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HEAT EXCHANGER

Filed Oct. 15, 1932

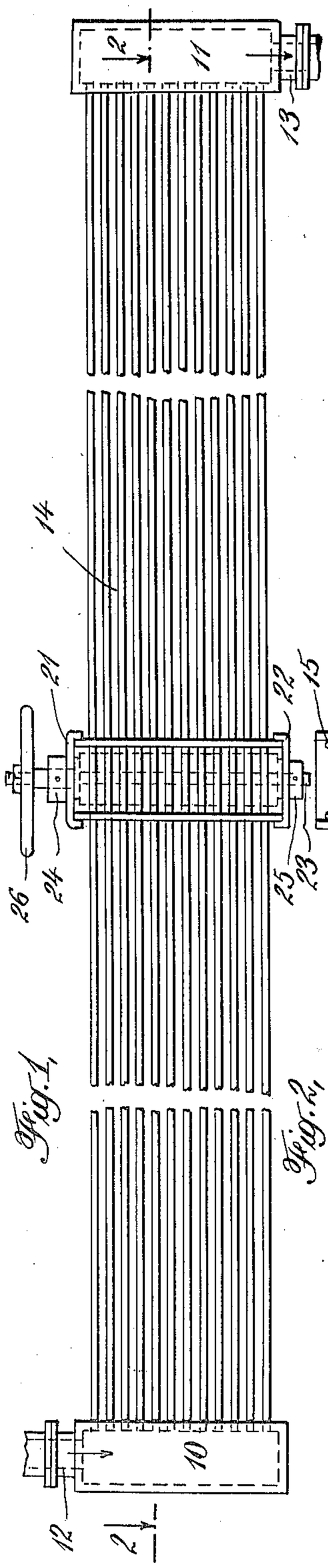

Fig. 1,

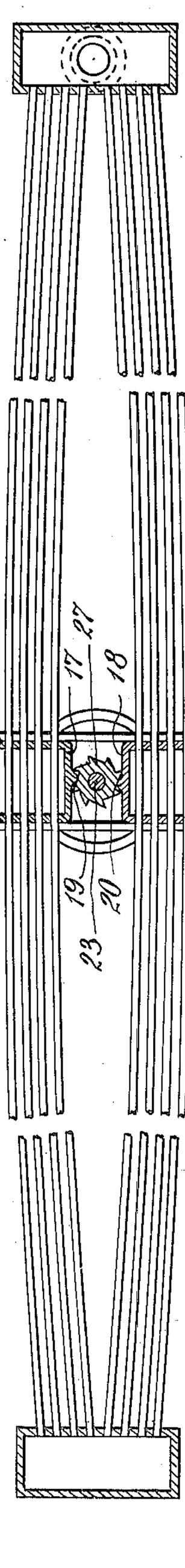

Fig. 2,

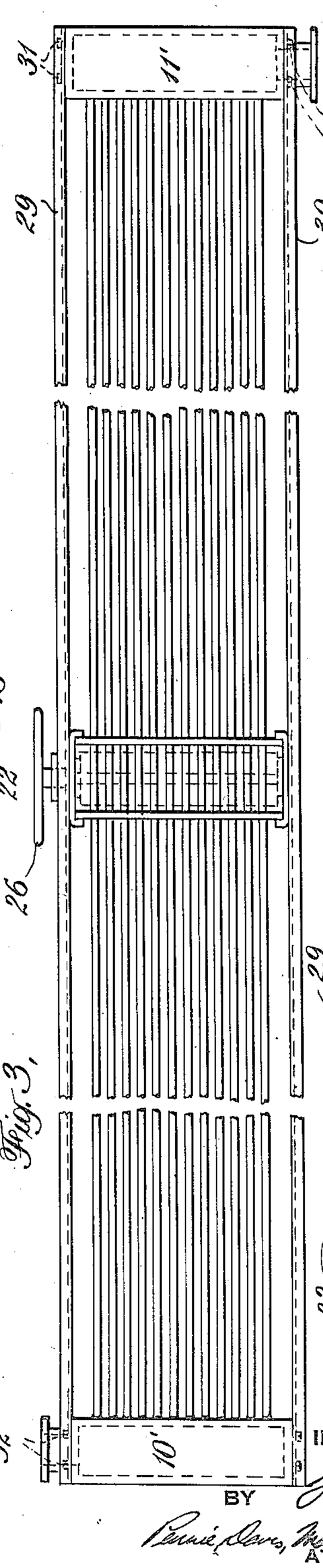

Fig. 3,

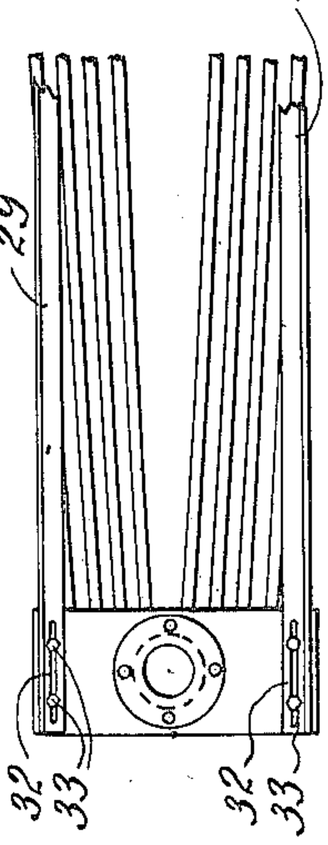

Fig. 4,

INVENTOR
Joseph Price

BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

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HEAT EXCHANGER

Joseph Price, West New Brighton, N. Y., assignor to The Griscom-Russel Company, New York, N. Y., a corporation of Delaware

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11 Claims. (Cl. 257—236)

This invention relates to heat exchangers and has particular reference to apparatus for cooling gases and liquids of any kind.

In certain localities, the water available for cooling purposes contains relatively large amounts of various salts which crystallize out of the water and form scaly deposits upon the surfaces where the temperature changes take place. In using this water in shell and tube heat exchangers or the like, the consequent heavy deposits of scale on or in the tubes result in inefficient operation of the exchangers and periodic shut-downs are required for the purpose of cleaning the scale from the tubes. Accordingly, the conventional types of shell and tube heat exchangers are unsuitable for use with cooling water of high salt content because of this scaling and in order to overcome it, the cooling water is sometimes treated to remove the objectionable salts before it is supplied to the exchanger. However, the tremendous volume of circulating water required for the volume of gases or liquids which are cooled in the heat exchanger renders this treatment extremely expensive and undesirable.

Instead of removing the objectionable scale-forming salts from the cooling water before introducing it into the heat exchanger, the deposit of the scale on the tubes is permitted and the scale subsequently is removed by periodically changing the temperature of a heat exchanger which is so constructed that the resultant substantial elongation or contraction of the tubes causes them to flex so as to crack off the scale deposited thereon or therein. Self-scaling heat exchangers of this construction operate satisfactorily to dislodge the scale