

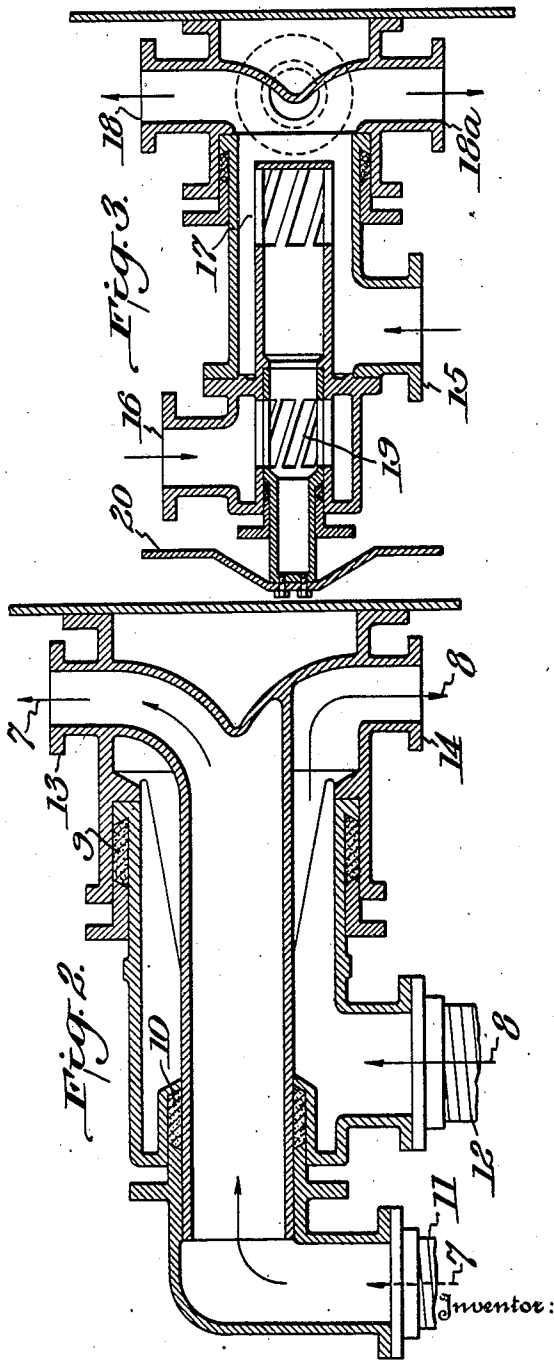
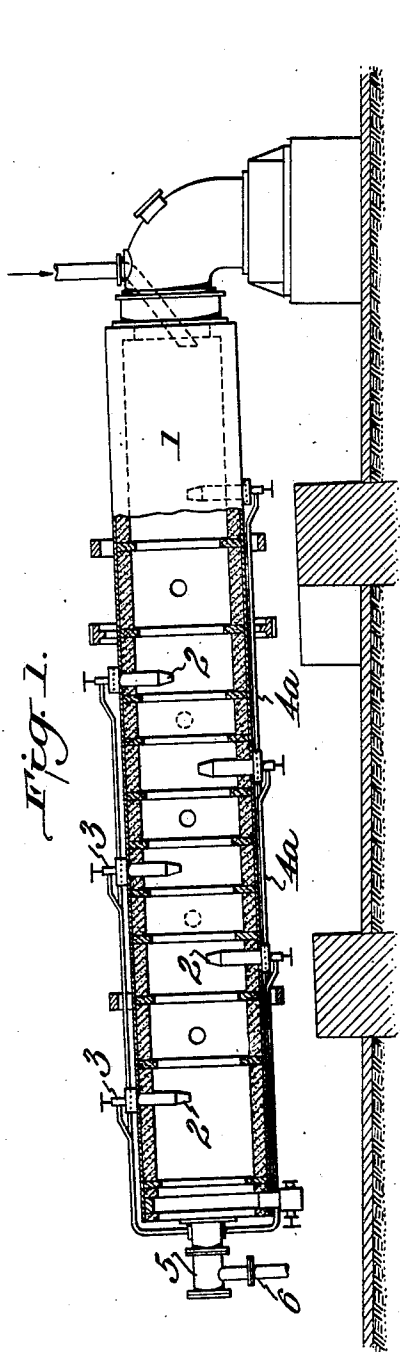
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C. P. DEBUCH

1,976,162

ROTARY TUBE FURNACE

Original Filed Nov. 9, 1932 4 Sheets-Sheet 1



Inventor:
Carl Paul Debuch,
By Potter, Pierce & Scheffler,
Attorneys.

