May 6, 1941. U. E. COONS 2,241,186

LIQUID COOLER

Filed March 16, 1940 2 Sheets-Sheet 1

Fig. 1.

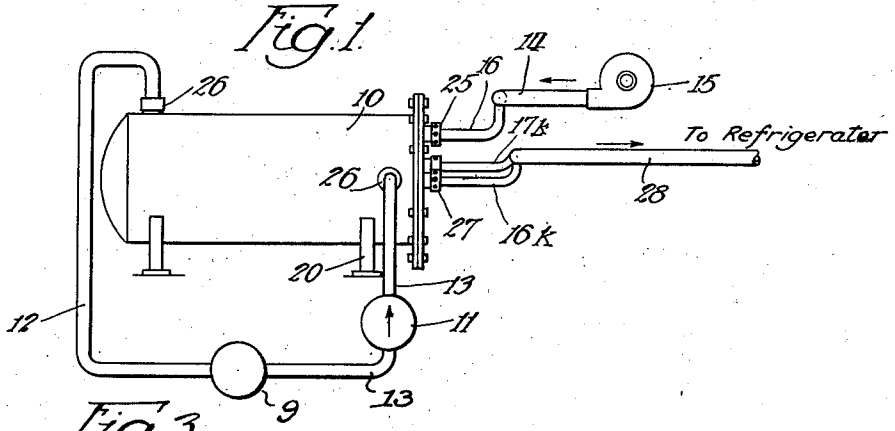


Fig. 3.

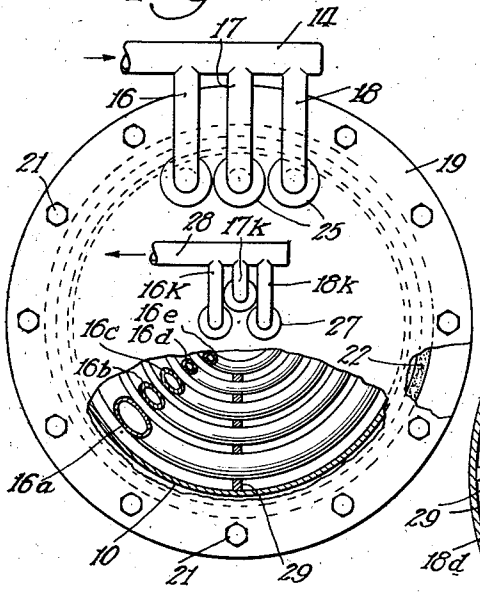


Fig. 4

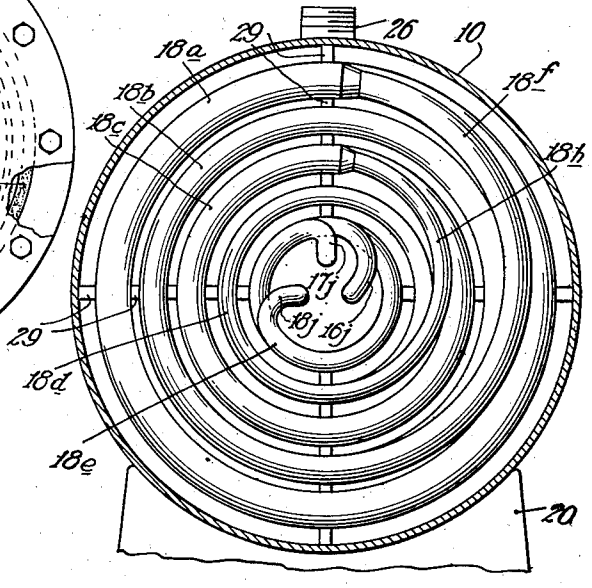
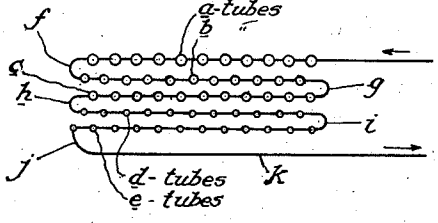


Fig. 6.



