March 1, 1949. R. C. BRIERLY ET AL 2,462,838

HEAT TRANSFER AUGMENTER

Filed April 3, 1945

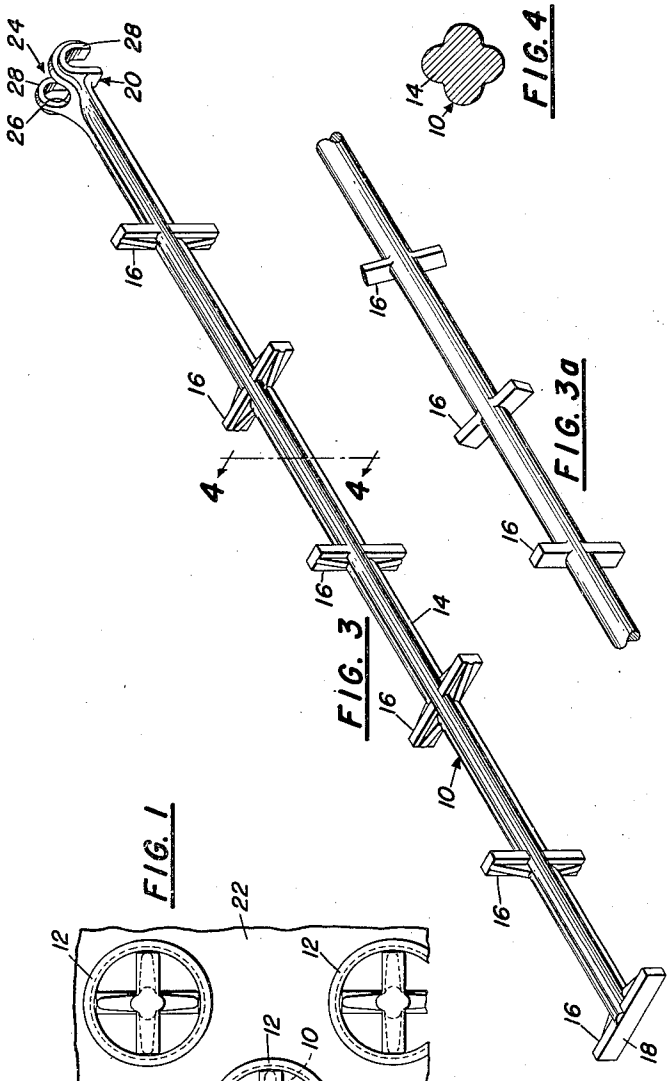


FIG. 3

FIG. 4

FIG. 3a

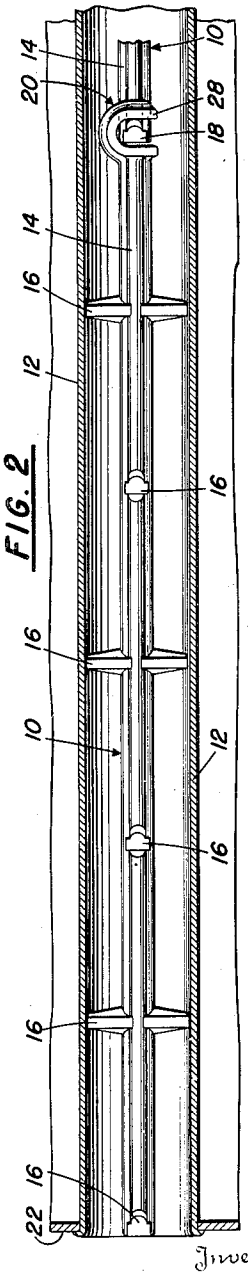


FIG. 2

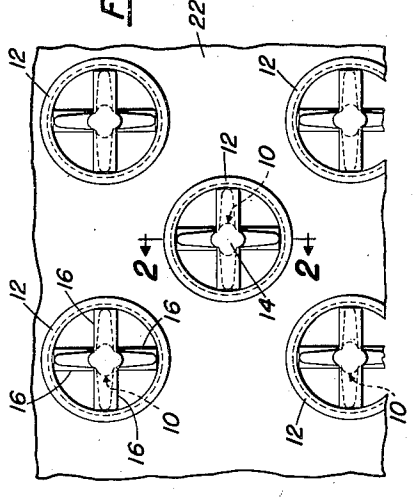


FIG. 1

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Patented Mar. 1, 1949 2,462,838

