March 8, 1949. G. C. POLK 2,463,996

HEAT EXCHANGE APPARATUS

Filed Feb. 19, 1947 2 Sheets-Sheet 1

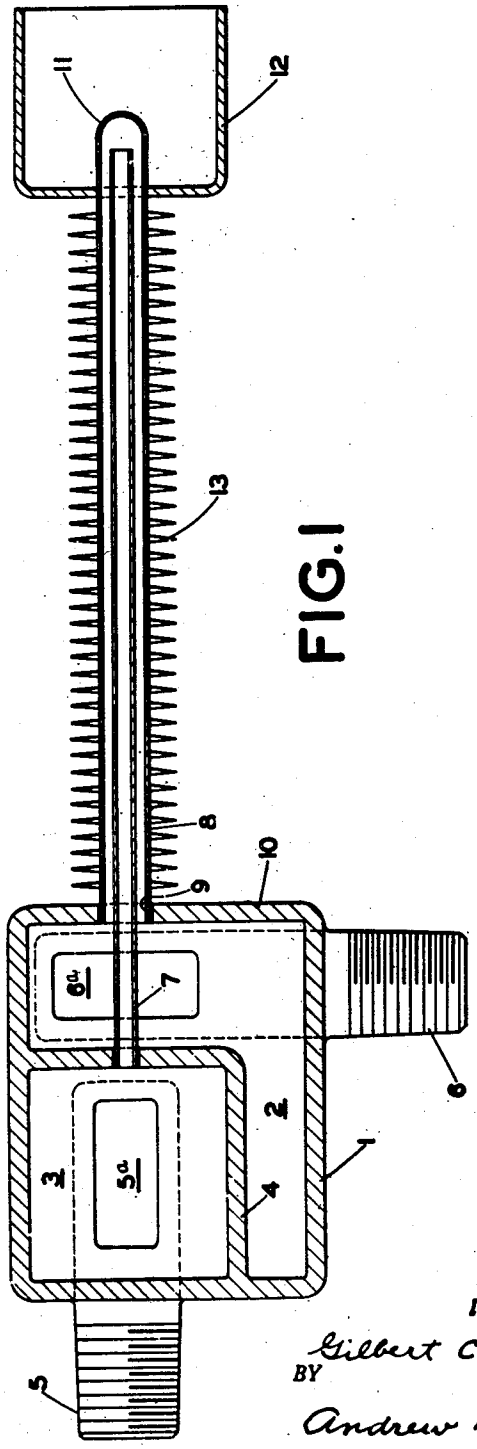


FIG. 1

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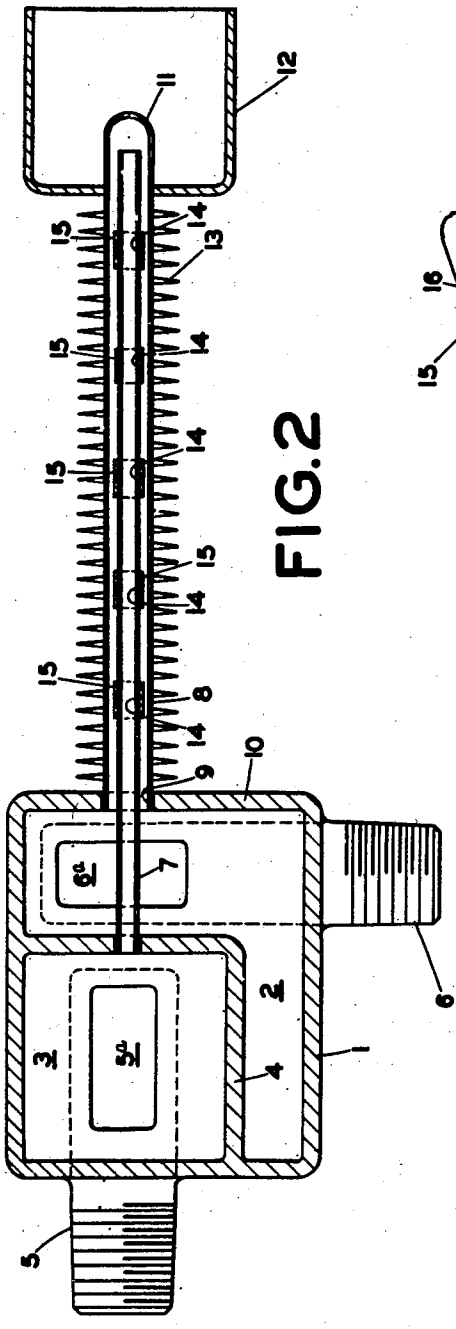


FIG.2

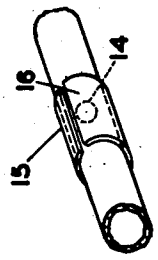


FIG.3

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HEAT EXCHANGE APPARATUS

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3 Claims. (Cl. 257—2)

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This invention relates to new and useful improvements in heat exchange apparatus.

