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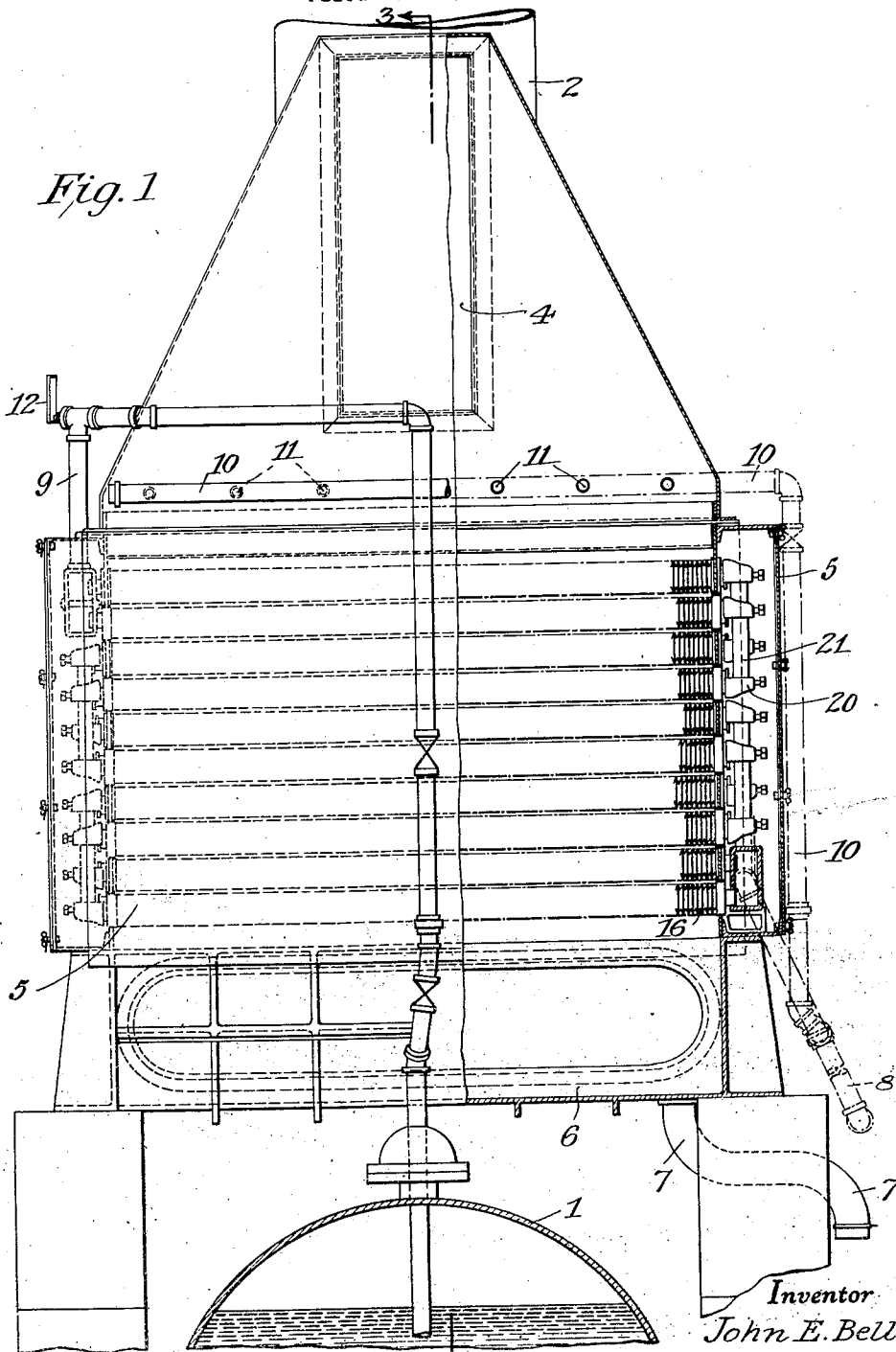
J. E. BELL

