Feb. 23, 1965 J. F. D. SMITH 3,170,512

HEAT EXCHANGER

Filed March 29, 1963

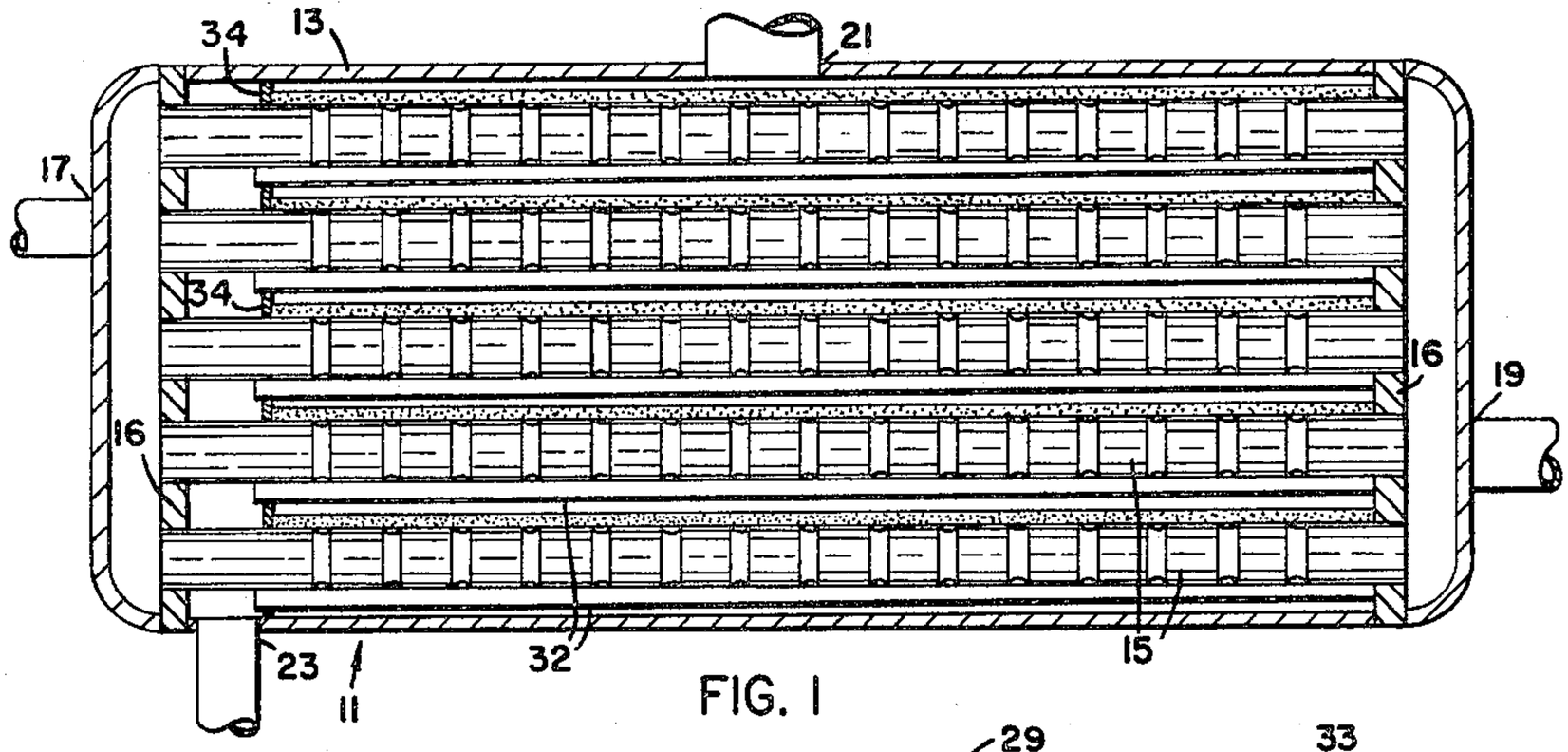

FIG. 1

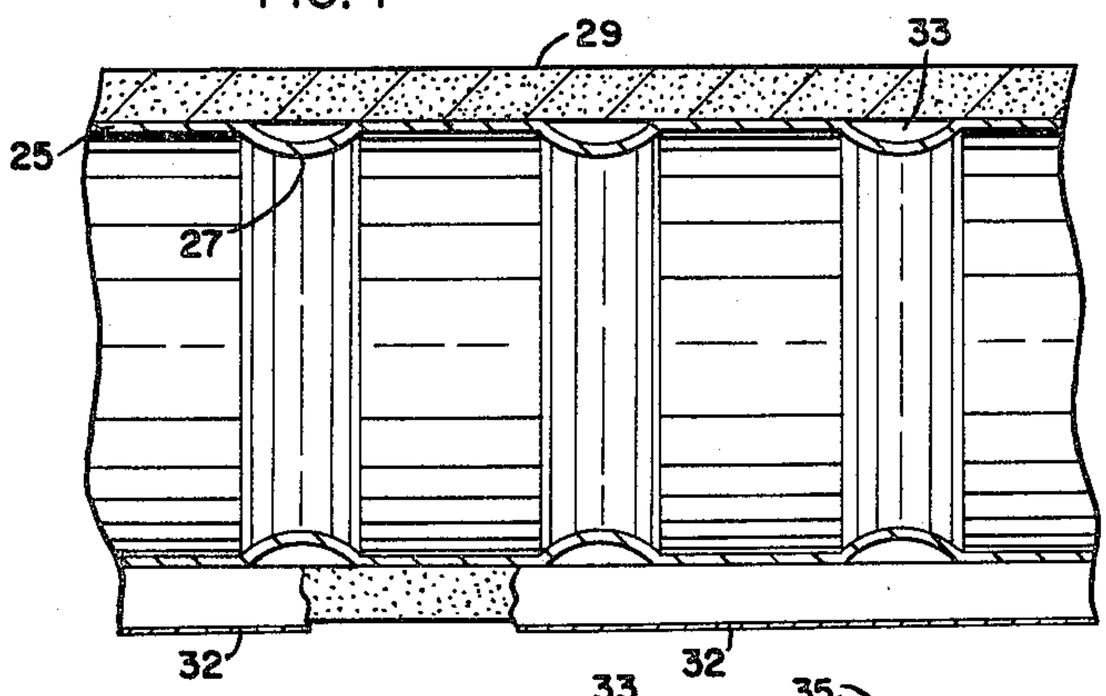

FIG. 3

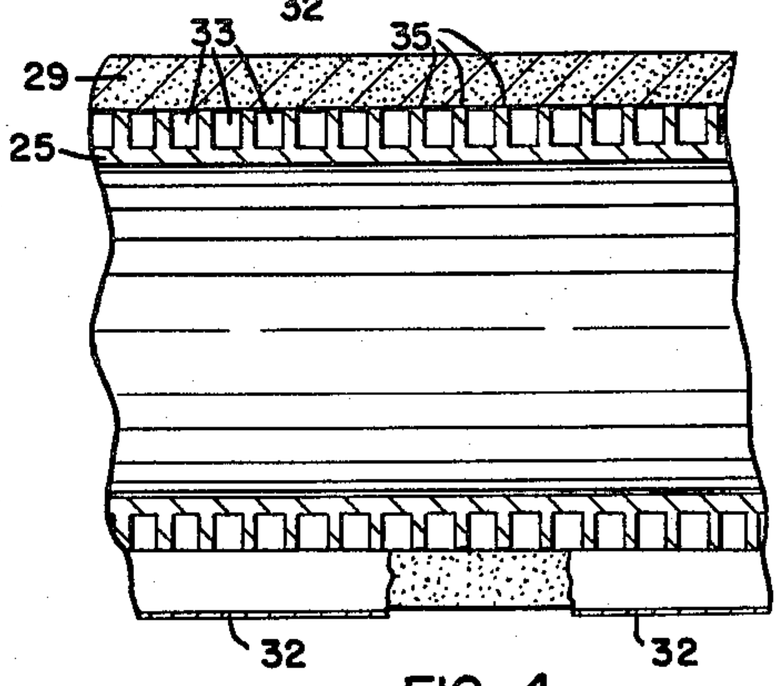

FIG. 4

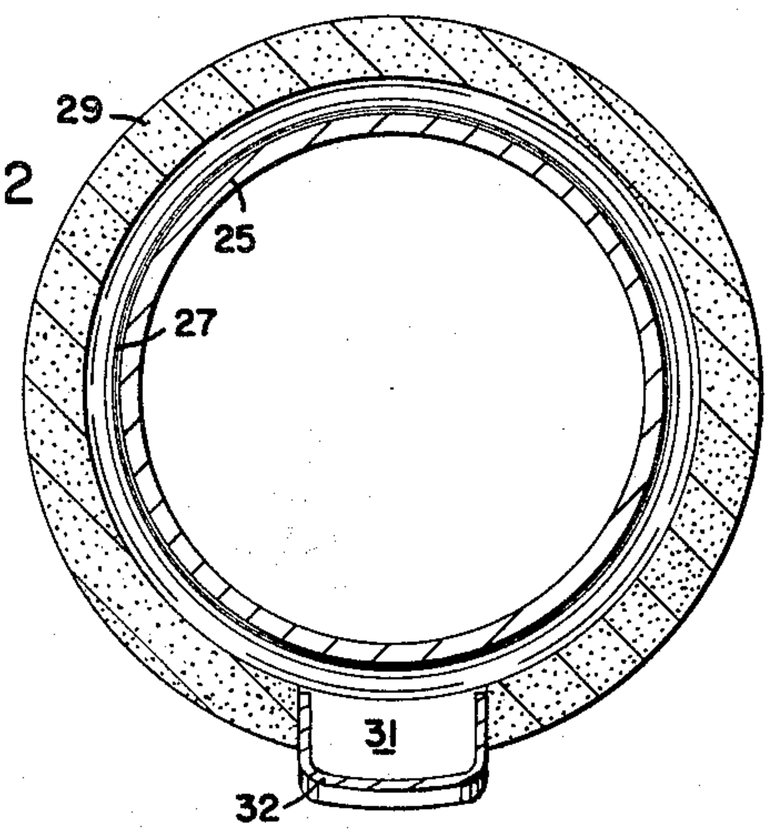

FIG. 2

INVENTOR.
JOHN F. D. SMITH.
BY John Gregg
ATTORNEY.

United States Patent Office

3,170,512

Patented Feb. 23, 1965

1

3,170,512
HEAT EXCHANGER

John F. D. Smith, Fayetteville, N.Y., assignor to Carrier Corporation, Syracuse, N.Y., a corporation of Delaware

Filed Mar. 29, 1963, Ser. No. 268,945
3 Claims. (Cl. 165—110)

This invention relates generally to heat exchange apparatus. More particularly, this invention pertains to improved heat exchange tubes for use in condensers.

Typical construction of condensers herein under consideration, comprises an enclosed shell having a plurality of heat exchange tubes disposed therein forming interior passageways. The shell is provided with suitable connections for passing two fluid mediums in heat exchange relationship with each other such that heat is transferred from one of the mediums to the other. The heat exchange tubes conduct a first fluid medium through their interior and provide a surface over which a second fluid medium in the gaseous state may flow. The temperature difference between these two fluid mediums is such that the second fluid medium will condense by dissipating its heat of condensation to the first fluid medium.

A substantial quantity of heat may be rejected in this manner; however, the heat transfer capacity of a given size condenser is limited to a great extent by the temperature difference between the two fluid mediums and is also highly dependent upon the contact surface available for heat transfer.

