No. 726,115. PATENTED APR. 21, 1903.

R. THOMSON.

METHOD OF THE COMBUSTION OF FUEL.

APPLICATION FILED JAN. 3, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

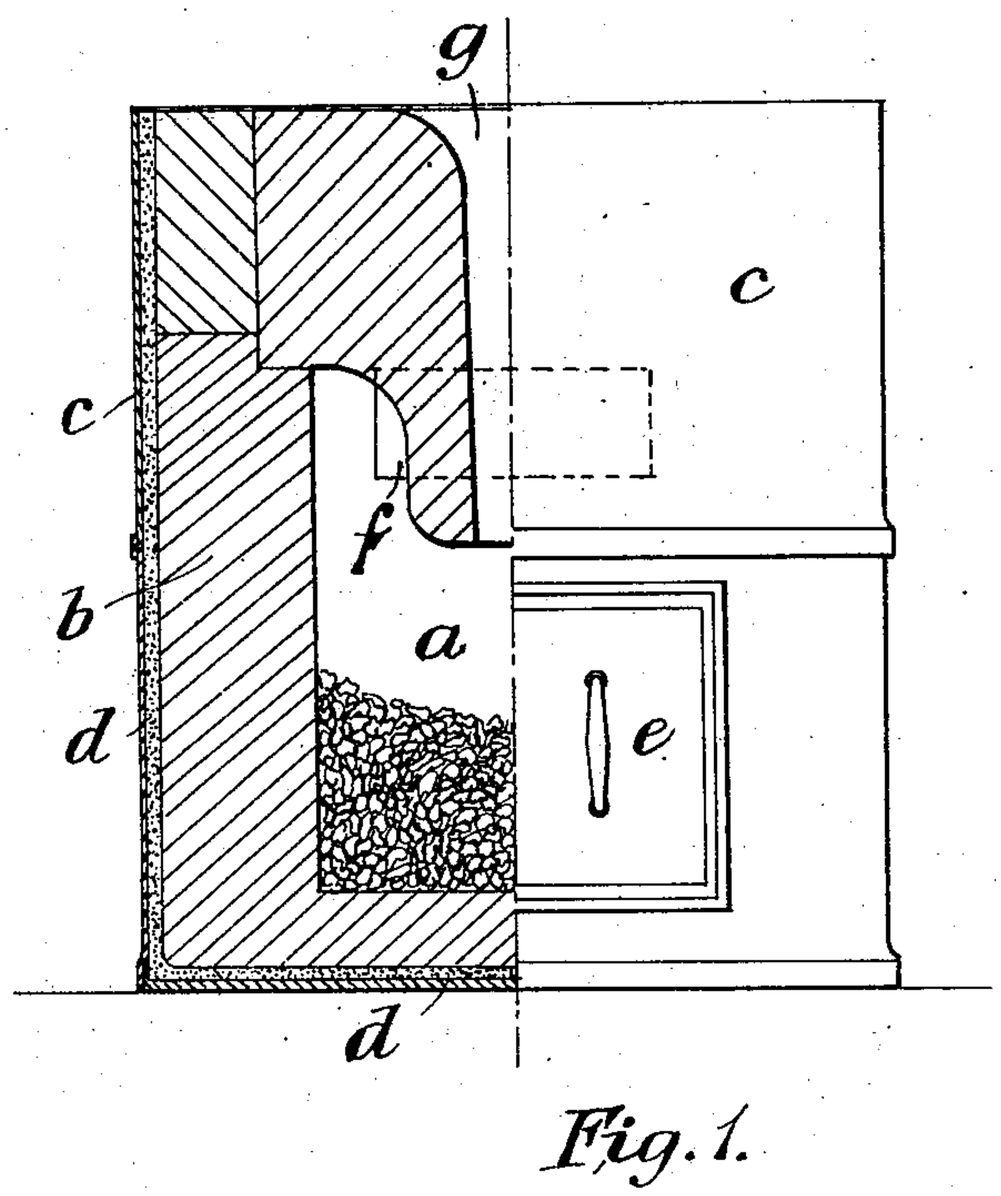

Fig. 1.

