# United States Patent [19]

**Ares et al.**

[11] **3,734,171**

[45] **May 22, 1973**


[54] **COIL FOR AIR DUCT INSTALLATION**


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[73] Assignee: **The Singer Company,** New York, N.Y.



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[52] **U.S. Cl.** .....**165/54,** 29/157.3 R, 98/40 C, 138/107, 165/76, 219/375

[51] **Int. Cl.** .....**F24h 3/02,** F16l 3/00

[58] **Field of Search**.....165/75, 76, 78, 54; 219/366, 374, 375, 376; 62/302, 448, 449; 29/157.3 R; 138/106, 107, 108



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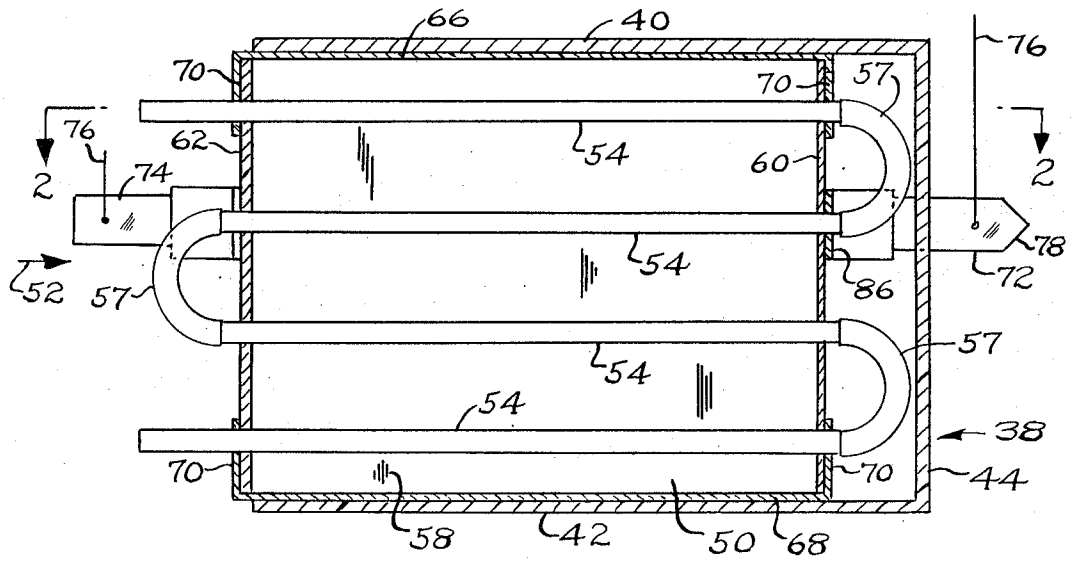
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[57] **ABSTRACT**

A cartridge-type heat exchange coil installed in a conventional air duct by way of a single side opening in the duct wall so that the coil rigidly positions itself within the duct cavity. The coil preferably has certain arms extending from its ends to provide duct-side piercing, positioning, and suspensioning. The arms are disposed outside the duct when the coil is installed, such that wires or straps can be attached to the arms to suspend the coil without appreciably loading or stressing the duct.


