P. T. LINDHARD.

BURNER FOR ROTARY KILNS, &c.

APPLICATION FILED AUG. 20, 1910.

1,042,576.

Patented Oct. 29, 1912.

2 SHEETS—SHEET 1.

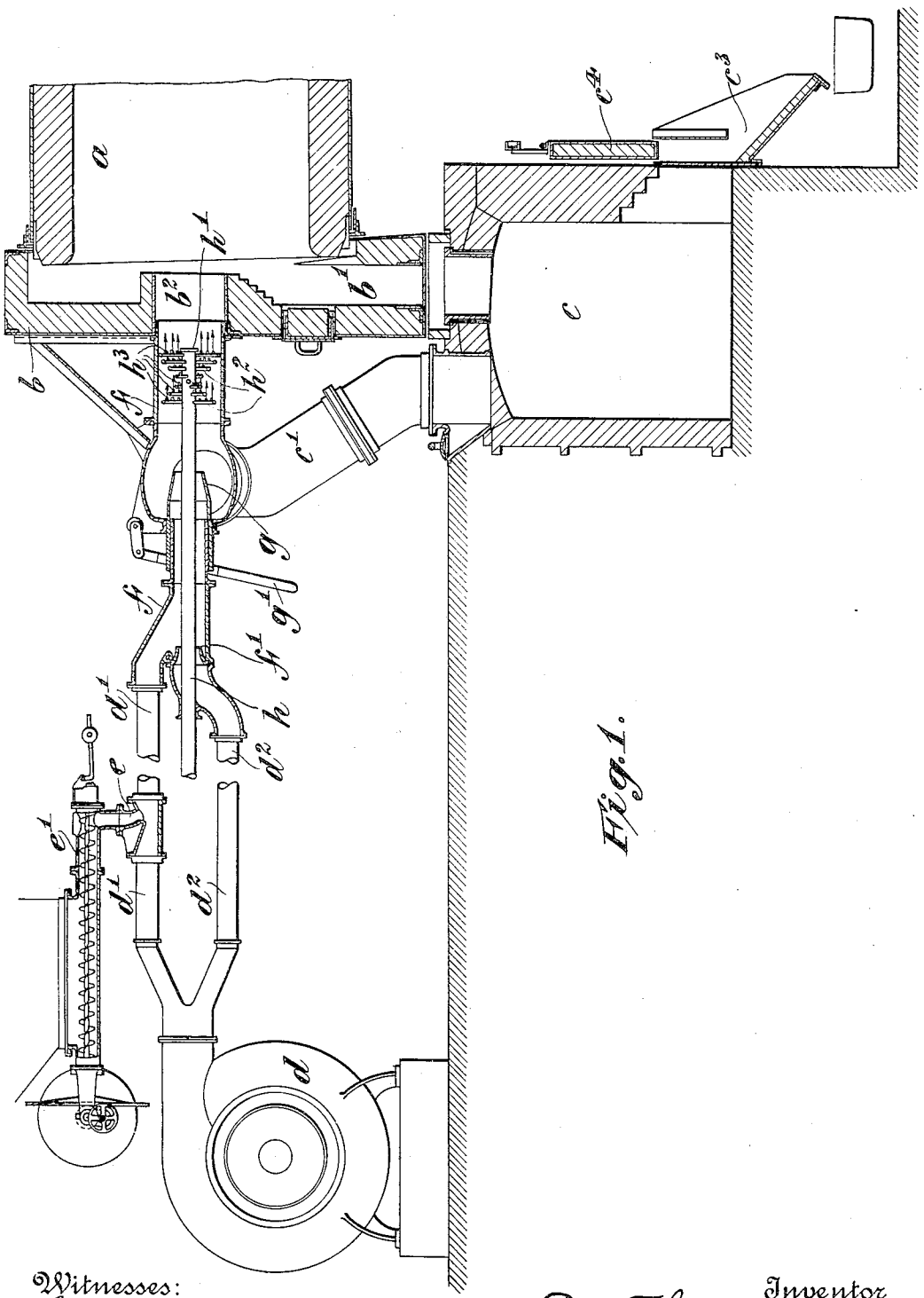

Fig. 1.