ECONOMIZER FOR STEAM BOILERS

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8 Sheets-Sheet 1

Fig. 1



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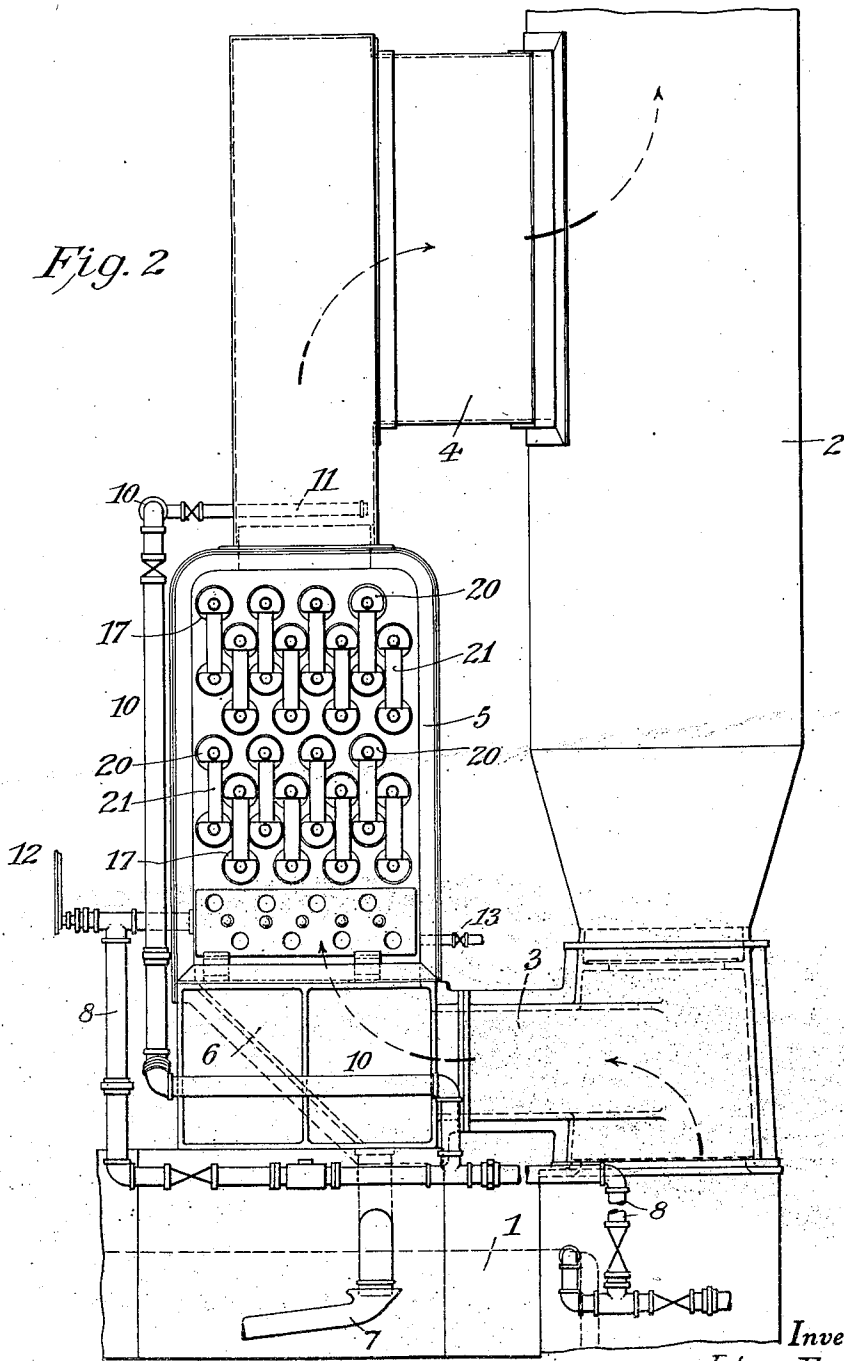
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Fig. 2



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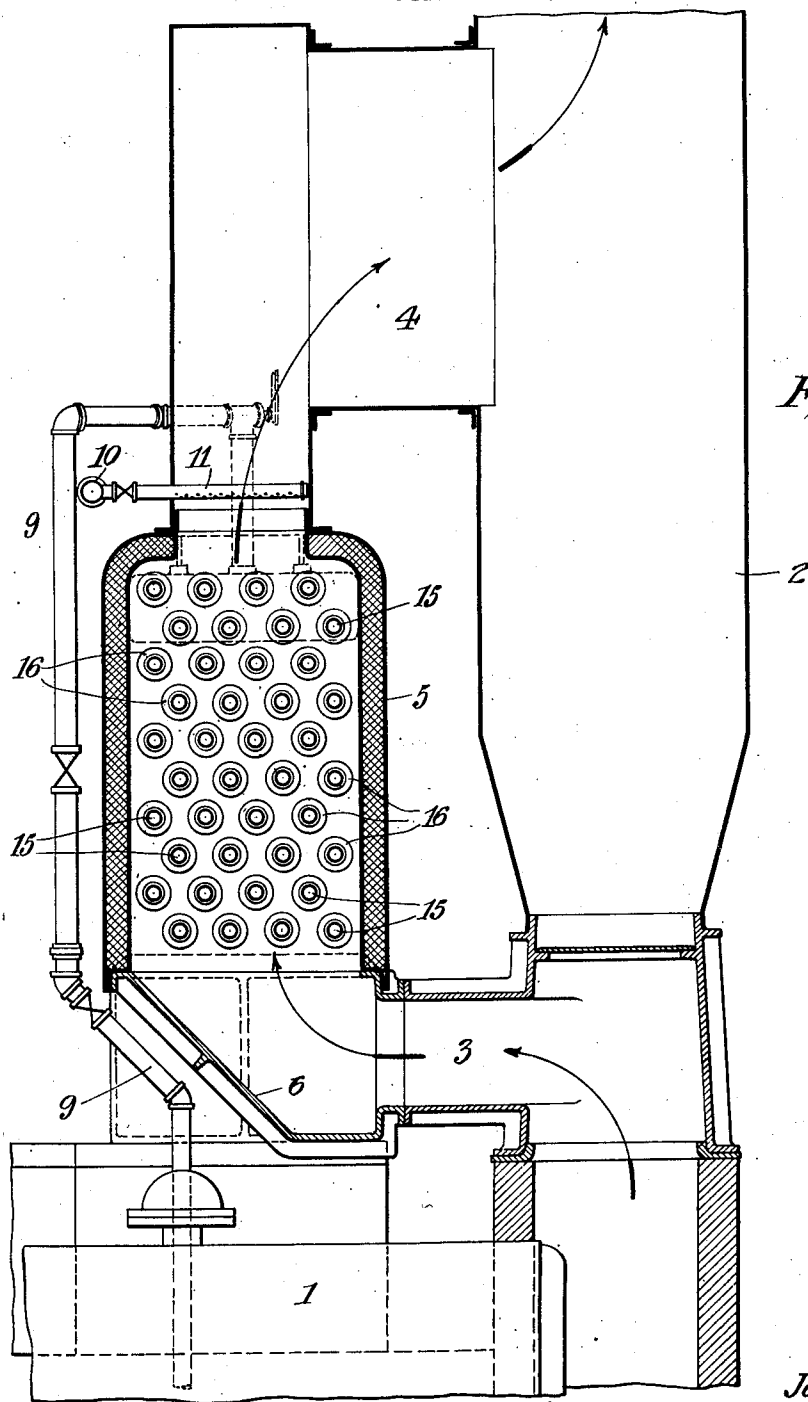
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Fig. 4.