Oct. 9, 1934.

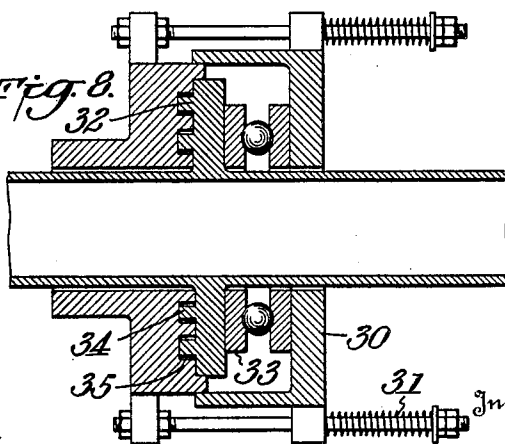
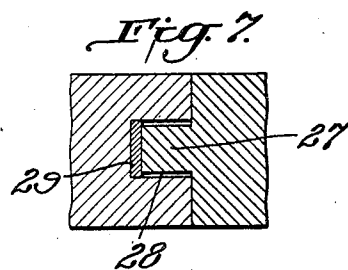
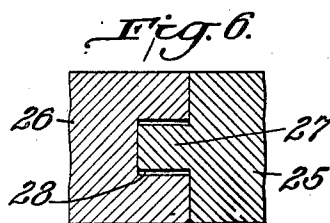
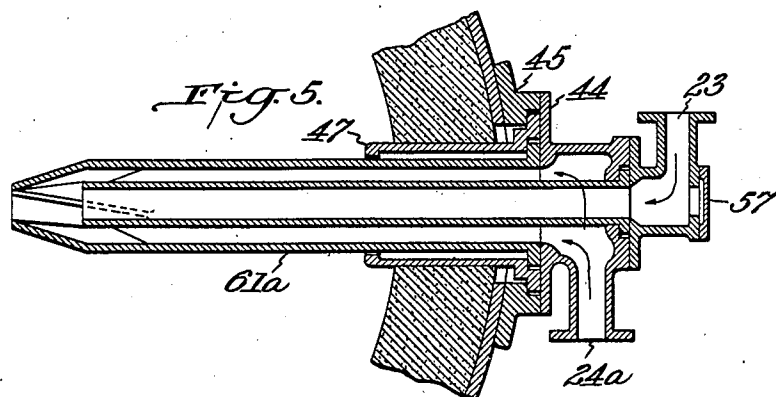
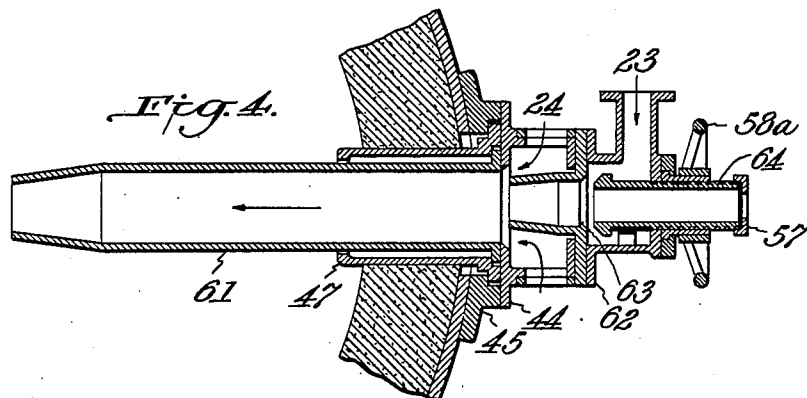
C. P. DEBUCH

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ROTARY TUBE FURNACE

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4 Sheets-Sheet 2



Inventor:

Carl Paul Debuch,

By *Potter, Price & Schaffer,*
Attorneys.

Oct. 9, 1934.

