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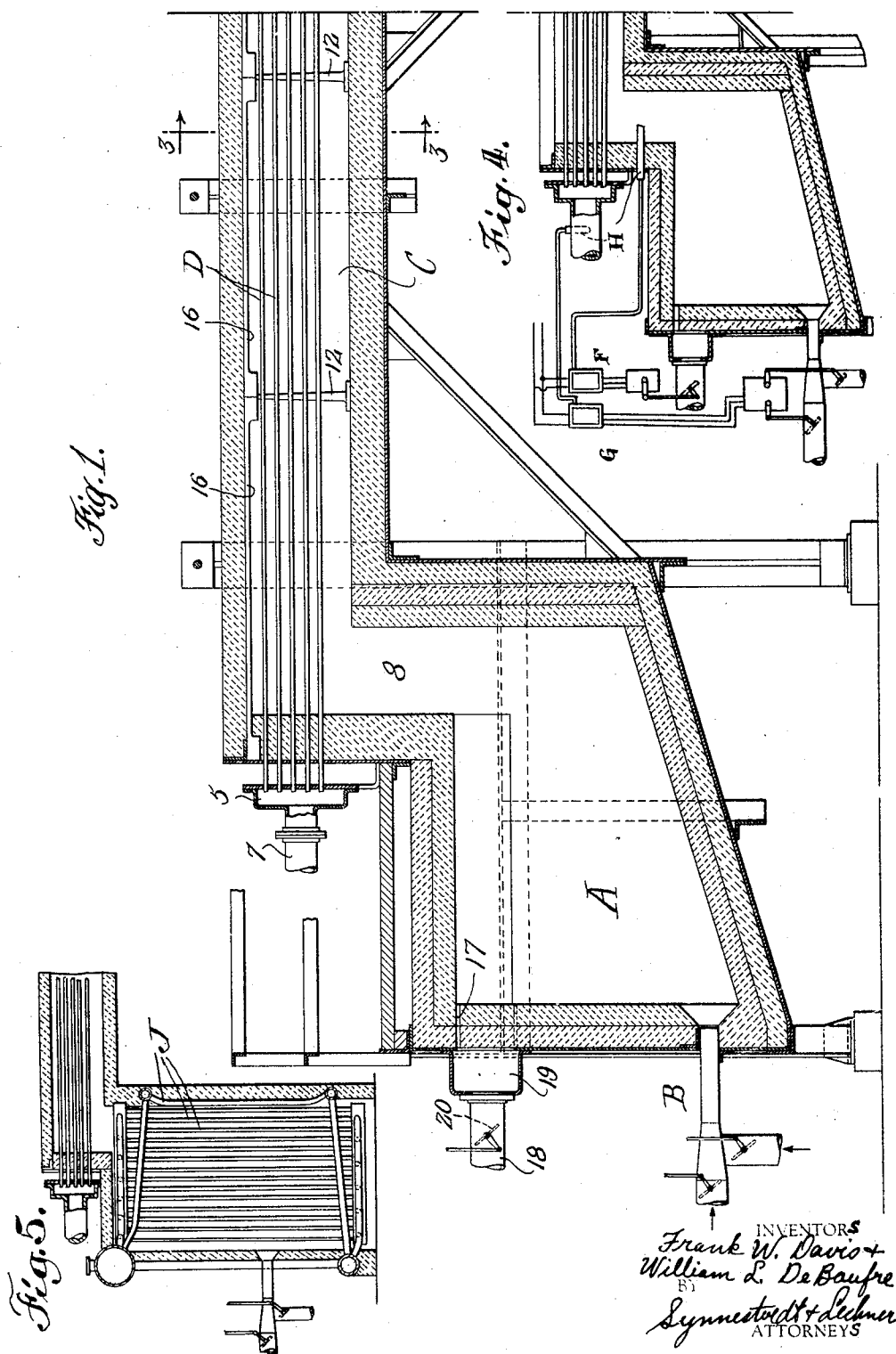
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APPARATUS FOR HEATING THE BLAST FOR BLAST FURNACES