when subjected to widely varying temperatures, either naturally or artificially. For example, the heat exchanger may be subjected to periodic live steam treatments or the like to secure a temperature change sufficient to cause the tubes to flex, or the exchanger is subjected to naturally changing temperature conditions, such as when the exchanger is cooled by a water spray, the cooling effect of which substantially changes because of variations in water flow, temperature, or because of changes in the velocity of the wind to which the spray is subject, or the like, so that the self-scaling action is automatic. A self-scaling heat exchanger of this type is disclosed in Patent No. 1,617,083 issued February 8, 1927 to the present applicant.

In certain classes of duty where the heat exchanger is subjected to substantially constant cooling temperatures, so that the natural thermal expansion or contraction of the tubes is insufficient to flex the tubes substantially and procure the self-scaling action, or where it is undesirable, impractical, or not feasible to submit the heat exchanger to periodic temperature treatments to secure the self-scaling action, it is desirable to provide a heat exchanger from which the scale may be removed without shutting down the apparatus to do so, or without making it necessary to remove the scale-forming salts from the cooling water before introducing it into the exchanger.

According to the present invention, a heat exchanger is provided wherein the tubes may be vibrated to crack the scale therefrom. In the preferred construction of the heat exchanger of this invention, the tubes communicate at opposite ends with headers, and the exchanger is so supported that at least one of the headers is movable relatively to the other to accommodate the changes in length resulting from the flexing of the tubes during vibration thereof, as well as to provide for the changes in length which result from normal elongation and contraction due to temperature changes. Adjacent groups of the tubes are held in tube supports located approximately at the longitudinal center of the tube bundle and having opposed anvil surfaces between which is located a vibrating member by means of which the tubes are vibrated, so that the scale deposited thereon or therein is cracked off.

