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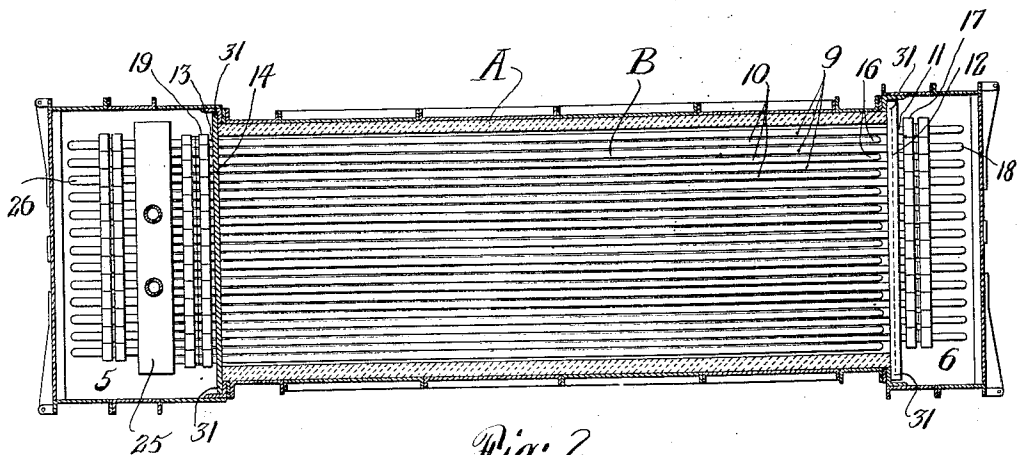
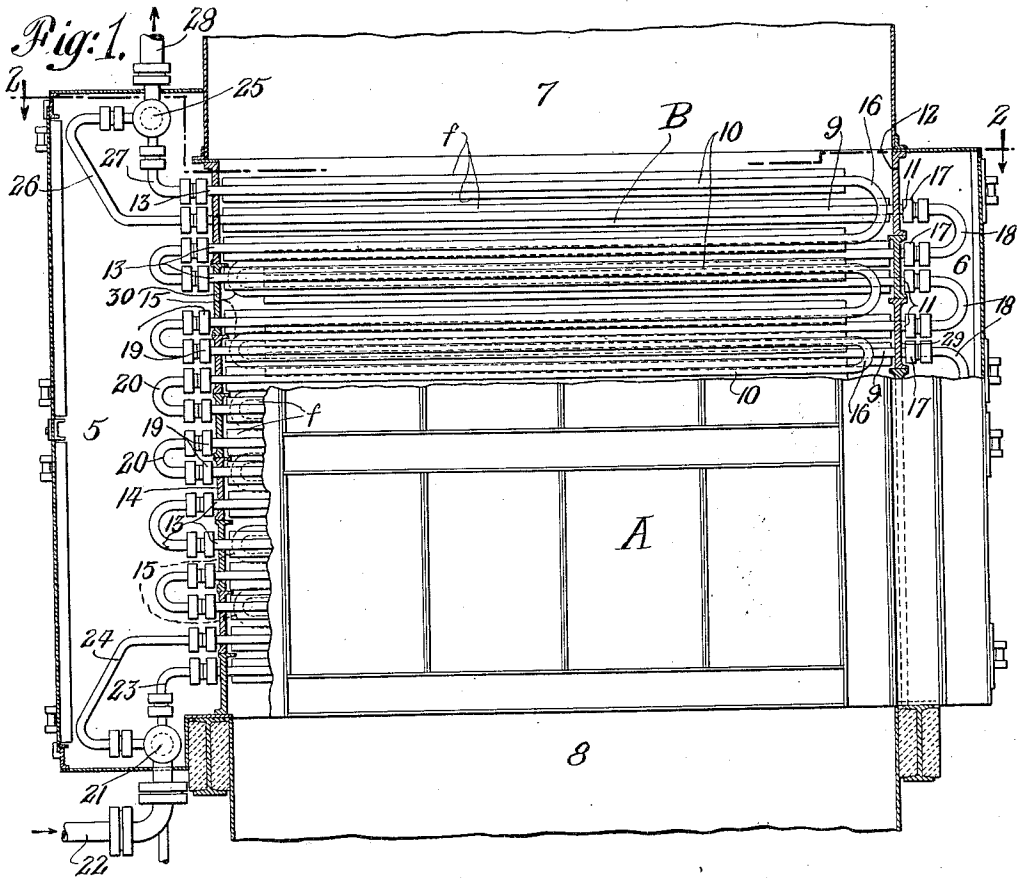
G. P. JACKSON ET AL