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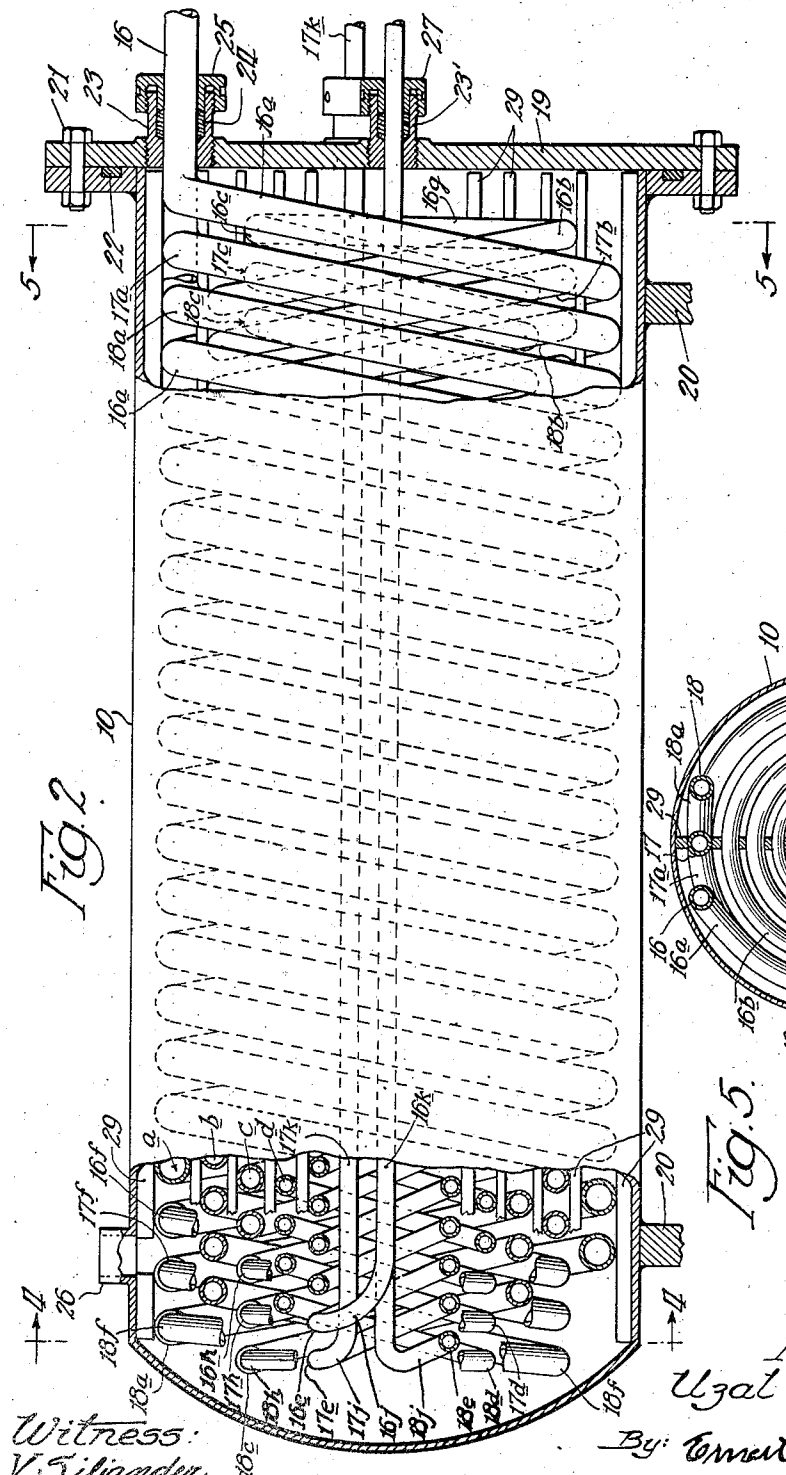


Fig. 2.

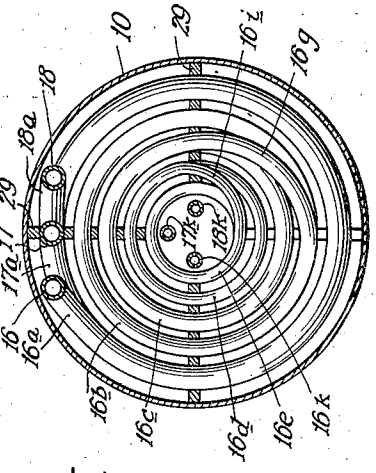


Fig. 5.

