June 17, 1930. J. E. BELL 1,764,189

APPARATUS FOR CLEANING ECONOMIZER TUBES

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Fig. 1,

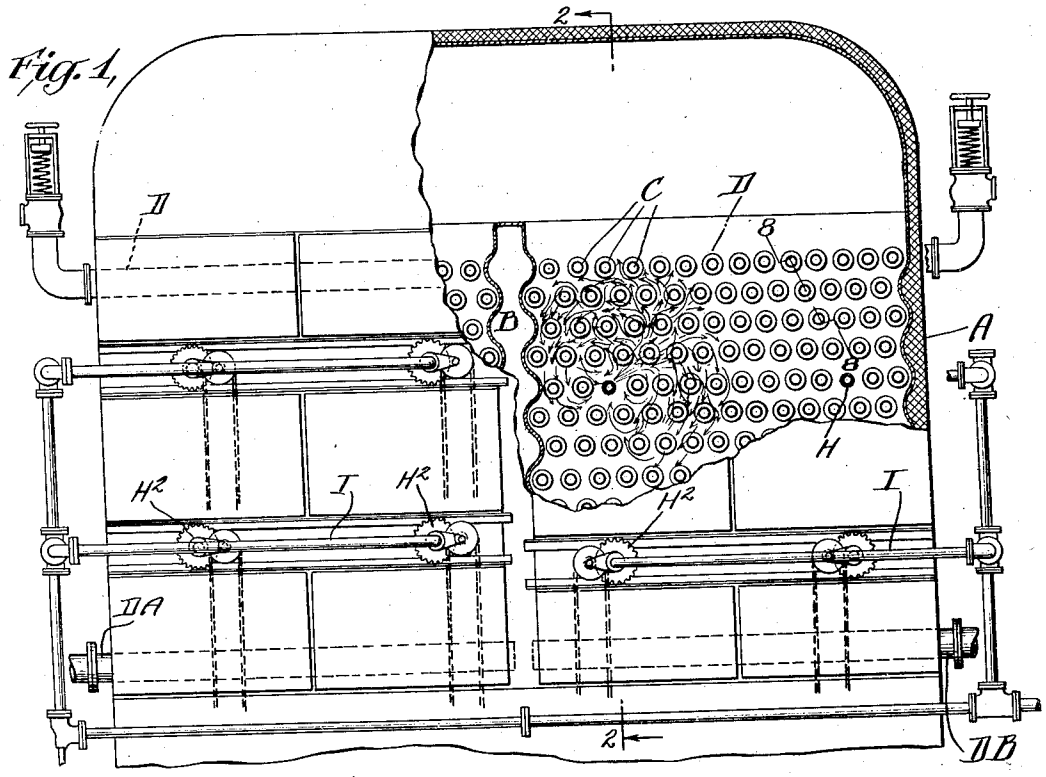


Fig. 8,

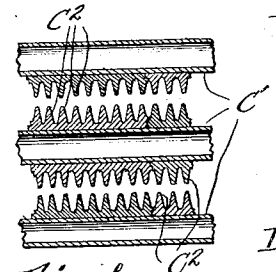


Fig. 2,

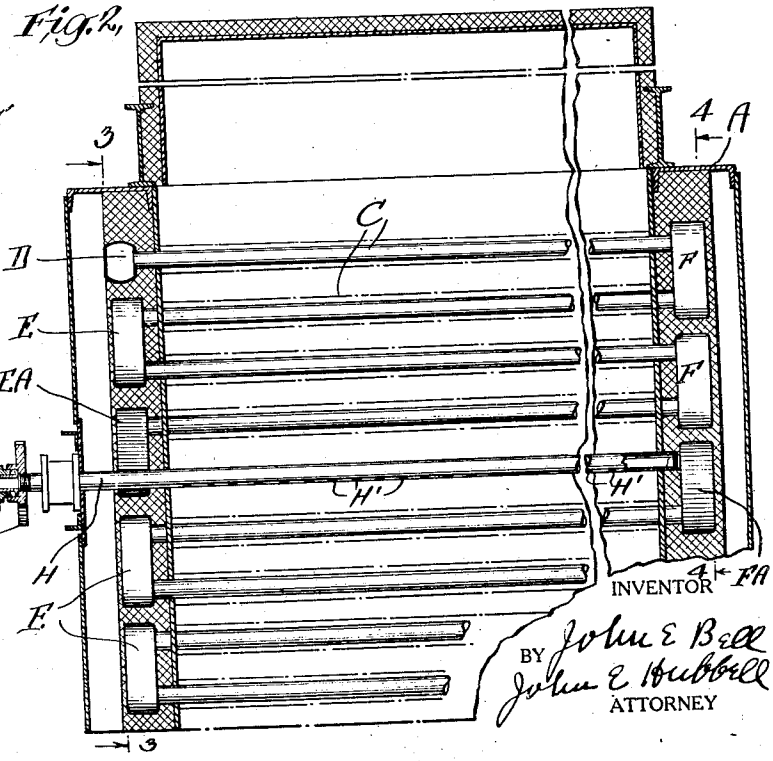
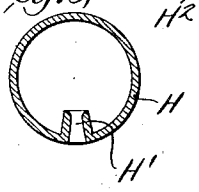