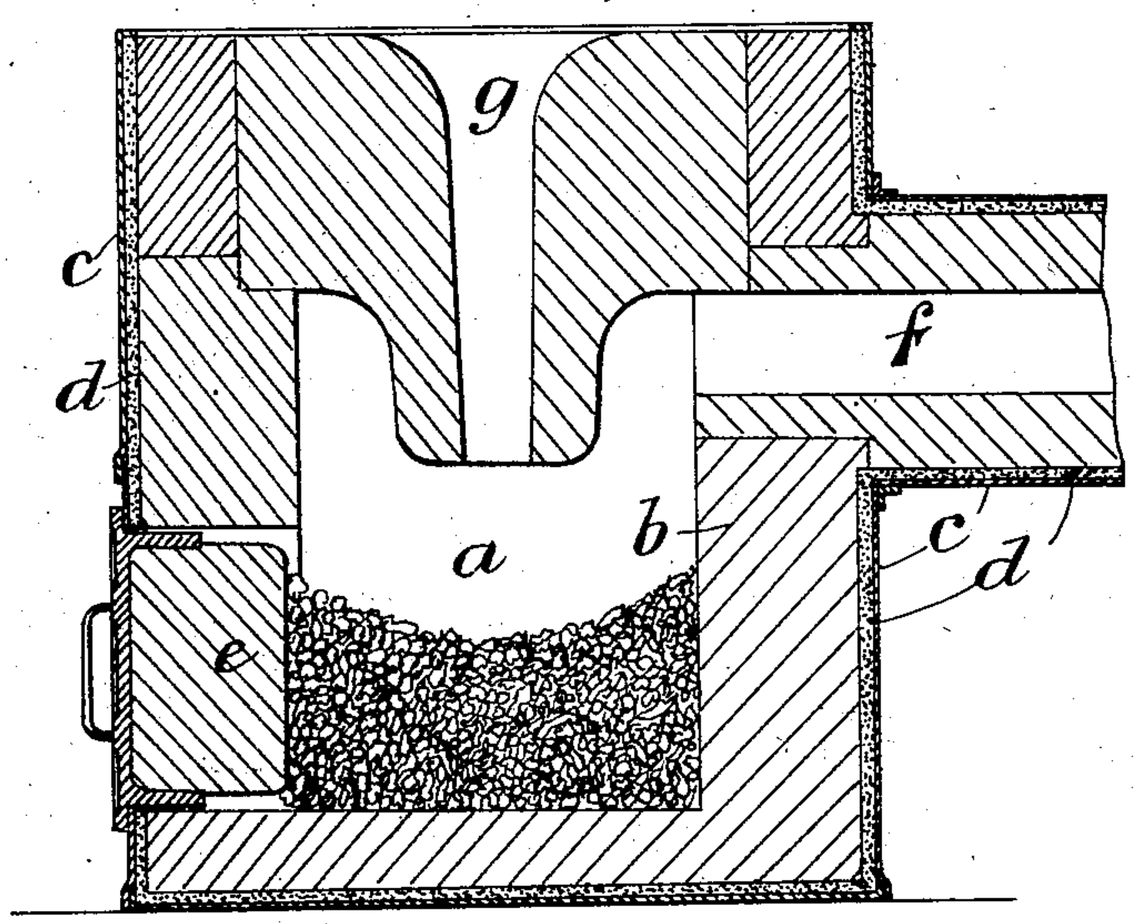

Fig. 2.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig3.