UNITED STATES PATENT OFFICE

2,462,838

HEAT TRANSFER AUGMENTER

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Application April 3, 1945, Serial No. 586,431

1 Claim. (Cl. 138—38)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention relates to means for improving heat transfer, and more, specifically, to means for increasing the transfer of heat from a heat charged body of fluid to the wall of a tube or other conduit through which the fluid passes.

In fire tube boilers of the type generally referred to as Scotch or Lancashire, the hot gases of combustion pass through a battery of tubes which are surrounded by water or wet steam in the case of superheating and the heat in the gases is given up to the walls of the tubes by convection and conduction. Due to the velocity of the gases as they pass through the tubes, and to the absence of obstructing means in the tubes, the gases tend to pass rapidly through the tubes giving up only the heat in the stream which is in immediate contact with the walls of the tubes. That is, due to what may be called stratification or coreing of the body of hot gases flowing through the tubes, and lack of turbulence, only a relatively small part of the hot gases come into direct contact with the walls of the tubes. While it is true that some of the heat in the inner core of the stream of hot gases is given up by conduction and convection through the gas itself, the maximum amount of heat transfer is produced by direct contact of the gases with the walls of the tubes.

It is, therefore, an object of this invention to provide means for increasing heat transfer by causing tubulence in the heat charged body of a fluid such as hot gas as it passes through a fire tube, thereby to reduce its velocity and bring substantially every part of the hot gas into contact with the wall of the tube in its passage from one end to the other of the tube.

To this end and in accordance with the invention, novelty resides in a heat transfer device adapted to be disposed in a fire tube comprising, a rod having a plurality of spaced projections extending radially therefrom with alternate projections staggered, thereby to create a tortuous path lengthwise of the tube, and hence, turbulent flow of the gases. As illustrated herein, the aforesaid projections may extend at right angles to each other or may be displaced in substantially spiral relation around the rod and lengthwise thereof, and each projection is preferably substantially rectangular in cross section. It is to be understood, however, that the specific arrangement of the projections may be varied in any suitable manner as long as it is such as to create turbulent flow of the gases.

It is a further object of the invention to provide a heat transfer device which may readily

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be modified in length to fit substantially any fire tube.

With this in view, invention resides in another aspect in a heat transfer device consisting of a plurality of sections of rod of a given length, preferably some fraction of the average tube length adapted to be arranged end to end lengthwise of the tube, each rod having radial projections thereon, as heretofore described, and a hook at one end thereof adapted to engage the terminal radial projections on the adjacent length of rod and hence to couple the rods in end to end relation. More specifically, the hook is bifurcated, thereby to straddle the terminal end of the adjacent rod at the point the hook embraces the radial projections.

The invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is an elevational view of a portion of a tube sheet into which the ends of fire tubes are clenched with the heat transferring device of the present invention disposed therein;

Fig. 2 is a sectional view lengthwise of a fire tube on line 2—2 of Fig. 1;

Fig. 3 is a perspective view of one section of the heat transfer device;

Fig. 3*a* is a perspective view of one section of a modified heat transfer device; and

Fig. 4 is a section taken on the line 4—4 of Fig. 3.