**12 Claims, 11 Drawing Figures**



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SHEET 1 OF 2

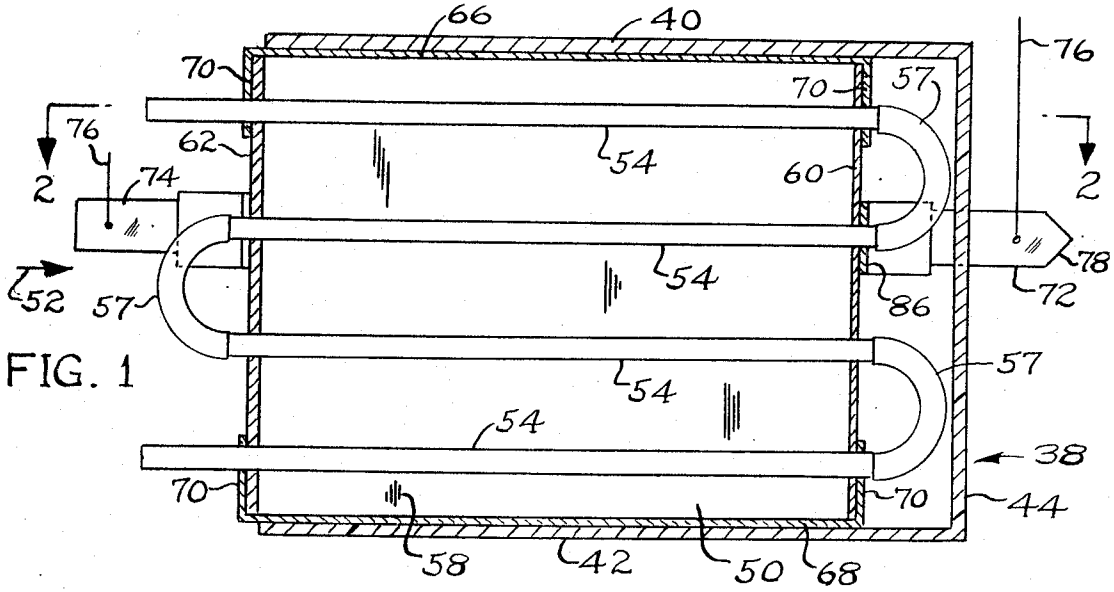



FIG. 1

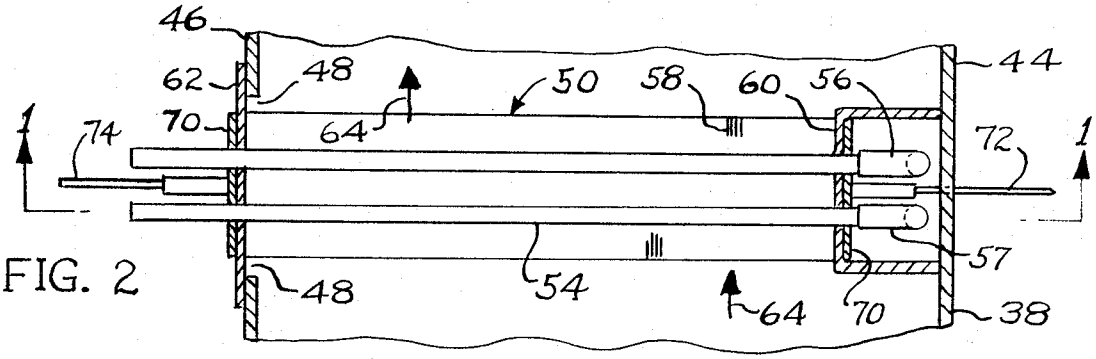



FIG. 2

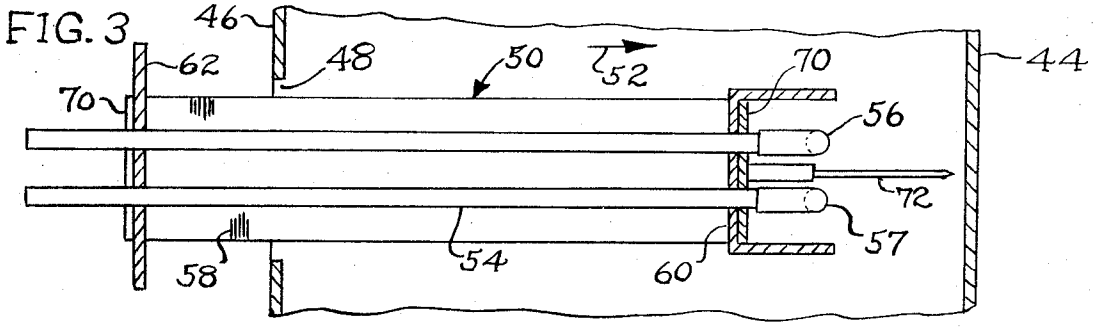



FIG. 3

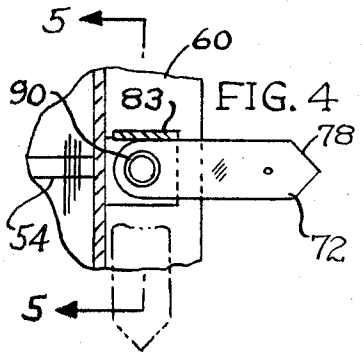



FIG. 4

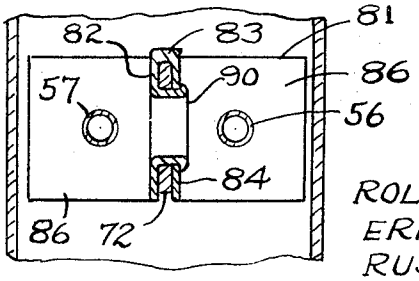



FIG. 5

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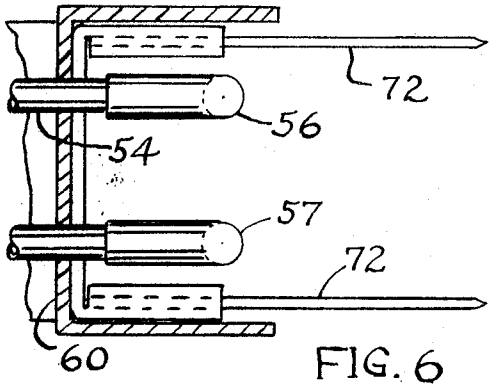



FIG. 6

