Dec. 8, 1936. C. P. DÉBUCH 2,063,233

ROTARY TUBE FURNACE

Filed Nov. 9, 1932 4 Sheets-Sheet 1

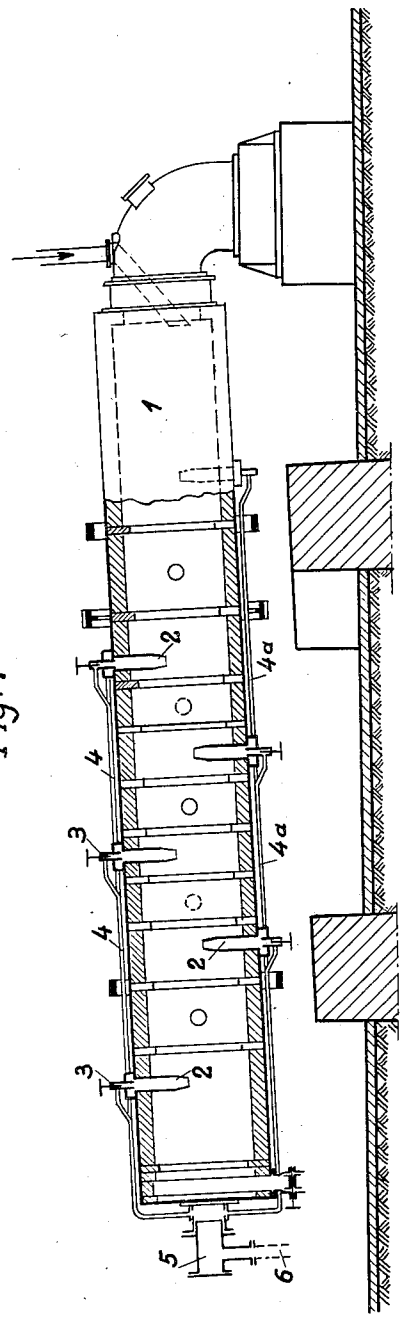


Fig. 1

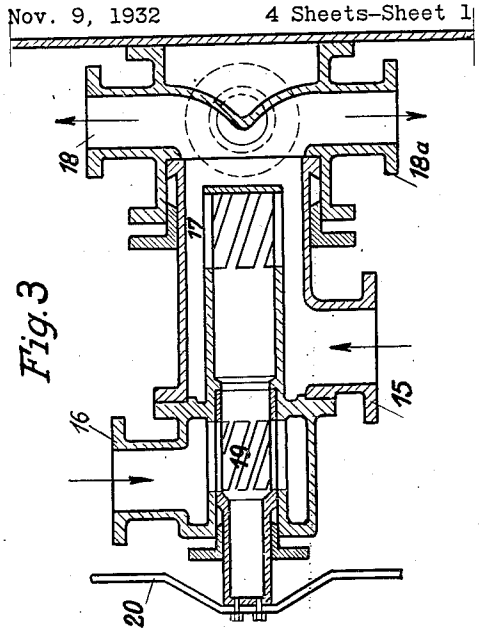


Fig. 3

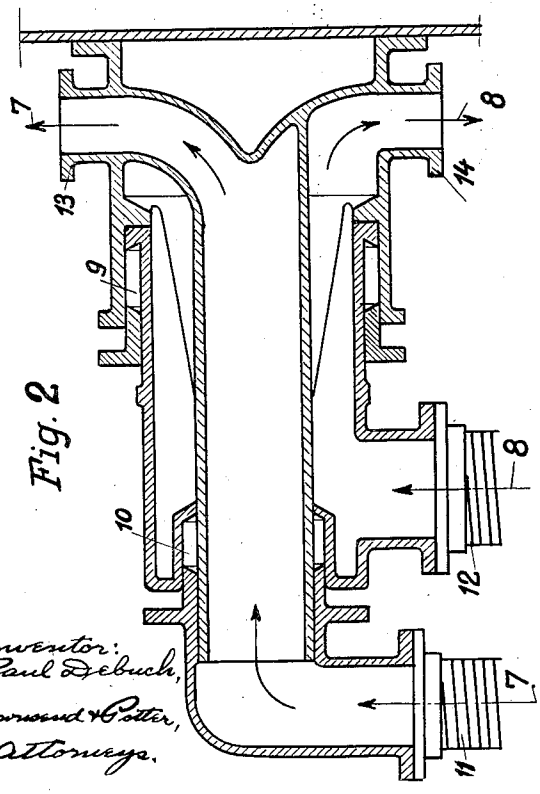


Fig. 2

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ROTARY TUBE FURNACE