Referring to Fig. 2, the heat transfer device illustrated is composed of a plurality of sections 10 adapted to be disposed end to end in a fire tube 12. Each section comprises a rod 14 having a plurality of spaced projections 16 extending radially therefrom, one of the projections 18 being located at the end of the section and constituting with means 20 at the opposite end of the section means for joining adjacent sections end to end. In the preferred form of the invention, as illustrated in Fig. 3, the alternate projections 16 are arranged to extend at right angles to each other, thereby to break up the straight line flow of the gases through the fire tube 12 and to cause turbulence, and hence, a maximum of contact between the gases and the wall of the tube. The disposition of the projections 16 at right angles to each other, however, is not to be considered as imperative, since any arrangement of the projections to create a turbulent flow of the gases through the tube may be employed. A modification of the disposition of the projections is shown in Fig. 3*a*, wherein the projections are displaced with respect to each other so that they form a substantially spiral arrangement from end

to end of the rod 10. The cross section of the projections 16 is not of any particular importance, however, it should be of sufficient dimensions to resist overheating, and bending or breaking when the section is placed in the fire tube. Furthermore, it is desirable that the projection be rugged enough to constitute means for cleaning the inner surface of the tube. This can readily be accomplished by rotating and oscillating the rod in the tube so as to dislodge combustible matter deposited on the inner surface of the tubes.

As illustrated herein, the fire tubes 12 for which my heat transfer device is particularly suited, are shown as of the type used in the Scotch or Lancashire boiler, the tubes being fixed at their ends in tube sheets 22, a fragmentary portion of one of which is shown in Fig. 1. The heat transferring devices 10, when disposed lengthwise of the fire tubes 12, as illustrated in Figs. 1 and 2, will rest on the lower portion of the wall of the tube by reason of the contact of the projections 16 with the wall. In order to permit easy insertion and removal of the device, the projections are made slightly shorter in length than the diameter of the fire tube so that a small clearance will be obtained between the outer ends of the projections and the inner wall of the tube. While the primary purpose of the projections 16 is to break up straight line flow of the hot gases, it is evident that the projection also serves as conductors for transferring heat from the gases directly to the walls of the tubes since the vertical projections on the underside of the rod and the horizontal projections at opposite sides of the rod contact the walls of the tubes.

The heat transferring devices, while illustrated for use in fire tubes of the Scotch or Lancashire boiler may be used in any other tube type boiler to break up straight line flow of any heat carrying body of fluid whether it is a gas or liquid. The spaces between the projections and the form, arrangement and number of the latter may be varied to suit the conditions, such as the volume of flow, the velocity and temperature. When used in the Scotch type boiler, it has been shown that there is an increased boiler efficiency, in some cases as much as 6 to 8% above those possible with bare tubes and with an ordinary pressure drop.

In order that the heat transfer device may be adapted to any length of boiler tube, it is preferable to make it up in sections which may be joined end to end, and these sections should be some fraction of the length of standard boiler tubes so that by joining a number of sections a heat transfer element may be made up which will be suitable for whatever length of tube that is encountered. As illustrated, the coupling means 20 comprises a hook 24, Fig. 3, at one end of each

section adapted to engage the terminal projection 18 of an adjacent section. The hook is bifurcated at 26 to provide a pair of spaced parallel fingers 28. The fingers 28 are U-shaped to embrace the projections 18, thereby to lock the sections in end to end relation, and to provide a connection which will transmit both reciprocal and rotational movement from one section to the next. The locking of the sections together by the aforesaid hook is important in that it permits manipulation of the entire string of sections from one end, for example, if it is desirable to clean the inner surface of a tube by oscillating the sections in the tube and also prevents loss of sections in a long tube and the necessity of fishing for them to remove them from the tube.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed for:

A heat transfer device adapted for use in a tube comprising a plurality of rods arranged end to end longitudinally of the tube, each rod having a plurality of radial projections extending from said rod toward the wall of the tube, all but one end projection of each rod being of a relatively narrow dimension longitudinally of the rod to afford some turbulence to the gases passing through the tube, said projections being spaced from one another a substantial distance axially thereof, said projections being arranged in staggered relationship with respect to each other around the rod thereby forming in combination with the tube a tortuous path lengthwise thereof, said one end projection being U-shaped in side plan and bifurcated in end plan and of greater width than said other projections to afford increased turbulence to the gases passing such location and to couple over the other end projection of an adjacent rod to provide a readily variable length heat transfer device having varied turbulence creating locations therealong.

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