

Nov. 3, 1942.

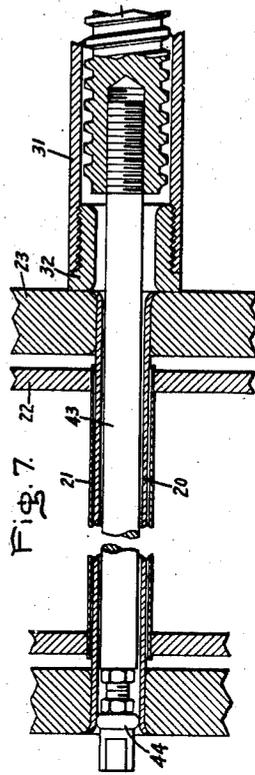
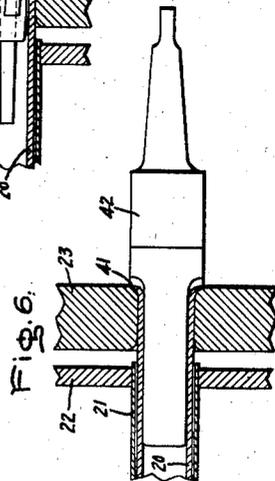
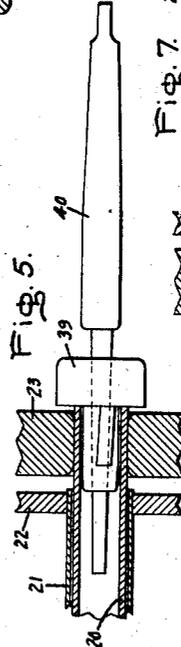
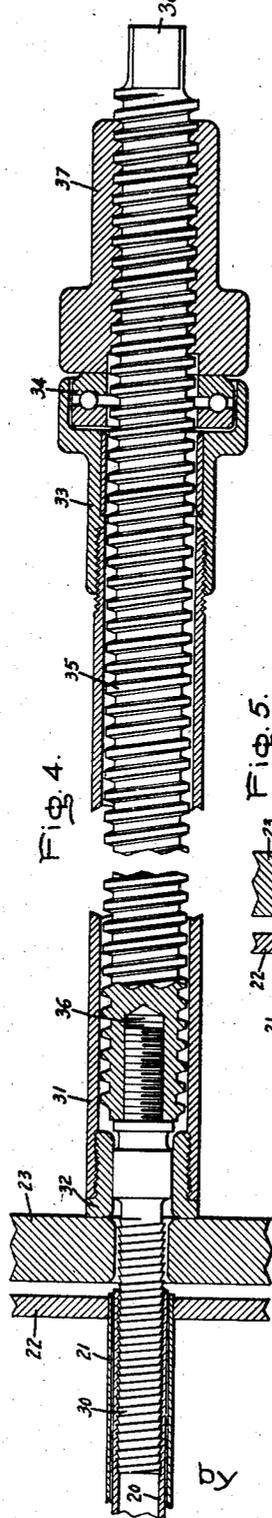
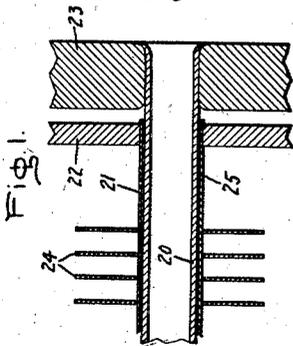
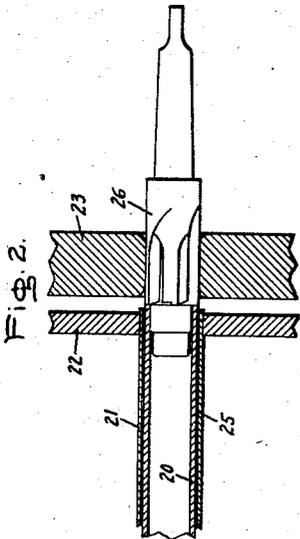
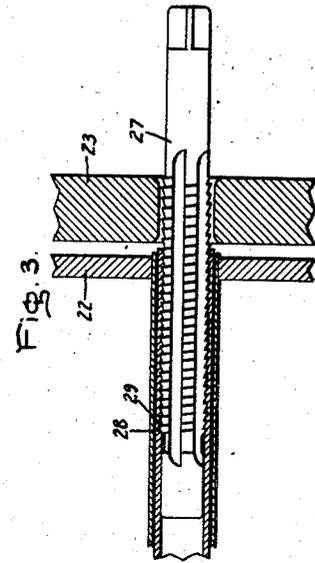
A. O. FLINDT

