. 2, is in the form of a strip of thin sheet metal. A plurality of parallel series of slots or holes 10 are punched therein in such a way as to form lateral flanges 11 and end flanges 12. These flanges 11 and 12 tend to grip the flat tubes 9, when they are inserted through the registering apertures in an assembly of the laminae 8, so as to increase the surface contact of the fins on the tubes, thereby facilitating the transfer of heat between the differently-temperated fluids passing through and around the tubes 9. The lamina 8, in between the holes 10, have spots 13 up-set to enlarge the surface contact of the metal with the fluid passing between the laminae, whereby to facilitate the transference of heat. These up-set spots also tend to reinforce the laminae.

The tubes 9 are likewise formed of a thin sheet metal similar to that out of which the laminae 8 are formed. They are preferably flat, as shown in Fig. 3, since in that form there is a higher coefficient of heat transfer between the fluid and the tube.

The preferred form of tube-assembling machine shown in the drawings comprises a supporting frame 14 upon which is mounted an assembly jig 15 into which the laminae or fins 8 are assembled by a laminae- or fin-assembling mechanism 16 and into which assembled fins a plurality of the flat tubes 9 are pressed by the tube-insertion means 17 operated by a power unit 18.

The main supporting frame 14 comprises a pair of lateral angle bars 19 and 20 and a pair of end bars 21 and 22 forming the top of the supporting frame and intermediate lateral bars 23 and end bars 24 forming a support for a platform 25 all of which is supported on legs 26. The platform 25 provides a mounting for the aforesaid power unit 18 and the power unit 27 which operates the laminae-assembling mechanism 16. The lower ends of the legs 26 are provided with telescopic extensions 28 which have apertures 29 registering with appropriate apertures in the main leg members and through which bolts 30 extend to permit an adjusting of the height from the floor of the mechanism supported on the frame 14.

The laminae- or fin-assembling jig 15 comprises upper and lower members 31 and 32 having their opposed faces formed with grooves 33. These members are supported in adjustably-spaced relationship on the frame 14 by means of suitable bolts 34 and nuts 35 fixed on the angle bars 19 and 20 at the four corners of the members 31 and 32. These grooved members 31 and 32 constitute a type of jig commonly used for hand-assembling of laminae 8. Members 31 and 32 with varying spacing of the grooves may be mounted on the frame 14 and the distance between the grooved faces may be altered, by adjusting the nuts 34, to accommodate laminae of varying widths.

The laminae- or fin-handling mechanism 16, by which a predetermined number of laminae 8

4

are assembled in the jig 15, is the subject matter of the hereinbefore-identified copending application and hence is not further described.

The preferred embodiment of the tube-insertion means constructed in accordance with this invention comprises a tube-pushing member 36 and a tube-bracing member 37 mounted on the upper part of the frame 14 between the assembly jig 15 and the right-hand end of said frame. These parts are operated respectively by the power unit 18 and the air pump 38.

The tube-pushing member 36 is slidably supported on the frame rails 19 and 20 between the end rail 22 and the jig 15.

The tube-pushing member 36 is reciprocated on the frame by means of a pair of shafts 39 and 40 slidably mounted in bearings 41 and 42 secured to the underside of the frame bars 19 and 20, near the middle thereof. These shafts have racks 43 and 44 formed on the underside which mesh with gears 45 and 46 fixed at the ends of a shaft 47 journaled in bearings 48 and 49. The shaft 47 is driven by the power unit 18, employing a conventional chain-and-sprocket mechanism 50 connected with a reduction gear 51 which in turn is connected by twin belts 52 to a reversible motor 53.

The tube-bracing member 37 is slidably mounted on the shafts 39 and 40 for movement between the adjacent side of the assembly-jig 15 and a point intermediate the jig and the tube-pushing member 36. This tube-bracing member is provided with slots or holes aligned with the registering slots or holes in the laminae or fins assembled in jig 15.

The air-pump 38, whereby the tube-bracing member 37 is reciprocated, is mounted on the underside of the top of the frame 14 and has the plunger thereof adjustably connected by a rod 54 to a tube 55 secured to the member 37. The cylinder is connected to a suitable source of air pressure so that when air is admitted thereto the piston therein will retract the member 37 from its position abutting the adjacent side of the assembly jig 15 to a point intermediate that and the retracted tube-pushing member 36 (see Figs. 5 and 6).

