Oct. 7, 1930. K. A. MAYR 1,777,411

COMBUSTION APPARATUS

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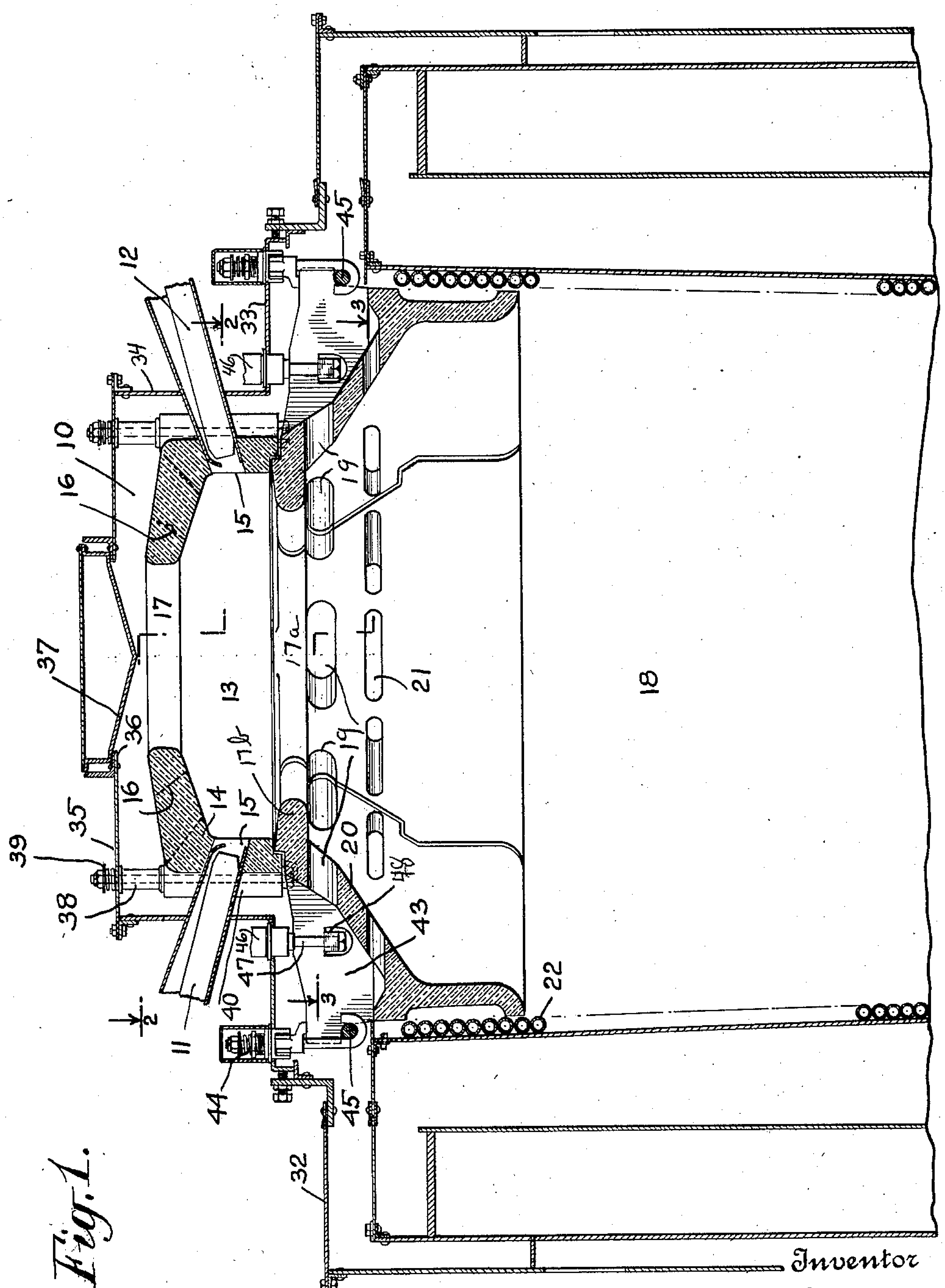

Fig. 1.

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Fig. 3.