Filed June 9, 1928

3 Sheets-Sheet 1



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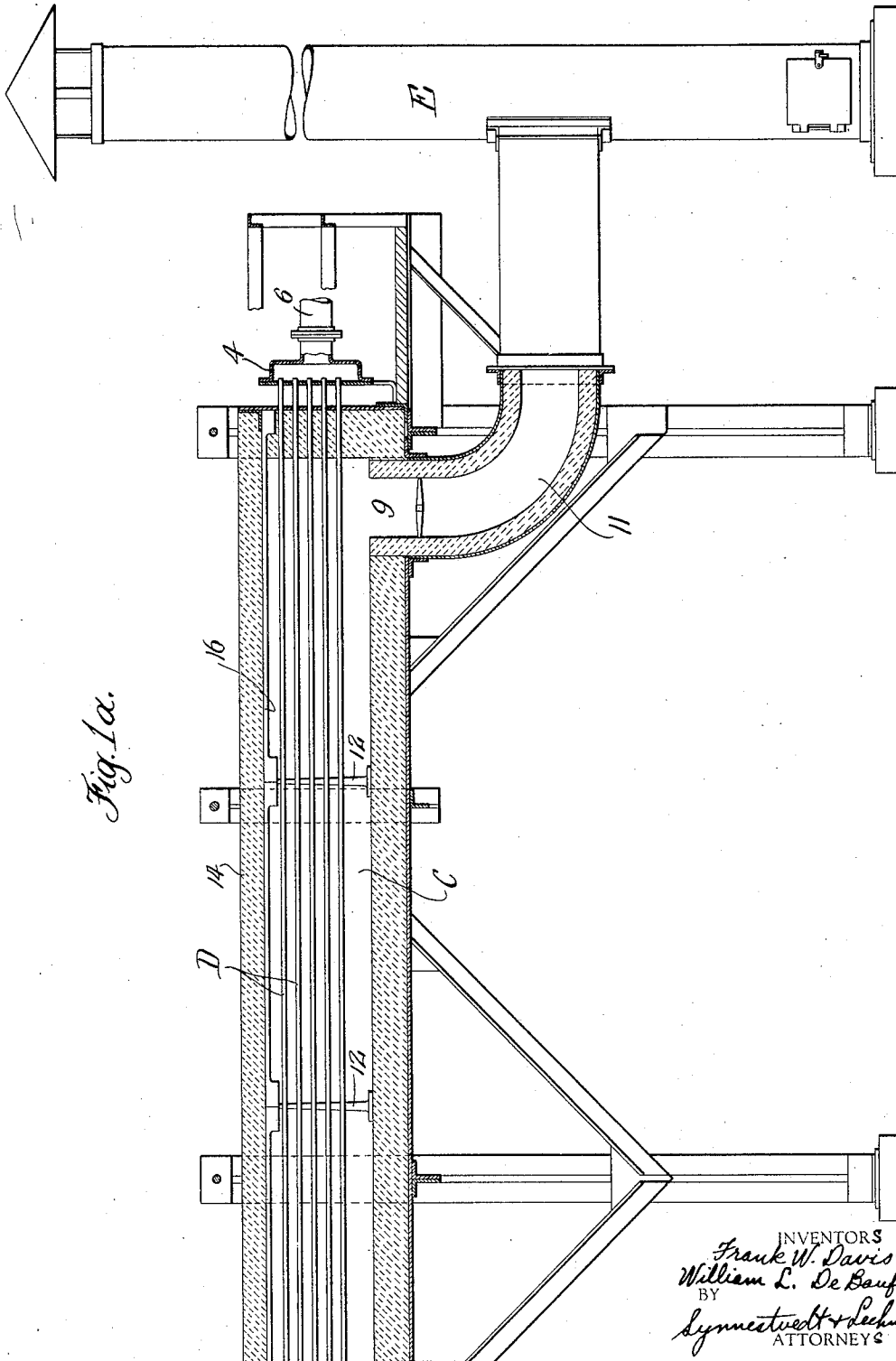
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