1,786,909

ECONOMIZER

Filed June 1, 1929

2 Sheets-Sheet 1



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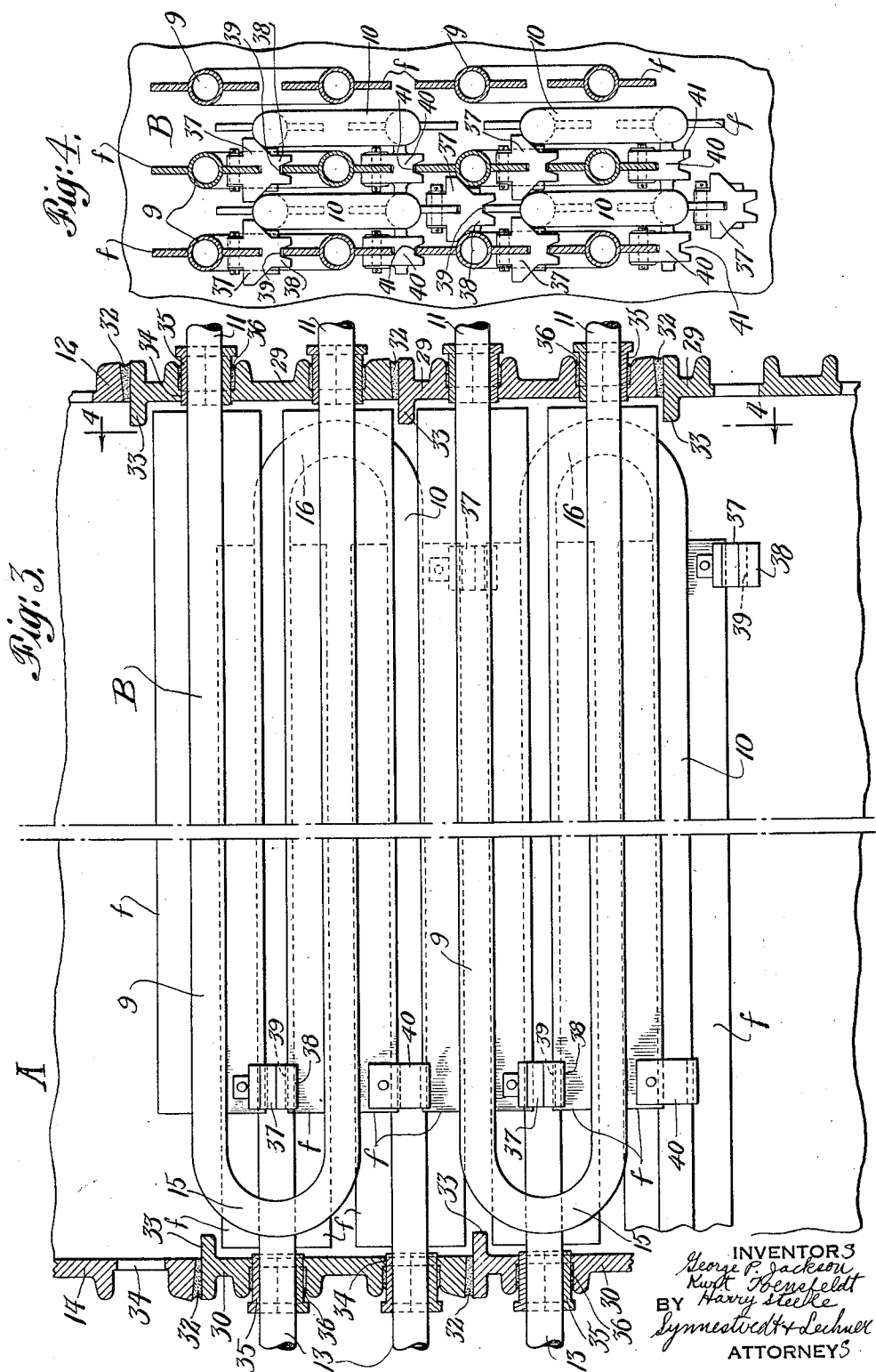
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UNITED STATES PATENT OFFICE