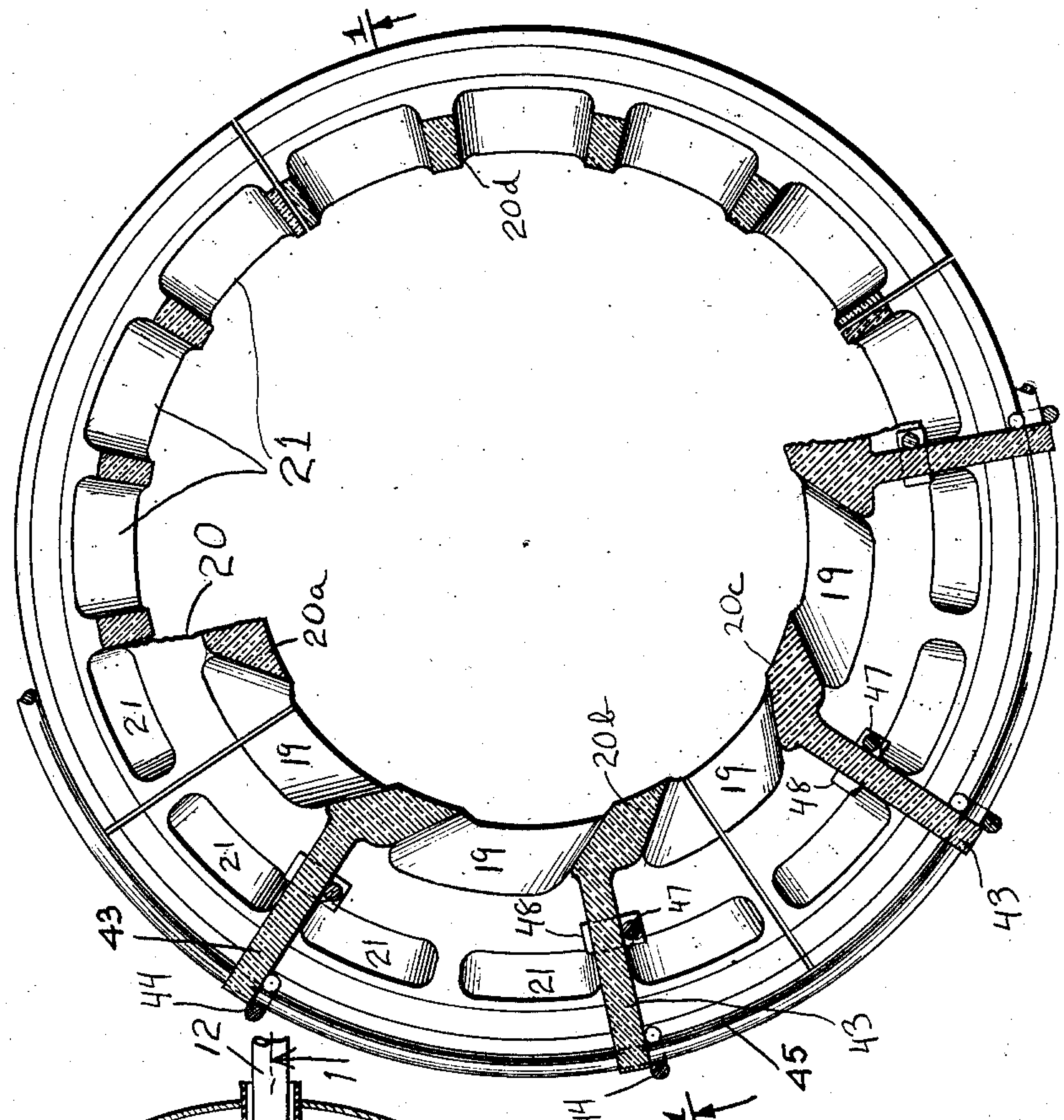

Fig. 2.