2,300,914

REPLACEMENT TOOL

Original Filed Oct. 7, 1939

2 Sheets, Sheet 1



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2 Sheets-Sheet 2

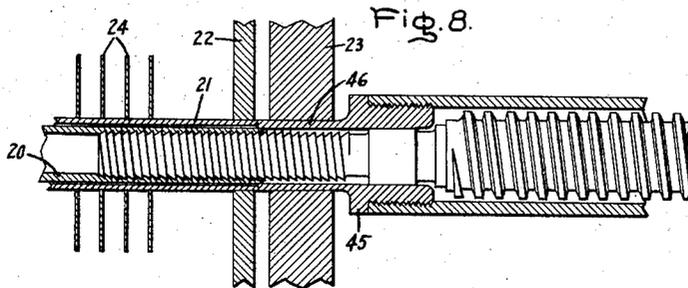
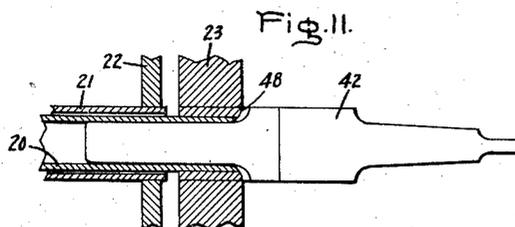
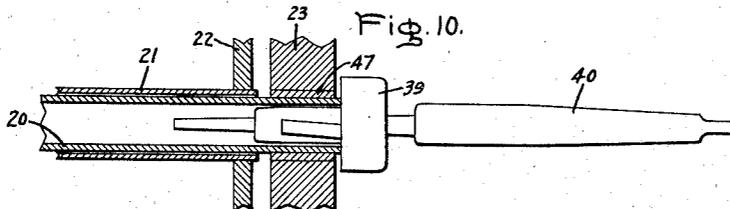
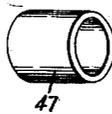


Fig. 9.



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UNITED STATES PATENT OFFICE

2,300,914

REPLACEMENT TOOL

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Original application October 7, 1939, Serial No.
298,432. Divided and this application March 3,
1941, Serial No. 381,569

1 Claim. (Cl. 29—88.2)

My invention relates to an improved replacement tool for changing the inner tube of two tightly fitted concentric tubes such as are found in a double tube surface air cooler.

This application is a division of my copending application Serial No. 298,432, filed October 7, 1939.

Surface air coolers in certain types of installations require extreme dependability and are sometimes provided with double tubes concentrically arranged so that if any leakage develops through corrosion of the inner tube, the cooling liquid will not pass into the air but will be drained away from a space between the inner and outer tubes which results from the outer tube being internally fluted. Replacement of damaged tubes without unnecessary delay generally is desirable and usually requires repairs at the place of the installation. With this type cooler difficulty is encountered in replacing leaky tubes because of the tight fit formed between the inner and outer tubes which is necessary to provide for the efficient transfer of heat therebetween. Tools to remove the inner tube must be designed to prevent dislodging or injuring of the outer tube.

An object of my invention is to provide a simple and efficient tool for replacing the inner tube of two tightly fitted concentric tubes.

Another object of my invention is to provide an improved apparatus for removing a tightly fitted tube from its support.

Further objects and advantages of my invention will become apparent from the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claim annexed to and forming a part of this specification.