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Fig. 4.

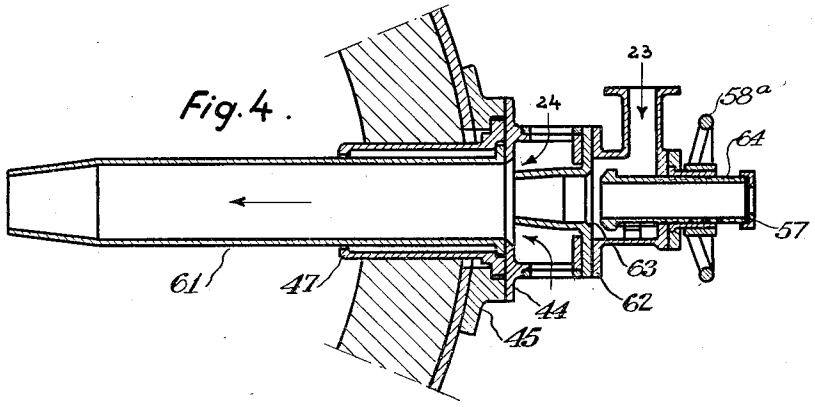


Fig. 5.

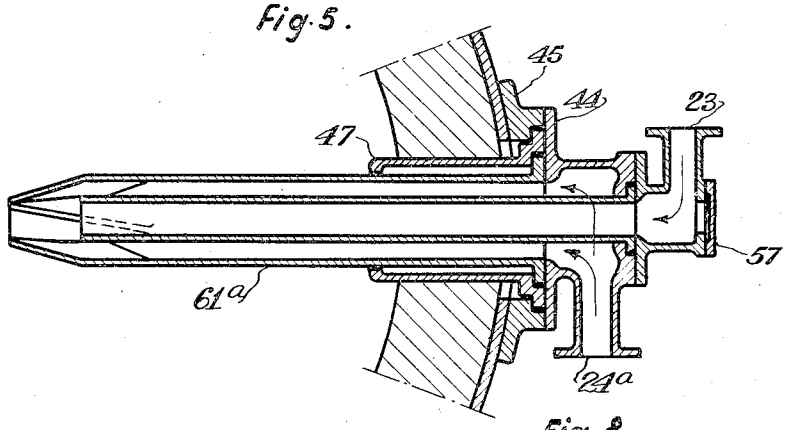


Fig. 6.

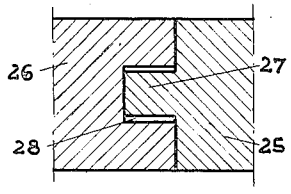


Fig. 7.

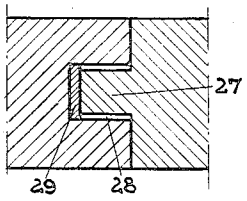
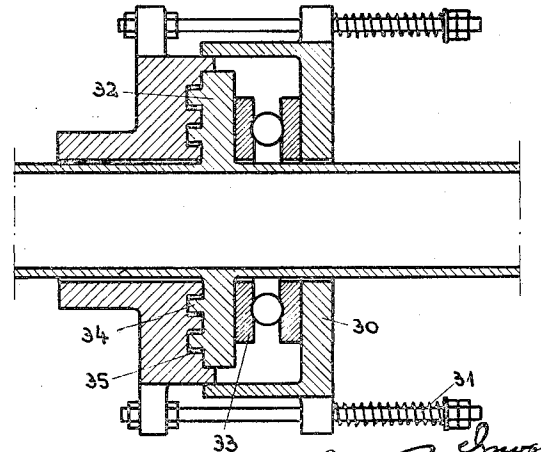


Fig. 8.