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UNITED STATES PATENT OFFICE

2,241,186

LIQUID COOLER

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Application March 16, 1940, Serial No. 324,305

8 Claims. (Cl. 62—141)

The invention relates to fluid coolers, and more particularly it relates to improved apparatus for lowering the temperature of water and other liquids in accordance with the methods described in my United States Patent No. 2,107,053, issued February 1, 1938.

The invention has as one of its objects the provision of an improved apparatus for reducing the temperature of water and other liquids below their freezing point without permitting the liquids to freeze, this being accomplished by causing the liquids to flow through a refrigerant at a rate such that freezing does not occur.

The invention has as another of its objects the provision of improved apparatus by means of which water and other liquids and fluids may be moved through a refrigerant at successively increased velocities, the velocities being correspondingly accelerated as the liquids become colder and at a rate such that the liquids or fluids will retain their fluidity although cooled to temperatures at which they normally congeal.

Another object of the invention is the provision of improved refrigerating apparatus including a plurality of helical tubular members through which water is adapted to be circulated, the helicals being so arranged that water passed successively through and discharged therefrom at selected volumetric rates per minute will have a successively increased velocity permitting the water to reach a temperature of 30° F. without freezing.

Still another object of the invention is to generally improve refrigerating apparatus of the kind described and to provide apparatus which is inexpensive to manufacture, durable, easily manipulated, economical in operation and satisfactory for its intended purpose.

Many other objects and advantages of the invention herein shown and described will be obvious to those skilled in the art from the disclosure herein given.

To this end, my invention consists in the novel construction, arrangement, and combination of parts herein shown and described and more particularly pointed out in the claims.

Referring now to the drawings wherein like reference characters indicate like or corresponding parts:

Fig. 1 is a diagrammatic view of apparatus embodying the principles of the invention;

Fig. 2 is an elevational view, partially in section, of a tank providing a container for a refrigerant having a multiplex system of tubes positioned in accordance with the principles of the invention;

Fig. 3 is an end elevational view partially in section further illustrating the container and tubes shown in Fig. 2;

Fig. 4 is a view along the line 4—4 of Fig. 2;

Fig. 5 is a view along the line 5—5 of Fig. 2, but drawn to a smaller scale; and

Fig. 6 is a diagrammatic view illustrating the path of fluid to be cooled as it is passing through one of a plurality of tubular members each arranged to provide a plurality of concentric telescoping helicals, the diameters of said conduits being smaller at their discharge than at their receiving ends with selected lengths thereof having successively smaller diameters in the direction of flow.

Referring now more particularly to the drawings, the invention is illustrated as embodied in apparatus including a tank 10 providing a container for a fluid refrigerant such as freon, ammonia, sulphur dioxide, or the like. The apparatus, illustrated diagrammatically in Fig. 1, includes in addition to the tank 10, a compressor 9 connected with the top of the tank at its rear end by a pipe 12 for conducting vaporized refrigerant from the tank to the compressor. A pipe 13 also provides a conduit connecting the compressor 9, through a condenser 11, with the front end of the tank 10, the pipe preferably opening into the tank at an elevation corresponding approximately with the elevation of the longitudinal axis of the tank. A main fluid delivery pipe 14 provides a conduit through which a centrifugal pump 15 forces liquid to be cooled from a source not shown into a plurality of tubular members or tubes projecting from the front end of the tank 10. Any suitable number of the tubes may be used and in the drawings, three are illustrated, these being generally designated by the numerals 16, 17, and 18, respectively.

The tank 10 preferably extends horizontally as shown and rests upon supporting members 20. The front end 19 of the tank 10 is fastened to the main body thereof by bolts 21 to permit its removal for access to the interior of the tank. A gasket 22 positioned between the flange of the tank and the end 19 is so arranged as to provide a fluid-tight seal for the joint.

The delivery ends of the tubes 16, 17, and 18 each extends through a sleeve 23 threaded into the end 19 of the tank. The sleeves 23 contain packing 24 compressed against the tubes by means of caps 25 to prevent leakage of refrigerant fluid through the sleeves. The tank 10

provides threaded annular flanges 26 providing fluid-tight connection therewith of the pipes 12 and 13, respectively. Refrigerating fluid is maintained in the tank 10 at any suitable pressure and degree of liquefaction by operation of the compressor 9. The successive stages of liquefaction and gasification of the refrigerant fluid by operation of the compressor is well known and since is forms no part of the invention, further description thereof is omitted.