It is an object of this invention to improve the heat transfer performance of condensers for use in refrigeration systems and the like.

Another object of this invention is to provide a heat exchange tube having a porous heat transfer surface and an arrangement for drainage of condensate.

These and other objects of this invention are achieved in the illustrated embodiments by providing a condenser having a plurality of horizontal heat exchange tubes disposed within its outer shell. These tubes are each comprised of an impervious metal pipe substantially covered by a porous metal jacket to define an elongated opening along the bottom of the jacket. Portions of the pipe and jacket are in spaced relation forming a plurality of annular passageways in communication with the opening in the bottom so that condensate formed in the porous jacket may flow into the passageways and drain out the opening into a drain trough.

The porous jacket is formed of a compacted metal powder that provides a very large surface area in relation to its volume available for heat transfer and may be any metal possessing good thermal conducting characteristics, for example, electrolytically produced dendritic copper powder. The term "porous" as used herein is defined as the characteristic of a body having a large number of minute internal cavities of capillary size which form surface interstices in communication with a number of the internal cavities to provide minute passageways whereby a fluid medium may pass through the body.

The various features and advantages of this invention will become apparent from the following description when considered in connection with the drawings wherein:

FIGURE 1 is a diagrammatic sectional view of a condenser having heat exchange tubes in accordance with this invention;