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ROTARY TUBE FURNACE

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Fig. 10.

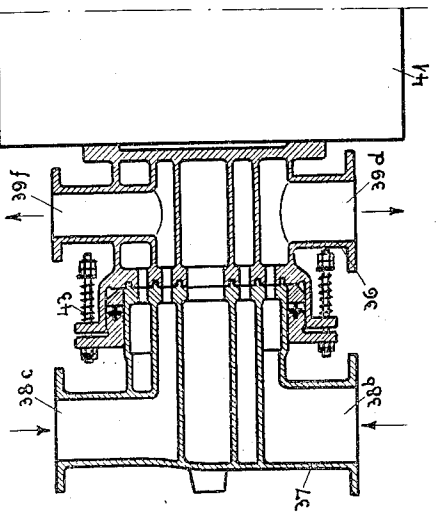


Fig. 11.

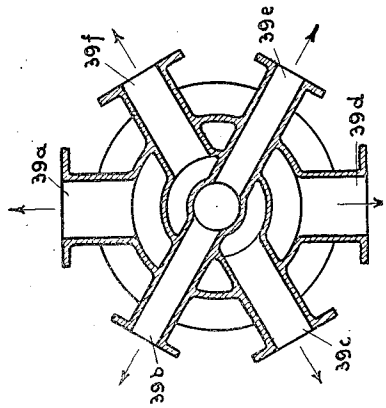


Fig. 9.

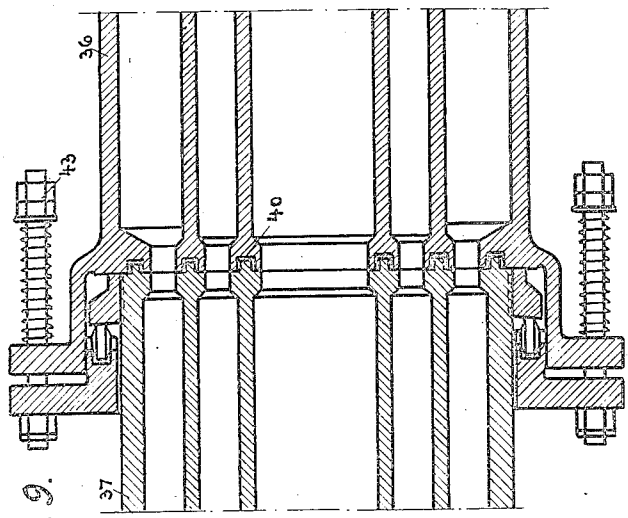
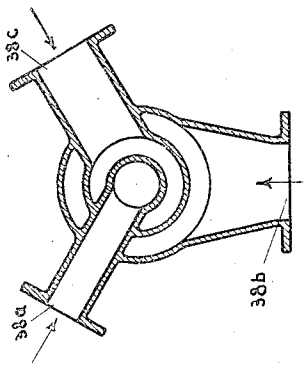


Fig. 12.



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Dec. 8, 1936. C. P. DÉBUCH 2,063,233