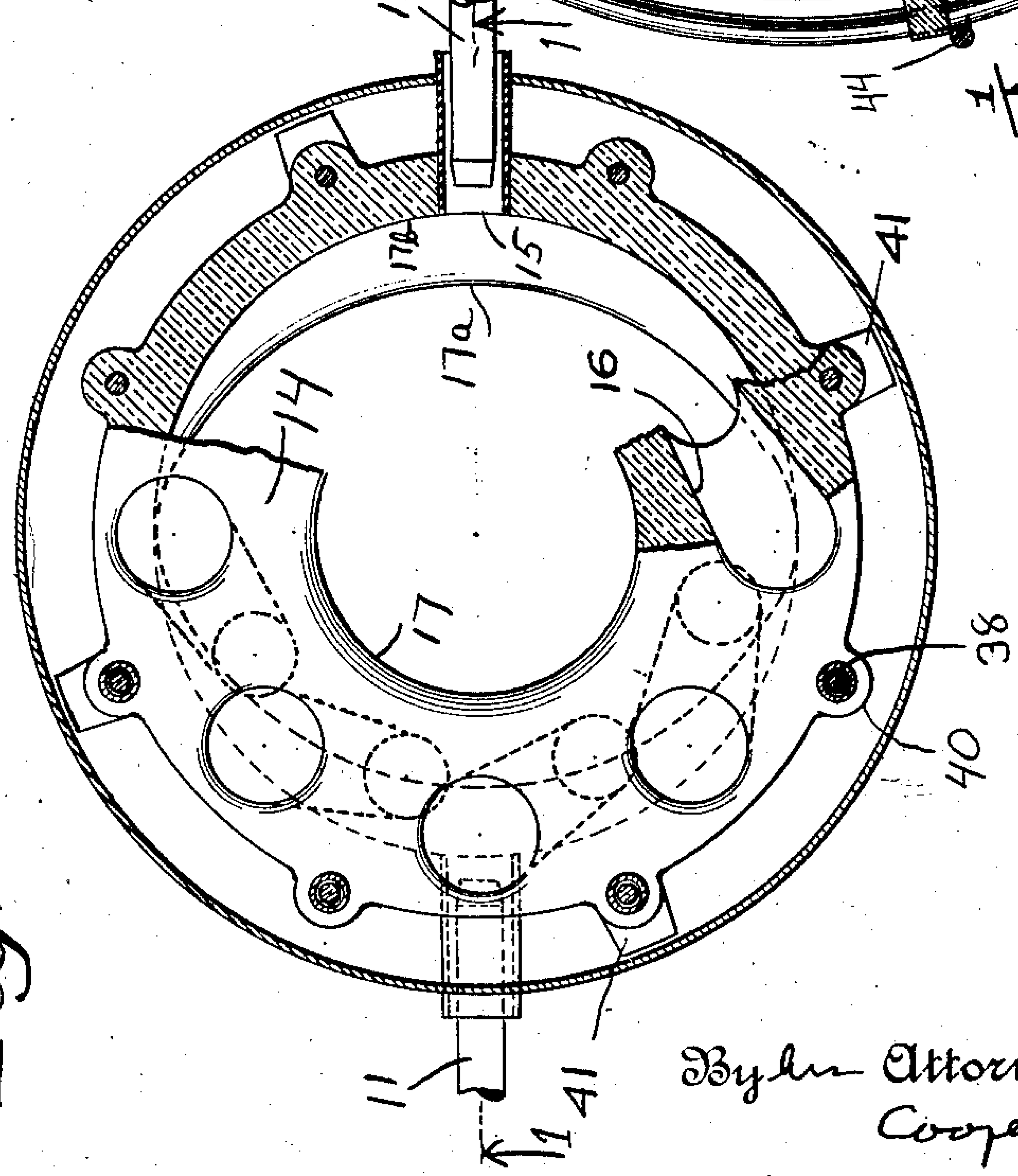

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Fig. 4.