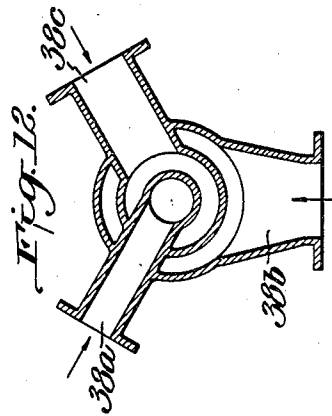
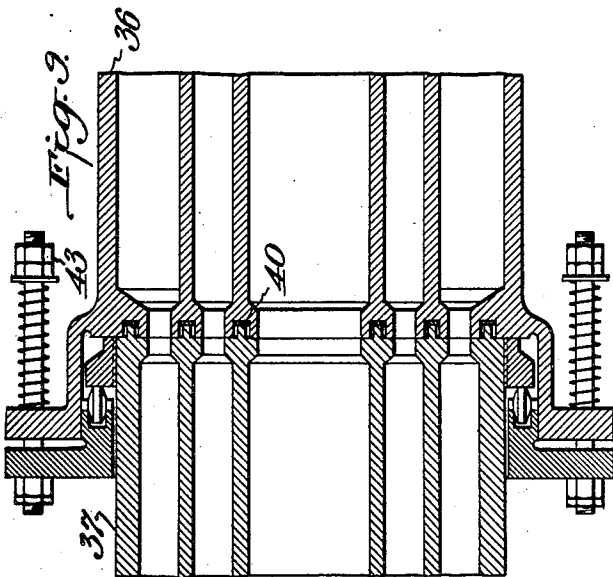
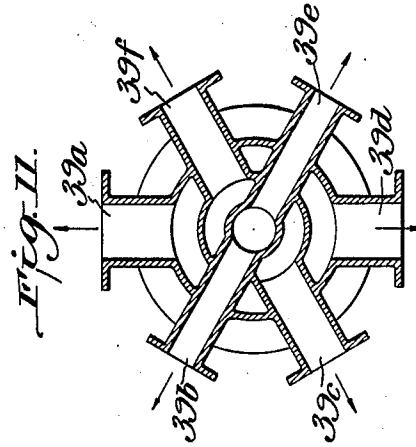
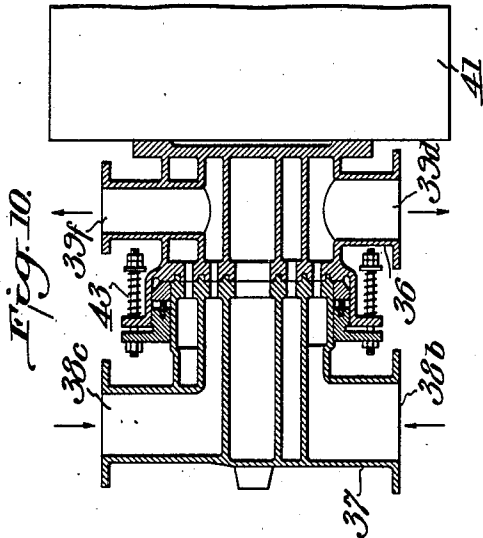
C. P. DEBUCH

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ROTARY TUBE FURNACE

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4 Sheets-Sheet 3



Inventor:

Carl Paul Debuch,

By Potter, Pierce & Schaeffer,
Attorneys.