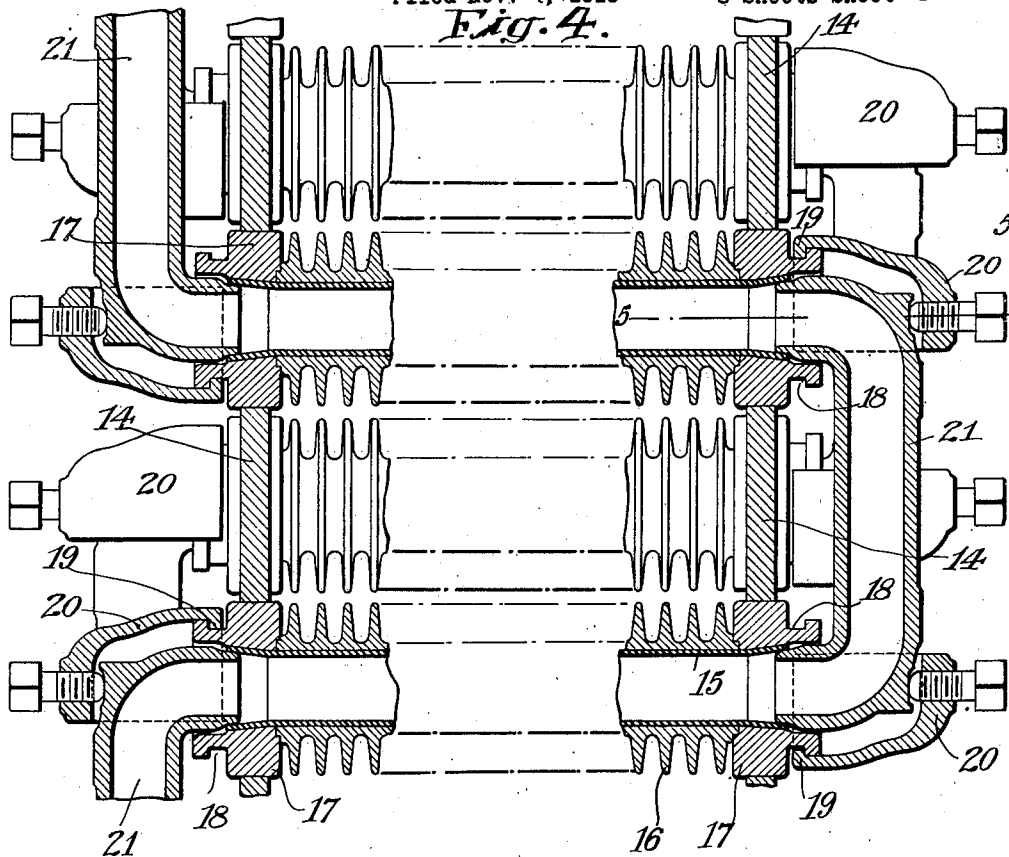
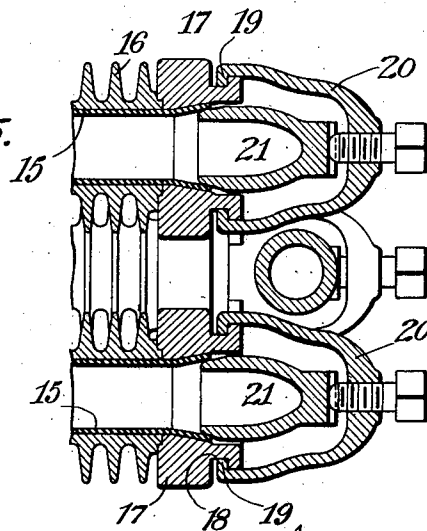


Fig. 5.