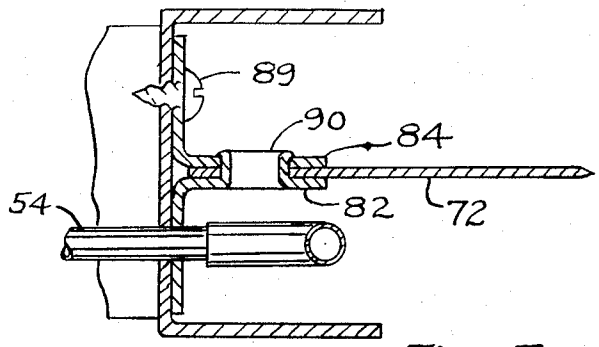



FIG. 7

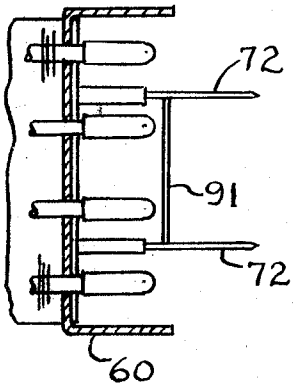



FIG. 8

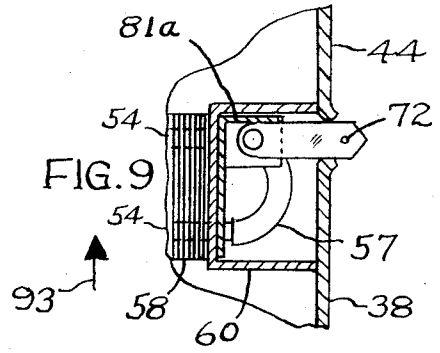



FIG. 9

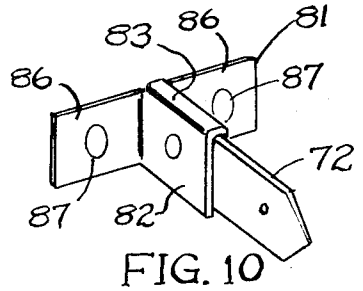



FIG. 10

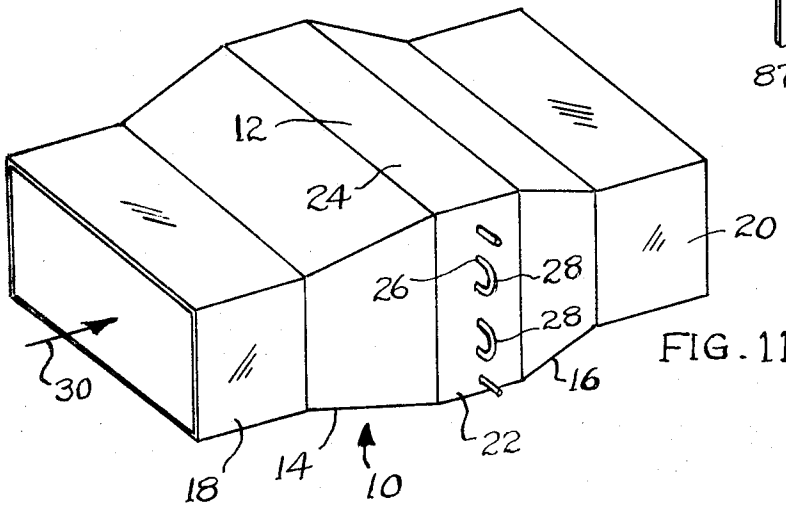



FIG. 11

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# COIL FOR AIR DUCT INSTALLATION

## THE DRAWINGS

FIG. 1 is a transverse sectional view taken through a horizontal air duct having a coil of the present invention mounted therein.