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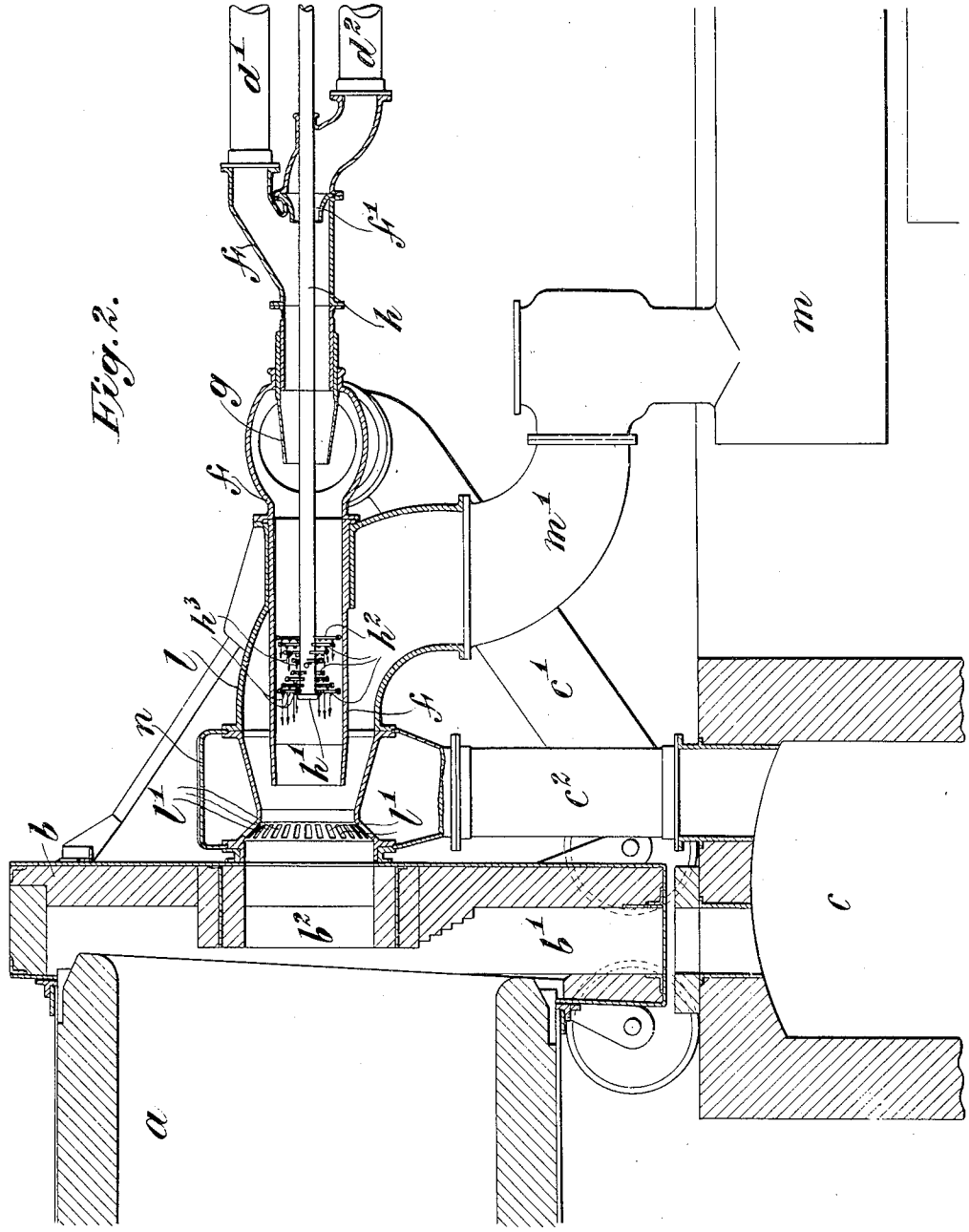
2 SHEETS—SHEET 2

Fig. 2.



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UNITED STATES PATENT OFFICE.

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BURNER FOR ROTARY KILNS, &c.

1,042,576. Specification of Letters Patent. Patented Oct. 29, 1912.

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To all whom it may concern:

Be it known that I, POVL T. LINDHARD, a subject of the King of Denmark, residing at Flatbush, in the borough of Brooklyn of the city of New York, in the State of New York, have invented certain new and useful Improvements in Burners for Rotary Kilns, &c., of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to the devices for supplying fuel and air to rotary kilns for the burning of cement or to other structures of similar nature.

The object of the invention is to provide an improved burner or fuel feeding device which is adapted for burning powdered coal alone or for burning powdered coal in combination with natural gas or producer gas, or both, as cost of coal or of gas or other conditions of use may render desirable. Thus it is often times desirable to burn a mixture of powdered fuel and natural gas, not only because the supply of natural gas may be insufficient, but because a flame which contains incandescent particles of the powdered fuel radiates heat better than a flame of gas alone. Again, if good coal, low in ash, is expensive, whereas a cheaper coal, high in ash, is procurable, it is desirable to use powdered fuel in connection with producer gas, since the ash produced by burning the cheaper fuel in the producer will not be introduced into the kiln, while the powdered fuel will improve the flame when burned in connection with the producer gas and will also furnish a more convenient means for regulating the temperature in the kiln. Besides providing for the burning of powdered and gaseous fuel either alone or in any of the combinations suggested, the improved burner provides also for a more intimate mixture of the fuel and the air than is usual and for the utilization of the waste heat of the burned material discharged from the kiln.

