C. G. BOSCH.

AIR HEATER.

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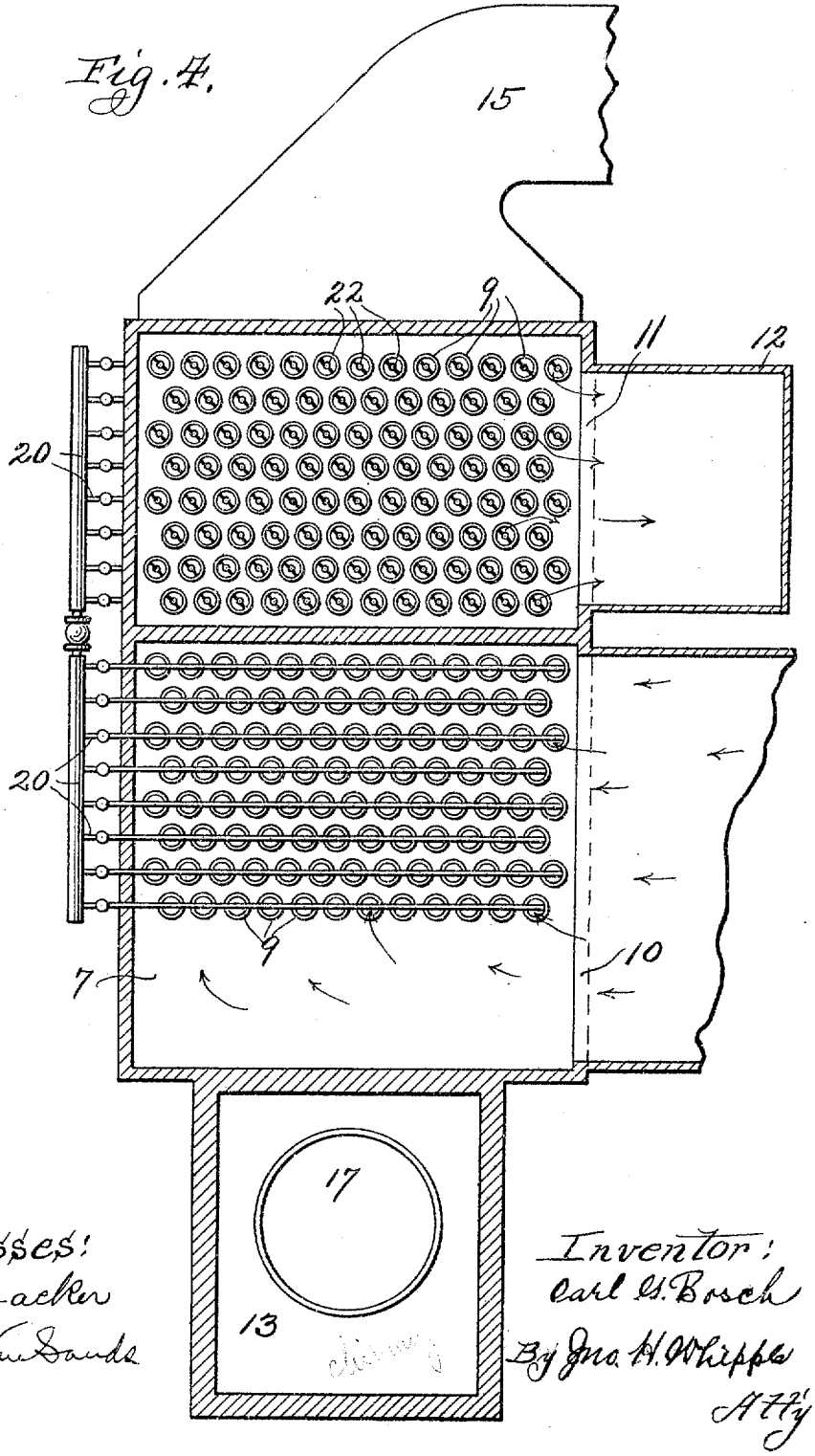
957,862. Patented May 17, 1910.

2 SHEETS—SHEET 2.

Fig. 4.



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AIR-HEATER.

957,862. Specification of Letters Patent. **Patented May 17, 1910.**

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To all whom it may concern:

Be it known that I, CARL G. BOSCH, of Cedar Rapids, Iowa, have invented certain new and useful Improvements in Air-Heaters, of which the following is a specification.