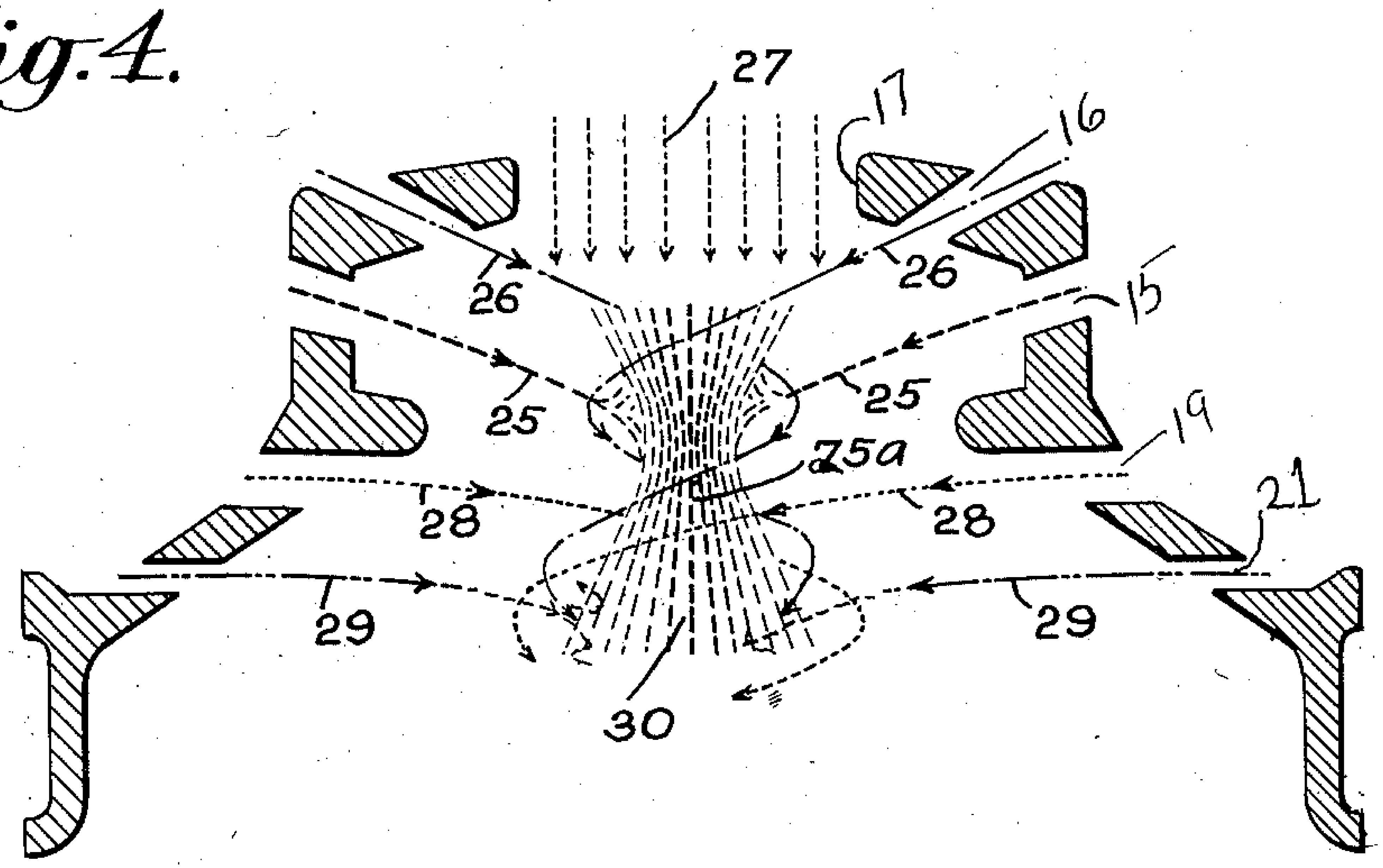
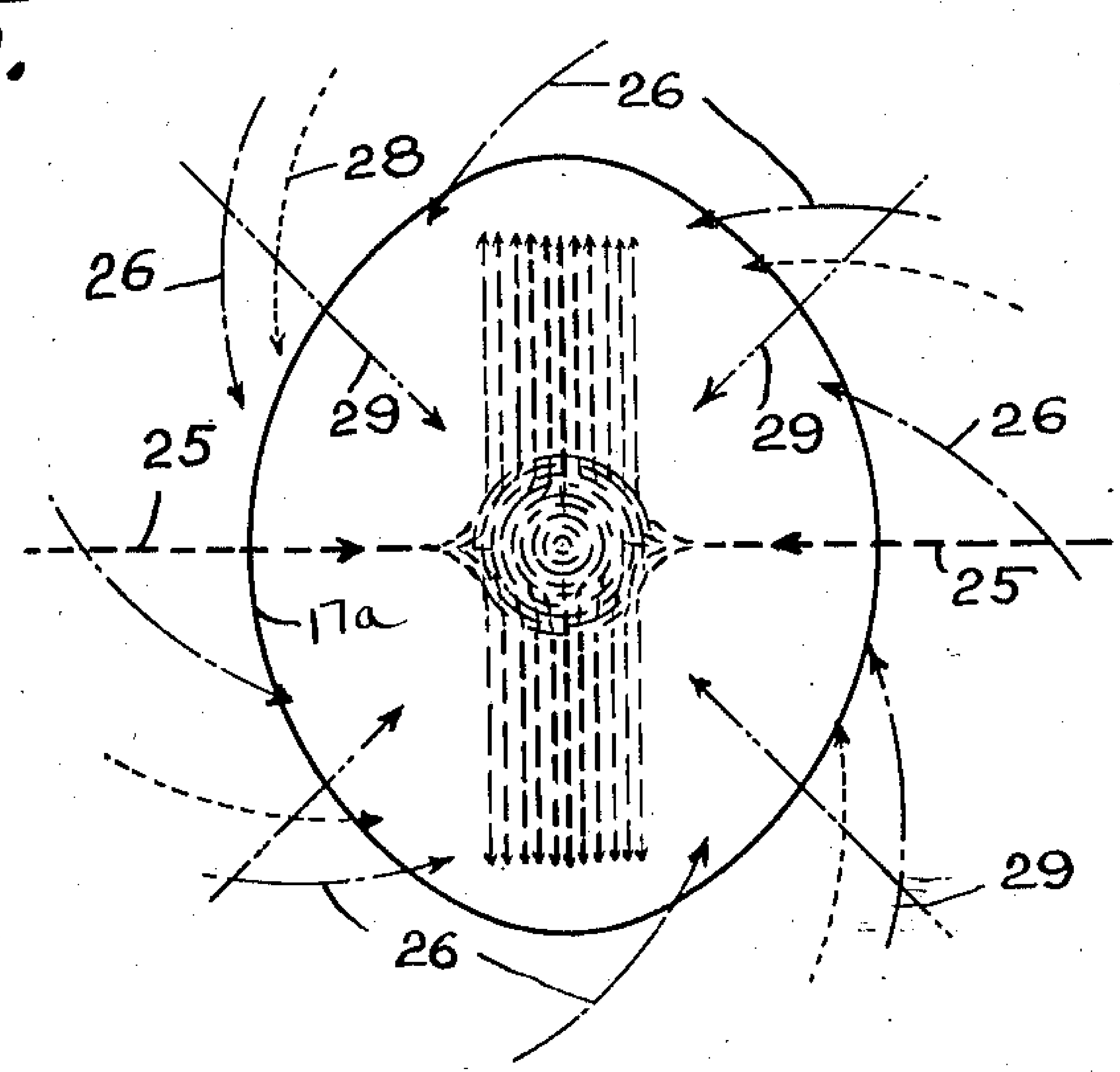