Suitable switches (not herein shown) are arranged at the right-hand end of the frame 14, one of which controls the starting of the electrical motor 53 and the other of which controls the admission of compressed air to the air pump 38.

The operation of the device, herein shown and described, is as follows:

The number of tubes that can be pushed simultaneously through a bank of assembled laminae depends upon several factors, among which are the following: the number of laminae in the bank; the width and consequent flexibility of the laminae between the members 31 and 32; the number of tubes to be eventually associated with a bank of laminae; and the resistance encountered by reason of the contact of the tubes and the flanges around the laminae holes or slots.

In many cases, therefore, it may be necessary to insert the tubes in successive groups. In any event, it has been found advisable, before inserting any large number of tubes, to insert one or more tubes at or adjacent to each corner of the bank of laminae. This will ensure the other laminae holes or slots being brought into registration and provide a preliminary rigidity to the laminae, preparatory to inserting the remaining tubes. On occasions where the laminae may be

5

rather wide and the bank contain a great many laminae, it also may be advantageous to make a further preliminary insertion of a few tubes at scattered points through the bank of laminae before inserting any large number of tubes.

After the required number of laminae or fins 8 have been assembled in the jig 15, and the registration of the slots or holes 10 has been checked and corrected where required, the first set of tubes 9 have their ends inserted through the registering slots or holes in the tube-bracing member 37 and into the registering holes in the first few of the laminae or fins, substantially as shown in Fig. 4. Thereupon the switch to the air pump 38 is operated so that the tube-bracing member 15 is shifted to the position shown in Figs. 5 and 6. In such a position this plate supports the tubes against buckling during the initial part of the forward movement of the tube-pushing member 36. To effect this movement of the member 36 the operator actuates the switch controlling the motor 53. The slow movement of the tube-pushing member 36 toward the assembly jig 15 presses the tubes 9 through the holes in the laminae 8. As the member 36 reaches the member 37, the latter is carried along until the movement of both members is arrested by contact with the assembly jig 15.

As the member 36 reaches the forward limit of its movement, it operates a switch (not shown) automatically reversing the motor 53. Thereupon the member 36 is returned to its initial position, shown in the Figs. 5 and 6. As it approaches such position it automatically actuates a switch (not shown) to cut off the current to the motor 53, thus bringing an end to the cycle.

Variations and modifications in the details of structure and arrangement of the parts may be resorted to within the spirit and coverage of the appended claims.

I claim:

1. A machine for assembling a plurality of slotted laminae on a plurality of transverse bonding elements comprising, a supporting frame, an assembly jig on said frame for supporting a plurality of slotted laminae with the slots therein in alined registration, a pusher mounted on said frame for movement transversely of the assembled laminae for pushing a plurality of bonding elements simultaneously through the registered laminae slots, driving means for advancing

6

and retracting said pusher, and a bonding-element bracing-member reciprocatingly mounted intermediate said jig and pusher and movable between a retracted position abutting said jig to permit the insertion of the ends of the bonding elements into the registered slots in the directly adjacent assembled laminae and an extended position intermediate said jig and retracted pusher to brace the bonding elements during the initial movement of said pusher.

2. A machine for assembling a plurality of slotted laminae on a plurality of transverse bonding elements comprising, a supporting frame, an assembly jig on said frame for supporting a plurality of slotted laminae with the slots therein in alined registration, a pusher mounted on said frame for movement transversely of the assembled laminae for pushing a plurality of bonding elements simultaneously through the registered laminae slots, driving means for advancing and retracting said pusher, a bonding-element bracing-member reciprocatingly mounted intermediate said jig and pusher and movable between a retracted position abutting said jig to permit the insertion of the ends of the bonding elements into the registered slots in the directly adjacent assembled laminae and an extended position intermediate said jig and retracted pusher to brace the bonding elements during the initial movement of said pusher, and means independent of said pusher-operating means for shifting said bracing-member from its retracted position into its extended position.

3. A machine for assembling a plurality of slotted laminae on a plurality of transverse bonding elements comprising, a supporting frame, an assembly jig mounted at one end of said frame for supporting a plurality of slotted laminae with the slots therein in alined registration, a tube-pusher mounted on said frame, gear racks slidably mounted on said frame and connected to said pusher for reciprocating the same, a tube bracing member mounted on said gear racks for reciprocating movement between said jig and a point intermediate said jig and pusher, motor driven gears meshing with said gear racks for advancing and retracting said pusher, and an air motor connected to shift said bracing member from its retracted position to said intermediate position.

FRED M. YOUNG.