My invention relates to air heaters which are designed to utilize the waste heat from steam boilers or other furnaces where the flue gases escape into the open air; and the objects of my improvements are, first, to provide an apparatus which is adapted to absorb the heat economically from the smoke and waste gases and apply the same to heating air for the purpose of warming buildings, drying grain, and especially adapted to drying malt in a malt house, and the like, wherever pure hot air is required; second, to provide such apparatus with suitable means for cleaning and keeping the apparatus clean in order to get the best results; and third, to provide means in conjunction with the apparatus for conveying the heated air to the place where it is to be used, and preventing it from being cooled off in transit. I have attained these objects by the apparatus constructed as illustrated in the accompanying drawings, in which—

Figure 1 represents a longitudinal vertical section of an apparatus constructed to embody my invention. Fig. 2 is a rear end elevation with the doors removed; and Fig. 3 is a detail showing a longitudinal section of a flue with a scraping or cleaning device within the same. Fig. 4 is an enlarged transverse section taken on line 4 4 of Fig. 1.

In the drawings like signs marked thereon refer to like parts throughout the several views.

I provide an air tight inner or central chamber 4 constructed of metal or concrete and preferably having a partition 5 extended lengthwise partway through it. At one end of chamber 4 I provide an end or outer chamber 6, and at the opposite end I provide another end or outer chamber 7 which is sub-divided horizontally into two compartments. Said chambers 6 and 7 are preferably made of sheet metal 7^a and are provided with doors 8.

The inner chamber 4 is provided with a large number of narrowly interspaced small tubes 9 (preferably about two hundred), which are preferably arranged in staggered relation, substantially fill chamber 4 and all communicate at one end with outer chamber 6 and at the other end with outer chamber 7, an equal number with each of its compartments, in such manner that hot smoke or waste flue-gases admitted to either compartment of outer chamber 7 will pass through that portion of said tubes connected therewith to outer chamber 6, and thence through the rest of said tubes in reverse direction to the other compartment of outer chamber 7.

The lower compartment of outer chamber 7 is provided with a large opening 10, at the side, which communicates with a flue (not shown) leading to a furnace from which hot smoke or waste gases escape and pass through such flue into the lower compartment of outer chamber 7, thence through the lower half of tubes 9 to outer chamber 6 and thence through the upper half of tubes 9 into the upper compartment of outer chamber 7. The upper compartment of outer chamber 7 is provided with a large opening 11 through which the smoke and waste gases escape into a flue 12 which leads to an exit flue or chimney 13.

The inner chamber 4 is provided with a large opening 14 through which a cold air flue 15 communicates with the upper part of said inner chamber, and also with a large opening at 16 which communicates with a flue 17, so that cold air admitted to flue 15 can pass through opening 14 into inner chamber 4 and around on the outside of and between tubes 9, passing around the end of the part-way partition 5 through the open space at 18 and on to the opening 16 and thence through the flue 17 leading to where the heated air is required to be used.

The tubes 9 in the lower part of chamber 4 receive the waste gases while they are hottest and hence are made hotter than the tubes in the upper part of chamber 4, and the cold air entering at 14 first passes through the cooler part of the tubes and thence passes on to hotter parts until passing out at 16 where said chamber is hottest.

The structure, comprising the inner chamber 4, the outer or end chamber 6, and the opposite outer or end chamber 7 and its subdivisions, considered as a whole, is regarded and denominated a four-compartment structure, and is combined with the group of narrowly interspaced small tubes 9 in inner part 4 and all connected at one end with outer part 6 and at the other end an equal portion with each subdivision of outer part 7 to make the best means for controlling