The tubes 16, 17, and 18 are each respectively arranged to provide a plurality of connected concentric telescoping helicals, extending substantially the full length of the tank 10. The three outer helicals respectively provided by the tubes 16, 17, and 18 are directly connected with the centrifugal pump 15 through the main pipe 14 and each consists of a plurality of coils preferably all of equal diameter, the coils of the three helicals being respectively designated as 16*a*, 17*a*, and 18*a*. The three helicals next smaller in diameter provided by the tubes 16, 17, and 18 consist of coils of equal diameter, the coils of the three helicals being respectively designated by the numerals 16*b*, 17*b*, and 18*b*. Likewise, a plurality of coils 16*c*, 17*c*, and 18*c* all of equal diameter and respectively provided by the tubes 16, 17, and 18 form three helicals next smaller in diameter than the helicals provided by the coils having the subscript *b*. Similarly, the three helicals next smaller in diameter than those provided by the coils having the subscript *c* consist of coils all of equal diameter respectively designated by the numerals 16*d*, 17*d*, and 18*d*. The three helicals having the smallest diameter consist of coils of equal diameter, the coils comprising the three helicals being respectively designated by the numerals 16*e*, 17*e*, and 18*e*. The three helicals respectively consisting of coils 16*a*, 17*a*, and 18*a* are respectively connected at the rear end of the tank by tube sections 16*f*, 17*f*, and 18*f* with the helicals consisting of coils 16*b*, 17*b*, and 18*b*. Likewise, the three helicals respectively consisting of coils 16*b*, 17*b*, and 18*b* are respectively connected at the front end of the tank with the helicals 16*c*, 17*c*, and 18*c* by means of tube sections 16*g*, 17*g*, and 18*g*. The three helicals respectively consisting of coils 16*c*, 17*c*, and 18*c* are respectively connected at the rear end of the tank with the three corresponding helicals consisting of coils 16*d*, 17*d*, and 18*d* by means of tube sections respectively designated by 16*h*, 17*h*, and 18*h*. Similarly, the three helicals respectively consisting of coils 16*d*, 17*d*, and 18*d* are respectively connected at the front end of the tank with the three smallest helicals consisting of coils 16*e*, 17*e*, and 18*e* by means of tube sections respectively designated by the numerals 16*i*, 17*i*, and 18*i*. The rear ends of the three helicals consisting of the coils 16*e*, 17*e*, and 18*e* are respectively connected by tube sections 16*j*, 17*j*, and 18*j* with straight tube sections 16*k*, 17*k*, and 18*k*.

The three tube sections having the subscripts *k* are shown as arranged in compact triangular relation and are positioned approximately in the middle of and extend longitudinally from the rear of the tank 10 to project through the front end 19 thereof. Since the contents of the sections 16*k*, 17*k* and 18*k* have reached the lowest possible temperature, one advantage of the sections being straight is that the contents are rapidly evacuated. Another advantage is that the sections are adapted for and may be used as mandrels about which the tubes are curved in forming the helicals. The spacings between the coils comprising the various helicals, the radial spacing between the respective helicals and the spacing of the inner straight tubes having the subscript *k* from each other and from the inner helical are such as to produce maximum efficiency in cooling.

The tube sections 16*k*, 17*k*, and 18*k*, extend through sleeves 23' mounted in the end 19 of the tank, the sleeve space surrounding the tubes being made fluid-tight by packing 24 compressed by caps 27 against the respective tubes and encompassing sleeves. The projecting ends of the tube sections 16*k*, 17*k*, and 18*k* are connected with a main discharge pipe 28 leading to a refrigerator or other cooling element where the fluid contents of the pipe absorb heat. If the fluid content of the pipe 28 is utilized solely as a heat transferring medium, it may be returned to the centrifugal pump 15 from the refrigerator or cooling element by a conduit not shown for recirculation through the helicals. The apparatus is especially adapted for use in cooling water below freezing so that it may be utilized by bakers in preparing dough at low temperatures as well as for numerous other uses wherein low temperature liquids are desirable.