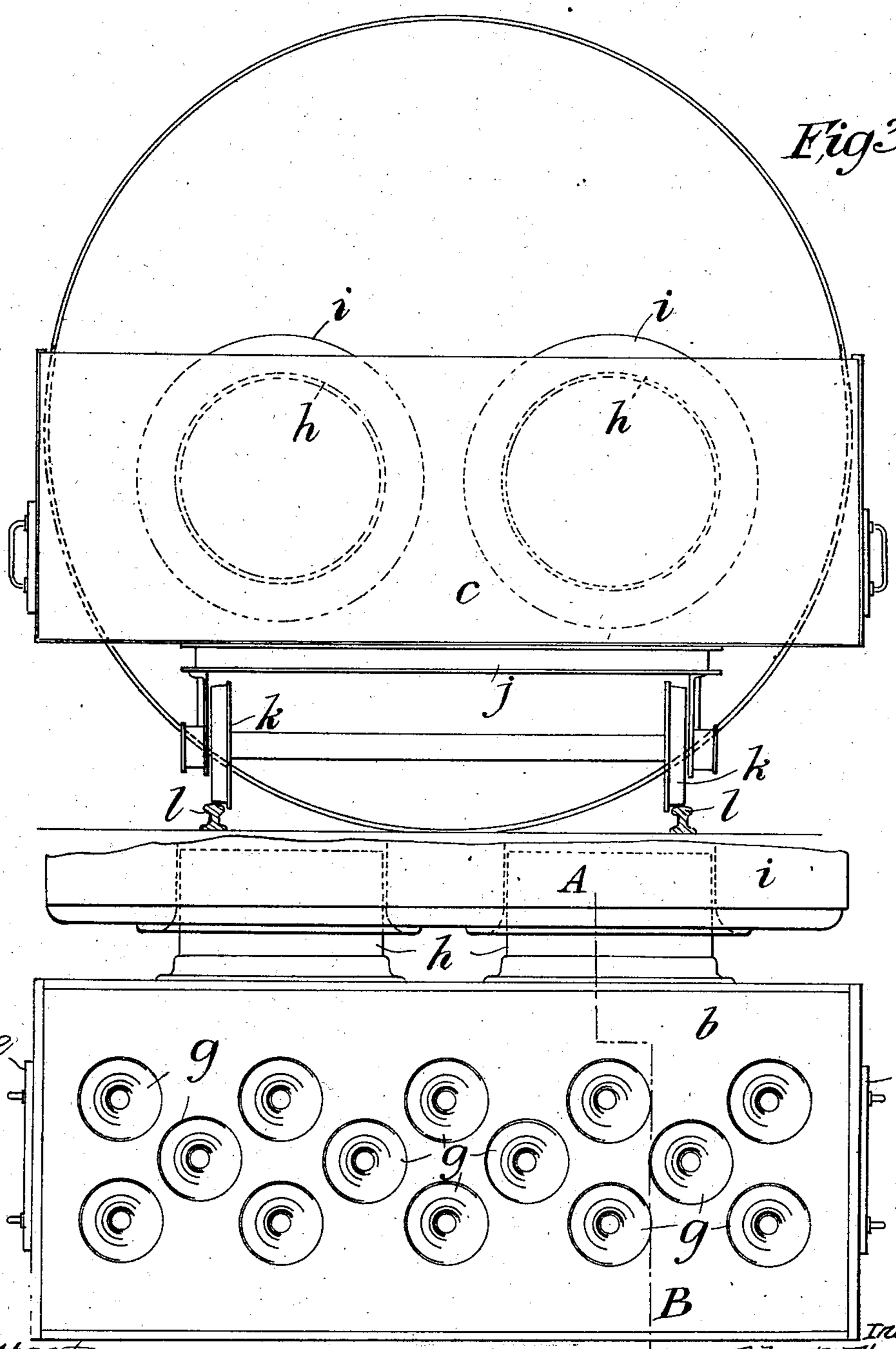

Fig4.

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NO MODEL. 3 SHEETS—SHEET 3.