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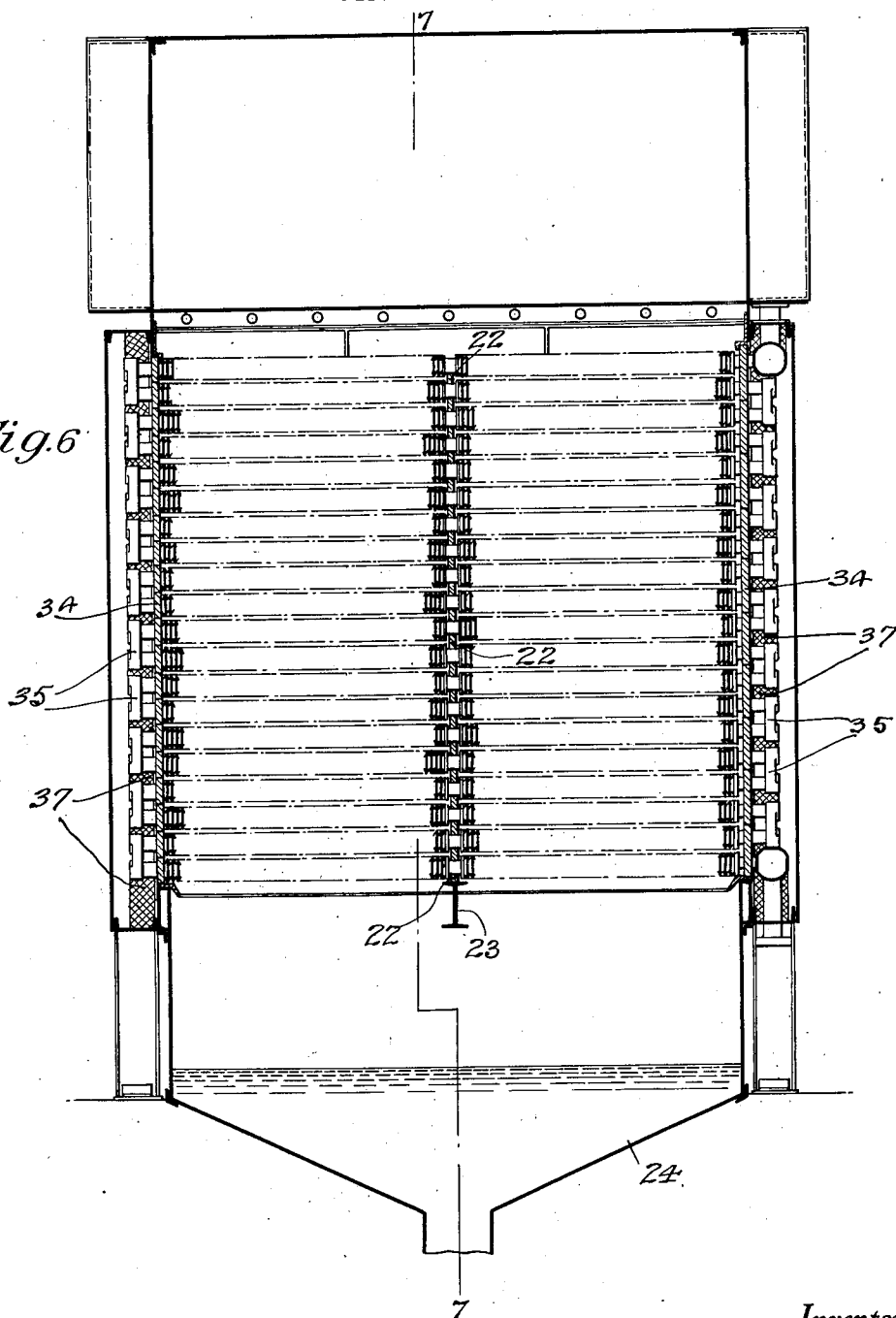
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ECONOMIZER FOR STEAM BOILERS

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Fig. 6



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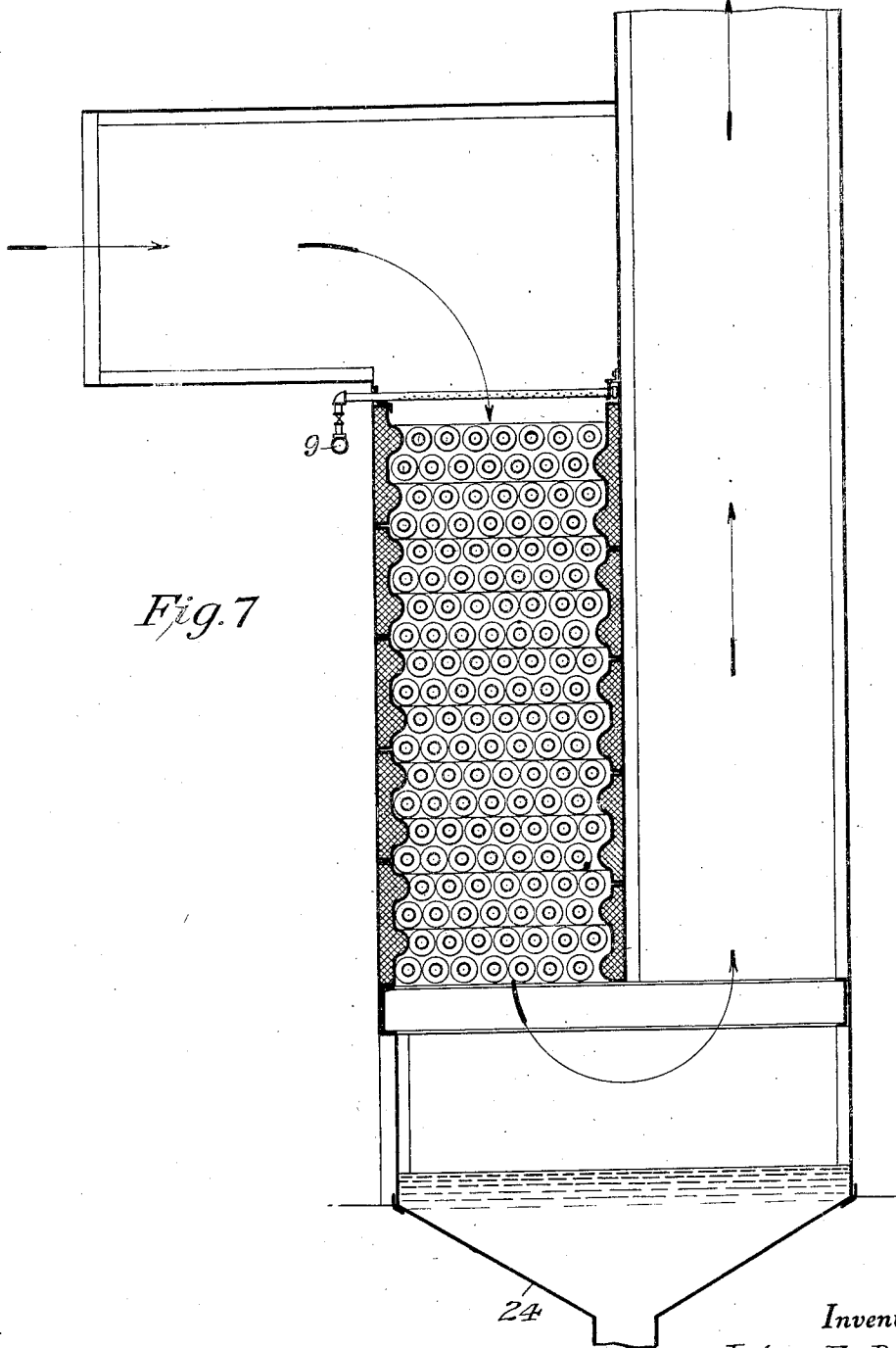