For a better understanding of my invention reference is made to the accompanying drawings wherein the different figures show my improved tool structure design, and illustrate successive steps of my improved method of tube replacement which employs my improved tool. My improved method, however, is described and claimed in my above mentioned copending application. Fig. 1 is a sectional side elevation of the inner and outer tubes of one end of a double tube surface air cooler; Fig. 2 is a sectional side elevation of the tubes shown in Fig. 1 with a tube and cutter inserted into the inner tube; Fig. 3 is a sectional side elevation of the tubes shown in Fig. 1 with a buttress thread tap inserted into the inner tube; Fig. 4 is a sectional

side elevation of the tubes shown in Fig. 1 with my improved replacement tool attached thereto; Fig. 5 is a sectional side elevation of a new inner tube fitted into the outer tube and with an expander inserted into the inner tube; Fig. 6 is a sectional side elevation of the tubes shown in Fig. 5 with a flanging tool inserted into the inner tube; Fig. 7 is a sectional side elevation of the tubes shown in Fig. 5, and a partial sectional side elevation of my improved replacement tool having attached thereto a ball inner tube body expander; Fig. 8 is a sectional side elevation of the tubes shown in Fig. 1 with a modification of my improved replacement tool shown in Fig. 4; Fig. 9 is a side view of a ferrule; Fig. 10 is a sectional side elevation of the tubes and expander shown in Fig. 5 with the ferrule shown in Fig. 9 inserted into a bore in the outer tube sheet; and Fig. 11 is a sectional side elevation of the tubes and ferrule shown in Fig. 10 with a flanging tool inserted into the inner tube.

Referring to the drawings, in Fig. 1, I have illustrated a portion of an apparatus to which my replacement tool, I have found, may be conveniently and efficiently applied. This apparatus has reference to any type wherein a plurality of tightly fitted concentric tubes may be found and includes a damaged inner tube 20 tightly fitted into an outer tube 21. In order to provide an enclosing casing for the apparatus, there is provided an inner tube sheet 22 to which is attached the outer tube 21. An outer tube sheet 23 separating water and air spaces is also provided in which the ends of the inner tube 20 are expanded to make watertight joints. The inner and outer tubes shown in Fig. 1 may have reference to any apparatus wherein there may be found two tightly fitted concentric tubes, and in the modification shown, the tubes have reference to an air cooler wherein the heated air from the device to be cooled passes over the outer tube 21. In order to improve the heat transfer characteristic between the circulating air and tube 21 there may be provided fins 24 on the outer surface of the outer tube 21. The inner tube is designed to carry the cooling fluid and the heat transfer in this type of surface air cooler will therefore be from the outer tube 21 to the surface of the inner tube 20, through the tube 20 and then to the cooling fluid which flows through the inner tube. In some installations where this double tube surface air cooler is applicable, such as on shipboard, the inner tube carries salt water, and salt water being somewhat corrosive causes, in due time, some failures in the inner tube. In

order to provide an arrangement for notifying the operator when an inner tube has sprung a leak, a series of longitudinal passages are formed between the two tubes by providing flutes 25 in the inner surface of the outer tube. Thus the water from the leak may flow into the nearest flute and then into the space between the inner and outer tube sheets where a suitable alarm or notifying arrangement may be placed.

My improved tool and method of changing the inner tube in an apparatus such as of the type already described must usually be employed at the place of installation. If the air cooler is a part of the cooling system of a piece of electrical equipment, it is obviously very important that the repairs on the cooler be made as quickly as possible so that the electrical equipment may be again ready for operation. Since my improved method and replacement tool finds a ready application in this type of equipment, it is obvious that the repairs to the double tube surface air cooler must be made without removing the apparatus to a repair shop. The steps, therefore, of my improved method which I have developed to remove the inner of two tightly fitted concentric tubes from an apparatus at the place of installation, such as the type already described, and by which I make use of my improved replacement tool, includes the two main operations of first removing the damaged tube and second replacing the damaged tube by a new one. Since the tubes form a part of a heat transfer device, they must obviously be in close surface contact so as to be able to efficiently allow the heat to pass through them. Because of this tightly fitted condition the inner tube must be removed very carefully so as not to damage the outer tube. In removing the damaged tube I first cut the ends of the tube loose from the outer tube sheet and then tap one end with a special screw thread so that the replacement tool assembly may be attached thereto. Upon removing the damaged tube a new tube is inserted in place thereof and expanded so as to be in good heat conducting contact with the outer tube. The various steps of my improved method, I have found, can be accomplished through the use of my improved single tool assembly which will be described hereinafter.