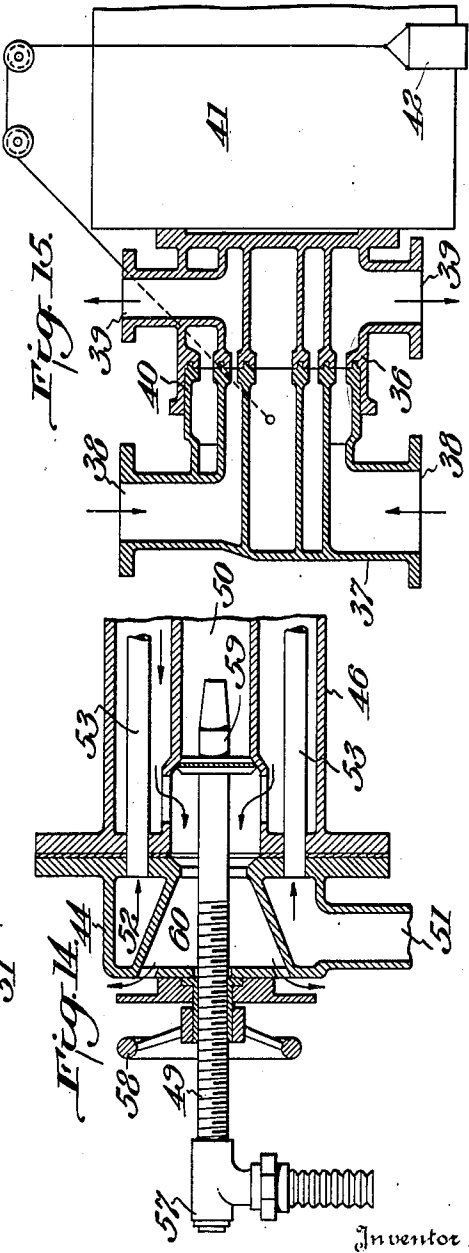
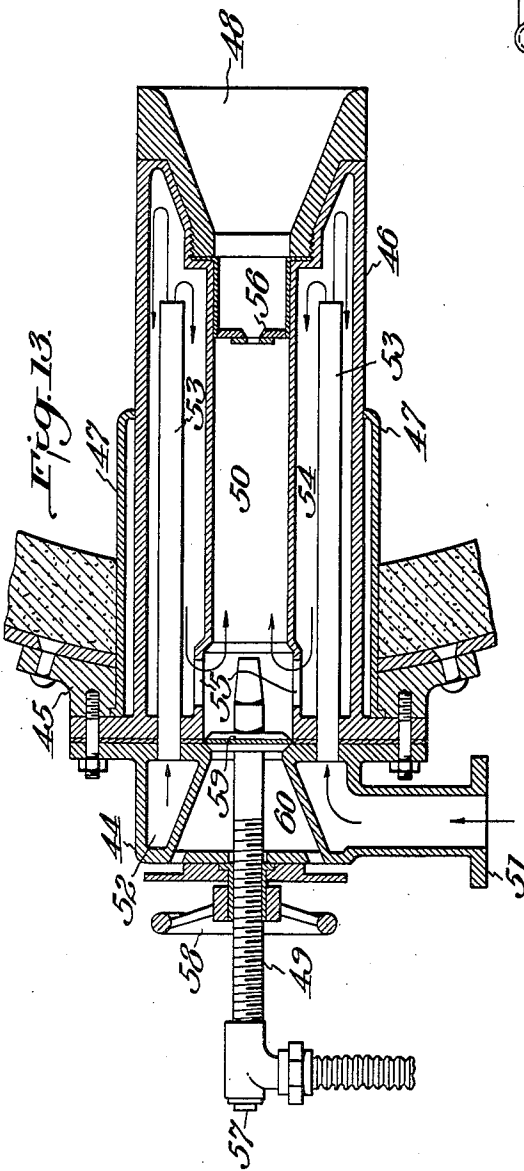
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C. P. DEBUCH

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ROTARY TUBE FURNACE

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Inventor:

Carl Paul Debuch,

By Potter, Pierce & Schaffler,
Attorneys.

UNITED STATES PATENT OFFICE

1,976,162

ROTARY TUBE FURNACE

Carl Paul Debuch, Frankfort-on-the-Main, Germany, assignor to American Lurgi Corporation, New York, N. Y., a corporation of New York

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5 Claims. (Cl. 263—33)

This invention relates to rotary-tube furnaces.

Up to the present, the application of the rotary-tube furnace has been restricted to a comparatively small number of uses, probably the chief reason for this being that, with the known rotary-tube furnaces, the temperature in every part of the furnace cannot be controlled. As a rule, the air of combustion is admitted into the rotary furnace at one end, and, in most instances, the burners also are situated at that end. Accordingly, the temperatures are highest at that end, and often attain undesirable peaks, while the other end of the furnace usually suffers from lack of heat. For many purposes this operative condition is harmless, and indeed often desirable. In many other instances, however, it is a drawback which cannot be counterbalanced even by the valuable special properties of the rotary furnace, such as the possibility of continuous operation, the highly effective intermixing of the materials under treatment, and so forth.

Rotary-tube furnaces are also known in which the nozzles supplying the fuel are disposed at right angles to the axis of the drum and nozzle blocks are passed through the shell of the drum.

Rotary-tube furnaces have also been heated by flameless surface combustion, the wall—or parts thereof—of the drum being made of material pervious to gases, and a mixture of combustible gas and air being forced, from a distributor head at the end of the furnace, into passages located in the furnace wall, from which it passes into the pervious furnace lining.

These arrangements, however, do not enable the temperature of the charge material to be adjusted to a uniform level throughout all parts of the furnace, since if merely the fuel be admitted through nozzles into various parts of the furnace, high temperatures are generated in the vicinity of the streams of fuel, thus giving rise to the danger of the charge becoming overheated in such localities. The same defect attaches to heating the furnace wall by flameless surface combustion, since the heated parts attain very high temperatures which are transmitted to the portions of the charge that are in immediate contact with those portions of the furnace wall. These methods of heating have accordingly been employed only in cases where specially high temperatures were desired in individual zones of the furnace.