The tube vibrating member preferably comprises a star wheel, or the like, engaging the opposed anvils of the tube supports and mounted on a shaft extending between the tubes, which are accordingly forcibly spread apart to accommodate the star wheel, so that the natural resiliency of the tubes resists the periodic flexing to which they are subjected when the star wheel is rotated and their periodic return movements upon release by the star wheel are so violent and abrupt that the scale deposited thereon or therein is effectively cracked off. The shaft of the star wheel is fitted with a handwheel, crank, or other operating member, which is actuated as often as is necessary to remove the scale deposits without requiring shutting down of the exchanger or the removal of any parts thereof. This arrangement is especially desirable in installations where the heat exchanger is submerged in cooling water, since the shaft of the star wheel may extend through the wall of the shell or other container in which the exchanger is mounted to per-

mit periodic scaling of the tubes of the exchanger without making it necessary to drain the shell to obtain access to the tubes for cleaning the scale therefrom.

For a better understanding of the invention, reference is made to the accompanying drawing, in which:

Fig. 1 is an elevation of a heat exchanger provided with means for vibrating the tubes in accordance with this invention;

Fig. 2 is a longitudinal section thereof as seen along the line 2—2 of Fig. 1.

Fig. 3 is an elevation of a modified form of the heat exchanger of this invention; and

Fig. 4 is a fragmentary top view of the same.

In this drawing, 10 and 11 are headers, the former having a fluid inlet 12, and the latter having a fluid outlet 13, although one of these headers may be equipped with both the fluid inlet and outlet in accordance with standard practice. Extending between and communicating with the headers 10 and 11 is a bundle of tubes 14.

Located at approximately the longitudinal center of the tubes 14 is a pair of tube supports 15 and 16 which divide the bundle of tubes into two groups. These tube supports 15 and 16 are U-shaped in cross-section and the flanges of the supports are perforated for the reception of the tubes 14 of each group. Tube supports of T-shaped cross-section may be used with equal facility, if desired. The adjacent surfaces 17 and 18, of the tube supports 15 and 16, respectively, serve as anvils for a purpose to be described later, each of these anvils 17 and 18 preferably having integral abutments 19 and 20, respectively.

Slidably embracing the opposite ends of both tube supports 15 and 16, are top and bottom plates 21 and 22 through which is journaled a shaft 23 having the collars 24 and 25 which bear against the top and bottom plates 21 and 22, respectively, and prevent axial movement of the shaft 23. One end of the shaft 23, preferably the upper end, is provided with a handwheel 26, whereby the shaft 23 may be rotated. An equivalent crank or other actuating member may be fitted on the shaft 23 instead of the handwheel 26, or the shaft may be power driven.

Fixed to the shaft 23 so as to rotate therewith is a vibrator 27 of non-uniform shape, such as the star wheel illustrated, or the like. Opposite notches of the star wheel 27 receive the abutments 19 and 20. The star wheel 27 is of appreciable diameter and forcibly spreads apart the normally straight tubes 14, which are divided into two groups by the tube supports 15 and 16. The natural resiliency of the tubes 14 of each group tends to urge the tubes into their normal straight parallel position with the result that the further displacement or spreading of the tubes upon rotation of the star wheel 27 by the handwheel 26 causes them to return violently and abruptly each time the opposite points of the star wheel 27 pass over the abutments 19 and 20 of the anvils 17 and 18, respectively. The tubes 14 of the heat exchanger are accordingly rapidly and violently shaken or vibrated as the star wheel 27 is rotated, so that scale deposited in or upon the tubes 14 is cracked from the tubes and thus dislodged.

The heat exchanger illustrated in Fig. 1 may be supported in any suitable way within a shell or other container except that provision must be made for the lengthening or shortening of the exchanger which is due to the flexing of the tubes by the star wheel in the manner described, as well for the normal elongation and contraction of the tubes resulting from temperature changes. Accordingly, one of the headers 10 or 11 of the heat exchanger may be fixed, while the other header is mounted so that it will be floating to accommodate the aforementioned elongation and contraction of the exchanger.