As shown in Fig. 2, my improved method of removing a damaged or leaky inner tube includes the first step, after having disconnected any water connections to the inner tubes, of cutting out the ends of the inner tube which project through the outer tube sheet with a cutter 26. This cutter may be of any suitable type known in the art and will not be described. In order to be able to remove the inner tube it is important to provide a means which will not tend to expand the inner tube as it is pulled from the outer tube. I have found that a buttress thread cut in the inner tube provides a means for removing the inner tube which does not tend to expand the inner tube as it is pulled from the outer tube, as might occur if a standard pipe thread were provided. This operation is shown in Fig. 3 and includes tapping the ends of the inner tube with a tap 27. This tap is so designed as to cause a buttress thread to be cut in the inner surface of the inner tube. The thread cut has an inclined surface 28 toward the cutting end of the tap and a radial surface 29 toward the head end of the tap. When such a suitable thread has been cut into the inner surface of the inner tube, the tap 27 is removed and the

stud 30 screwed therein. The stud is then attached to a feed screw of my improved replacement tool which will now be described.

My improved method may be efficiently carried out, I have found, with my improved replacement tool or feed screw assembly which is illustrated in Fig. 4. This tool or feed screw assembly includes a tubular casing 31 which has a bushing 32 attached to one end thereof. This bushing may be attached to the casing by any suitable means such as by threads. The function of this bushing is to provide a bearing surface for one end of the feed screw assembly, and also to provide a bearing in which the stud 30 may rotate. At the other end of the tubular casing 31, there is provided a bearing housing 33 which is attached by any suitable means, such as by a press fit, to the outer surface thereof. This housing carries a thrust bearing 34, whose function will be more fully described hereinafter. Inside the casing and extending substantially the entire length thereof there is provided a feed screw 35. This feed screw has in one end a bore 36 into which one end of the stud 30 may be attached. The attachment may be effected by any suitable means such as by providing threads in the bore 36 and on the cooperating end of the stud 30. The other end of the feed screw extends beyond the thrust bearing so that a feed screw nut 37 may be screwed thereon. With the feed screw assembly attached to the inner tube in the manner as described above, and shown in Fig. 4, the inner tube may be removed in the following manner: The feed screw 35 is held stationary by any suitable means such as by a wrench inserted on a square end 38 thereof. Another wrench is then applied to the feed screw nut 37 and upon turning it in a clockwise direction the feed screw is caused to move outwardly. This operation draws out the tap stud 30 and the defective inner tube. The force necessary to remove the inner tube is developed by the turning of the nut 37 on the feed screw 35. The nut is held from moving in an axial direction by the thrust bearing 34 which is in turn held by the casing 31 which bears on the stationary outer tube sheet 23 through the bushing 32. The outer tube is now in a condition for the insertion therein of a new inner tube.

The new tube may be of the standard type, a supply of which is usually kept where the apparatus has been installed. This standard tube is of such a size that it slides easily into the bore of the outer tube. However, since heat must be efficiently conducted between these two tubes, it is necessary to make the inner tube tightly fit the inner surface of the outer tube. The remaining steps of my improved process were developed to effect this result and include the steps of first expanding the ends of the inner tube into close contact with its supporting outer tube sheet and then expanding the inner tube so that it makes a tight surface contact with the inner surface of the outer tube.

The first operation therefore on the new tube is shown in Fig. 5 and includes the expanding of the ends of the inner tube into the bore of the outer sheet by an expander 39. This expander provides an arrangement for exerting a radial force on the ends of the inner tube and comprises a housing formed with three rollers which are adapted to be forced outwardly by an expander drive pin 40. After the ends of the inner tube have been expanded into close contact with the bore of the outer tube sheet, the ends of

the tube may be flanged over at 41 (Fig. 6) by a flanging tool 42. This flanging tool has a curved axial cross-sectional portion back of the pilot to effect this operation. When this is done it will be seen that the ends of the inner tube are firmly secured to the outer tube sheets, and it finally becomes necessary to expand the entire length of the inner tube, so that the outer surface of the inner tube will be in good thermal contact with the inner surface of the outer tube. In order to do this, a ball expander is provided as shown in Fig. 7. This ball expander includes a long rod 43 which extends through the entire length of the tube and is attached at one end to the feed screw 35 and has attached to its opposite end a hardened expander ball 44. The expander rod 43 may be attached to the feed screw in the same manner as the stud 30 was. It may be seen that the same replacement tool or feed screw assembly is used to effect operation of the ball expander as was used to remove the defective inner tube. This expander is now drawn through the inside of the inner tube by holding the feed screw 35 from turning and by rotating the feed screw nut 37 in a clockwise direction. This causes the feed screw to move axially through the tube and carry with it the expander rod 43 with the expander ball 44 attached to the further end thereof.