FIGURE 2 is an end view of a heat exchange tube as contemplated by this invention;

FIGURE 3 is a sectional view of the heat exchange tube shown in FIGURE 2;

FIGURE 4 is a sectional view of the heat exchange tube in a modified form as contemplated by this invention.

2

Referring more particularly to the drawings, FIGURE 1 shows a condenser **11** having an outer shell **13** with a plurality of heat exchange tubes **15** horizontally disposed therein and supported by the tube sheets **16**. Condenser **11** is provided with connections **17** and **19** for conduction of a first fluid medium which passes through the interior of the heat exchange tubes **15**. A second condensable medium enters the condenser **11** at connection **21** located in the upper portion of the shell **13** and the formed condensate leaves the bottom of the shell **13** from a drain connection **23**.

The construction of heat exchange tubes **15** in accordance with this invention is shown by FIGURES 1 and 2. An impervious metal pipe **25** has formed therein a plurality of annular indentations **27** spaced along the longitudinal axis of pipe **25**. A porous metal jacket **29** substantially covers the impervious metal pipe **25** and defines an elongated opening **31** (FIGURE 2) extending along the bottom of the jacket **29**. Fixed within the opening is a trough **32** as disclosed in U.S. Patent No. 2,983,115 and is incorporated herein by reference. The porous metal jacket **29** and annular indentations **27** combine to form therebetween the walls of internal annular passageways **33** which communicates with the opening **31** at the bottom of jacket **29**. The impervious pipe **25** and porous jacket **29** may be mechanically bonded together by any suitable method such as brazing to form a good thermal bond therebetween.