ROTARY TUBE FURNACE

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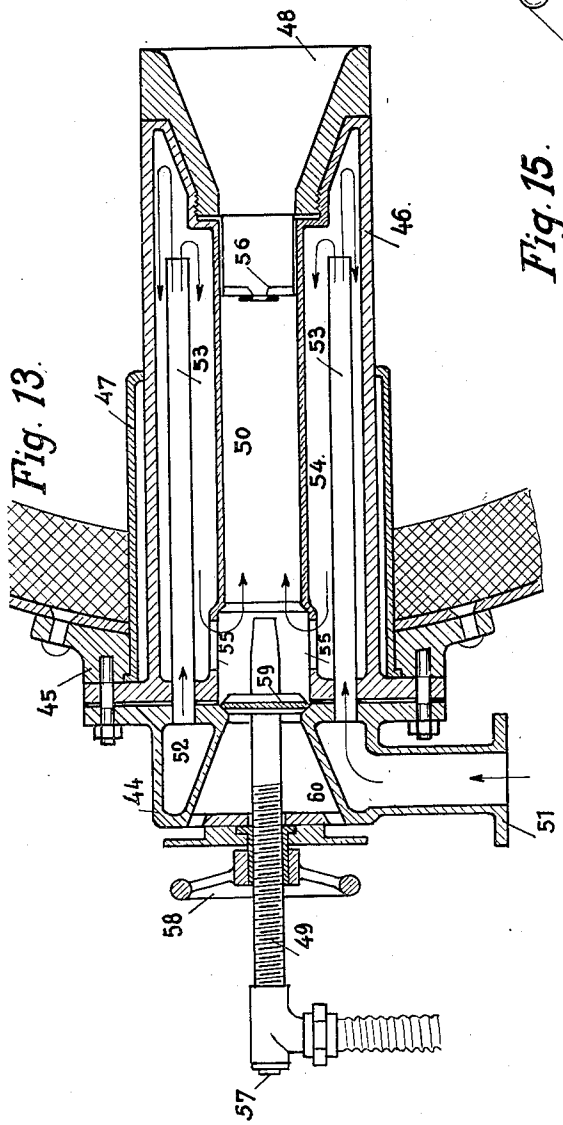


Fig. 13.

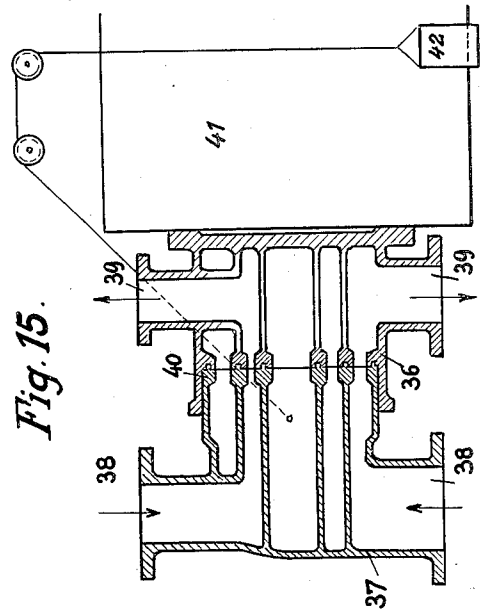


Fig. 15.

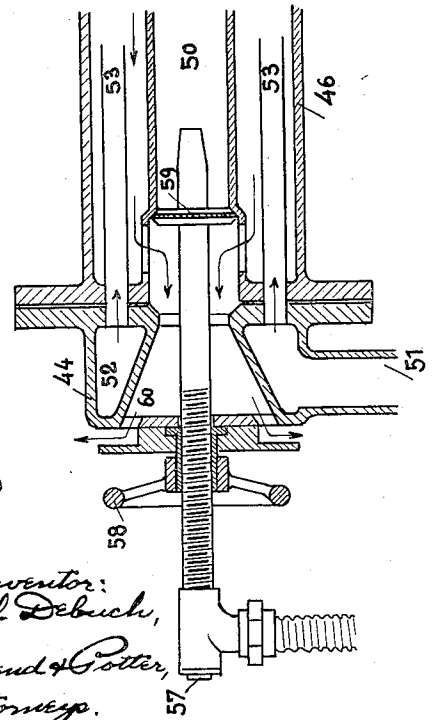


Fig. 14

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Patented Dec. 8, 1936 2,063,233

UNITED STATES PATENT OFFICE

2,063,233

ROTARY TUBE FURNACE

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

Application November 9, 1932, Serial No. 641,935
In Germany July 6, 1931

5 Claims. (Cl. 23—279)

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, thust 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 stimulate 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 manipulating 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 unfavourable 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 **4***a*. 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 **18***a* 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 bottom of the groove by an annular projection **27** provided on the other member.