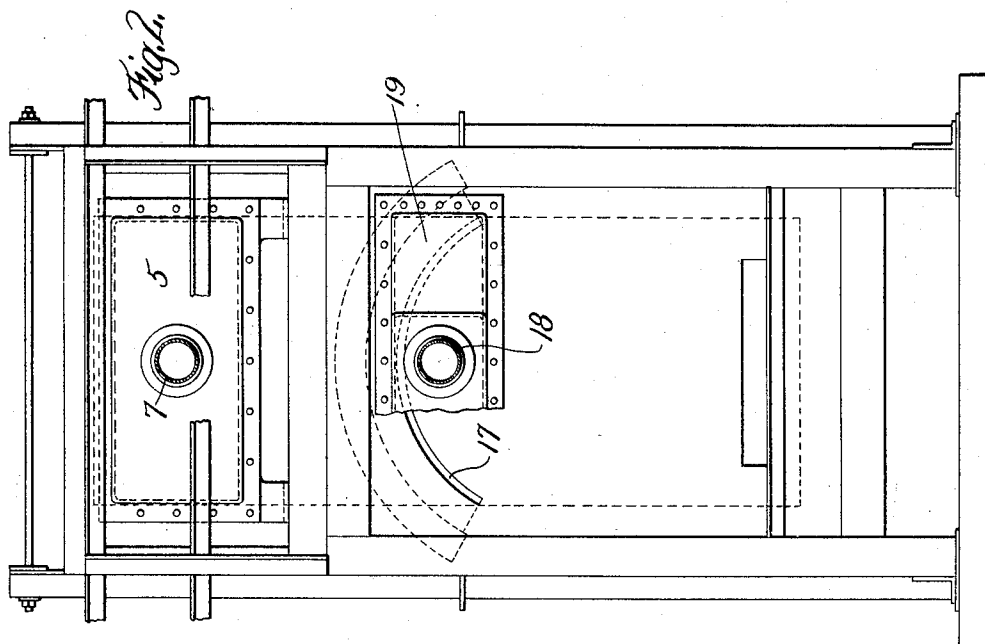
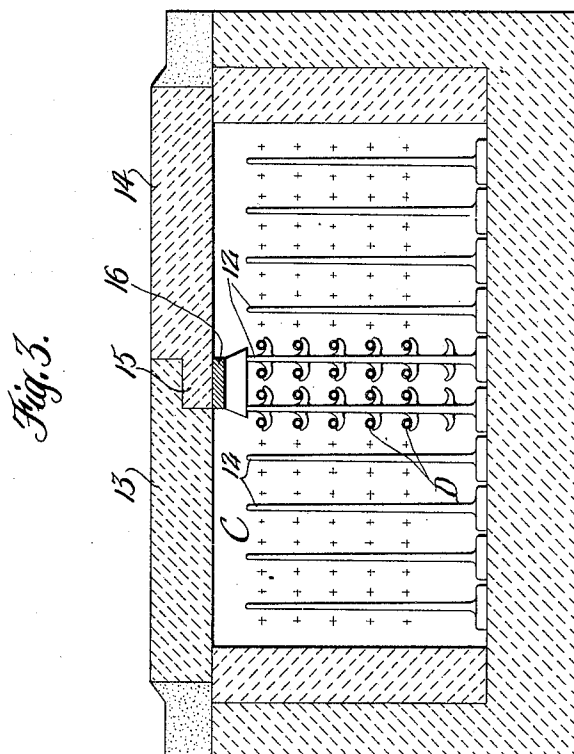
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APPARATUS FOR HEATING THE BLAST FOR BLAST FURNACES