The pitch of the three helicals respectively consisting of coils 16*a*, 17*a*, and 18*a* is the same and is such that the coils of these helicals are each positioned as shown between and concentric with the corresponding coils of the other two helicals. The other groups of three helicals which respectively consist of coils having subscripts *b*, *c*, *d*, and *e*, also have their coils arranged and positioned as described for the coils consisting of the outer helicals having the designating subscript *a* so that each of the coils of each group of helicals is positioned between corresponding coils formed by a different tube.

Each group of three helicals comprising coils of the same diameter are separated from the next adjacent group of helicals by spacer bars 29 extending longitudinally of the tank. The diameters of the coils comprising the different groups of helicals is such that cylindrical spaces of substantially uniform radial dimensions are provided between the various groups of helicals, the dimensions of the spaces being relatively small as shown so that a substantial portion of the tank capacity or volume is occupied by a relatively large number of substantially equally spaced coils, the described spacing and arrangement being such as to utilize the refrigerant in a manner conducive to maximum efficiency for transfer of heat.

In order that liquid may be cooled below its freezing point, as set out in the above designated patent, it is necessary that the velocity of the liquid through the coils be accelerated as the liquid is cooled to prevent it from freezing. The receiving end of the tubes 16, 17, and 18 and the outer group of helicals are of a uniform inner diameter, as shown, which for the purpose of description may herein be considered as one inch. The acceleration of velocity is accomplished by having the inner diameter of the tubes comprising the two next smaller groups of telescoping helicals uniform and smaller than the inner diameter of the outer group of helicals and larger than the inner diameter of the two inner groups of helicals, the diameters of the latter being likewise shown as uniform. The amount the inner diameters of the coils should be decreased in the direction of flow of the liquid to obtain maximum efficiency in cooling liquid contents of the tubes

below freezing point depends upon a number of factors not necessary to be set out in order to explain the invention. However, it is found in practice that use of the apparatus with ammonia as a refrigerant is highly efficient in apparatus having the inner diameters of the tubes successively diminished so that the cross sectional area of each tube is reduced approximately fifty per cent when the liquid has traveled through approximately seventy-five per cent of its lineal path.

Delivery of the refrigerant from the compressor 11 into the front end of the tank 10 adjacent the discharge end of the tubes wherein the temperature of the liquid contents has been reduced as low as possible without freezing and discharge of the refrigerant at the top and rear end of the tank where the liquid contents of the tubes has a relatively high temperature also contributes to the efficiency of the apparatus.

Thus, it will be seen that the invention provides improved apparatus for cooling liquids and fluids below their normal freezing temperature without affecting the fluidity of such liquids or fluids.

Having thus described my invention, it is obvious that various immaterial modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts herein shown and described or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. Apparatus of the kind described comprising a container for a refrigerant, a tube providing a conduit for passing fluid through the container, said tube being arranged to provide a plurality of coils so connected as to form a plurality of concentric telescoping helicals, one end of said tube being adapted to deliver fluid to said helicals and the other end of said tube to discharge fluid therefrom, the delivery end of the tube and the coiled portion thereof through which the fluid initially flows having a larger inner diameter than the discharge end of said tube and the coiled portion thereof through which the fluid is passed immediately before its discharge, said delivery end comprising a straight section extending through the central region and being arranged substantially symmetrical to the longitudinal axis of said helicals.

2. Apparatus of the kind described comprising a container for a refrigerant, a tube providing a conduit for passing fluid through the container, said tube arranged to provide a plurality of coils so connected as to form a plurality of concentric telescoping helicals, means connected with one end of said tube operable to deliver fluid to the outer one of said helicals, said helicals being so connected that the fluid passes from said outer helical having the largest coils, thence through the helical having the next largest coils and so on sequentially until it passes through the helical having the smallest coils and from which the fluid is finally discharged from the container, the fluid receiving end of the tube and the coiled portion thereof through which the fluid is initially passed having a larger inner diameter than the discharge end of said tube and coiled portion thereof through which the fluid is finally passed, the portion of the tube through which the fluid is intermediately passed having an inner diameter smaller than the diameters of that portion of the tube through which the fluid is initially passed and larger than the diameter of that portion of the tube through which the fluid is finally passed as aforesaid.