The porous metal jacket **29** employed by this invention is generally a preformed body formed of a compacted metal powder, for example, electrolytically produced dendritic copper powder. The process used to compact the metal powder may be any number of techniques in the powder metallurgical art providing the resulting compact remains porous as heretofore defined. It is desirable that the compact be sintered to provide rigidity, however, the operation must be such that the internal cavities are not sealed off from communication with each other.

In FIGURE 4, there is shown a modification of the heat exchange tube **15** as contemplated by this invention. In this construction the impervious metal pipe **25** is provided with a plurality of extended fins **35** thereon and is the type frequently employed in heat exchangers. The same porous metal jacket **29**, heretofore described, substantially covers the extended fins **35** and may also be mechanically bonded thereto. A plurality of internal annular passageways **33** which communicate with the opening **31** (FIGURE 2) are again formed between the impervious pipe **25** and porous jacket **29** defined by the extended fins **35**. The trough **32** is included in this construction.

The operation is such that the first fluid medium passing through the interior of the heat exchange tubes **15** removes heat from a condensable medium delivered into the condenser shell **13** through connection **21**. The condensable medium enters the many internal cavities of the porous jacket **29** wherein it gives up its heat of condensation and condenses. The condensate continues on through the porous jacket **29** into the internal passageways **33** wherein it is conducted to the elongated opening **31** for drainage into the trough **32**. A secondary tube sheet **34** is provided at one end adjacent one of the tube sheets **16** and interconnects the trough **32** of each tube to the connection **23** for drainage from condenser **11**.

In addition to the high heat transfer performance obtained by this invention, other advantages are provided over prior art condensers. For example, it is possible to reduce the size and obtain the same capacity due to the large heat transfer area provided by the porous metal jacket without a proportional increase in volume.

Various other advantages and applications will occur

to those skilled in the art and it is understood that this invention is not limited to the described embodiments but may be otherwise practiced within the scope of the following appended claims:

I claim:

1. A condenser comprising an elongated, heat conducting, impervious, metal, heat exchange tube, the enterior surface of said heat exchange tube having a shape defining a plurality of substantially circumferentially extending, substantially annular, grooves; a porous heat conducting, metal jacket being secured in heat exchange relation with substantially the entire exterior surface of said heat exchange tube and defining with said annular grooves a plurality of condensate passages; said porous metal jacket having formed therein an opening extending below and in communication with each said annular passage of said heat exchange tube, said opening defining a passage for the removal of condensate from said plurality of condensate passages.

2. A condenser as defined in claim 1 further including a relatively impervious, channel shaped, trough member, secured to said porous jacket and extending below said opening formed in said porous metal jacket, said trough being adapted to pass condensate from said plurality of condensate passages to a desired location.

3. A condenser of a type adapted to condense refrigerant vapor for use in a refrigeration system comprising a condenser shell having a passage for admitting refrigerant vapor into said shell and a passage for withdrawing refrigerant condensate therefrom; a plurality of hollow impervious, metal heat exchange tubes disposed substantially horizontally within said shell, each said heat exchange tubes having an exterior surface having a shape defining a plurality of substantially circumferentially extending, substantially annular, grooves; a porous heat conducting metal jacket being secured in heat exchange relation with substantially the entire exterior surface of said heat exchange tube and defining with said annular grooves a plurality of condensate passages, said porous metal jacket having formed therein an opening extending below and in communication with each said annular passage of said heat exchange tube, said opening defining a passage for the removal of condensate from said plurality of condensate passages, and a relatively impervious channel shaped trough member secured to said porous jacket and extending below said opening formed in said porous metal jacket, said trough being adapted to pass condensate from said plurality of condensate passages; a pair of tube sheets supporting said heat exchange tubes within said shell and defining with said shell a passage for the admission and withdrawal of a cooling heat exchange fluid for passage through the interior of said heat exchange tubes; a third tube sheet disposed adjacent and in spaced relation with one of said pair of tube sheets, said third tube sheet defining with said one tube sheet a chamber for the collection and withdrawal of condensate, said channel shaped trough member extending through said third tube sheet and being open to said chamber formed between said third tube sheet and said one tube sheet so as to discharge condensate drained from said condensate passages, along said trough, into said chamber.

References Cited by the Examiner

UNITED STATES PATENTS

2,361,854	10/44	McCormack	62—505
2,941,759	6/60	Rice et al.	165—133
2,983,115	5/61	Caswell	165—110 X

CHARLES SUKALO, *Primary Examiner.*

KENNETH W. SPRAGUE, *Examiner.*