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3 Sheets-Sheet 3



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APPARATUS FOR HEATING THE BLAST FOR BLAST FURNACES

Application filed June 9, 1928. Serial No. 284,096.

This invention relates to the heating of the blast for blast furnaces.

One of the primary objects of the invention is to provide apparatus whereby the temperature difference between the gas receiving heat and the gas giving up heat may be maintained at a value such that the heat is efficiently transferred without causing failure of metallic tubes separating the gases.

Another object resides in the provision of apparatus whereby we are enabled to make the mass flow of the gas giving up heat approximately equal the mass flow of the gas receiving heat.

A further object of the invention is the provision of apparatus whereby the temperature in the smelting zone of a blast furnace may be governed by regulation of the temperature of the blast thru regulating the mass flow of the heating medium with respect to the mass flow of the blast being heated.

How the foregoing, together with such other objects and advantages as may hereinafter appear, or are incident to our invention, are realized is illustrated in preferred form in the accompanying drawings, wherein—

Figs. 1 and 1a constitute, when placed side by side, a sectional elevation of apparatus constructed in accordance with our invention, certain of the parts appearing in elevation.

Fig. 2 is an end elevation looking toward the right in Fig. 1.

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

Fig. 4 is a fragmentary sectional elevation of a modification of the invention.

Fig. 5 is a fragmentary sectional elevation of a further modification of the invention.

Referring to the drawings, we have illustrated a stove for heating the blast of a blast furnace comprising, in general, a combustion chamber A, burner means B for introducing fuel to be burned in the combustion chamber, the fuel preferably being derived from the blast furnace, a long shallow channel C for the gaseous products of combustion, a multiplicity of metallic tubes D in said channel for the blast air to be heated, and a stack E.

The tubes D are connected at one end into an intake header 4 and at the other end into a

discharge header 5, the air being supplied, under pressure, as by a fan (not shown) to the header 4 by the pipe 6 and being led from the header 5 by the pipe 7 which leads to the blast furnace.

A throat 8 is provided for the combustion chamber A through which the products of combustion pass from the upper part of the combustion chamber into the lower part of the gas channel C. The channel C is provided with a damper controlled outlet 9 for the gaseous products of combustion, which outlet is preferably located at the bottom of the channel and is connected with a stack E by means of an elbow connection 11. The draft is preferably forced as by means of a fan not shown.

The tubes D are supported at a plurality of points along their length by means of supports 12. Referring to Fig. 3 it will be seen that each support 12 carries or supports two adjacent vertical rows of tubes whereby expansion and contraction difficulties are overcome, i. e., any support is free to expand or contract without affecting the others. In their simple construction these supports offer no material obstruction to the flow of the gaseous products of combustion.

The roof of the gas channel C is preferably constructed in the manner of a removable cover to give access to the interior of the channel, it being, in this instance, shown as made of two parts 13 and 14 jointed at 15. A central brace 16 is provided at the joint 15.

As thus far described, it will be seen that the gaseous products of combustion pass through the throat 8 into the channel C and pass over and along the tubes to the outlet 9, and that the air to be heated passes through the tubes from the header 4 to the header 5, i. e., the hot gases pass in counterflow to the air to be heated.

Without provision to the contrary, however, in such an arrangement the tubes D would be subjected to temperatures at and above the temperature of failure of the tubes, particularly at the warm end, and, consequently, the tubes would have every short life, this for the reason that the theoretical flame

temperature of any fuel gas is higher than the temperature of failure of the tubes.

The heat content of products of the efficient combustion of blast furnace gas per unit mass is considerably in excess of the desired heat content of the same quantity of blast. As a result, in all previous methods of heating an air blast by the combustion of gas, the mass flow of air was greatly in excess of the mass flow of the hot products of combustion. When the air is being heated by direct transfer of heat from the hot gas through a metallic boundary, the above conditions result in a very great temperature drop between hot gas and cooler air at the hot end of the apparatus. Or, since the metal boundary assumes a temperature approximating the mean of the two temperatures, it follows that the temperature difference between the air being heated and its metal containing walls is excessively high. Since the maximum permissible temperature of the retaining walls is limited to a value safely below that at which the metal is softened or destroyed, it follows that with this system of operation the maximum air temperature obtainable is very low.

We aim to overcome such difficulties by lowering the temperature of the gaseous products of combustion to a safe value before impingement on the tubes occurs, and at the same time, obtaining the desired mass flows, and we have illustrated one method of accomplishing this in the drawings, which method is as follows:

The gas introduced by the burner B is burned in the combustion chamber A at a rate which will supply the desired amount of heat to the air being heated. When firing this at such a rate, the volume of the gaseous products of combustion is insufficient to obtain the desired mass flow. We, therefore, introduce into the furnace a gas, preferably an inert gas such as nitrogen, which, in addition to increasing the mass of the heating medium, reduces the temperature thereof to a safe value before impingement on the tubes occurs.

This gas is introduced preferably through a curved opening or slot 17 communicating with the upper portion of the combustion chamber, the gas being led to the slot 17 by means of a suitable pipe 18 and a casing 19. The quantity of the cool gas may be regulated, as by means of a damper 20; to the extent that the gas mixture is approximately equal in mass flow to that of the air being heated. A non-oxidizing gas is preferred to further protect the tubes. The point of admission of this gas being under the arch, the latter is protected.

Thus we have provided a process and apparatus whereby we are enabled to maintain the temperature difference between the hot gas and blast air approximately constant along the entire transfer surface and secure

efficient heat transfer while, at the same time, the tubes are not subjected to a destructive temperature.