Fig. 9,



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Fig. 3

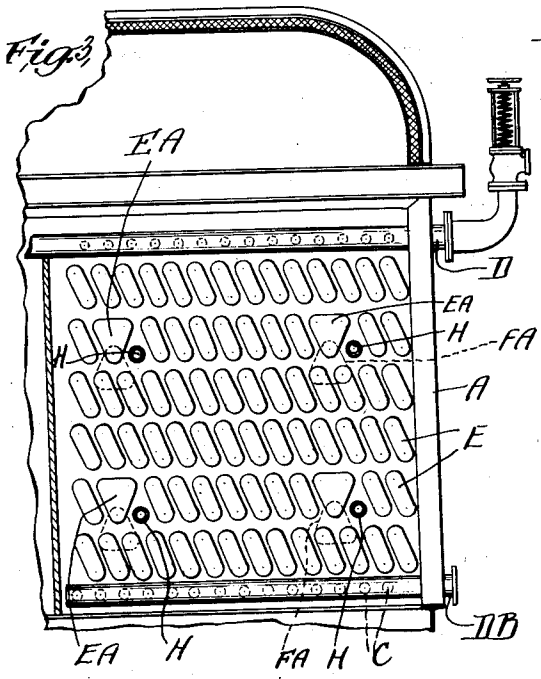


Fig. 4

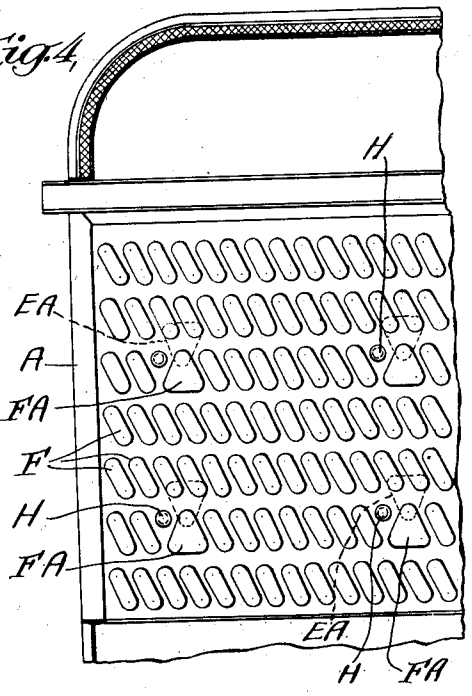


Fig. 5

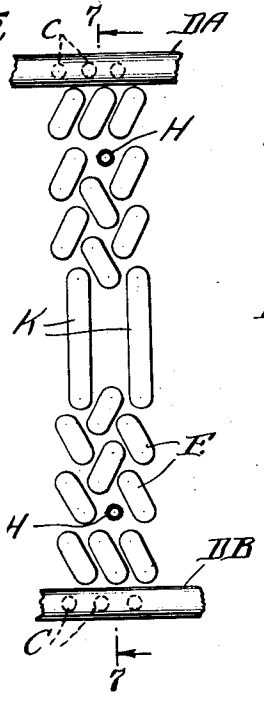


Fig. 6

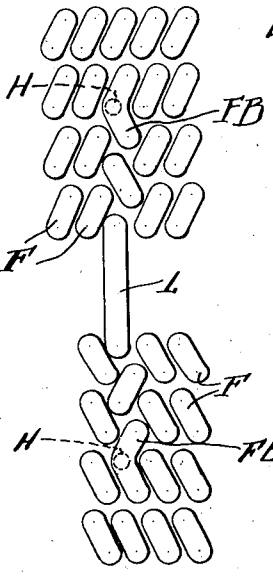
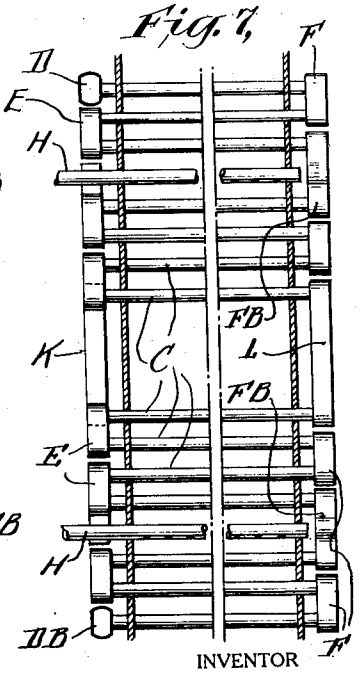


Fig. 7



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Patented June 17, 1930

1,764,189

UNITED STATES PATENT OFFICE

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APPARATUS FOR CLEANING ECONOMIZER TUBES

Application filed September 17, 1923. Serial No. 663,106.

My present invention relates to fluid heating apparatus of the type in which the fluid heated is passed through tubes the outer surfaces of which are swept by heating gases, and the general object of the invention is to provide such apparatus with effective provisions for removing soot or furnace dust deposited on the outer surfaces of the tubes from the furnace heating gases, while permitting a relatively close spacing of the tubes, and relatively simple end connections between tubes connected in series.

The invention was primarily devised, and is especially adapted for use in economizers comprising a bank or banks of closely spaced tubes, each of which is externally corrugated or provided with alternating circumferential ribs and grooves increasing the heat absorbing surface of the tube. In such apparatus a relatively close spacing of the tubes is practically essential to reduce the bulk and cost of apparatus of given capacity and the close spacing of the tubes and their corrugated external surfaces makes effective cleaning provisions absolutely essential to the continued operation of the apparatus.

In accordance with the present invention I employ soot blowing pipes receiving a suitable cleaning fluid under pressure as air or steam, and discharging the cleaning fluid through orifices distributed along the length of each pipe, and arrange these soot blowing pipes in the bank of tubes, in effect by removing one of the heating tubes to make room for each soot blowing pipe which thus occupies the position in the bank of tubes which otherwise would be occupied by one of the heating tubes. Since in the type of economizer for which my invention was primarily devised, and in analogous heat exchange apparatus the fluid