GEORGE P. JACKSON AND KURT TOENSFELDT, OF FLUSHING, NEW YORK, AND HARRY STEELE, OF NEWARK, NEW JERSEY, ASSIGNORS TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

ECONOMIZER

Application filed June 1, 1929. Serial No. 367,669.

This invention relates to apparatus such as economizers, reheaters, superheaters, and the like, and one of its primary objects is to provide a simple, compact and efficient apparatus of this character.

Another object of the invention is the provision of an economizer employing a plurality of rows of tubes arranged for back and forth traverse therethrough in which the number of joints is very greatly reduced over known tubular economizers.

A further object of the invention is the provision of a novel tube arrangement for tubular economizers.

Still other objects have to do with the manner of supporting the tubes, and the ready accessibility of the tubes for cleaning, removal and replacement.

A more specific object is the provision of novel means for guiding tubes in their removal.

Another object of the invention is to provide an economizer employing a novel arrangement of U-bent tubes whereby considerably more heating surface may be obtained in a given sized heater than has heretofore been possible, or, stated more specifically, we provide an arrangement of the tubes of the economizer whereby the economizer will occupy but approximately 60% of the space of known tubular types for the same amount of heating surface.

We also contemplate a further reduction in the size of the economizer by the employment of fins on the tubes.

Another object is to provide an improved economizer of the character set forth in which a relatively lower draft loss is experienced.

Still another object resides in an arrangement of tubes whereby better flow conditions are obtained.

Generally stated, we aim to provide an economizer of small space proportions, of relatively low water pressure drop, and having a relatively small number of tube joints, and of relatively low cost.

How the foregoing, together with such other objects and advantages as may hereinafter appear, or are incident to my invention,

are realized, is illustrated in preferred form in the accompanying drawings, wherein—

Fig. 1 is a front elevation of an economizer embodying my invention with a portion thereof appearing in section and with certain portions being more or less diagrammatically shown as they appear in full detail in other figures of the drawings.

Fig. 2 is a plan section taken on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged, fragmentary, foreshortened, sectional elevation illustrating the tube arrangement, tube sheets, and supports for the tubes in detail, and

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

Referring to the drawings, the economizer comprises in general, a main casing A having two end compartments 5 and 6, a gas inlet 7, preferably at the top, for a heating medium, such as flue gas, and a bottom gas outlet 8; and a plurality of tubes B arranged in a manner now to be described.

The tubes B may be termed U-bent tubes and they are arranged in a plurality of vertical rows divided into two sets 9 and 10, each set comprising a plurality of horizontally spaced vertical rows of tubes supported from opposite end portions of the casing, and each row comprising a plurality of vertically spaced U-bent tubes.

The tubes of the set 9 are supported adjacent their open end portions 11 from a tube sheet 12 located adjacent one end wall of the casing, in this instance, the right hand end, which tube sheet is spaced sufficiently from the casing end wall to provide the chamber 6, and the tubes of the set 10 are supported adjacent their open end portions 13 from a tube sheet 14 located adjacent but spaced from the other or left hand end wall of the casing to provide the chamber 5. The tubes of the set 10 are so located with respect to the set 9 that they occupy the spaces between the rows of the set 9 and they are arranged in staggered relation, i. e., alternate U-tubes, transversely considered, are raised above the other tubes by approximately one half the vertical spacing of the horizontal legs of

the U-tubes as will be clear from inspection of Figs. 3 and 4.