FIG. 2 is a sectional view taken on line 2—2 in FIG. 2.

FIG. 3 is a sectional view in the same direction as FIG. 2, but illustrating the coil partly inserted into the duct.

FIGS. 4 and 5 illustrate a suspension arm structure useful in practice of the invention.

FIGS. 6, 7 and 8 illustrate other suspension arm structures useful in carrying out the invention.

FIG. 9 is a fragmentary sectional view taken through a vertical air duct having a coil of the present invention mounted therein.

FIG. 10 is a perspective view of the suspension arm shown in FIGS. 4 and 5.

FIG. 11 is a perspective view showing a conventional duct-coil arrangement.

## CONVENTIONAL PRACTICE

FIG. 11 shows a conventional heat exchange assembly 10 adapted for mounting in a horizontal air duct, not shown. Assembly 10 comprises a finned heat exchange coil 12 secured between two transition duct sections 14 and 16 and two straight rectangular duct sections 18 and 20. Coil 12 includes two laterally spaced tube sheets (one of which is shown at 22), and two interconnecting baffle sheets (the upper one of which is shown at 24). The projecting ends of the single row of fluid tubes 26 are interconnected by U-bends 28 to provide a sinuous flow path for heat exchange fluid such as steam, hot water, chilled water, or vaporizable refrigerant. The non-visible sections of the tubes 26 between the tube sheets are equipped with plate fins or ribbon fins for assisting heat transfer on the air side of the tubes; direction of air flow is designated by numeral 30.

The various duct and coil sections are usually field-connected by bolt-flange arrangements or by bar-slip connections, as shown in U.S. Pat. No. 3,182,717 issued on May 11, 1965 in the name of R. E. Pierce. Whichever method of connection is employed, the various duct sections in assembly 10 must usually be successively attached together in the predetermined order dictated by their positions in the duct. Thus, as the first step duct 14 may be connected to duct 18, coil 12 may then be connected to duct 14, etc. The complete assembly 10 is attached at its upstream end to the already-completed air supply duct, and the next duct section is then attached onto the downstream end of assembly 10.

The transition duct sections 14 and 16 may in practice flare or taper in vertical planes and/or horizontal planes, depending on job-site clearance conditions. Usually the vertical overhead clearances are minimal, and therefore the more common practice is to flare and taper the sections in horizontal planes. The extent of the tape or flare is determined by system conditions, such as permissible air pressure drop, air temperature change requirement, water flow velocity, fin spacing, etc. In general, the flare or taper is intended to reduce the linear flow velocity of the air, thereby allowing a larger fin spacing for lower air flow resistance and also



providing for greater coil face area for more heat transfer surface.

One difficulty with the conventional arrangements of FIG. 11 is that the coil must usually be at the jobsite at the time the duct assembly 10 is being fabricated; it is difficult to fit coil 12 into the assembly at a later date because the coil must have a fairly close tolerance fit to provide air-sealing ability between adjacent sections 14 and 16. Coil removal, if operational failure occurs within the coil, is equally as difficult because of these close tolerances.

Another difficulty is that the weight of coil 12 must be supported or borne by the adjacent duct sections. When the coil has a large face area and/or multiple rows of tubes the coil may have an operating weight as much as 150 pounds or more, in which case both the connecting and adjacent duct sections may be stressed or deformed.

An additional difficulty stems from the fact that the coil position is affected by any tilt or side dip in the adjacent duct sections. Thus if the duct sections are tilted to one side then the coil will also be tilted. Depending on the coil header-tube arrangement, some coils should be pitched to one side a certain amount (e.g. one-eighth inch per foot of tube) or set level for proper condensate drainage or antifreeze up protection. With the conventional assembly methods and devices of FIG. 1 a proper coil positionment is not always possible.

A further difficulty is that removal or replacement of the coil (for repair or maintenance) causes a complete perimeter break between sections 14 and 16. This means that the air flow must be stopped while the coil is being repaired or replaced.

## PRESENT INVENTION

The present invention overcomes the above difficulties in that the coil of this invention is formed as a slidable cartridge for insertion into the duct system through a cut-out in the duct sidewall. Preferably the coil is fabricated to include at least one knife arm that pierces through the opposite sidewall of the duct during insertional movement of the coil cartridge; the knife arms can function as hanger devices to support the coil weight independently of the adjacent duct sections. The comtemplated arrangement is such that (1) the coil can be installed at any time during or after the duct work erection, (2) the coil weight is in large measure not transmitted to the adjacent duct sections, (3) the pitch of the coil can to a certain extent be controlled or regulated, and (4) the coil can be temporarily removed from the duct without terminating the air flow.