the movement of the escaping hot waste gases in the manner required for absorbing the maximum amount of heat therefrom. And the same four-compartment structure, and group of tubes with part-way partition 5 and having inlet opening 10 and outlet opening 16 arranged in proximity with one another on one side of said part way partition and the inlet opening 14 and outlet opening 11 in proximity on the opposite side of said part-way partition, constitute the best means for controlling the movement of the cold air around the tubes in the manner required to have it take and carry off the maximum amount of such heat. But I have found that the tubes in such four-compartment structure, having a size adapted to attain a fairly practical efficiency as a means of saving waste heat as contemplated will clog so rapidly as necessarily to require cleaning means in conjunction with the tubes and adapted to be operated at frequent intervals without interruption of the draft through the tubes. To obviate this difficulty and provide the best air heater ever made to my knowledge, I have provided and incorporated suitable cleaning means adapted to be worked at short intervals and without shutting off the draft of the products of combustion, for practically cleaning such small tubes and keeping them clean while in operation. Such cleaning means consists in a series of jets arranged opposite to the tubes and at the ends thereof where the waste gases enter them for applying steam or air to the interior of the tubes to travel in the same direction with the waste gases, and scrapers applied inside the tubes with means for working the scrapers.

I provide a jet 19 for each of the individual tubes arranged in front of the open ends thereof where the waste gases enter, as shown in Fig. 3. These jets are connected to a system of piping 20 joined with a main from any suitable source of supply whereby steam or air may be furnished at suitable intervals under pressure sufficient to spray the same into the tubes 9. The piping and jets are applied in the lower subdivision of chamber 7 and in the upper part of chamber 6 at the places where the smoke enters said tubes, so that the steam or air jetted in must enter with the smoke and travel in said tubes in the same direction with it, and no soot, ashes or dirt from the furnace will be thrown into the jets or piping.

The scraper device consists preferably of a flat thin strip of metal 21, provided with a twist, as shown in Fig. 3, adapted to fit the interior of the tube so that it may be rotated therein and scrape the interior of the tube from end to end. A rod 22 is attached to one end of the metal strip and supported in a suitable bearing at 23. One of the shafts 22 has a square end to which a crank 24 can be applied for rotating the same. I prefer to provide the shafts 22 with sprocket wheels 25 whereby a sprocket chain connecting several of the parts 22, contained in any single row or several rows of the tubes may be rotated at the same time. The means for rotating the scraper does not include steam or a fluid applied to the scraper as a means for operating it.

The means for working the scrapers is located in the lower part of outer compartment 6 and in the upper division of the part 7 and one or more of the shafts 22 extend through an opening or openings in the doors 8, as shown in Fig. 3, whereby the crank may be applied without opening the door and the cleaning devices may be worked without shutting off the smoke and while the heater is in full operation, the dust etc. formed by the scrapers in the tubes being carried by the united forces of the draft and the jets toward and to the exit chimney 13.

The principle of the invention is contained in a four-compartment structure, the compartments being relatively arranged as shown and provided with inlets 10 and 14 and outlets 11 and 16, a large number of small tubes 9 extending through and closely filling the inner one of said compartments (as chamber 4), and communicating with the other three compartments (as chamber 6 and divided chamber 7), whereby a blast entered at inlet 10 can pass through the tubes to outlet 11, and a blast entered at inlet 14 can pass between the tubes to outlet 16, and cleaning means, comprising jets and piping therefor arranged within the outer compartments, and scrapers in the tubes and means other than steam or fluid for operating the same, adapted to be worked for cleaning the tubes without shutting off the draft through the tubes.

What I claim is:—

1. In an apparatus of the class described, the combination with a four-compartment structure comprising an inner chamber and having an outer chamber 6 extended over one end and a divided outer chamber 7 extended over the other end, the structure being provided with inlets at 10 and 14 and outlets at 11 and 16, of a group of narrowly-interspaced small tubes comprising a large number of such tubes within said inner chamber substantially filling the same and communicating with said outer chambers, two groups of jets located respectively at opposite ends of the tubes, one in the upper part of chamber 6 and the other in the lower division of chamber 7, scrapers within the tubes and means other than steam or fluid arranged for working the scrapers without shutting off the draft through the tubes, as specified.

2. In an apparatus of the class described, the combination with a four-compartment structure, comprising an inner chamber 4 having an outer chamber 6 extended over one end and an outer divided chamber 7 extended over the other end, of a group of narrowly-interspaced, small tubes comprising a large number of such tubes substantially filling said inner chamber and all communicating at one end with outer chamber 6 and an equal portion communicating at the other end with each division of outer chamber 7, said inner chamber being provided with an inlet opening 14 and an outlet opening 16 and said divided outer chamber 7 being provided with an inlet opening 10 in close proximity to outlet 16 and with an outlet opening 11 in close proximity to inlet opening 14, and a partway partition in said inner chamber connected to the end wall midway between said inlet 14 and outlet 16, as specified.