In carrying out roasting processes according to another known method, pulverulent sulphidic ore is blown into the furnace, through nozzles, at a point near the discharge end, in order to stimu-

late the reaction which otherwise becomes more sluggish towards the finish. Such a method of regulating the temperature, though practicable, is nevertheless extremely defective. The injected material not only comes into action at the point of introduction, but is seized upon by the gases and distributed over a wider zone of the furnace. This measure is therefore of value only where longer zones inside the furnace are to be influenced. The defect that the actual heating of the furnace takes place at one end, and that dangerous peak temperatures are generated in the vicinity of that end, still remains as such.

These aforesaid drawbacks are obviated by the present invention, which enables the temperature to be modified at convenience in any point of the furnace and at any time while the furnace is running. In particular, it enables a uniform temperature to be maintained throughout the furnace. With this object, according to the invention, the rotary-tube furnace is provided with burners which pass through the furnace shell and are distributed over its entire length and periphery. In order to ensure continuous control of the supply of fuel and air, the requisite pipes for such supply are located outside of, but integrally connected with, the furnace. They are fed by a distributor head situated at one end of the furnace, and each burner can now be adjusted, at any time, as convenient, so that the working condition of the furnace is completely under control. According to the invention, the burners themselves project into the interior of the furnace to a point at which they are not covered up by the layer of charge material. Consequently, the combustion cannot be obstructed by the movement of the charge—as would be the case in heating by flameless surface combustion or in admitting the fuel alone through the furnace shell—and, above all, there is no local overheating of the charge through direct contact with the burner flame.

The advantage provided by the invention may be illustrated by an example.

In caustically burning magnesite, temperatures of 900° C. must not be exceeded, since at higher temperatures the caustically burned magnesite becomes dead-burnt, which greatly reduces its value. In the existing furnaces, heated from one end and in which the burning temperature has to be generated by a burner situated on one side, it is impossible to prevent the permissible temperature from being exceeded in that part of the furnace that is nearest the burner. The case is different when the furnace is heated in accordance with the invention. By suitably manip-

ulating the burners the material freshly charged into the furnace can be quickly preheated to the burning temperature, and this temperature can be uniformly maintained throughout the whole length of the furnace.

To continue with the example, it is possible, in this manner, when burning magnesite, to maintain a temperature of 800° C. all along the furnace, that is to say, to render the whole interior of the furnace available for the causticizing process.

The supply conduits for fuel, air of combustion, inert or reducing gases and other fluid media to be admitted into the rotary furnace can be connected to the distributing pipes of the furnace by means of connection members which are disposed concentrically with the axis of the rotary furnace, the junctions between the rotary and fixed conduits for the fluid media being fitted with stuffing boxes.

At the seat of the connection a rotary member is concentrically fitted in or over a fixed member, and the stuffing box for preventing the escape of the medium flowing through the two members is inserted between their facing peripheral surfaces. When stuffing boxes are used, however, wear of the surfaces and packing means is inevitable in the long run, and repacking is required at intervals.

For this reason a special connecting means, which is not attended with this drawback, is preferred for the rotary furnace according to the present invention. At the points of attachment, the lengths of piping to be connected together are provided with metallic surfaces disposed at right angles or obliquely to the rotational axis of the furnace. These surfaces are in direct sliding contact and are pressed together with sufficient force to produce the desired impermeability to gas or liquids.

The specific superficial pressure on the joint does not, however, need to be very high, a slight excess over the pressure exerted by the fluid medium being sufficient. The surfaces in sliding contact work themselves progressively into more intimate contact during use, so that the tightness of the joint is never endangered. Even the penetration of dust, or similar fine solid substances, between the packing surfaces is in no wise injurious because, at the worst, they merely increase the wear of the contact surfaces and, as experience has shown, the amount of such wear is small even under unfavorable conditions. It does not affect the efficiency of the packing, since, in all cases, one of the members to be connected can easily be arranged so as to slide in the longitudinal direction of the rotational axis. There is also no difficulty in arranging for the establishment and maintenance of the necessary contact pressure. For example, the fixed member can be pressed against the rotary member by the aid of springs, inserted between the former and fixed abutments. The same effect can also be obtained by the tension of a cord. The abutment needed in any event can also be provided on the rotary member.