heated ordinarily passes from one side of the bank of tubes to the other serially through tubes at different distances from the sides of the bank, the replacement of any one heating tube by a soot blowing pipe necessarily involves a change in the end connections to adjacent heating tubes, and my invention comprises a novel arrangement of such connections whereby the desired general conditions of flow of the fluid heated are maintained, and changes in the general design of the apparatus are avoided.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification; for a better understanding of the invention however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is an elevation of an economizer with parts broken away and in section;

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

Fig. 3 is a partial section on the line 3—3 of Fig. 2;

Fig. 4 is a partial section on the line 4—4 of Fig. 2;

Figs. 5 and 6 are views generally similar to Figs. 3 and 4, respectively, illustrating a modified construction;

Fig. 7 is a partial section on the line 7—7 of Fig. 5;

Fig. 8 is a partial section on the line 8—8 of Fig. 1; and

Fig. 9 is a transverse section through one of the soot blower pipes.

In Figs. 1 to 4 of the drawings I have illustrated the use of my present invention in an economizer comprising a casing A having a central partition B providing up and down passes for the heating gases connected together at their upper ends and communicating at their lower ends with a suitable inlet and outlet, respectively, for the heating gases. In each pass of the economizer as shown, there is a bank of horizontally disposed tubular heating elements C. These elements preferably consist each of an inner tube C′ of wrought metal, and an outer externally corrugated casing formed of cast iron sections, C^2 as shown in Fig. 8. The casing A is advantageously formed as shown of inner and outer metal walls with a space between them packed with Sil-o-cel or analogous material. Preferably as illustrated, the inner sides of the side wall of the casing and the

sides of the partition B are corrugated to correspond to the arrangement of the tubes C in horizontal rows with the tubes in adjacent rows staggered with respect to one another, thereby avoiding a laning action of the heating gases at the sides of the tube banks.