3. An apparatus of the class mentioned, comprising an inner chamber provided with an inlet and an outlet opening and with outer chamber 6 and an outer divided chamber 7, the latter having an inlet opening 10 and an outlet opening 11, a group of small tubes closely filling said inner chamber and communicating with said outer chambers, a system of jets and supply piping therefor connected with the tubes in the lower division of outer chamber 7 and with the tubes in the upper part of outer chamber 6, scrapers within said group of tubes, and means connected with the lower part of outer chamber 6 and with the upper division of outer chamber 7 for operating said scrapers.

4. An apparatus of the class mentioned, comprising an inner chamber provided with an inlet opening and an outlet opening and with outer compartments, said outer compartments being also provided with inlet openings and outlet openings, a group of small tubes closely filling said inner chamber and communicating with said outer compartments, a system of jets and supply piping in connection at one end of said inner chamber with the lower portion of said tubes and at the other end of said chamber with the upper portion of said tubes, a system of scrapers within the tubes and means for operating the same.

5. An apparatus of the class mentioned, comprising a large inner chamber provided with inlet opening and an outlet opening, an outer divided chamber 7 covering one end of said inner chamber and having an inlet and an outlet opening and an outer chamber 6 covering the other end of said inner chamber, a group of small tubes closely filling said inner chamber and communicating with said outer chambers at both ends of said inner chamber, a system of jets and supply piping in connection with the tubes where they communicate with the lower division of said outer chamber 7 and with the opposite end of the tubes, where they communicate with the upper part of said outer chamber 6.

6. An apparatus of the class mentioned, comprising a large inner chamber provided with an inlet opening and an outlet opening, a divided chamber 7 covering one end of said inner chamber and having an inlet and an outlet opening, and an outer chamber 6 covering the other end of said inner chamber, a group of small tubes closely filling said inner chamber and communicating with said outer chambers at both ends of said inner chamber, a system of scrapers within said tubes, a system of jets and supply piping connected with the tubes where they communicate with the lower compartment of said outer divided chamber 7 and with the opposite ends of the upper tubes where they communicate with the upper part of said outer chamber 6, and means for operating the scrapers.

7. In an apparatus of the class mentioned, the combination with a four-compartment structure, there being a large inner compartment and three outer compartments and the structure being provided with an inlet 10 and an outlet 11 for the products of combustion and an air inlet 14 and air outlet 16, of a group of small tubes 9 closely filling said inner compartment and communicating with said outer compartments, two systems of jets adapted to operate in the direction of the draft through said tubes and piping therefor, scrapers within said tubes, and mechanical means for operating said scrapers, said means being arranged in two groups in parallel relation at opposite ends of said four-compartment structure, as specified.

8. In an apparatus of the class mentioned, the combination with a large inner chamber having an inlet and an outlet of closed outer compartments at the ends of said large inner chamber one of said closed outer compartments being provided with an inlet in proximity to the outlet of said large inner chamber, and another of said closed outer compartments being provided with an outlet in proximity to the inlet of said large inner chamber, a group of tubes in said large inner chamber connecting with the closed outer compartments at opposite ends of said large inner chamber, scrapers within the tubes, and means for operating the scrapers, as specified.

9. In an air heater, the combination with an inner chamber 4 having an inlet at 14 and an outlet at 16 of an outer compartment 6 at one end and a divided compartment 7 at the other end, a group of small tubes 9 in said inner chamber 4 and communicating with compartment 6 and both divisions of

compartment 7, a system of piping 20 with jets in connection with the tubes in the lower division of compartment 7 and with the tubes in the upper part of compartment 6, as specified.

10. In an air heater, the combination with an inner chamber 4 having an inlet and an outlet of an outer compartment 6 at one end and an outer divided compartment 7 at the other end, a group of tubes in inner chamber 4 and communicating with outer compartments 6 and 7, scrapers in said tubes, jets and a system of piping 20 in the lower division of outer compartment 7 and in the upper part of compartment 6 and means in the lower part of outer compartment 6 and in the upper division of outer compartment 7 for rotating the scrapers as specified.

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Witnesses:
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