Fig. 5.



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UNITED STATES PATENT OFFICE

KARL A. MAYR, OF NEW YORK, N. Y., ASSIGNOR TO SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT, OF SIEMENSSTADT, NEAR BERLIN, GERMANY, A CORPORATION OF GERMANY

COMBUSTION APPARATUS

Application filed October 4, 1927. Serial No. 223,857.

This invention relates to improvements in furnaces for powdered, liquid or gaseous fuels and has for its principal objects provisions of an improved furnace construction which will more efficiently mix finely divided fuel with the air for combustion to the general end that a more homogeneous, complete and better combustion may be secured.

Other objects of the present invention reside in the provision of a construction which will permit free and independent expansion of any parts of the apparatus which are subject to high and variable heat.

A further object of the present invention resides in the provision of a construction which will provide for cooling of various parts of the apparatus by the entering air and for thereby raising the incoming air temperature.

A further object of the present invention resides in the provision of a furnace construction which will afford a relatively cool zone or antechamber at certain points near the point where the fuel enters whereby high and excessive radiant heat effects in certain parts of this zone or antechamber are considerably minimized and also in the provision of a further main combustion chamber in which the more intense and complete combustion takes place.

Other objects of the present invention reside in the provision of novel means for directing the fuel and air into the ante and main combustion chambers to the general end that better operating results are secured which will be more fully pointed out hereinafter.