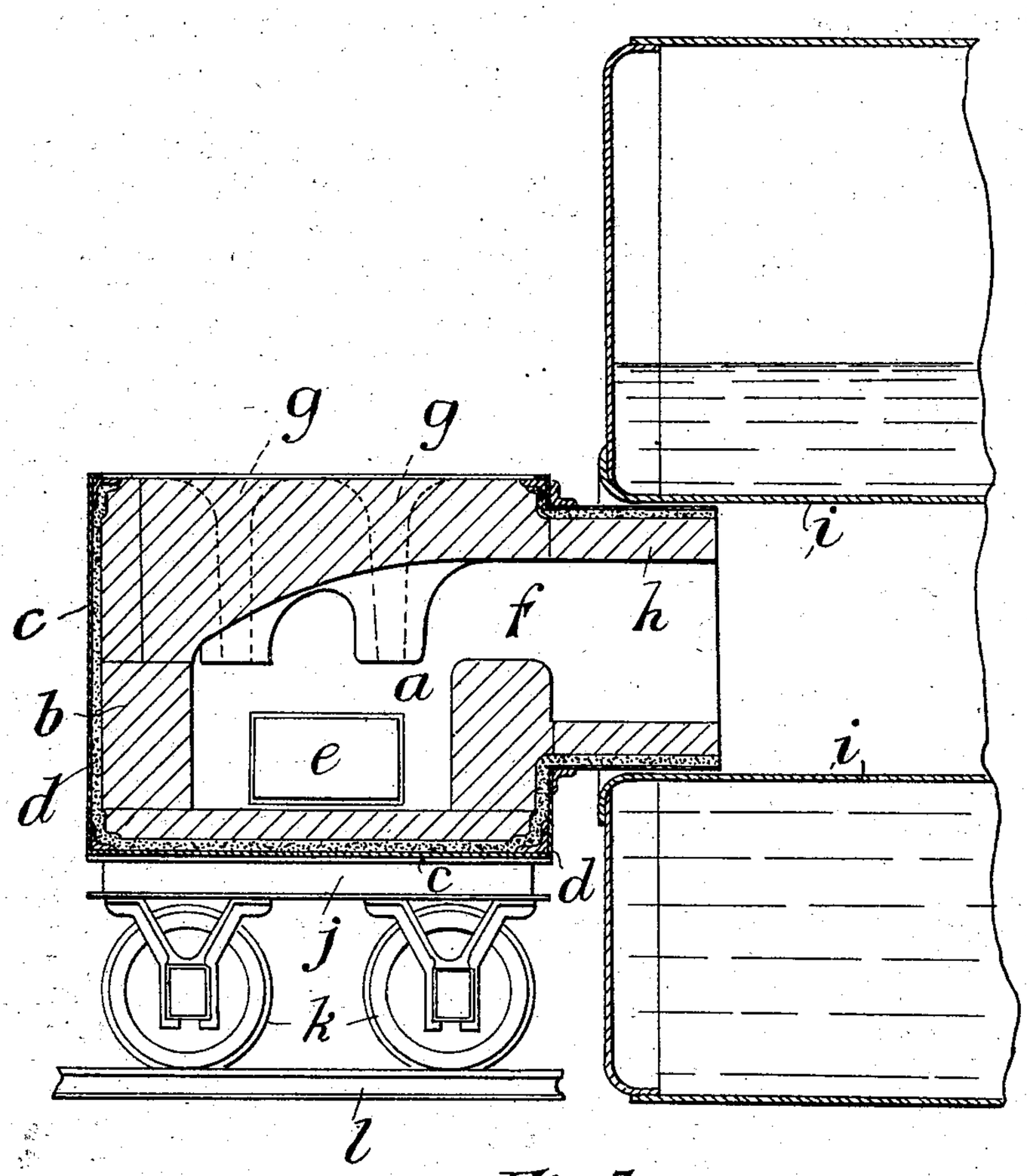

Fig. 5.

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UNITED STATES PATENT OFFICE.

ROBERT THOMSON, OF GLASGOW, SCOTLAND.

METHOD OF THE COMBUSTION OF FUEL.

SPECIFICATION forming part of Letters Patent No. 726,115, dated April 21, 1903.

Application filed January 3, 1903. Serial No. 137,704. (No model.)

To all whom it may concern:

Be it known that I, ROBERT THOMSON, a subject of the King of Great Britain and Ireland, residing at 21 Bothwell street, in the city and county of Glasgow, Scotland, have invented certain new and useful Improvements in Methods of the Combustion of Fuel, (for which I have made application for Letters Patent in Great Britain, No. 24,514, dated December 2, 1901; in Austria, dated February 8, 1902; in Hungary, dated February 12, 1902; in Germany, dated February 14, 1902; in France, dated December 1, 1902; in Italy, dated December 6, 1902, and in Spain, dated December 15, 1902,) of which the following is a specification.

My invention relates to improvements in methods for the combustion of solid, pulverized, liquid, and gaseous fuel. They are applicable to kilns, refuse-destructors, furnaces for the melting of metals or smelting ores, and to boiler and all other types of furnaces.

In furnaces for the combustion of solid fuel as hitherto generally employed the air is supplied either to pass wholly through the fuel or to pass partly through the fuel and partly direct to the gases evolved therefrom, the principal supply of air always entering the fuel by one surface, passing through it, and, together with the generated gases, emerging from and leaving by another surface. The air is often supplied under forced or induced draft and is also sometimes previously heated.

When combustion has been started, the green fuel, if it be capable of distillation, first distils under the action of the heat generated by combustion of the incandescent fixed portion. The distillation and other combustible gases are immediately on their emission from the fuel intermingled with and passed off contaminated by the inert gases produced by combustion of the solid constituents of the fuel.