3. Apparatus of the kind described comprising a container for a refrigerant, a tube providing a conduit for passing fluid through the container, said tube being arranged to provide a plurality of coils so connected as to form a plurality of telescoping helicals, one end of said tube being adapted to receive and to deliver fluid into the larger of said helicals and the other end being adapted to discharge fluid from the inner of said helicals, the inner diameter of the receiving end of the tube and a selected length of coiled portion thereof through which the fluid is initially passed being uniform, and the inner diameter of other selected portions being uniform, said inner diameters of the tube being successively smaller in the direction of flow.

4. Apparatus of the kind described comprising a container for a refrigerant, a plurality of tubes each providing a conduit for passing fluid through the container, said tubes each being arranged to provide a plurality of coils so connected as to form a plurality of concentric telescoping helicals of the same number and of substantially the same dimensions as the corresponding helicals of the other tubes, each of said tubes having one end adapted to receive and to deliver fluid to its helical comprising the largest coils and its other end adapted to discharge fluid from its helical comprising the smallest coils, the receiving end of each tube and coiled portion thereof through which the fluid initially flows having a larger inner diameter than its discharge end and the coiled portion thereof through which the fluid finally flows, said tubes being assembled in the container with the corresponding helicals of each tube having their coils interposed between the similar coils of the other tubes, the receiving end of each tube and the coiled portion thereof through which the fluid initially passes having a larger inner diameter than the inner diameter of its discharge end and the coiled portion thereof through which the fluid is finally passed.

5. Apparatus of the kind described comprising a container for a refrigerant, a plurality of tubes each providing a conduit for passing fluid through the container, said tubes each being arranged to provide a plurality of coils so connected as to form a plurality of concentric connected telescoping helicals, each of said tubes providing the same number of helicals, corresponding helicals of each tube having the same diameter and pitch and being of substantially the same length, said tubes being assembled in the container with the coils of corresponding helicals concentric and positioned between and extending spirally parallel to the coils of the corresponding helicals provided by the other tubes, one end of each of said tubes being adapted to receive fluid for passage therethrough and the other end of each of said tubes being adapted to discharge fluid so delivered, selected sections of each tube in the order in which fluid flows therethrough having uniform inner diameters, said inner diameters of the tubes being successively smaller in the direction of flow.

6. Apparatus of the kind described comprising a container for a refrigerant, a plurality of tubes each providing a conduit for passing fluid through the container, said tubes each being arranged to provide a plurality of coils so connected as

to form a plurality of concentric connected telescoping helicals, each of said tubes providing the same number of helicals, corresponding helicals of each tube having the same diameter and pitch and being of substantially the same length, said tubes being assembled in the container with the coils of corresponding helicals concentric and positioned between and extending spirally parallel to the coils of the corresponding helicals provided by the other tubes, one end of each of said tubes being adapted to receive fluid for passage therethrough and the other end of each of said tubes being adapted to discharge fluid so delivered, means operable to simultaneously deliver fluid to the receiving ends of said tubes, selected sections of each tube in the order in which fluid flows therethrough having uniform inner diameters, said inner diameters of the tubes being successively smaller in the direction of flow, the discharge end of said tubes extending through the central region and being arranged substantially symmetrical to the longitudinal axis of said helicals.

7. Apparatus of the kind described comprising a container for a refrigerant, a tube providing a conduit for passing fluid through the container, said tube being arranged to provide a plurality of coils so connected as to form a plurality of concentric telescoping helicals, one end of said tube being adapted to deliver fluid to said helicals and the other end of said tube to discharge fluid therefrom, the delivery end of the tube having a larger inner diameter than the discharge end thereof, and the coils provided by said delivery end being larger in diameter than the coils comprising said discharge end.

8. Apparatus of the kind described comprising a horizontally extending cylindrical container for a refrigerant, a tube providing a conduit for passing fluid longitudinally back and forth through the container, said tube being arranged to provide a plurality of coils so connected as to form a plurality of concentric horizontally extending helicals, one end of said tube being adapted to deliver fluid to said helicals and the other end of said tube to discharge fluid therefrom, the delivery end of the tube and the coiled portion thereof through which the fluid initially flows having a larger inner diameter than the discharge end of said tube and the coiled portion thereof through which the fluid is passed immediately before it is discharged.

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