At the front end of the economizer, the top row tubes C in both banks are connected to an intermediate header D; the bottom rows of tubes C in one pass are connected to a water inlet header DA, and the bottom row of tubes in the other pass are connected to the water outlet header DB. In each pass the tubes C in each intermediate horizontal row are each connected at one end of the economizer to a corresponding tube C in the row above, and at the other end of the economizer the tubes are connected each to a corresponding tube C in the row below. As shown these connections are all made by return bends or header boxes E at the front end of the economizer, and by similar return bends or header boxes F at the other end of the economizer, except when the connections are made by special connectors EA and FA as hereinafter explained. Owing to the staggered arrangement of the tubes in adjacent horizontal rows, the return bends E and F are inclined to the vertical as shown in Figs. 3 and 4.

Soot blower pipes H are interspersed among the tubes C in such fashion that the tubes C and pipes H in each pass of the economizer form a bank of uniformly spaced tubular elements composed mainly of heating tubes C. The pipes H are sufficiently numerous and so distributed in the bank that the cleaning jets discharged by them will adequately clean all of the heating tubes. As shown there are four pipes H in each bank arranged in pairs with one pipe in each pair directly above the other pipe of the pair, though the number of pipes H employed and their arrangement may be varied as conditions make desirable.

In the economizer construction illustrated, the return bends E and F and the special connectors EA and FA, connect the various heater tubes C to form a plurality of separate paths of flow between the headers to which the tubes C in the top and bottom rows are directly connected. In general, each path of flow comprises a vertical zigzag row of tubes C, including one tube C in each horizontal tube row, but with the described arrangement the two vertical zigzag rows which include the pipes H, each contains two less tubes C than the other rows. The fluid heated is passed from the tube C above each pipe H into the tube C immediately below it in the same vertical row, through a tube C immediately alongside the soot blower pipe, by means of a pair of special end connectors EA and FA, connected to the opposite ends of the last mentioned tube C. The connector EA is in the form of a triangular shaped box and connects the last mentioned tube C to the two tubes C in the horizontal row above the corresponding pipe H, which are in the same zigzag vertical rows with the pipe H and the tube C alongside it to which the connector EA is connected. The connector FA which may be identical in construction with the connector EA, connects the tube C alongside the soot blower pipe H to the two tubes C in the horizontal row below the pipe H which are in the same zigzag vertical rows with the tubes above the soot blower pipe to which the connector EA is connected. With this arrangement each tube C, to the ends of which connectors EA and FA are connected, forms in effect, a common portion of two side by side and otherwise separate paths of flow for the fluid heated from one side of the tube to the other. These two paths of flow are of the same length as the paths formed by the vertical tube row not containing or adjacent the pipes H, but the velocity of flow through each tube C forming a common part of the two paths of flow is double that through the other tubes C in the row.

The soot blowing provisions including the pipes H are of well known type. Each pipe H is mounted in bearings to permit it to be rotated by means of a sheave and chain operated gear H^2, and thus rotate its discharge outlets H′ about the pipe axis. Preferably each discharge outlet H′ is formed by a nozzle part as shown in Fig. 9, which is adapted to give high velocity to the jet of cleaning fluid discharged through it. The pipes H are connected to cleaning fluid supply piping I which comprises a nonrotatable portion I′ in alignment with, and through which steam, or other cleaning fluid is passed at suitable pressure into each rotatable pipe H. The end of each pipe H remote from the corresponding pipe portion I′, is closed.

With the described construction I am enabled to incorporate approved and effective soot blowing provisions in a bank of closely spaced tubes providing the usual multiple paths of flow for the fluid heated, without changing the general design or capacity of the apparatus, and without requiring new or additional structural elements other than the simple special end connecting parts EA and FA which are duplicates of one another, and the only change in operation of the apparatus is that the flow velocity through each tube connected at one end to a connection member EA and at its opposite end to a connection member FA, is doubled. The disposition of these end connectors EA and FA in the space available to receive them causes no difficulty notwithstanding the limited character of that space.

Soot blowing provisions arranged in a bank of tubes as disclosed herein, are especially effective when those tubes comprise externally