The sliding-contact metallic surfaces may be formed by machining the corresponding parts of the connections. In many cases, however, it may be advisable to insert special rings, to take up the wear, between the two members to be connected, in which event a certain amount of play may exist between the two members, so that the intermediate member does not need renewal until partly worn away. In such case, the surfaces of

the packing that are in sliding contact are not necessarily planar. On the contrary, the connections may be so designed that the packing surfaces in mutual contact are of labyrinthine pattern, the number of the serrations depending on the conditions the device has to meet in respect of pressure, rotational velocity, and so forth.

Where a plurality of rotary and fixed pipes are to be simultaneously connected together, both these members and the packing devices are disposed concentrically to one another and to the axis of the furnace, and the packing devices may lie in the same plane; though it is also possible to offset them in the direction of the rotational axis.

These connections have behaved so well, in use, that their application for other purposes than those of the rotary furnace according to the invention appears to be suitable, for example for making gas—or liquid-tight connections on revolving pipes or vessels (such as rotary autoclaves), or vessels equipped with stirrers, and also for blowers and pumps.

As already mentioned, in the case of burners fitted to the rotary furnace according to the invention, the burner nozzle must extend so far into the interior of the furnace that it cannot be covered over by the charge material in the furnace. The burner nozzle is carried, for example, on a stem which projects, through the furnace wall, to a sufficient distance inside the furnace chamber.

The nozzle and stem are preferably provided with artificial cooling means, and the cooling medium may consist, for example, of the air of combustion, which is preheated at the same time, after which it can be mixed with the fuel and the mixture then passed to the burner.

According to the invention, the burner can also be arranged in such a manner that, when it is temporarily shut off, the cooling medium can, nevertheless, be led away, for example, to be discharged, after use, into the open air instead of into the furnace.

Burners of this type possess noteworthy advantages in respect of flame formation and flame development, which can always be adjusted to the optimum condition by means of the now possible convenient adjustment of the distance between the burner nozzle and the furnace wall, and of the burner stem and the like.

The bore of the burner can be fitted with a baffle, which sets up a powerful whirling motion, by which the fuel and air of combustion are intermingled, in known manner. This baffle has a central bore, so as not to hinder observation of the flame.

In order more clearly to understand the nature of the invention, reference is made to the accompanying drawings, which illustrate diagrammatically an embodiment of the furnace and in which:

Fig. 1 shows the furnace, partly in section and partly in elevation. The other figures represent sections through details of the furnace equipment.

Figs. 2, 3, 8 and 10 are four typical embodiments of the distributor head;

Figs. 6, 7, 9, 11, 12 and 15 show details of this device, and

Figs. 4, 5, 13 and 14 show various designs of burner.

Fig. 1 represents a rotary furnace which is heated, according to the invention, by the aid of burners 2, distributed over the length and perimeter of the furnace and projecting through the

furnace shell. The fuel and air of combustion are supplied to the burners, from a fixed pipe 6 and distributor head 5, through the pipes 4 and 4a, which are located outside the furnace and turn with it. In this furnace, the usual heating from the end is dispensed with entirely. The introduction of the charge is indicated by an arrow. The opposite end is completely closed. Each of the burners can be regulated, and turned on and off independently, by the members 3.

Fig. 2 represents an embodiment of a distributor head, in which the fuel (such as producer gas) and the air of combustion are supplied separately and are passed—also separately—to the nozzles by way of the pipes 4 and 4a. The arrow 7 indicates the course of the gas, and arrow 8 that of the air of combustion. The gas-tight connection between the fixed supply pipes 11 and 12 and the rotating pipes 14 and 13, situated in the central axis of the furnace, is obtained by means of the stuffing boxes 9 and 10.

Fig. 3 shows another embodiment of a distributor head, in which the gas and air are also supplied to the distributor head through the branches 15 and 16. They are mixed in the chamber 17 and pass, in the condition of mixture, through the branches 18 and 18a into the pipes leading to the burners. There is no need to point out that, with slight modifications, solid or liquid fuel can be mixed with the air of combustion in a distributor head of this type. The supply can be regulated by means of the circular slide 19, which is provided with oblique slots and is adjustable by means of the lever 20.

In these distributor heads, the stuffing-box packings may also be replaced by the packing devices of the present invention, the principle of which is illustrated in Figs. 6 to 8.