## FIGS. 1 THROUGH 3

FIGS. 1 and 2 show a horizontal rectangular air duct 38 having a top wall 40, bottom wall 42, right side wall 44, and left side wall 46. Side wall 46 is provided with a rectangular access opening 48 extending the full vertical dimension between top wall 40 and bottom wall 42. This opening is conventionally formed at the jobsite by conventional tin snips or other cutter devices, the nature of which depends on the duct material. Usually the duct will be galvanized steel or fiberglass. After the opening is formed the illustrated finned-tube heat exchange coil 50 can be installed in duct 38 by sliding the coil through opening 48 in the arrow 52 direction. FIG. 2 illustrates coil 50 fully inserted into the duct. FIG. 3 illustrates the coil partly inserted into the duct.

Coil 50 comprises two rows of fluid tubes 54 (four tubes per row) connected together by conventional U-bends 56 and 57 to form a sinuous fluid tube construction. Hot water, steam, etc., can be introduced to the uppermost tubes 54 and exhausted through the lowermost tubes 54 after giving up heat to the conventional plate fins 58 carried on the tubes. Tubes 54 extend between two tube sheets 60 and 62 which go the full height of the coil, thereby forming baffles for directing the air through the fins 58 instead of bypassing through the spaces occupied by U-bends 56 and 57. Tube sheet 60 is shown as a channel member, while tube sheet 62 is shown as a flat sheet member. It will be understood that the entire space between tube sheets 60 and 62 is occupied by fins 58 so that air flowing horizontally in the arrow 64 direction is heated as it passes through the fin spaces. The channel character of tube sheet 60 isolates and insulates U-bends 57 from the flowing air stream so that heat transfer is effectively confined to the finned areas of the tubes.

The FIG. 1 coil is provided with upper and lower baffle sheets 66 and 68, each having inturned ends 70 which are apertured to encircle the adjacent tubes 54. During manufacture of the coil the tubes 54 are loosely extended through the assembly comprising tube sheets 60 and 62, a stack of fins 58 and the flanged baffle sheets 66 and 68. Conventional rod-type mandrels are then run through the tubes to expand the tubes into tight gripping relation with the apertures in flanges 70, tube sheets 60 and 62, and fins 58; this operation produces a rigid sub-assembly. U-bends 56 and 57 are soldered or otherwise secured to the projecting ends of tubes 54 to form the complete coil.

FIG. 2 illustrates the invention applied to a coil having two rows of tubes 54, but it will be understood that the invention is also applicable to coils having more or less rows of tubes; it will also be understood that the number of tubes in each row can be increased, for example from the illustrated four tubes to 10 tubes. Coil size is commonly in the range between 1 foot to 5 feet long (distance between tube sheets 60 and 62), and between one-half foot and 2 feet high (distance between baffle sheets 66 and 68), all in accordance with the existing dimensions of the jobsite duct 38. The coil weight is of course influenced by its size, and also by the fin material (copper or aluminum) and fin spacing; commonly the fins are spaced eight fins per inch of tube length or 14 fins per inch of tube length. The weight of the dry coil is commonly in the general range from about 5 pounds up to about 150 pounds. The coil is useful as an add-on "booster" device for commercial, residential and industrial heating or tempering systems, wherein conditioned air is supplied to different zones through duct work. The coil may be used in a horizontal duct system as shown in FIG. 2 or in a vertical duct system (FIG. 9).

Installation of the FIG. 2 coil at the jobsite involves a manual movement of the coil through opening 18 in the arrow 52 direction. The coil is provided with a piercing element 72; consequently as the coil approaches duct wall 44 piercing element 72 forms an opening in wall 44 such that element 72 extends outwardly beyond the duct as shown in FIG. 1 and 2. The exposed external portion of element 72 constitutes an arm structure which can be used to suspend the coil in a floating position within duct 40, whereby the weight of the coil is only slightly transmitted to the duct. This independent suspension feature is of principle advantage when the coil is a relatively large heavy coil, for example in excess of 50 pounds.