Fig. 7

24

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Fig. 8

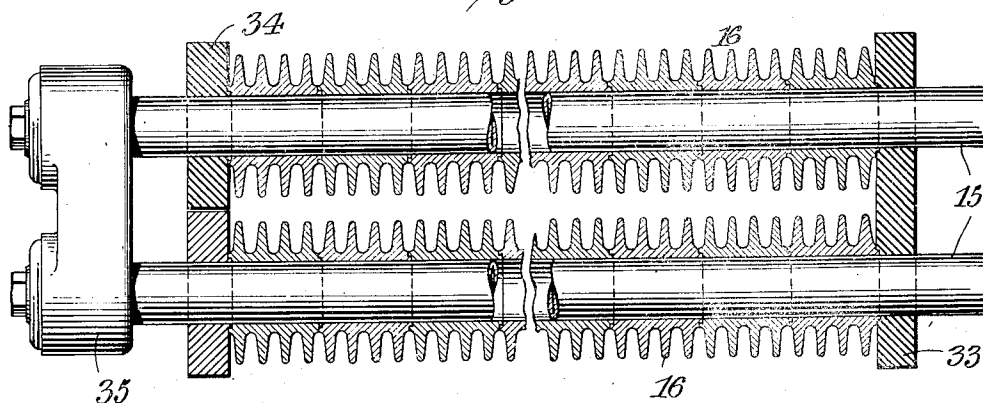


Fig. 9

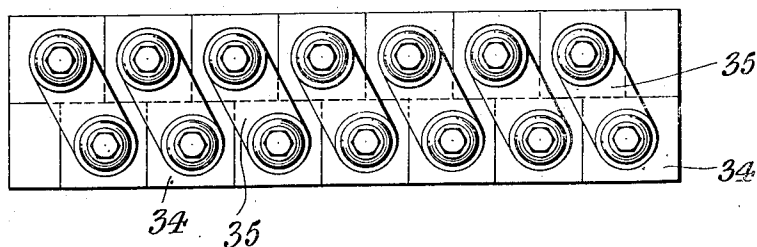
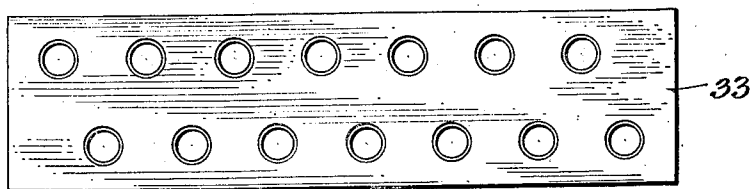


Fig. 10



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ECONOMIZER FOR STEAM BOILERS

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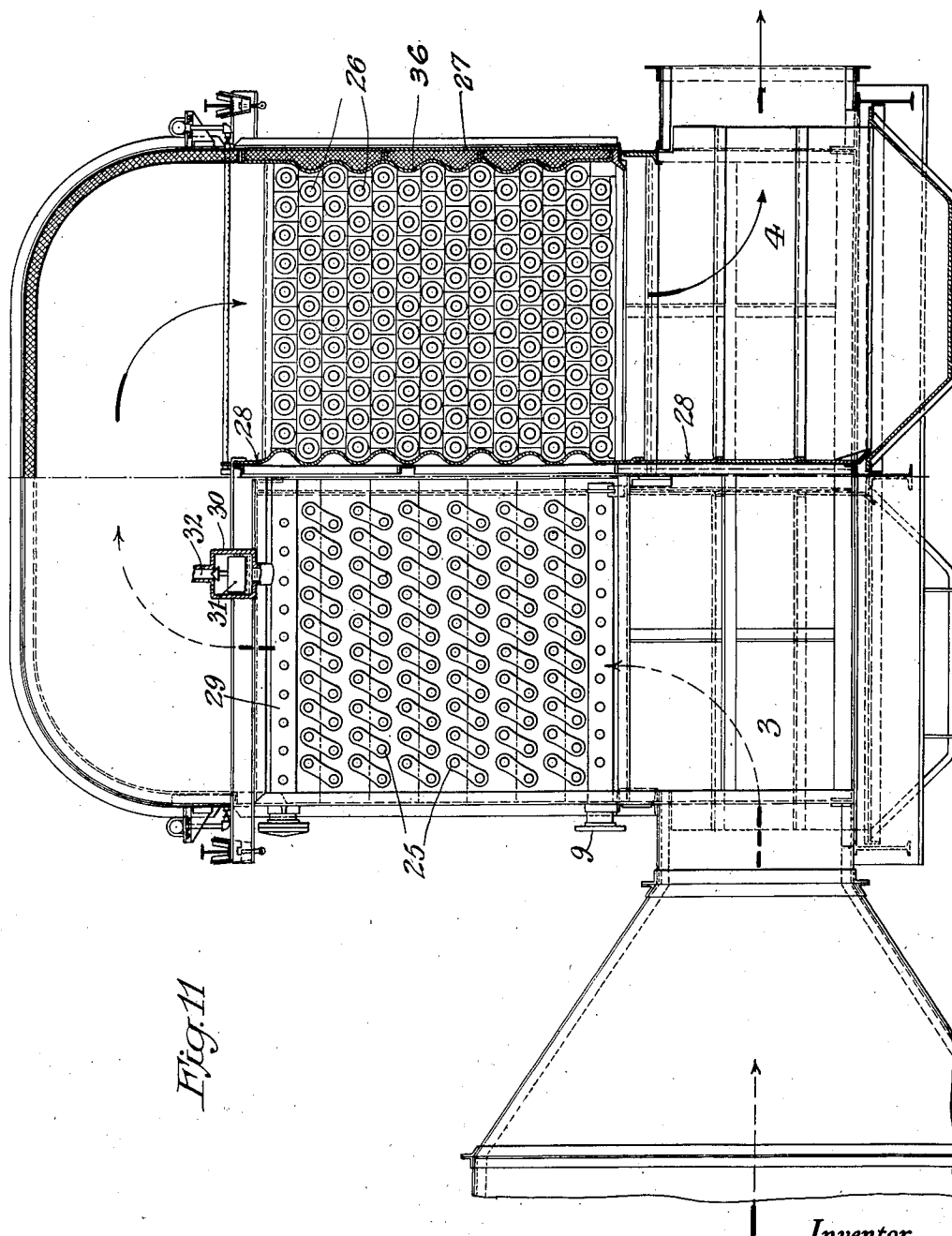