The invention will be more fully explained hereinafter with reference to the accompanying drawings in which it is illustrated and in which—

Figure 1 is a view in sectional elevation showing a portion of the kiln with its closure and clinker pit and the means for supplying fuel and air to the kiln. Fig. 2 is a similar view, with some of the parts omitted but showing in addition means for supplying producer gas.

The kiln *a* may be of any usual or suitable construction and is shown as of the ordinary construction of such rotary kilns as are commonly used in the burning of cement. The discharge end of the kiln is covered by a movable hood or closure *b* through which the mixture of fuel and air is supplied to the kiln as hereinafter described, while the burned material is discharged from the kiln, preferably through a channel *b'* formed therefor in the hood, into a pit *c*. From the pit *c* the clinker may be discharged as through a chute c^3 provided with an adjustable door c^4, while air passes through the chute and into the pit where it is heated by contact with the hot clinker, such heated air eventually passing into the kiln to support combustion therein. A fuel pipe *f* is arranged to direct the mixture of fuel (whether powdered or gaseous or both) and air through a suitable opening b^2 in the hood *b* into the kiln *a*. To this fuel pipe is connected a means, such as a fan *d*, shown in Fig. 1 and omitted from Fig. 2 in order to save space. As shown the connection from the fan *d* to the fuel pipe proper has two branches *d'* and d^2. The branch *d'* has located therein an injector nozzle *e* for powdered solid fuel, such as coal, the powdered fuel being supplied to the injector nozzle by any suitable means such as the screw feed indicated generally at *e'* in Fig. 1. The nozzle *e* and the portion of the branch pipe *d'* about it form an injector by which the mixture of powdered fuel and air is carried forward into the fuel pipe *f* and thence into the kiln *a*.

For the purpose of assisting in the forward movement of the powdered fuel the branch d^2 from the air supply connects with an injector nozzle *f'* in the fuel pipe between the powdered fuel injector nozzle *e* and the kiln, the powdered fuel being by the injector formed by the nozzle *f'* and the portion of the pipe about it kept in suspension and driven forward into the kiln with suitable velocity. The blast of air from the fan *d*, preferably after the admixture of the powdered fuel therewith, is carried through another injector nozzle *g* which is also located in the fuel pipe nearer the discharge end of the kiln and forming with said pipe an in-

jector, this nozzle *g* being preferably formed as a sleeve which is adjustable longitudinally by means of the lever *g'*, so as to vary the position of the injector nozzle. From the pit *c* a connection *c'* conducts the heated air to the fuel pipe in proximity to the injector nozzle *g*, so that the blast of air or of the mixture of powdered fuel and air through the injector nozzle shall induce a movement of the heated air from the pit into and through the fuel pipe and into the kiln.

From the above description and upon reference particularly to Fig. 1 it will be obvious that the present invention resides primarily in the provision and unique arrangement of casings, nozzles or like elements constituting injectors. The specific embodiment here given as an example may be thus stated—1st—the injector nozzle *e* to which is fed powdered fuel discharging in the air duct *d'*; 2nd—the injector nozzle *f'* discharging air into the fuel pipe *f* in proximity to the outlet branch *d'*; 3rd—the injector nozzle *g* discharging into the fuel pipe *f* in proximity to the connection *c'*; and the discharge of fuel from pipe *h* intermediate said last mentioned injector and the kiln proper. The claims designate the combination of elements by which the injector action is obtained, *i. e.* nozzles and surrounding casings, simply as an injector.

It is to be understood that other elements or other arrangements of the same producing injector actions may be employed.

As a means for conveniently introducing gas of any kind to be mixed with the mixture of powdered fuel and air and to regulate the flame in the kiln, the pipe *h*, connected with the supply of gas, is introduced centrally in the fuel pipe *f* and is preferably carried forward to a point near the forward extremity of the fuel pipe so that the gas may be mixed with the mixture of powdered fuel and air. In order that the mixture of the gas with the previously formed mixture may be thorough and intimate, the gas nozzle or the outlet of the pipe *h* is preferably formed by closing the end of the pipe by a cap, as at *h'*, and securing to the pipe *h* a series of radial pipes h^2 which are spirally arranged and are provided with small holes h^3 on their forward side through which the gas is discharged in parallel jets and is thereby thoroughly intermingled with the previously formed mixture before the mixture enters the kiln.