To provide oxygen for combustion of the combustible portion of these gases requires the intimate admixture of a sufficient volume of air not only with these, but with the inert gases as well. This necessitates the supplying of air largely in excess of that which can be utilized in combustion, the gases being thus burned more or less completely on their way to the chimney and quite apart from and without the assistance of the incandescent fixed portion of the fuel. By this method of working complete combustion is seldom or never attained, and some of the gases pass away unburned, either owing to a deficiency of the air-supply or, if the air-supply be sufficient, owing to the cooling effect of the air on the gases before the necessary intimate admixture of air and gases can be effected, thus preventing the attainment of the high temperature necessary for the maintenance of combustion.

My invention therefore has for its object to secure concentrated and complete combustion of the fuel practically without the usual excess of oxygen in such a manner that the maximum temperature available from the fuel and the best heating effect may be produced, maintained, and utilized.

The features of my invention will be described hereinafter, and particularly pointed out in the claims.

In the accompanying drawings, which illustrate one form of furnace for carrying out my improved method of combustion, Figure 1 is an elevation of the furnace in part section. Fig. 2 is a complete sectional elevation of the furnace, the section being taken on a plane at right angles to that of Fig. 1. Figs. 3 to 5 illustrate, by way of example, one mode of applying my improved furnace for steam-raising in a Lancashire boiler. Fig. 3 is a front elevation of the furnace and boiler. Fig. 4 is a plan of Fig. 3, and Fig. 5 is a sectional elevation on the line A B of Fig. 4. In this figure the trolley structure which supports the furnace is not shown in section.

Corresponding parts are designated by the same reference-letters in the several figures.

The furnace consists of a chamber *a*, which may be of rectangular or other suitable section in plan and is provided with a heat-resisting inclosing wall *b*, of fire-brick or other suitable material, lining an external metal casing *c*. Between the casing and the fire-brick lining *b* is interposed a packing *d* of material which is a non-conductor of heat.

The furnace is provided with a door *e* to enable the ashes and clinker to be readily removed.

In the side wall of the chamber I provide an opening *f*, through which the highly-heated

products of combustion escape under natural chimney-draft or through which they may be withdrawn by means of a mechanical draft-inducing appliance, such as a fan, or by means of a steam-blast introduced into the chimney-flue.

To supply the air for combustion, I provide one or more tubular roof-openings, such as *g*, which is preferably trumpeted out toward its upper end, so as to secure the maximum flow of air through the tube. The tube *g* is of relatively small sectional area to that of the exhaust-opening *f*, so that the air acquires a high velocity in passing through the tube into the furnace. The tube is also of considerable length in relation to its diameter in order to give direction to the entering air-stream.

In the working of the furnace the reduction of pressure which is produced within the chamber *a* by the chimney or other draft employed causes a powerful stream of air to pass in through the tube *g* with great velocity and strike downward through the highly-rarefied gases in the furnace with considerable force onto the fuel or other material capable of becoming incandescent placed on the hearth. The quantity of air supplied, the force of its impact, and the consequent consumption of fuel are dependent on the strength of the exhaust through the opening *f*. The direction of the entering air-stream being substantially opposed to that of the highly-rarefied combustion-gases, the air is brought into immediate and intimate contact with the incandescent fuel and emerging combustible gases at the point of their emission from the fuel. These gases are driven back by means of the steady stream of air playing on the fuel and are burned in contact or in conjunction with the incandescent solid portion of the fuel or other material on the hearth. The fuel is thus completely burned practically within the chamber itself, producing more intense combustion than would be the case if the solid and gaseous parts of the fuel were burned apart from each other.

The fuel is fed through the tube *g*, and the feed may be conducted by hand in the usual way, or any well-known form of mechanical appliance may be provided for enabling an automatic continuous feed through the tube to be effected in regular working of the furnace. Where liquid, pulverized, or gaseous fuel is to be burned, the fuel is charged into the tube *g*, so that it is carried into the furnace with the air-stream, and thus this pulverized, gaseous, or liquid fuel is subjected to the velocity of the entering air-current and is impelled thereby against the bed of incandescent material, and the said fuel or the gases evolved therefrom are driven deeply into the incandescent bed. In the combustion of liquid and gaseous fuel the hearth or bottom of the furnace is preferably covered with a bed of pieces of broken refractory material, onto and among which the mixed stream of fuel and air plays, complete combustion being effected in a similar manner to that of solid fuel. Instead of pieces of broken refractory material I may place pieces of carbon, such as coke, on the hearth, so as to insure the production of a flame which is neutral—that is, containing neither unburned gases nor oxygen.