Fig. 11

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UNITED STATES PATENT OFFICE.

JOHN E. BELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ECONOMIZER FOR STEAM BOILERS.

Application filed November 7, 1919. Serial No. 336,284.

To all whom it may concern:

Be it known that I, JOHN E. BELL, a citizen of the United States of America, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Economizers for Steam Boilers, of which the following is a full, clear, and exact description.

The invention which forms the subject of my present application for Letters Patent is an improvement in economizers for steam boilers, and to aid in an understanding of the nature and purpose of my improvements certain facts in connection with devices of this class may be prefatorily stated.

In the use of economizers a serious trouble arises from the tendency to external corrosion due to the condensation of moisture on the surface of the tubes and the presence of a certain amount of absorbed sulphur dioxide.

The problem of selecting a non-corrosive metal for these tubes has heretofore proved insurmountable. The greater the proportion of moisture carried by the furnace gases in passing over the economizer tubes, and the greater the amount of sulphur in the fuel, the more pronounced will be the pitting of the tubes. The colder the feed water is as it enters the economizer, the greater the opportunity offered for condensation of corrosive vapors on the tube surface. Even when these devices are supplied with hot feed water, there are times, particularly in starting up, when the water is cold, and condensation and pitting takes place.

Wrought steel economizers have been tried time and again, and have been abandoned by reason of the rapidly destructive effect of this external pitting. Brass and copper tubes have also been tried, but with the same results. In fact the only available metal for these devices which is sufficiently non-resistant to external corrosion is cast iron, and this metal has been adopted and for years has been the standard material for the purpose.

There are, however, objections to its use not less serious in their way than those to the use of corroding metals. Primarily, cast iron economizers are not suitable for high pressure service for obvious reasons. Again, the tubes of an economizer are liable to become rapidly coated with dust and soot,

for the removal of which at relatively short intervals, a washing of the tubes by jets of water is the most practicable method. But even cast iron tubes will soon give way under this treatment and holes be eaten through them by the corrosive effects of the water. Moreover if the tubes be hot when the water reaches them, then sudden cooling is likely to result in the development of cracks, so that in either event the tubes must be frequently replaced.

Pitting and cracking become more and more dangerous as the pressure on the economizer increases, and this has led to the present strenuous efforts to perfect an economizer that may be used economically, and that is at the same time suitable for modern high pressure service. These efforts have resulted in the installation or proposal of various expedients, for example, in some instances a cast iron economizer through which the coolest water is pumped at low pressure has been combined with a wrought steel economizer with galvanized tubes for the high pressure part. But such devices are very expensive, not only in the cost of actual construction, but especially in the cost of the means for housing them, and in the steel work for supporting their great bulk.

In seeking to overcome the above stated objections I have devised an economizer which has proved successful beyond expectations. In my improved device I use wrought steel tubes which are enclosed in a casing of cast iron, preferably in sections in the form of corrugated rings which are shrunk or otherwise applied over the steel tubes, thereby extending the heating surface and facilitating washing. This economizer, on account of the large amount of surface that can be crowded into a given space, requires little, if any, change in the building and is moreover cheaper in cost. The extended surface of the iron rings can be pitted throughout their entire thickness with no effect whatever on either the capability of the tubes to withstand pressure, or on their heat absorbing capacity. In this form of economizer the pitting would take place through the cast iron rings from the outside rather than through that part of the metal in contact with the steel tube, for while the gases may come in contact with such parts, the greatest velocity of the gas

is over the ring surface. The rings serve, so to speak, as a shield for the tubes proper, and this is not true of the ordinary economizer in which the gases impinge directly on the tube surface and corrosion must therefore be most active where this impingement occurs.

In my improved economizer the steel tubes provide the strength to withstand a high pressure, and the cast iron rings forming the sectional casing provide a surface that can contract and expand, and are of a material that will withstand the corrosive action resulting, not only from condensation, but from the use of washing water. In carrying out the invention I use certain new arrangements of the tubes, the water jets and other parts of the apparatus which will be described in the following parts of the specification in which reference is had to the accompanying drawings.

Fig. 1 is a part elevation and part vertical section of an economizer embodying my invention.