The U-bends 15 and 16 of the sets of tubes are located within that portion of the casing which is bounded at its ends by the tube sheets 12 and 14, it being noted that the U-bends or loops of the tubes of alternate vertical rows are arranged as rights and lefts.

Flanges 17 are provided at the open ends of the tubes of the set 9 for attachment of return bends 18 which serve to connect the tubes of each row of the set 9 for back and forth traverse therethrough and flanges 19 are provided at the open ends of the tubes of the set 10 for attachment of return bends 20 which serve to connect the tubes of each row of the set 10 for back and forth traverse there-through. The return bends 18 and 20 are located in the compartments 6 and 5 respectively.

In order to increase the heating surface of each tube fins *f* may be provided on the tubes, which fins extend longitudinally of the tubes and are preferably located in a vertical plane.

The water or other medium to be heated is led to a lower header 21 by means of a pipe or pipes 22 and from this header to the tubes of the set 9 by means of a plurality of bent pipes 23, one for each row of the set, the points of connection being made to the lowermost tubes of the rows. A second plurality of bent pipes 24 is also provided, for leading the medium to be heated to the tubes of the other set 10, which pipes 24 are connected to the lowermost tubes of the rows of said set.

The water traverses back and forth through the tubes and ultimately enters an upper header 25 into which the uppermost tubes of the sets 9 and 10 are connected by means of a plurality of bent pipes 26 and 27 respectively. The water is led off by means of a pipe or pipes 28.

From the foregoing it will be seen that the rows of tubes are serially connected into the main inlet and outlet headers 21 and 25 respectively, and that the points of connection and the removable bent pipes 23, 24, 26 and 27 are so arranged that in case of leakage, any nipple connected into the headers may be readily rerolled without disturbing either the header or any economizer tube connected thereto.

Reverting now to the tube sheets or tube supporting plates 12 and 14 at the ends of the economizer, it will be seen that they are built in vertical removable sections, the sections of the tube sheet 12 being designated as 29 and those of the tube sheet 14 as 30. Each section includes a horizontal or transverse row of U-tubes. The sections are fastened at 31 to vertical framing members of the casing A and are sufficiently vertically spaced to permit of a caulking seal therebetween as indicated at 32.

By the removal of a tube sheet section,

after having removed all interfering return bends all U-tubes within the horizontal row included by the section are exposed for inspection, cleaning and removal. For the purpose of supporting the horizontal row of U-tubes while the tube plate, which otherwise supports them, is removed, we provide a broad flange 33 on the top edge of each section, which flange projects inwardly to serve as a ledge on which the fins of the tubes may rest. In this connection it is pointed out that when the section to be removed is unfastened from the side frame supports, it will drop by the amount of the caulking space between sections and thereby lowers the tubes so that the fins thereof will rest on the projecting ledge of the section below. The tube plate is then free to be removed, it being pointed out that the holes 34 in the tube plates are made large enough and of proper configuration to clear the flanges at the ends of the tubes. The space remaining between the tubes and the holes is filled by a split collar 35 which fits the tube snugly and around which caulking is driven into the annular space 36.

The U-tubes, in addition to being supported adjacent their open ends are also supported at their loop ends by means of the members 37 illustrated in Figs. 3 and 4. The members 37 are fastened to the fins *f* adjacent the loop ends of the tubes and rest or ride on the two lower neighboring tubes at a point near where they are supported in the tube sheet. The members may be fastened to the bottom fin of either the upper or lower straight leg of the U-tubes, the location in either case being such that the members will clear the loops of the tubes on which they rest or ride when the tubes carrying the members are being drawn out of the casing.

As herein shown, the members 37 are carried by the upper straight legs of the tubes of the set 9 and by the lower straight legs of the tubes of the set 10. When tubes are being withdrawn, the members 37 serve as shoes or sliding members adapted to slide along the supporting tubes which act as rails. Thus the tubes are guided in their removal.