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, 10 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. **38***a–c* are three feed pipes for fluid media, such as combustible and incombustible gases, and also air. **39***a–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 a 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 **58***a* is a handwheel 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 mixes 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. Device for the introduction of fluid agents into a rotary tubular furnace comprising, in combination, a cylindrical chamber located at one end wall of the rotary tubular furnace its walls revolving with the rotary tubular furnace and its side walls being concentric with the furnace axis; at least one pipe connecting said chamber with at least one passage in the shell of the rotary tubular furnace and revolving with the rotary tubular furnace; a stationary feed pipe for the fluid agent opening into said chamber and having metallic end surfaces at its end towards the furnace these end surfaces engaging the end surfaces of the cylindrical walls of said chamber, and means for pressing the end surfaces of said stationary feed pipe hermetically against the end surfaces of the revolving walls of said chamber, the end surfaces of said chamber and of said feed pipe engaging each other with packing grooves and tenons in the section through the axis of the furnace, a metallic ring being positioned in at least one of said grooves.

2. Device according to claim 1, in which the metallic ring is a wear-resistant steel ring.

3. Device for the introduction of fluid agents into a rotary tubular furnace comprising, in combination, a plurality of cylindrical chambers located at one end wall of the rotary tubular furnace their walls revolving with the rotary tubular furnace and their side walls being concentric with each other and with the axis of the furnace; at least one pipe connecting each chamber with at least one passage in the walls of the rotary tubular furnace and revolving with the rotary tubular furnace; a plurality of stationary feed pipes for fluid agents opening into each chamber their ends being of annular construction and concentric to each other and to the axis of rotation of the furnace and having metallic surfaces at the ends engaging the end surfaces of the cylinderical walls of said chambers; and means for pressing the end surfaces of said stationary feed pipes hermetically against the end surfaces of the revolving walls of said chambers, the end surfaces being located in a plane perpendicular to the axis of the furnace.

4. Fluid tight connection between relatively rotating supply and distributing pipes for fluid media in which a plurality of concentric supply pipes communicate with a plurality of concentric distributing pipes by means of metallic end surfaces provided on the supply and distributing pipes and disposed perpendicularly to the axes of the latter, said end surfaces providing sliding contacts, said connection being further characterized in that a plurality of separate concentric passages are provided for the separate movement of a plurality of fluid streams from said supply pipes into said distributing pipes.

5. Device for the introduction of fluid agents into a rotary tubular furnace, comprising a cylindrical chamber located at one end of the rotary tubular furnace, its walls revolving with the rotary tubular furnace and its side walls being concentric with the axis of the furnace; a tube connecting said chamber with at least one passage in the walls of the rotary tubular furnace and rotating with the rotary tubular furnace; a plurality of non-rotary feed pipes for fluid agents opening into the chamber, their ends being of annular construction and lying concentric to each other and to the axis of rotation of the furnace, with metallic end surfaces at the ends that fit on the end surfaces of the cylindrical walls of the chamber; means for pressing the end surfaces of the non-rotating feed pipes airtight against the end surfaces of the rotary walls of the chamber; and means for introducing a plurality of fluid agents through said non-rotating pipes into said chamber and there mixing them.

CARL PAUL DÉBUCH.

Certificate of Correction

December 8, 1936.

Patent No. 2,063,233.

It is hereby certified that the name of the patentee in the above numbered patent was erroneously written and printed as "Carl Paul Débuch" whereas said name should have been written and printed as Carl Paul Debuch, as shown by the records of this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of March, A. D. 1937.

[SEAL]

HENRY VAN ARSDALE,
Acting Commissioner of Patents.