Fig. 2 is a view in elevation of the same device taken from the right of Fig. 1.

Fig. 3 is a vertical section on the line 3—3 of Fig. 1.

Fig. 4 is a sectional detail of the economizer tubes and connections.

Fig. 5 is a sectional view of the same parts on line 5—5 of Fig. 4.

Fig. 6 is a vertical central section of a modified arrangement of economizer tubes.

Fig. 7 is a sectional view of the same on the line 7—7 of Fig. 6.

Figs. 8, 9 and 10 are detail views of the tubes and their supports detached from the economizer and as prepared for transportation.

Fig. 11 is a vertical section of a further modification.

In all the figures I have used the same reference numerals to indicate corresponding parts.

The general arrangement of the device is well shown in Fig. 3, in which 1 is the boiler, 2 the flue stack, and 3, 4 are lateral passages from the stack forming a by-pass for the hot gases through the economizer. The latter device proper is a casing 5 having side walls composed of cast iron plates with an intermediate filling of insulating material, and is mounted on a combined cast iron box and pan 6 joined to the passage 3 and constituting a gas inlet as well as a collecting pan for wash water that may be applied to the economizer tubes for cleaning them.

A drain pipe 7 connected with the pan 6 carries off the water and such dust as may collect in said pan, and in the form of device shown in Figs. 1 to 3, 8 is the inlet pipe to the economizer connected in this instance with the tubes at the bottom of the bank, 9 is the feed outlet pipe from the top of the

economizer to the boiler, and 10 is a pipe connected with the inlet pipe and terminating above the economizer pipes in a cross pipe to which are connected spray pipes 11 having a series of nozzles or jets from which wash water may be delivered to the economizer tubes. The other usual accessories for these devices, such as thermometers 12, a blow off pipe 13 and the like are used, but in view of the art call for no extended description.

The economizer pipes are supported in substantial side walls 14 composed of cast iron plates in the manner shown in Figs. 4 and 5. Each pipe is composed of a wrought steel tube 15 in a cast iron casing 16, the latter composed, preferably, of rings or sections shrunk or expanded on or otherwise united closely and firmly to the inner tubes. All exposed portions of the tubes are encased in these rings except at the ends where cast iron disks 17 are placed over the inner tubes, and fit into holes drilled or otherwise formed in the iron plates 14. The disks 17, at the outer edges, are formed with grooves 18 to receive the projecting tongues 19 of the bell shaped clamps 20, which force the ends of the return bends 21 into the tube ends.

In the figures under consideration it will be observed that the economizer tubes of one row are staggered with respect to the adjacent rows, in other words, the tubes of one row are over spaces between tubes in the next lower row and beneath the spaces in the next row above. The spray tubes 11 moreover extend over the tubes transversely, and this arrangement possesses marked advantages. The water sprayed onto the bank of tubes from above, is deflected back and forth as it descends, so that all portions of the surface are washed clean, which would not be the case were the tubes in vertical rows and not staggered, and it would be only in a measure true did the tubes present plain in lieu of corrugated surfaces.

In my economizer the water falls across the whole width of the bank of tubes, and because of the corrugated surface of the latter the width of the space washed by each spray pipe is maintained practically constant from the top to the bottom of the bank, as the corrugations prevent the water from spreading out longitudinally on the tubes.

These results would not follow were the spray tubes placed parallel to the tubes, the water from one jet in such case being to a certain extent shed in passing from row to row, as it is by the shingles in a roof and to effectively clean the tubes under such conditions, all of the jets would have to be turned on at the same time. This is objectionable, as it would cool the feed water too much and would moreover interfere with the draft. By my arrangement the spray

pipes with their jets can be turned on, one at a time, and in this way the entire bank cleaned without unduly cooling the feed water or interfering with the draft.

5 In all economizers the greatest absorption of heat takes place when the cold water enters at the point where the gases leave, and gradually works toward the point where the hot gases enter, whereby the hottest water
10 leaves the tubes where the hottest gases enter. This is known as counter-current and a true arrangement for securing this effect possesses very marked advantages in economizer construction. The ordinary economizer, however, is made up of a series of
15 sections of cast iron, and the flow of water through all of the sections is the same, the cold water coming in at the bottom headers where the gases are hottest and leaving at the top where the gases after giving up a
20 part of their heat also leave.

Occasionally the economizer is divided into two or three parts, and the water is pumped through these parts in series in an effort to approximate a counter-current arrangement, but at best this is only a make-shift. In my plan of construction, however, the wrought steel tubes may either be expanded into connecting boxes at their ends,
25 or joined in some other practicable manner, and as many tubes as may be desired may be connected in series. When the feed water enters at the bottom of a group of such tubes any steam that may be formed in the tubes, in the event that the flow of water is stopped,
30 or that the gases are hot enough to form steam, passes up through one tube after another and out at the top without damage to the economizer. By my arrangement also
35 it is possible to so connect the economizer with the boiler that water hammers are entirely avoided even though the economizer is making steam, and any number of tubes are connected in series. In a cast iron economizer, a water hammer is liable to wreck the apparatus, for which reason makers of these devices have been very careful not to connect the tubes in series.

When connecting the tubes in series as above set forth, the rows of tubes may be either vertical or horizontal, but the vertical rows are preferable if any substantial quantity of steam is formed in them. Horizontal rows, however, can be used by having
50 the connecting bends in all the tubes in one plane.

In Figs. 6 and 7 a modification of the economizer is shown which secures the advantages just above discussed. In these figures the length of the tubes is such as to require an intermediate support 22 resting on a suitable beam 23.