Referring now to the members 37 which are secured to the fins of the bottom legs of the U-tubes, for example, those of the second row from the left in Fig. 4, it will be seen that the members are provided with a portion 38 projecting downwardly between the two supporting or guiding tubes, which portion is provided with a groove 39 adapted to receive the upper fin of the upper leg of the U-tube therebelow. The members 37 do not normally seat on the fins as indicated by the clearances in Fig. 4. However, when the tubes on which the members normally rest are removed, then the clearance is taken up and the members seat on the upper fins just mentioned. Under similar circumstances, the U-

tubes which have the members 37 secured to the lower fins of the upper leg, for example, those of the first and third rows from the left in Fig. 4, require for their support special members or spacers 40 which we have secured on the bottom fins of the lower legs of the U-tubes. These spacer members 40 are provided with grooves 41 adapted to receive the upper fin of the tube therebelow and function similar to the downwardly projecting portions 38 of the members 37 just described. In addition, the projecting portions 38 and the spacer members 40 serve to maintain the various tubes in alignment.

Through the practice of our invention an economizer is provided in which the vertical rows of tubes may be brought very much closer together than is possible in the usual tube type of economizer having straight tubes with removable outside return bends connecting the tubes at each end of the economizer and in which considerably more space must be provided in order to accommodate the return bend flanges at each tube end. The closer spacing is possible because of the employment of U-tubes arranged as rights and lefts with their loops within the casing and with the flanged return bends for one set at one end of the casing and with those of the other set at the other end of the casing. The arrangement results in making the economizer occupy, say, approximately 60% of the space of the usual type above mentioned for the same amount of heating surface. Furthermore, by increasing the heating surface of each tube by adding fins to it, the number of tubes, return bends, joints and size of the economizer may be reduced again, while still retaining the same amount of heating surface.

The reduction may be carried even further because of the reduced number of rows of tubes that the gases must pass over which results in a relatively lower draft loss. If it is desired to obtain the same draft loss as in the case of the usual type of economizer, the velocity of the gases may be increased, thereby increasing the rate of heat transfer which will permit a relative reduction in total heating surface required for the same performance of the economizers.

By arranging the U-bends of horizontal rows as rights and lefts, as above pointed out, with the flanged return bends connecting the open ends of the U-tubes to the open ends of the U-tubes of the rows above and below, two separate paths are defined for the water flow through the economizer, one running serially through the return bends along one side and the other serially through the return bends along the opposite side.

In the usual type of economizer, there is but one such serial flow and consequently the water must flow approximately twice as fast, for the same tube size. It must also flow

through more than twice the length of tubing, for not only has the flow been cut approximately in half in our improved economizer, but the length of tubing has been additionally reduced by the presence of fins on the tubes.

The net result is the reduction of the water pressure drop through our economizer to less than one fifth of that of the usual type. By the selection of proper size tubing the velocity of the water may be maintained such that the flow will insure a desirable heat transfer rate and that deposit of small gas bubbles will be kept washed off the tube surface and corrosion thereby minimized in cases where insufficient deaeration of the feed water exists.

In cases where the gas temperature within the economizer becomes so high as to possibly injure the tube plates, we propose to employ refractory tile or plastic refractory on the inside of the tube plates. The tile may be constructed to be locked in place by the fins of the tubes and to be removable and replaceable without injury to it. The inner walls of the casing may also be refractory lined.

We claim:—

1. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of rows of U-bent tubes in said casing, means for connecting the open ends of the U-bent tubes of each row for back and forth traverse therethrough, and means for supporting the tubes, said rows of tubes being arranged in interspaced relation with the U-bends of the tubes of adjacent rows at opposite ends of and within the casing.

2. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of rows of U-bent tubes, said tubes being entirely within the casing except for their open end portions which extend to the outside of the casing, means for connecting the open ends of the U-bent tubes of each row for back and forth traverse therethrough, and means for supporting said tubes, said rows of tubes being arranged in interspersed relation with the U-bends of the tubes adjacent rows at opposite ends of and within the casing.

3. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of adjacent rows being supported from and extending through opposite tube sheets, said rows being arranged in interspersed relation and with the loop portions of the tubes located between the tube sheets, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

4. An economizer comprising, in combination, a casing having inlet and outlet for

a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of adjacent rows being supported from and extending through opposite tube sheets, said rows being arranged in interspersed relation and with the loop portions of the tubes located between the tube sheets, means for connecting the open ends of said tubes for back and forth traverse therethrough, and means for supporting said tubes adjacent the U-bends from the open end portions of adjacent tubes.

5. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of spaced rows of U-bent tubes supported from one tube sheet adjacent the open ends of the tubes, a plurality of spaced rows of U-bent tubes supported from the other tube sheet adjacent the open ends of the tubes, said last mentioned plurality of spaced rows of tubes occupying the spaces between the first mentioned rows, and means for connecting the open ends of said tubes for back and forth traverse therethrough, and said tubes having their loop portions located within the casing.

6. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of spaced rows of U-bent tubes supported from one tube sheet adjacent the open ends of the tubes, a plurality of spaced rows of U-bent tubes supported from the other tube sheet adjacent the open ends of the tubes, said last mentioned plurality of spaced rows of tubes occupying the spaces between the first mentioned rows, means for supporting the loop portions of the tubes from the open end portions of adjacent tubes, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

7. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of spaced rows of U-bent tubes supported from one tube sheet adjacent the open ends of the tubes, a plurality of spaced rows of U-bent tubes supported from the other tube sheet adjacent the open ends of the tubes, said last mentioned plurality of spaced rows of tubes occupying the space between the first mentioned rows, means adjacent the loop portions of the tubes for maintaining the tubes in parallel spacing, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

8. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of spaced rows of U-bent tubes supported adjacent their open ends from an end wall of the casing, a plurality of spaced rows of U-bent tubes sup-

ported adjacent their open end from the opposite end wall of the casing and occupying the spaces between the first mentioned rows, the loop portions of the U-bent tubes being within the casing, and the U-bent tubes of the second mentioned rows being in staggered relation to the tubes of the first mentioned rows, and means outside said end walls for connecting the open ends of said tubes for back and forth traverse therethrough.

9. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of spaced rows of U-bent tubes supported adjacent their open ends from an end wall of the casing, a plurality of spaced rows of U-bent tubes supported adjacent their open ends from the opposite end wall of the casing and occupying the spaces between the first mentioned rows, the loop portions of the U-bent tubes being within the casing, and the U-bent tubes of the second mentioned rows being in staggered relation to the tubes of the first mentioned rows, and means outside said end walls for connecting the open ends of said tubes for back and forth traverse therethrough, together with fins on said tubes extending longitudinally thereof.

10. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, said tube sheets comprising a plurality of removable sections for giving access to the tubes of the economizer for cleaning, removal and replacement, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

11. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, said tube sheets comprising a plurality of removable sections each of which is arranged to give access to a different row of tubes transversely of the economizer for cleaning, removal and replacement of the tubes, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

12. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, said tube sheets comprising a plurality of removable sections each of which is arranged to give access to a different row of tubes transverse-

ly of the economizer for cleaning, removal and replacement of the tubes, means on said sections adapted to support the tubes of the transverse rows upon removal of a header section, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

13. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, fins on said tubes extending longitudinally thereof, said tube sheets comprising a plurality of removable sections, each of which is arranged to give access to a different row of tubes transversely of the economizer, and means on said sections adapted to be engaged by the fins to support the tubes of the transverse rows upon removal of a header section.

14. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, sectional end tube sheets for said casing, a plurality of spaced vertical rows of U-bent tubes in said casing supported adjacent their open ends from one of the end tube sheets, a second plurality of spaced vertical rows of U-bent tubes in said casing supported adjacent their open ends from the other end tube sheet and occupying the spaces between the first mentioned rows, detachable means for connecting the open ends of said tubes for back and forth traverse therethrough, means carried adjacent the loop ends of the tubes of the first plurality of rows adapted to engage the tubes of the second plurality of rows for giving support to said tubes at their looped portions, means carried adjacent the loop ends of the tubes of the second plurality of rows adapted to engage the tubes of the first plurality of rows for giving support to said tubes at their looped portions, the sections of said tube sheets being removable without disturbing the tubes, the tubes being removable through the opening provided by a removed section, and said means carried adjacent the loop ends of the tubes acting on the tubes which they engage as slides to guide the tubes in their removal.

In testimony whereof we have hereunto signed our names.

GEORGE P. JACKSON.
KURT TOENSFELDT.
HARRY STEELE.

DISCLAIMER

1,786,909.—*George P. Jackson* and *Kurt Toensfeldt*, Flushing, N. Y., and *Harry Steele*, Newark, N. J. **ECONOMIZER**. Patent dated December 30, 1930. Disclaimer filed February 19, 1934, by *Wilfred R. Wood* and *Irving Trust Company*, as receivers of *International Combustion Engineering Corporation*, assignee.

Hereby enters this disclaimer to that part of the claims in said specification which are in the following words, to wit:

"1. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of rows of U-bent tubes in said casing, means for connecting the open ends of the U-bent tubes of each row for back and forth traverse therethrough, and means for supporting the tubes, said rows of tubes being arranged in interspaced relation with the U-bends of the tubes of adjacent rows at opposite ends of and within the casing.

"2. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium, a plurality of rows of U-bent tubes, said tubes being entirely within the casing except for their open end portions which extend to the outside of the casing, means for connecting the open ends of the U-bent tubes of each row for back and forth traverse therethrough; and means for supporting said tubes, said rows of tubes being arranged in interspersed relation with the U-bends of the tubes adjacent rows at opposite ends of and within the casing.

"3. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of adjacent rows being supported from and extending through opposite tube sheets, said rows being arranged in interspersed relation and with the loop portions of the tubes located between the tube sheets, and means for connecting the open ends of said tubes for back and forth traverse therethrough."

"5. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of spaced rows of U-bent tubes, supported from one tube sheet adjacent the open ends of the tubes, a plurality of spaced rows of U-bent tubes supported from the other tube sheet adjacent the open ends of the tubes, said last mentioned plurality of spaced rows of tubes occupying the spaces between the first mentioned rows, and means for connecting the open ends of said tubes for back and forth traverse therethrough, and said tubes having their loop portions located within the casing."

"7. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of spaced rows of U-bent tubes supported from one tube sheet adjacent the open ends of the tubes, a plurality of spaced rows of U-bent tubes supported from the other tube sheet adjacent the open ends of the tubes, said last mentioned plurality of spaced rows of tubes occupying the space between the first mentioned rows, means adjacent the loop portions of the tubes for maintaining the tubes in parallel spacing, and means for connecting the open ends of said tubes for back and forth traverse therethrough."

"10. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, said tube sheets comprising a plurality of removable sections for giving access to the tubes of the economizer for cleaning, removal and replacement, and means for connecting the open ends of said tubes for back and forth traverse therethrough.

"11. An economizer comprising, in combination, a casing having inlet and outlet for a heating medium and having end tube sheets, a plurality of rows of U-bent tubes in the casing, the open end portions of alternate rows being supported from and extending through opposite tube sheets, said tube sheets comprising a plurality of removable sections each of which is arranged to give access to a different row of tubes transversely of the economizer for cleaning, removal and replacement of the tubes, and means for connecting the open ends of said tubes for back and forth traverse therethrough."

[Official Gazette March 27, 1934.]

CERTIFICATE OF CORRECTION.**Patent No. 1,786,909.****Granted December 30, 1930, to****GEORGE P. JACKSON ET AL.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 101, claim 1, for "interspaced" read interspersed; same page, line 115, claim 2, after the word "tubes" insert the word of; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of March, A. D. 1931.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.