An object of this invention is to provide a heat exchange apparatus by which uniform heating may be obtained across the heating tube thereof.

Another object is to provide a heat exchange apparatus the tube of which will be free from clogging due to freezing of condensate.

This invention consists in the novel construction and arrangement of parts, to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawings to be taken as part of this specification, there are fully and clearly illustrated two preferred embodiments of the invention, in which drawings:

Figure 1 is a view showing a heat exchange apparatus in horizontal section therethrough,

Figure 2 is a horizontal section of a modification of this invention, and

Figure 3 is a view in perspective of a portion of the inner tubing shown in Fig. 2.

Referring to the drawings by characters of reference, the numeral 1 designates a steam or other vapor supply header. The header 1 is divided into two chambers 2 and 3 by an interior wall 4. There is an inlet member 5 communicating with a port 5a for supplying steam to chamber 3. An outlet member 6 communicating with port 6a is provided for drainage of condensate from chamber 2. A steam supply tube or conduit 7 conducts steam from the chamber 3 of the header 1. The tube 7 is sealed in and extends thru the interior wall 4 of the header 1. Another tube 8 surrounds tube 7 and is sealed in an aperture 9 in the exterior wall 10 of the header 1. The outer tube 8 is closed at its end portion 11. Affixed to and carried by the tube 8 at the end portion 11 is a shield member 12. Surrounding and affixed to tube 8 are a plurality of heat transfer elements or spiral fins 13. The fins 13 are optional in the construction of this apparatus but provide additional and more efficient heat transfer surface if used. The tube 7 extends within the outer tube 8 into the closed end portion 11 which is surrounded by the shield member 12.

In operation this form of the invention functions as follows: Steam or other heating vapor is conducted through the inlet connection 5 to chamber 3 of the header 1. From the inlet chamber 3 the steam passes through the inner tube 7 into the outer tube 8 at the end portion 11. Although some of the steam may condense in tube 7 the greater part of the steam is condensed in

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the space between the inner tube 7 and the outer tube 8 and drains by gravity into the drainage chamber of the header 1 to be conducted therefrom through the outlet connection 6. In this form of heat exchange apparatus the shield member 12 which encloses the end portion 11 of the tube 8 in which the steam is condensed, functions to prevent the condensed steam from freezing and clogging this end portion 11. In older forms of heat exchange apparatus the inner tube 7 did not extend into the shielded area of the end portion 11 which is protected by the shield member 12 and so the point at which the steam discharged from the inner tube into the outer tube was not protected from the cold gases passing thereover and frequently the condensate would freeze blocking that area.

In the modification shown in Figs. 2 and 3 all of the parts shown in Fig. 1 are present. In this modification there are a number of small holes or apertures 14 through the wall of the inner tube 7 whereby some of the steam may escape into tube 8 before reaching the end portion 11. Surrounding tube 7 preferably at all of the apertures 14 are cylindrical spring closure members 15. The spring closure members 15 are affixed to tube 7 at one or more points and have a free end portion 16 closing the aperature 14 which it overlies. The spring closure members 15 are responsive to a differential of pressure between the tubes 7 and 8. Any suitable valve mechanism responsive to the aforementioned pressure differential could be used in lieu of the members 15 to serve the same purpose.

In operation this modification of the invention functions as follows: As in Fig. 1 steam is supplied through the header 1 and the condensate removed therefrom in an identical manner. It is to be understood that the header as shown in Figs. 1 and 2 is not essential to the functioning of this invention, any suitable means for supplying steam and removing condensate would function equally well. In this form of the invention when steam is admitted to tube 7 under a predetermined pressure of say, 5 pounds per square inch, the closure members 15 open under the pressure differential thus permitting part of the steam to pass from tube 7 into tube 8 before reaching the end portion 11. When the steam is throttled to a lower pressure the closure members 15 close blocking flow of steam therethrough thus forcing the steam to travel the entire length of tube 7 before entering tube 8 wherein the steam is condensed. When the steam is admitted under the predetermined pressure and is able to

pass through the apertures 14 a greater capacity for heating throughout the length of the tube is obtained. Since a reduction in steam pressure causes the closure members 15 to close, an inherent disadvantage of perforated tube heat exchangers is avoided in that the steam is forced to travel the entire length of tube 7 before substantial condensation can begin. If none of the closure members 15 were present, most of the steam when at low pressure would escape through the apertures 14 adjacent to the header giving a non-uniform heating of the tube. The amount of steam forced to travel to the end portion 11 must be sufficient to maintain the end portion 11 at a temperature above the freezing point of the condensate together with the aid of the safety means, namely the shield member 12. In this modification the shield member 12 functions as in Fig. 1 to prevent the cold gases from passing over the end portion 11 and thereby reducing the possibility of freezing and clogging at that point. If the end portion 11 should happen to freeze and clog, a slight increase in pressure of the steam from the point of supply would cause the closure members 15 to open permitting circulation of the steam to continue. This continued circulation of the steam would cause the end portion 11 to be heated by conduction thus melting any obstruction of frozen condensate therein. In this form of the invention it would be possible to dispense with the shield member 12 inasmuch as the closure members 15 would permit continued circulation of steam as heretofore described. A greater efficiency and less danger of freezing would be obtained however by the use of the shield member 12 in this modification.