Arm structure 72 generally supports the right half of the coil; a second similar arm structure 74 may be used to support the left half of the coil. Suitable wires, cables or straps 76 may be attached to the arm structures 72 and 74 to support the coil weight from overhead beams or pipes (not shown). Arm structure 72 has a sharpened pointed leading edge 78 for the aforementioned wall-piercing function, but arm structure 74 need not necessarily perform a piercing function, and its exposed end can be blunt or non-sharpened. Holes can be formed in each arm structure 72 or 74 for attachment of the cable or strap.

Access opening 48 is necessarily somewhat wider than the width of coil 50 because the access opening is formed at the jobsite with non-precision equipment, and also because a certain clearance must be maintained to permit the coil to be slid into the duct in the arrow 52 direction. The tube sheet 62 overlaps and extends laterally beyond access opening 48, such that screws or the like can be inserted through marginal areas of the sheet to secure the coil in the duct.

The sharpened edge 78 of arm structure 72 can in some cases be hazardous to personnel during shipment of the coil to the site or while the coil is at the site awaiting installation. Therefore arm structure 72 is preferably mounted so that it can be retracted or pivoted to a safe position wherein its edge 78 is within the U-shaped baffle 60. FIGS. 4 and 5 illustrate one manner of pivotally mounting knife element 72 for retraction of its sharpened edge 78. As there shown, the blade-like knife element 72 is mounted on a bracket 81 which comprises two parallel plates 82 and 84 extending outwardly from a back plate 86. As shown in FIG. 10, plates 82 and 84 may take the form of a channel and plate 86 may take the form of tabs or wings bent at right angles to the two channel walls; various types of walls, bent plates, etc., can be used to form the bracket assembly.

Plates 82 and 84 are suitably formed to provide a sleeve-like pivot mount 90 (FIG. 4) for the blade element 72. When the blade element is pivoted downwardly about the axis of pivot 90 the knife edge 78 is disposed within channel 60 where it is unlikely to cut anyone handling the equipment. Preferably the spacing between plates 82 and 84 corresponds with the thickness of the blade element 72 so that the blade is frictionally retained in its "up" operating position except when manually depressed to its "down" transit position. The interconnecting wall 83 between plates 82 and 84 can serve to limit upward movement of the blade.

Mounting plate 86 may have pre-formed circular holes 87 therein spaced according to the spacing of tubes 54. With such an arrangement the arm assembly can be located with mounting plate 86 against the face of channel 60 prior to the aforementioned tube-expansion step; during the expansion step the tubes expand into tight engagement with plate 86, thereby rigidly locking the plate onto the coil.

While blunt arm 74 (FIG. 1) is shown as a pivotal element it need not be, because it does not have to have a sharpened cutting edge and because it need not project fro its tube sheet as far as knife arm element 72. If desired, arm element 74 could be formed as an integral

part of the upper flange **70**, or arm element **74** could be omitted and the upper tubes **54** used as suspension devices.

## MODIFIED SUSPENSION ARM STRUCTURES

FIG. **6** illustrates a double knife arm structure useful particularly with very heavy coils where a single knife might not provide sufficient support for the coil.

FIG. **7** illustrates an arrangement in which the knife arm is mounted on the coil using one of the heat exchange tubes (expanded) and a sheet metal screw **89.** The FIG. **5** arrangement is preferred because of the rigid locking action provided by the multiple tubes.

FIG. **8** is similar to FIG. **6** except that it shows four rows of coils unstead of two; also the two knife elements are interconnected by a tie bar **91** so that both elements are ensured of being in the same horizontal angle of attach when they pierce the duct wall (to prevent the coil from tilting).

## FIG. 9

FIG. **9** represents a fragmentary portion of a coil adapted to be used in a vertical air duct wherein the air flows up (as shown by arrow **93**) or down through the fins **58** carried on tubes **54.** The suspension arm **72** is pivotally carried on a mounting bracket **81**a generally similar to aforementioned bracket **81.** However the bracket is somewhat differently oriented to channel **60** because the coil is horizontally disposed rather than vertically as in FIG. **1.**

Insertional movement of the FIG. **9** coil into the duct is in a horizontal direction with the coil lying on its side. Since the coil does not ride along the bottom wall of the duct during its insertional movement, it may be necessary in some cases to provide special support devices at the trailing end (**62**) of the coil to maintain the coil in the desired horizontal orientation during the latter stages of the insertional movement. Also, it may be necessary to provide the coil with two support knives **72** to prevent tilt of the coil normal to the plane of the paper.