If desired, however, we may carry on the dilution to a point where the temperature difference at the warm end is made less than at the cold end, and, in this way the tubes may be subjected to a maximum temperature but slightly above the final temperature of the air. In other words in the case of the blast furnace a blast temperature may be safely obtained which approaches very closely the maximum permissible operating tube temperature.

Referring to Figure 4 the desired temperature difference may be maintained as by means of an automatic flow device F for the diluent. Also an automatic device G may be employed to regulate the flow of combustible gas and air to the furnace so as to maintain the desired exit temperature of the blast from the stove. Thermo-couples H arranged to indicate or record the temperature difference may be employed.

To increase the overall efficiency we may fire at a rate such as provides the desired mass of gaseous products and then lower the temperature thereof to a safe value by usefully absorbing heat as by locating evaporating elements for generating steam in the combustion chamber. Thus, for example, we may employ water walls J for the combustion chamber as illustrated in Fig. 5.

The amount of evaporating surface of these elements will be such that the temperature of the gases leaving them will be sufficiently high to impart proper heat to the air blast. These elements may be used in conjunction with or in substitution for the diluent.

By providing evaporating surfaces in the combustion chamber we are enabled to increase the rate of firing, over that safely permissible in a refractory combustion chamber, and thus obtain the desired mass flow of the products of combustion. In either case, however, i. e., in the case of dilution in a refractory furnace, or in the case of employing evaporating surfaces, the ultimate result is that the mass flow of the gas losing heat is made to approximate the or in some cases exceed mass flow of the gas gaining heat.

From the foregoing it will be seen that we are enabled to control the temperatures of the smelting zone of a blast furnace by controlling the blast air temperatures through the regulation of the mass flow of the heating medium with respect to the mass flow of the blast air.

We claim:—

1. A stove for heating the blast of a blast furnace comprising in combination, a combustion chamber, a channel for the gaseous products of combustion having a gas inlet at one end portion and a gas outlet at the

other end portion, a multiplicity of metallic tubes in said channel and extending longitudinally thereof, and constituting a channel for the blast, means for leading the blast to said last mentioned channel at the end opposite the inlet end of the first mentioned channel, means for leading the blast away from the other end of the blast channel, means for introducing fuel to be burned in said combustion chamber, and means to increase the volume of heating gases to secure a mass flow of the heating gases which is at least approximately equal to the mass flow of the blast being heated.

2. A stove for heating the blast of a blast furnace comprising, in combination, a combustion chamber, a channel for the gaseous products of combustion having a gas inlet at one end portion and a gas outlet at the other end portion, a multiplicity of metallic tubes in said channel and extending longitudinally thereof, and constituting a channel for the blast, means for leading the blast to said last mentioned channel at the end opposite the inlet end of the first mentioned channel, means for leading the blast away from the other end of the blast channel, means for introducing fuel to be burned in said combustion chamber, and means for introducing gas into the combustion chamber to supplement the gaseous products of combustion, the parts being proportioned so that sufficient supplemental gas may enter to make the mass flow of the heating gas at least approximately equal to the mass flow of the blast being heated.

3. A stove for heating the blast of a blast furnace comprising, in combination, a combustion chamber, a channel for the gaseous products of combustion having a gas inlet at one end portion and a gas outlet at the other end portion, a multiplicity of metallic tubes in said channel and extending longitudinally thereof, and constituting a channel for the blast, means for leading the blast to said last mentioned channel at the end opposite the inlet end of the first mentioned channel, means for leading the blast away from the other end of the blast channel, means for introducing fuel to be burned in said combustion chamber, and regulable means to increase the volume of heating gases to secure a mass flow of the heating gases which is at least approximately equal to the mass flow of the blast being heated.

4. A stove for heating the blast of a blast furnace comprising, in combination, a channel for the gaseous products of combustion having a gas inlet at one end portion and a gas outlet at the other end portion, a multiplicity of metallic tubes in said channel constituting a channel for the blast, said tubes having inlet for the blast at their ends opposite the inlet end of the first mentioned channel and having outlet for the blast at their

other ends and means for subjecting said blast tubes to temperate heating gases having at least approximately the same mass flow as the gases being heated.

In testimony whereof we have hereunto signed our names.

WILLIAM L. DE BAUFRE.
FRANK W. DAVIS.

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