In the construction shown in Fig. 1, since the outer tube is very tightly held to its inner tube sheet the outer tube will not break loose from the sheet when the inner tube is removed by the arrangement shown in Fig. 4. I have found that soldering is an effective way of securing the outer tube to the inner tube sheet so that this joint will not break when the inner tube is removed. However, when a less tight joint has been formed between the outer tube and the inner tube sheet, I have found that there is a possibility that this joint will break when the inner tube is removed by the arrangement shown in Fig. 4. In order to overcome this difficulty a modified form of my improved tool arrangement shown in Fig. 4 may be used, which is illustrated in Fig. 8. The essential steps of a modified method which may be used when there is not a tight joint between the outer tube and its inner tube sheet is shown by the Figs. 8-11. In Fig. 8 it will be seen that a similar tool arrangement is used as shown in Fig. 4 except that the bushing 32 has been replaced by a bushing 45 which is not constructed to bear on the outer tube sheet but has a tubular extension 46 which is properly dimensioned to extend through a hole in the outer tube sheet and bear on the end of the outer tube. With such an arrangement it will be seen that a force substantially equal to and opposite to the force necessary to remove the inner tube will be transmitted to the outer tube. In order to provide a hole in the outer tube sheet large enough to accommodate the tubular extension 46 of the bushing, it is necessary to cut into the outer tube sheet when cutting out the ends of the inner tube, as is shown in Fig. 2 with a cutter slightly larger than the outside diameter of the inner tube. This may be accomplished by merely selecting a slightly larger cutter 26 than that shown in Fig. 2. Then, in order to conveniently expand the ends of the newly inserted inner tube,

as is done by the operation shown in Fig. 5, I have found that it is desirable to make up for the increased material removed from around the bore of the outer tube sheet when the larger cutter 26 is used. A convenient way of accomplishing this result is to place a ferrule 47 (Fig. 9) into the bore which was cut by the larger cutter 26. This ferrule is a short tube whose length is substantially equal to the thickness of the outer tube sheet and whose thickness is substantially equivalent to the material removed from the outer tube sheet by the larger cutter 26. Then a new inner tube may be inserted and ends expanded into the bore of the ferrule by an expander 39, this operation being similar to the operation shown in Fig. 5. This step is shown in Fig. 10. Before expanding the ends of the newly inserted inner tube, as shown in Fig. 10, it may be desirable to first expand the ferrule into tight surface contact with the outer tube sheet. This may be done with the same expander 39 used in the step illustrated in Fig. 10, or with a similar one of slightly larger size. Then after the ends of the inner tube have been expanded into close contact with the bore of the ferrule, the ends of the tube may be flanged over at 48 by the flanging tool 42. This step is illustrated in Fig. 11. Then the final step of this modified method is similar to that shown in Fig. 7 and provides for the expansion of the entire inner tube into close surface contact with the inner surface of the outer tube.

In view of the foregoing, it will be seen that I have described an improved apparatus for removing the inner of two tightly fitted concentric tubes and further for causing a newly inserted tube to be placed in tight surface contact with the outer tube. As an example of an application of this apparatus, I have described its application to the replacement of the inner tube of a double tube surface air cooler, but it is, of course, to be understood that this tool is applicable wherever it is desirable to replace the inner tube of an assembly of two tightly fitted concentric tubes.

Although I have shown and described particular embodiments of my invention, I do not desire to be limited to the particular embodiments described, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

A tool adapted to cooperate with the inner of two tightly fitted concentric tubes including a tubular casing having a bushing at one end, a bearing housing at the other end, a feed screw extending through the bore of said tubular casing, a stud bolt, and a feed screw nut, said feed screw having connection at one end with said stud bolt and at the other end having threaded thereon said feed screw nut, said bearing housing having a thrust bearing adapted to cooperate with said nut, and said bushing having a portion arranged as a bearing surface for said stud and a shoulder extending around the end of said casing to provide a bearing surface for said casing.

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