In the modified form of the new heat exchanger illustrated in Figs. 3 and 4, the headers 10′ and 11′ are connected by tie bars or rods 29 and 30 for shipping purposes. These tie bars or rods 29 and 30 are secured at one end by bolts 31 or the like to one of the headers, such as header 11′, and are provided with at their opposite ends with the elongated slots 32, or their equivalent through which pass the bolts 33, or the like, which secure these bars or rods to the other header 10′ in the manner illustrated in Fig. 4. These slots 32 permit the elongation and contraction of the heat exchanger resulting from the flexure of the tubes by the vibrator when the handwheel 26 is rotated, and also accommodate the elongation and contraction of the tubes of the heat exchanger resulting from temperature changes.

One or more of the new heat exchangers may be mounted within a shell or the like in accordance with conventional practice, and the corresponding number of shafts 23 for actuating the tube vibrators preferably extend through stuffing boxes or the like in the wall of the shell or other container, so that the vibrators of the several exchanger units may be actuated from outside of the shell or other container.

It will be seen that in the heat exchanger of this invention, the scale normally deposited upon or within the tubes, when cooling water having a high mineral salt content is used, may be readily, quickly and effectively removed as often as may be necessary, depending upon the concentration and rate of deposit of the mineral salts on the surfaces of the tubes. Rotation of the handwheel or other actuating device of the vibrator secures violent vibration of the tubes as the result of the natural tendency of the tubes to maintain their normal initial position, which may be straight or slightly bowed.

Although a particular form of vibrator for the tubes of the exchanger has been illustrated and described, it is to be understood that equivalent forms of vibrators, such as strikers, cams, ratchets, or the like, may be used with equal facility within the scope of the invention, and that the invention may be used on boilers and other apparatus subject to scale deposits resulting from the use of water having a high mineral content.

I claim:—

1. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a member permanently associated with said tubes for delivering a rapid succession of blows thereto to dislodge the scale therefrom, and means for actuating the member.

2. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a striker engageable with the tubes and permanently associated therewith to dislodge the scale therefrom, and means for actuating the striker.

3. In a heat exchanger for use with cooling water from which scale-forming substances de-

posit, the combination of a header, tubes communicating with the header, a member permanently associated with the tubes for displacing the tubes from their normal position and suddenly releasing them to permit them to return to their normal position due to their natural resiliency, and means for actuating the member.

4. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, means permanently associated with the tubes for alternately flexing and releasing the tubes to vibrate them for dislodging the scale deposited thereon, and means for actuating the last-mentioned means.

5. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a permanent support for the tubes spaced from the header, and means for delivering a rapid succession of blows to the support to flex the tubes supported thereby for dislodging the scale deposited on the surfaces of the tubes.

6. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a support for the tubes, a shaft mounted adjacent to the support, and a member interposed between the support and the shaft and actuable by the shaft to oscillate the support and the tubes supported thereby for dislodging the scale deposited on the surfaces of the tubes.

7. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a support for the tubes, a rotary member of irregular shape engaging the support, and means for rotating the member to oscillate the support and the tubes supported thereby for dislodging the scale deposited on the surfaces of the tubes.

8. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, means dividing the tubes into a plurality of groups and including a vibrator for vibrating as units the several groups of tubes to dislodge the scale deposited on the tubes, and means for actuating the vibrator.

9. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a member of irregular shape dividing the tubes into a plurality of groups, and means for actuating the member to vibrate the several groups of tubes for dislodging the scale deposited on the tubes.

10. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a pair of tube supports dividing the tubes into two groups, a member of irregular shape interposed between the tube supports, and means for actuating the member to oscillate the supports for vibrating the tubes supported thereby to dislodge the scale deposited thereon.

11. In a heat exchanger for use with cooling water from which scale-forming substances deposit, the combination of a header, tubes communicating with the header, a pair of adjacent tube supports each supporting a plurality of tubes, a star wheel engaging and spreading apart the tube supports so as to flex the tubes, a shaft for the star wheel, and means for rotating the shaft to alternately flex and release the tubes supported by each tube support for vibrating them to dislodge the scale deposited on the tubes.

JOSEPH PRICE.