In Fig. 6, 25 is the rotary and 26 the stationary member of a connection, 26 being, for example, the wall of a stationary gas pipe and 25 the wall of a rotary gas pipe, which is to be connected to the former and rotates about the axis of the pipe. The end face of the pipe 25 is provided with the annular projection 27, and the end face of 26 with a groove 28 fitting said projection. The end face of the projection 27 is pressed so firmly against the base of the groove 28 that no gas can escape between them.

According to Fig. 7, a carefully machined ring 29, of high-grade material and intended to take up the wear, is inserted in an annular groove in one of the members of the joint and is pressed against the bottom of the groove by an annular projection 27 provided on the other member.

Fig. 8 shows how the requisite contact pressure is obtained by means of a screw cap 30 and the springs 31, so that a relatively heavy pressure is set up between the cap 30 and the actual packing ring 32 rotating in relation to the latter. In order to lessen the friction between the packing ring and screw cap, a ball bearing 33 is inserted between them. A plurality of packing joints 34 and 35 can be disposed concentrically.

Figs. 9-12, inclusive, and 15 show the application of such packing devices to a distributor head of the rotary furnace according to the invention. 36 is the rotary member (mounted on and rotating with the furnace) of the distributor head, and 37 is the fixed member of the latter. 38a-c are three feed pipes for fluid media, such as combustible and incombustible gases, and also air. 39a-f are the delivery pipes conveying the fluid media from the distributor head to the places of their employment in the furnace. Each

of these feed pipes can be connected with a plurality of delivery pipes, as shown in Figs. 11 and 12. 40 are the packing devices at the points of junction of the several concentric pipes. In the embodiment according to Fig. 15, the fixed member 37 is pressed against the member 36, which turns with the furnace 41, by the tension of a cord and the weight 42.

According to Figs. 9 and 10, the contact pressure is produced by springs 43.

Fig. 9 shows, on a larger scale, the actual joint according to Fig. 10.

The action of the burner according to Fig. 4 is based, in known manner, on the gas being fed (at 23) to the burner from a distributor pipe (not shown) under such high pressure that the air of combustion is automatically drawn in (at 24) from the surrounding atmosphere by the effort of suction. According to Fig. 4, 44 represents the inlet portion of the burner, which element is situated outside of the furnace and is attached to the furnace wall by means of a flange 45. Ports 24, in inlet portion 44, admit atmospheric air into the burner. Connected to this intake member 44 is the burner stem 61, surrounded by the insertion member 47. Gaseous fuel fed, at 23, to the burner under pressure enters the burner by way of the gas intake portion 62 which latter is attached to the inlet portion 44, communicating therewith through the opening 63. Adjustment of the rate of admission of gas to the burner is made possible through the agency of the adjustable hollow closure tube 64 which may be seated in opening 63. 57 represents a peephole cap at the outer end of tube 64, and 58a is a hand-wheel for adjusting the position of tube 64 with respect to opening 63. In the burner according to Fig. 5, fuel and air are supplied separately, under pressure—for example by the aid of the distributor head shown in Fig. 2—and are not mixed until they reach the burner head.

So-called jet blocks, known per se, can also be employed as burners, since, in such case, the supply of fuel and air can also be accurately regulated by the devices according to the invention. Such burners are also arranged, in a similar manner to those according to Figs. 4 and 5, so as to project through the charge material in the furnace.

Another gas burner is shown, in burning position, in Fig. 13, and in cooling position in Fig. 14. The burner consists of the intake portion 44, which is situated outside the furnace and is attached to the furnace wall by means of a flange 45 in the usual manner. Connected with this intake 44 is the burner stem 46, surrounded by the insertion member 47. The burner nozzle 48 is seated on the stem. These three members of the burner are made separately and assembled to form the complete burner, so that, in the event of wear of any of the parts they can be replaced independently of the rest.

The fuel, such as gas or oil, flows from the connection pipe through the supply pipe 49 into the pipe 50, which is preferably arranged centrally. The corresponding air is admitted into the annular chamber 52 of the burner member 44 through the branch 51. It then passes through pipes 53 (of any suitable number) to near the free end of the stem 46 and then back through the annular space 54 formed by the burner stem 46 and the pipe 50. In this manner, an intensive cooling of the stem 46 and nozzle 48 is produced. Finally, the air enters, through the uniformly distributed peripheral openings 55, into the pipe 50,

where it is mixed with the fuel, such as gas. In order to obtain a more intimate mixing, the pipe 50 is provided with an internal baffle ring 56 which sets the fuel mixture in vortical motion, the mixture being then ignited and burned in the nozzle 48.