Further and more detailed objects of the present invention reside in the provision of a construction which will protect the burner tips against excessive heat and which will also keep these tips cool.

A further object of the present invention resides in the provision of a construction which will secure an intimate mixture of fuel and air so that combustion may be completed within a very small space.

Provision is made for setting up a whirling or revolving action of the burning mixture so that all zones of the combustion space will act equally and whereby stratified combustion is avoided, even if the introduction of fuel and air is not initially such that an equal loading over the combustion space is secured.

A further object of the present invention resides in the provision of means for setting up further turbulance of the burning mixture in order to make the mixture more intimate and in order to prevent excessive rotary motion which might cause a throwing out of the coarse or badly atomized fuel particles towards the cooler walls of the combustion chamber.

A further object of the present invention resides in the provision of a construction which will be simple to assemble and disassemble and one which will afford ready accessibility to the various parts.

Further objects and advantages will be hereinafter more fully set forth in the accompanying specification, defined in the claims and shown in the accompanying drawings, which show by way of illustration what I now consider to be a perfect embodiment of the invention.

In the drawings Figure 1 is a transverse sectional view of my improved furnace.

Fig. 2 is a transverse sectional view taken on line 2—2 of Fig. 1 and looking in the direction of the arrows.

Fig. 3 is a sectional transverse view taken on line 3—3 of Fig. 1 and looking in the direction of the arrows.

Fig. 4 is a diagrammatic view showing the direction of the various fuel and air jets and the paths of flow of the fuel air which by the resultant combination afford the desired action.

Fig. 5 is a diagrammatic view showing the impinging action of the fuel streams.

According to the present invention, provision is made in an antechamber for introducing the fuel in impinging streams which somewhat incline toward the main combustion chamber. Air is also directed towards the finely divided fuel in this zone in tangential and inclined streams to set up an initial revolving action and in this primary zone further air is introduced centrally and axially which directs the mixture towards the main combustion chamber and also supplies air for combustion in the center of the burning mass. The amount of this air previously referred to is insufficient to effect complete combustion of the fuel. As the burning mixture passes towards the main combustion chamber further air is introduced tangentially with respect to the chamber and other air is introduced substantially radially or perpendicularly to the axis of the combustion chamber in order to provide further combustion air about the outside of the burning mass and in order to introduce air streams directly into the burning mass to provide further turbulence and a complete and homogeneous combustion throughout the entire space. The effect of the co-acting air streams is such that while the revolving action of the burning mass is maintained, such action is not allowed to become excessive or reach such a point that badly atomized fuel will be thrown out of the burning mass towards the relatively cooler walls of the combustion chamber.

The construction is such that a cloud of fuel particles is pierced by streams of air and then the mixture of air and fuel is directed to pierce flowing streams or a sheet of fresh air so that the burning fuel is constantly being attacked by air as the combustion proceeds.

The general construction and the manner in which combustion is secured will be first explained and afterwards various features of design will be set forth in further detail.

Broadly, the entering incoming air enters the apparatus from an upper jacket space generally designated 10 in Fig. 1. 11 and 12 are the fuel nozzles, two of these are shown in the present embodiment, but it is apparent that any desired number may be used. These nozzles extend towards one another and incline somewhat downwardly as shown in Figs. 1 and 2. The antechamber 13 is defined by a refractory construction, generally designated 14 and provided with openings 15 for the burners 11 and 12, which openings are suitably inclined. Other openings 16, Figs. 1 and 2 are provided, which openings extend tangentially and downwardly to set up a whirling or revolving action of the burning fuel and also provide air for supporting combustion in part. The top of the antechamber is provided with a central opening 17 which directs air for supporting combustion centrally into the burning mass. The pulverized finely divided fuel streams are suitably ignited. They impinge upon one another causing spreading and deflection of the fuel.

If two burners are employed the opening 17^a is preferably oval in contour as shown in Figs. 2 and 5. If the burners were disposed horizontally instead of being inclined a flat disc-like body of fuel would result from the impinging streams. The inclination of the burners causes a parabolic dispersion of the fuel particles spreading outwardly as indicated by lines 25^a on Fig. 4. The oval permits a ready egress and development of this desired diverted fuel flow. The impinging center of this fuel mass is directly attacked by the air stream 27 and prevents undesired upward spreading of the fuel particles.