In order to obtain the best results in working the furnace, the feeding of the fuel should be as nearly as possible continuous and the fuel-surface or the surface of refractory material should be maintained within such a distance from the lower extremity of the tube *g* that the air discharging from the tube preserves its columnar or stream-like form until it strikes the fuel, and in order that the products of combustion may be withdrawn from the chamber without interfering with the inflowing air-stream I cause the air-supply tube *g* to depend from the roof of the furnace, so that its lower extremity is beneath the level of the exhaust-outlet *f*.

The height of the roof above the fuel-surface should be such as to secure the maximum reverberatory heating effect consistent with the provision of sufficient space for the expansion of the gases by combustion, for by means of the heat reflected from the roof the charges of fresh fuel introduced into the furnace attain the combustion temperature with great rapidity. When solid fuel is used, it becomes almost instantly ignited on the upper surface by the reverberated heat, so that by the action of the air-blast combustion is more rapidly propagated downward.

I have found furnaces to work well when constructed with air-inlet tubes fifteen inches long and two and three-quarters inches internal diameter, one tube being provided over each square foot of hearth-surface and with the area of the outlet for the combustion products about seven times the area of the air-inlet ports. The distance between the hearth on which the fuel rests and the lower end of the air-inlet tube was about twelve inches, and the fuel mass was maintained at a level about four inches below the end of the tube. Such a furnace with an air-suction equal to eight-tenths of an inch of water at the outlet from the furnace burns without smoke about fifty pounds weight of washed bituminous nut coal per square foot per hour.

When the furnace is worked with an air-supply at ordinary temperature, natural chimney-draft is usually sufficient to maintain a powerful blast of air through the tube *g;* but by employing a mechanical draft appliance for diminishing the pressure within the furnace a further increase in the power of the blast can be obtained. Heated air may be supplied to the furnace by providing a side communication between the tube *g* and a supply of hot air, the upper end of the tube being closed to atmosphere and only used for feeding the fuel into the furnace; but in this case the effect of the draft requires to be in-

creased in order to compensate for the diminished density of the air by increasing its speed, so that it may be supplied in quantity sufficient for combustion of the fuel.

The method of combustion which I have described above may be employed with advantage for many purposes—for example, steam-raising, steel-smelting, ore-smelting, and the distillation of gas from fuel in kilns and other furnaces. Figs. 3 to 5 illustrate one of its applications, in which my improved furnace is shown adapted to a Lancashire boiler. The furnace is of the same construction as that described above; but instead of a single air-inlet tube *g* I provide a number of such tubes, so as to supply the volume of air necessary for combustion of the larger fuel-body employed. The furnace is provided with two exhaust-outlets *f*, to which are attached short fire-resisting tubes or flues *h*, adapted to fit into the boiler-flues *i*, as shown in Figs. 4 and 5. In order that access to the boiler-flues may be readily obtained for cleaning or other purposes, the furnace is attached to a trolley-frame *j*, supported by wheels *k* on rails *l*, thereby enabling the furnace to be moved bodily away from the boiler and returned into position again. The joint between the outside of the tubes *h* and the boiler-flues should be made air-tight in any convenient manner—for example, by means of a luting of clay or lime—so as not to impair the efficiency of the flue-draft in the working of the furnace.

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

1. The method of effecting fuel combustion which consists in feeding the fuel into a furnace together with an air-supply for combustion, the air entering the furnace with high velocity, so as to impinge upon incandescent material below; depositing the fuel upon the incandescent material within the area on which the air-supply impinges; causing the air to penetrate deeply among the incandescent material, and to carry down with it the gases evolved from the fresh fuel; igniting the gases within the incandescent mass; and drawing the combustion-gases upward through the incandescent mass outside of the area on which the air impinges, whereby combustion is completed within and immediately above the incandescent material.

2. The method of effecting fuel combustion which consists in feeding air and fuel into a furnace with the air directed at right angles to the surface of an incandescent bed of material therein closed against the passage of air or gas at its bottom, the entering fuel being subjected to the high velocity of the entering air and the gases evolved from said fuel being forced down into the incandescent bed while the combustion-gases are drawn upward through the incandescent material outside of the area on which the air impinges, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

ROBERT THOMSON.

Witnesses:
ALBERT E. PARKER,
PERCIVAL M. DAVIES.