The arrangement shown in Fig. 2 is substantially similar to that shown in Fig. 1 except that provision is made for the introduction of producer gas. The fuel pipe *f* with its connections to the fan and to the powdered fuel feed, the injector nozzle *g* with its connection *c'* to the pit *c*, and the gas pipe *h* with its radial discharge pipes h^2, are arranged and coöperate in the manner already described, but the fuel pipe *f* is withdrawn somewhat from the hood *b* and around it is a casing *l*, forming an injector with the pipe *f* by which the flow of producer gas from the producer *m* through the connection *m'* is induced. In order that heated air from the pit *c* may be added to the mixture after the addition of the producer gas, a second casing *n* is arranged around the end of the casing *l*, heated air from the chamber *c* being conducted to the chamber within the casing *n* through a connection c^2 and admitted to the opening b^2 in the hood *b* through suitable openings *l'* formed in the flaring end of the casing *l* or of an extension thereof, so that the heated air is admitted at all points about the previously formed mixture and passes with the same into the kiln.

It will be understood that various changes in details of construction and arrangement to suit different conditions of use may be made without departing from the spirit of the invention which is not limited to the precise construction shown and described herein.

I claim as my invention:

1. The combination of a kiln, a fuel pipe of relatively restricted area through which fuel mixed with air and without combustion may be introduced into the kiln, an injector, means to supply powdered fuel to said injector, means to supply air under pressure to said injector to mix with the powdered fuel, a second injector to which the first discharges and itself discharging into the fuel pipe, means to supply additional air under pressure to said second injector to assist in the forward movement of the mixture from the first injector and to secure a more intimate mixture of the fuel with the additional air, an injector nozzle disposed within the fuel pipe intermediate the second injector and the kiln through which the mixture of powdered fuel and air passes, a pit in which the material is discharged from the kiln and air is admitted and a connection independent of said pit connection to conduct heated air from said pit to the fuel pipe in proximity to said injector nozzle to secure an intimate and heated mixture of the powdered fuel and air before the same enters the kiln.

2. The combination of a kiln, a fuel pipe through which fuel mixed with air may be introduced into the kiln, an injector, means to supply powdered fuel to said injector, means to supply air under pressure to said injector to mix with the powdered fuel, a second injector to which the first discharges and itself discharging into the fuel pipe, means to supply additional air to said second injector to assist in the forward movement of the mixture from the first injector and to secure a more intimate mixture of

the fuel with the additional air, an injector nozzle disposed within the fuel pipe intermediate the second injector and the kiln through which the mixture of powdered fuel and air passes, a pit into which the material is discharged from the kiln and air is admitted, a connection to conduct heated air from said pit to the fuel pipe in proximity to said injector nozzle to secure an intimate and heated mixture of the powdered fuel and air before the same enters the kiln and means located beyond said injector nozzle and adjacent to the kiln to introduce an aeriform fluid under pressure to regulate the flame in the kiln.

3. The combination of a kiln, a fuel pipe through which fuel mixed with air may be introduced into the kiln, an injector, means to supply powdered fuel to said injector, means to supply air under pressure to said injector to mix with the powdered fuel, a second injector to which the first discharges and itself discharging into the fuel pipe, means to supply additional air to said second injector to assist in the forward movement of the mixture from the first injector and to secure a more intimate mixture of the fuel with the additional air, an injector nozzle disposed within the fuel pipe intermediate the second injector and the kiln through which the mixture of powdered fuel and air passes, a pit into which the material is discharged from the kiln and air is admitted, a connection to conduct heated air from said pit to the fuel pipe in proximity to said injector nozzle to secure an intimate and heated mixture of the powdered fuel and air before the same enters the kiln and means located beyond said injector nozzle and adjacent to the kiln to introduce a gaseous fuel into the fuel pipe to mix the gaseous fuel with the heated mixture of powdered fuel and air to regulate the flame in the kiln.

4. The combination of a kiln, a fuel pipe through which fuel mixed with air may be introduced into the kiln, an injector, means to supply powdered fuel to said injector, means to supply air under pressure to said injector to mix with the powdered fuel, a second injector to which the first discharges and itself discharging into the fuel pipe, means to supply additional air to said second injector to assist in the forward movement of the mixture from the first injector and to secure a more intimate mixture of the fuel with the additional air, an injector nozzle disposed within the fuel pipe intermediate the second injector and the kiln through which the mixture of powdered fuel and air passes, a pit into which the material is discharged from the kiln and air is admitted, a connection to conduct heated air from said pit to the fuel pipe in proximity to said injector nozzle to secure an intimate and heated mixture of the powdered fuel and air before the same enters the kiln, means located beyond said injector nozzle and adjacent to the kiln to introduce an aeriform fluid under pressure to regulate the flame in the kiln, means to introduce producer gas into the fuel pipe beyond said last named means and means to supply heated air from the pit to the fuel pipe to support the combustion of said producer gas.

This specification signed and witnessed this 30th day of July, A. D., 1910.

POVL T. LINDHARD.

Signed in the presence of—
AMBROSE G. O'SHEA,
E. A. GERKEN.