## FEATURES OF THE INVENTION

It will be seen that with the illustrated arrangements the coil can be installed in the duct at any stage in the duct-formation process; the coil can thus be delivered to the jobsite after the ductwork has been completed. Accordingly all coils in the system can be installed and hooked-up to their piping at the most advantageous time. The invention also enables coils to be installed in existing duct systems without revamping sections of the ductwork; it is a comparatively easy process to form access opening **48** after the duct is in place.

Previous to this invention it has been proposed to install electric heat units in the ducts by inserting them through access openings in the ducts in a manner somewhat similar to that proposed herein. However such electric heat units are very light structures and do not pose the same installation problems presented by the finned fluid coils contemplated by this invention. We propose the use of special suspension arms **72** and **74** for rigidly centering and supporting the coil substantially independently of the duct. Using such centering-suspension arms it should be possible to achieve levelling or pitched positionment of the coil; additionally the suspension arms may double as support devices for the duct section that contains the coil. Thus, instead of the duct supporting the coil the reverse in fact occurs, namely that the coil supports the duct. With very heavy coils this should enable coils to be used with relative ease in situations where it was not heretofore practical.

One further advantage of the proposed arrangement is that the coil can at any time be removed for repair or replacement without shutting off the air flow, except during the actual time it takes to effect coil removal and duct side patch. Thus, with the air flow temporarily stopped the coil can be removed, a sheet material patch can be applied over access opening **48** and the air flow resumed until the coil is repaired or a new coil is ordered and received from the factory. With conventional arrangements as depicted by FIG. **11** it is not feasible to provide a temporary patch because there is a complete perimeter break between duct sections.

We claim:

**1.** In combination with an air duct, heat exchange assembly comprising a finned tube coil positioned in said duct, two outwardly extending arms mounted on opposed sides of such coil, such arms projecting externally of said duct, and means connected to the external portions of said arms rigidly to support the coil in the duct and to assist in supporting the duct itself.

**2.** The combination of claim **1** wherein said coil is positioned in said duct by insertion through an aperture in one wall of the same, the arm on the leading side of the coil being formed with a sharpened edge to pierce the opposed duct wall and subsequently extend therethrough.

**3.** In combination with an air duct having an aperture in one wall, a heat exchange assembly comprising a coil and at least one arm extending outwardly from one side of said coil, said arm being formed with a sharpened edge, whereby said coil may be inserted into said duct by passage through said aperture with said sharpened arm edge piercing the opposed duct wall for penetration therethrough.

**4.** The combination of claim **3** wherein said coil has a second arm extending outwardly from an opposed side thereof, said arms in the inserted position of said coil projecting outwardly from opposite sides of said duct.

**5.** The combination of claim **4** wherein said coil has two parallel tube sheets from which the arms extend, the leading tube sheet having two end projections extending outwardly from the coil to isolate the coil U-bends from duct air flow and to position the coil by abutting said opposed duct wall.

**6.** The combination of claim **4** further including suspension means attached to the projecting portions of said arms rigidly to position said coil in said duct and to assist in supporting the duct itself.

**7.** The combination of claim **4** wherein said coil has two parallel tube sheets, the trailing tube sheet being configured completely to cover said duct aperture upon insertion of the coil.

**8.** A rectangular air duct having an access opening in one side wall, a finned tube heat exchange coil installed in said duct by sliding same through said opening, said coil including two tube sheets, an arm extending from the leading tube sheet through the opposed duct side wall and means connected to said arm externally of said duct to center and suspend the coil in the duct.

**9.** The combination of claim **8** wherein said arm structure has a sharpened leading edge operable to

pierce the duct sidewall as the coil is being moved into the duct.

**10.** The combination of claim **9** wherein said one arm structure is movably mounted on its tube sheet so as to have a horizontal "piercing" position and a vertical "retracted" position.

**11.** A horizontally oriented rectangular air duct having an access opening in one of its walls; a finned tube heat exchange coil disposed in an upright position within the duct so that the coil fins are vertical and parallel to the direction of air flow; said coil comprising horizontal tubes extending between laterally spaced tube sheets, and a cutter element projecting laterally from one of the tube sheets to pierce through a duct side wall as the coil is moved through the access opening into the duct.

**12.** The arrangement of claim **11** wherein said one tube sheet is of channel cross section, and the coil comprises U-bends disposed within the channel.

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