In this Fig. 6 is also shown the construction of the end walls which I prefer to use. These are composed of the cast iron plates

34, which resting one upon another form the inner wall of the chamber, and through these plates the bare ends of the tubes pass, being connected outside of said walls by the usual headers 35. Around these connections heat insulating material 37 is packed or placed. This constitutes a very efficient form of end wall.

In these figures also the water inlet 8 for the economizer is at the bottom and the outlet 9 at the top, but, as shown in Fig. 7, the draft is from the top to the bottom of the bank of tubes, so that a true counter-current arrangement is thus provided for.

The bank of tubes is, in this case, mounted above a water tank in a box 24 having a conical bottom and an outlet from the apex. The water box constitutes an efficient cinder trap. The draft down through the pipes imparts to the cinders a relatively high velocity, and by reason of their specific gravity as compared with air, together with their momentum, they are not deflected to follow the draft up the flue but fall into the water which may be contained in the box 24.

In Fig. 11 a further modification of the device is shown, in which two banks of economizer tubes 25 and 26 are shown enclosed in a casing the side walls of which are composed of steel plates 27, to which are bolted sections of a lining composed of cast iron filled with an insulating material. The main casing is divided into two parts by cast iron plates 28 so that practically all the interior walls of the casing are composed of cast iron.

In this form of the apparatus, as in that shown in the other figures, particularly Fig. 7, the inner side walls 36 or those parallel with the tubes of non-corrosive cast iron, are not flat but corrugated as shown, said walls thus conforming to the contour of the bank of tubes and in close proximity thereto, as shown, and thus securing an improved and important result. Were this inner wall flat, there would be much greater spaces between it and the tubes than between the tubes themselves, from which it would result that the hot gases would follow paths along the side walls and would not be distributed over the tubes. A further advantage results from the use of such corrugated walls in that the water introduced to clean the economizer tubes will not tend to flow down the side walls, but by the corrugations will be deflected onto the tubes and thus facilitate cleansing of the latter. By means of the insulation the heat is confined to the chamber or passage containing the tubes and the steel outer walls are more perfectly protected.

The banks of economizer tubes are substantially of the same construction as those previously described, but are arranged above the hot gas passages 3 and 4. The gases

enter at 3, pass up through the first bank of tubes, then over and down through the second bank. Preferably the outlet 9 for hot water is at the bottom of the first bank of tubes, where the hottest gases enter, so that a true counter-current effect is secured. If the tubes are in series, or if steam is liable to form in the tubes a vent for its escape is provided in the cross header 29. This device is a box 30 containing a float valve 31 which controls a vent pipe 32. If steam rises in the header the float valve falls and the steam escapes, but when the header is full of water this rises in the box 30 and closes the valve.

Figs. 8, 9 and 10 show a modified way of mounting or supporting the economizer tubes. In this case the tubes at one end have plain surfaces and are expanded into openings in a cast iron plate 33 which forms one side wall of the casing. The other wall is made up of square sections or blocks 34 of cast iron, through each of which is an opening through which passes the other end of the tubes. Cross or end connections 35 connect the tubes in their proper order.

By this means the economizers may be made up and shipped in sections which are readily assembled. Moreover, should it become necessary to replace any one or more tubes the projecting plain surfaced ends may be cut off, the tubes with their blocks at the other ends withdrawn and others put in their places.

The plan of construction hereinabove described has proved, upon extended practical use, to be of great economic value. The economizers may be readily and cheaply constructed and used under the most exacting conditions with results that heretofore have been obtained only by the most complicated and expensive constructions.

Novel subject matter disclosed but not claimed herein, is claimed in my co-pending application Serial No. 572,166, filed July 1, 1922.

What I claim as my invention is:—

1. An economizer for steam boilers comprising in combination a bank of horizontally disposed tubular elements each having external circumferentially extending ribs and valved water supply means for discharging water downward onto the top of said bank of tubes to wash off the external tube surfaces.

2. The apparatus of claim 1 further characterized by the fact that each of the economizer tubes comprises an inner thin walled

steel tube and an externally corrugated cast iron casing therefor.

3. The invention set forth in claim 1 in which means are provided for supplying the washing water to different longitudinal sections of the bank of elements at different times.

4. In an economizer for steam boilers, a bank of horizontally disposed tubes having external circumferentially extending ribs, and means for washing the external tube surfaces comprising spray pipes arranged over the bank of tubes in position to discharge water onto the tubes in jets transverse in direction to the lengths of the tubes, and valved water supply connections to said spray pipes.

5. In an economizer for steam boilers, a bank of horizontally disposed tubes having external circumferentially extending ribs in combination with means for washing the external tube surfaces, comprising a plurality of spray pipes located above the bank of tubes and extending transversely to the length of the latter and spaced at intervals along the length of the tube bank, and separate valved water supply connections to said spray pipes.

6. In an economizer for steam boilers, the combination with one side wall composed of one or more extended plates and an opposite wall composed of small sectional plates, of tubes with plain surfaces at their ends which pass through spaced holes in the extended plates and single holes in the sectional plates, respectively, and exterior end connections for said tubes.

7. A counter current boiler economizer comprising two banks of horizontally disposed tubes arranged side by side, means for passing the heating gases first upward through the inter-tube space of one bank and then downward through the inter-tube space of the outer bank, means for passing the water to be pre-heated back and forth through tubes at successively higher levels in the last mentioned bank and then back and forth through tubes at successively lower levels in said one bank, a vent for the discharge of steam from the tubes at top of the last mentioned bank, and a valve controlling said vent automatically opening to permit the discharge of steam and closing to prevent the discharge of water through the vent.

In testimony whereof I hereunto affix my signature.

JOHN E. BELL.