The nozzle 48 is of ceramic material or metal and is screwed into the burner stem 46. This arrangement enables, on the one hand, nozzles of various shapes to be inserted and the form of the flame to be modified, while, on the other hand, these nozzles can be easily replaced in the event of damage from any cause. The cross-sectional ratios of the pipe 50 and nozzle 48 are so calculated that the rate of flow of the fuel mixture in the pipe 50 exceeds the velocity of ignition. According to the amount of the supply, the rate of flow in the flared bore of the burner nozzle 48 sooner or later becomes equal to the velocity of ignition, so that the flame burns at a point more or less remote from the orifice of the nozzle. If, from any cause, the flame back fires, the baffle 56 soon becomes red hot, since the development of the flame then commences in the pipe 50. The incandescence of the baffle or of a stay on which it is carried, or also of a second stay that can be disposed at a suitable point in the pipe 50, can be easily observed through a peephole 57, so that remedial measures can be adopted at once. The baffle 56 therefore discharges a dual function. On the one hand, it thoroughly intermingles the fuel mixture, under normal working conditions, and on the other, the baffle, or its supporting stay, glows when the burner lights back, and thus reveals a change in the combustion process in the burner. Finally, said baffle, being perforated, does not prevent the charge in the furnace from being observed—according to the position of the burner, or the furnace—through the peephole 57.

If, for any reason, the burner is not in use,—or temporarily out of use—while the furnace is running, it might possibly become damaged by the hot atmosphere of the furnace. According to the present invention, under such conditions, the fuel supply alone is shut off, for example by a throttle member in the supply pipe. Moreover, by turning the handwheel 58 (as shown in Fig. 14), the valve plate 59 on the gas supply pipe 49 is pushed forward so as to close the pipe 50. The air continues to take the same course as when the burner is in operation, as far as to the intake slots 55, from which point, however, it now passes off into the atmosphere through openings 60 in the intake member 44. This arrangement assures the air acting solely as cooling medium and being prevented from entering the furnace.

Of course, even in that position of the burner, the fuel, such as gas, can still be admitted into the furnace so that it can react with the atmosphere or charge in the furnace.

If, for any reason, the burner is to be detached from the furnace—for example for changing the nozzle 48—this can be very easily effected, according to the present invention, without fear of affecting the durability of the furnace masonry,

since the firmness of the masonry is ensured by the insertion member 47. This latter also performs the function of protecting the burner stem 46 from mechanical attack by the furnace charge when the furnace is running. This member 47 is preferably of highly refractory material.

This arrangement enables the feed to the burners to be varied at convenience and also any convenient number of burners to be kept in, or put out of, operation in the same furnace.

I claim:

1. In a rotary tube furnace structure provided with means, including a fluid media-distributing pipe situated outside of and turning with the rotary furnace, for leading a fluid media to a point on the perimeter of said furnace, a burner communicating with said media-leading means, said burner comprising a member for the supply of fluid fuel and air situated on the outside of said furnace, a stem projecting through the furnace and into the interior thereof, and a nozzle carried on said stem, said stem being surrounded for at least a part of its length within the furnace by an annular insertion member constituting a shield to protect the stem against wear, said insertion member forming an abutment for the furnace masonry along the portion of said member adjacent the wall of the furnace and at its inner end tightly encircling the stem and providing a means for holding fast the stem in predetermined position.

2. A fuel burner for a rotary tubular furnace with a shaft extending through the furnace wall and into the interior thereof for a substantial distance and terminating in a nozzle and in which the portion thereof which supplies fuel and combustion air is located outside of the furnace, said burner being characterized by a jacketed space surrounding the burner shaft and adapted for complete traverse by combustion air, said jacketed space extending through the wall of the furnace and into the interior thereof to a point adjacent the nozzle of the burner, said burner being further characterized by openings provided in the lower part of the burner shaft for passage of combustion air from said jacketed space into said shaft and by a valve slidable lengthwise of the burner shaft and adapted when slid inwardly of the shaft to close the said passages between the jacketed space and the interior of the shaft and for discharging air from said jacketed space into the outer air.

3. Rotary tubular furnace burner as defined in claim 2, characterized in that passages are arranged in said jacketed space for supplying air to said space at a point adjacent the burner nozzle.

4. A burner as defined in claim 2, characterized in that a baffle is positioned within said stem.

5. A burner as defined in claim 2, characterized in that a baffle is positioned within said stem and in that means are provided in said supply member for visually determining a condition of said baffle from without the burner.

CARL PAUL DEBUCH.