It has been found in practice that a heat exchange apparatus as shown in Fig. 1, with an unperforated inner tube 7, gives a uniform heating of the air passing thereover since the condensate from the end portion 11 flowing back toward the header 1 is heated countercurrently by the incoming steam passing through the inner tube 7. It has been found that a small clearance between the inner tube 7 and the outer tube 8 (e. g. .563" I. D. for the outer tube and .375" O. D. for the inner tube) will cause the condensate to flow in countercurrent heat exchange relationship with the steam in tube 7 giving the uniform heating desired. This type of tube arrangement is difficult to freeze at the end portion 11 but when it does freeze it is difficult to thaw out. This type of tube arrangement has the disadvantage of giving a low heating capacity even at high steam pressure ratings.

In a heat exchange apparatus with a perforated inner tube 7 a greater potential capacity for heat transfer is obtained but there is an unequal heating under reduced steam pressures, a greater amount of heat being released under reduced pressure condition at the end adjacent the header 1. This tube arrangement has the disadvantage of freezing up easily at low steam pressures or with a modulated steam system, however when frozen this type of tube is easier to thaw out.

The modification shown in Figs. 2 and 3 combines the advantages of the unperforated and the perforated type inner tubes but minimizes the disadvantages. With a modulated steam system this modification gives high heating capacity, uniform heating, low tendency to freeze, and ease of thawing in the event of freezing.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. In a heat exchange apparatus for transferring heat to a gaseous stream, a conduit wherein the condensing of a vapor transfers heat to said gaseous stream, said conduit having one end closed and having an opening at the other end for removal of condensate, a second conduit for conducting said vapor to said first conduit, said second conduit being positioned interior of said first conduit and discharging said vapor into the closed end portion of said first conduit, said second conduit having one or more apertures therein operable to permit some of said vapor to enter said first conduit before said vapor reaches said closed end portion, spring closure means affixed to and substantially surrounding a portion of said second conduit and cooperable with at least one of said one or more apertures to control the flow of vapor therethrough, said spring closure means being responsive to the differential of pressure betwen said second and said first conduits and operable to open at a predetermined pressure, said one or more apertures and said spring closure means being operable to permit continued circulation of vapor in the event of freezing and clogging of the closed end portion of said first conduit so that said continued circulation would supply sufficient heat by conduction to the closed end of said first conduit to melt out any frozen condensate obstructing said closed end portion and said vapor condensing in the space between said first and second conduits.

2. In a heat exchange apparatus for transferring heat to a gaseous stream, a conduit wherein the condensing of a vapor transfers heat to said gaseous stream, said conduit having one end closed and having an opening at the other end for removal of condensate, a second conduit for conducting said vapor to said first conduit, said second conduit being positioned interior of said first conduit and discharging said vapor into the closed end portion of said first conduit, said second conduit having one or more apertures therein operable to permit some of said vapor to enter said first conduit before said vapor reaches said closed end portion, spring closure means affixed to and substantially surrounding a portion of said second conduit and cooperable with at least one of said one or more apertures to control the flow of vapor therethrough, said spring closure means being responsive to the differential of pressure between said second and said first conduits and operable to open at a predetermined pressure, said one or more apertures and said spring closure means being operable to permit continued circulation of vapor in the event of freezing and clogging of the closed end portion of said first conduit so that said continued circulation would supply sufficient heat by conduction to the closed end of said first conduit to melt out any frozen condensate obstructing said closed end portion, said vapor condensing in the space between said first and second conduits, a shield member enclosing the closed end portion of said first conduit and operable to prevent the flow of said gaseous stream over said closed end portion, said second conduit extending into said closed end portion enclosed by said shield, and said shield being operable to prevent said vapor from freezing and clogging said closed end portion.

3. In a heat exchange apparatus for transferring heat to a gaseous stream, a conduit wherein the condensing of a vapor transfers heat to said gaseous stream, said conduit having one end closed and having an opening at the other end for removal of condensate, a second conduit

for conducting said vapor to said first conduit, said second conduit being positioned interior of said first conduit and discharging said vapor into the closed end portion of said first conduit, said second conduit having one or more apertures therein operable to permit some of said vapor to enter said first conduit before said vapor reaches said closed end portion, closure means affixed to and substantially surrounding a portion of said second conduit and cooperable with at least one of said one or more apertures to control the flow of vapor therethrough, said closure means being responsive to the differential of pressure between said second and said first conduits and operable to open at a perdetermined pressure, said one or more apertures and said closure means being operable to permit continued circulation of vapor in the event of freezing and clogging of the closed end portion of said first conduit so that said continued circulation would supply sufficient heat

by conduction to the closed end of said first conduit to melt out any frozen condensate obstructing said closed end portion and said vapor condensing in the space between said first and second conduits.

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