corrugated casings C^2 of cast iron, as in the preferred construction illustrated, because of the manner in which the corrugation ribs and grooves define and direct the eddy currents of the intertube tube space atmosphere which are induced by the cleaning fluid jets discharged through the soot blower orifices H'. When a jet of fluid is discharged with substantial velocity into the atmosphere, the jet sets up eddy currents in the form of whirls, all about the axis of the jet, in planes intersecting the axis of the jet. With the described arrangement, the corrugations and ribs of the elements define flow channels or paths of flow for the eddy currents whereby the eddy current whirls produced are made mainly transverse in direction to the length of the tubular elements C, as indicated by the arrows in Fig. 1. With a close spaced tube arrangement, the cleaning fluid jet discharged through an orifice H' is substantially arrested, and its energy dissipated within a short distance from the soot blower pipe from which the jet issues, and the direct cleaning effect of the jet is comparatively small. The whirls or eddy currents set up by the jets however, extend outward from the soot blower tube from which the jet issues for a distance considerably greater than does the jet proper, and with a suitably high jet velocity and volume, the eddy currents have sufficient velocity to exert a tube cleaning effect which is much greater than the direct cleaning effect of the jet proper. This indirect cleaning effect is mainly instrumental in making the described soot blowing provisions effective. to secure the desired cleaning effect, a high jet velocity is required and in practice when the fluid heating apparatus is associated with a steam generating plant, steam at the boiler pressure is utilized as the cleaning fluid. With steam at a normal boiler pressure of 150 lbs. per square inch or above, the jets discharged directly against bare wrought metal tubes would cut into the tubes, and might dangerously weaken them in a comparatively short time. When the tubes are encased in cast metal however, as in the preferred construction illustrated, the cutting action is of no importance partly because the cast iron is less subject to the cutting action than is wrought iron or steel, but mainly because a cutting effect which may be sufficient in extent to dangerously weaken a bare tube of wrought metal, does no particular harm to the cast iron casing sections C^2, wnich may be eaten or cut away to a considerable extent without weakening the tubular elements or appreciably reducing their heat absorbing areas.

In Figs. 5, 6, and 7, an alternative arrangement is employed in which the tubes C in each pass are arranged in two banks, one above the other, which are shown as spaced apart, though this is not essential. The tubes C in the bottom row of each upper bank are each connected to a corresponding tube in the top row of the lower bank by a connector K or L. The general inclination to the vertical of the end connectors E and F, made necessary by the staggered arrangement of the tubes C in adjacent horizontal rows, is reversed in one bank with respect to that for the other bank. Special end connectors FB are employed in this construction only at the rear end of the economizer, and each of these is elongated to connect the tubes C in the same zigzag vertical row immediately above and below a corresponding pipe H. The effect of this is to reverse the direction of flow through one of the tubes C connected by each connector FB with respect to the other tubes C in the same horizontal row. With one or more pairs of soot blower pipes H in each vertical row and a corresponding pair or pairs of end connectors FB, so that the direction of flow is reversed an even number of times in each vertical row, the direction of flow through the tubes C at the ends of the row is not changed. The inclination of the end connections E and F connecting tubes C in which the direction of flow is reversed, is the reverse of the adjacent connections E and F. The special end connections FB each comprises a portion parallel to the end connections F alongside it and an oppositely inclined portion. As the drawings indicate, the special arrangement of end connections in the construction shown in Figs. 5, 6, and 7 is compact and well adapted to the space requirements. The adjacent tubes C in the zigzag vertical rows in which there are no pipes H are connected at the front end of the apparatus by elongated connectors K, and the tubes in each row in which there are pipes H are connected at the head end of the economizer by an elongated connector L. In Figs. 5, 6, and 7, the velocity of flow through the various tubes in any vertical row is the same, but the path of flow formed by the various tubes C in each vertical row containing soot blower pipes H is shorter by the length of two tubes C, than the flow paths formed by another vertical row of tubes.

While in accordance with the provesions of the statutes I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. Fluid heating apparatus comprising a bank of tubular elements one or more of which are soot blower pipes while the remainder form conduits for the fluid to be heated and connections to the ends of the conduit elements connecting said elements in rows and thereby forming multiple paths of

flow for the fluid to be heated, from one side of the bank to the other, each of which paths includes all of the conduit elements in the corresponding row, said connections including parts connecting the two conduit elements at opposite sides of each soot blower pipe and in the same row with the latter through a conduit element in an adjacent row.

2. Fluid heating apparatus comprising in combination a bank of tubular elements one or more pairs of which serve as soot blower elements while the others are conduits for the fluid to be heated, said elements being arranged in rows extending from one side of the tube bank to the other, with the two soot blower pipes of each pair in the same row which also comprises one or more conduit elements between the two soot blower pipes, and one or more conduit elements at the opposite side of each soot blower pipe from the other soot blower pipe, and connections to the ends of the conduit elements connecting all of the said elements in each of said row for series flow therethrough.

Signed at New York city, in the county of New York and State of New York, this 14th day of September, A. D. 1923.

JOHN E. BELL.