It is the intention that the combustion be relatively slight in the primary antechamber 13 and that the more intense and more complete combustion take place in the main combustion chamber 18. As the burning fuel mass passes downwardly from the antechamber 13 into the main combustion chamber 18, this burning mass is attacked by further air for supporting combustion, which enters through tangentially disposed openings 19 in a lower refractory construction, generally designated 20. This air supply sets up a further and more intense whirling action of the burning mass, and creates a more intense combustion. The air for supporting combustion is further augmented by additional air streams which are introduced in a substantially radial direction into the burning mass through ports 21. The effect of the latter two air streams, viz the tangential streams and the radial streams is to cause an intense and complete combustion in a comparatively short space in the combustion chamber 18 and the radial streams serve the further purpose of breaking up any stratification of combustion which might have occurred on account of unequal supplies of fuel from the burners or unequal supplies of air for combustion. The combustion in the main combustion chamber is homogeneous throughout and furthermore excessive whirling action is obviated which might cause throwing out of coarse or badly atomized fuel particles towards the walls 22 of the combustion chamber.

Fig. 4 shows in somewhat diagrammatic manner the stream action. The lines 25 (see also Fig. 5) represent the entering fuel streams which impinge and form a cloud. Lines 26 represent the first or upper tangential air streams and lines 27 represent the central air streams.

In practice, approximately twenty per cent of the air may enter at 26 and say forty per cent on the paths 27. Lower down, the lower tangential air jets are represented by the lines 28 and the radial jets are represented by lines 29. Combustion is extremely intense at point 30.

The disposition of the burners 11 and 12 in the openings 15 is such that the burner tips are protected from intense radiant heat. Such protection is secured by the flanged portion 17^b which acts to shadow the ends of the burners from the intense radiant heat zone. Furthermore, these burners are cooled by a small quantity of cool fresh air which is drawn in directly from the outside of the apparatus around the burners.

According to the present invention, it is not intended the ignition or intense combustion should occur in the antechamber. Ignition and initial combustion preferably takes place in the center adjacent the division of the ante and main chambers and accordingly the antechamber is comparatively cool. The incoming air from casing 10 even though it may be initially somewhat preheated serves to cool the refractory constructions 14 and 20.

Construction details

Provision is made for supporting refractory constructions 14 and 20 independently of each other from the top of the furnace. As shown, the top part of the casing 10 comprises sheet metal plate structures 32, 33, 34 and 35. Plate 35 may be provided with an opening 36 opposite opening 17 and closed by a suitable heat resisting lid 37 which may be removed to provide access to the interior of the furnace. The refractory construction 14 may be made in sectional form or as here shown it can be in a single piece. It is preferably supported by bolts 38 which are spring supported by means such as 39 from plate 35. Bolts 38 preferably are located in flange portions 40 upon the outer and cooler side of the refractory 14 so as to be cooled by the incoming air. The refractory section 14 may further be provided with exterior centering and aligning flanges 41 best shown in Fig. 2.

The refractory construction 20 is supported independently of the refractory section 14 and is preferably spaced slightly therefrom. The lower refractory section 20 preferably but not necessarily, is made in sections. In Fig. 3 this refractory construction is shown as being made up of four sections designated 20^a, 20^b, 20^c and 20^d, but it will be understood that any number of sections may be employed. Each section is provided with integral radial flange portions 43. In order to support the refractory assembly 20, a number of looped end spring hanger bolts 44 are provided which are carried by the plate section 33 and which support a ring 45. The ends of the flanges 43 project over and rest upon this ring. Other spring hangers 46 are provided which are resiliently supported by the plate member 33 and which have bolts 47 carrying horizontally extending members 48 at their lower ends which project into apertures in the flange portions 43.

The foregoing construction provides for free expansion of the various refractory parts when highly heated. The springs in the hangers are preferably of a material which does not readily lose its resiliency under high heat and these spring hangers hold the refractory parts yieldingly to the upper plate structure and allow freedom of movement as expansion occurs under heat.

The upper refractory 14 may be made of any ordinary refractory material but on account of the high and intense radiant heat in the main combustion chamber, the refractory 20 should be built of high heat resisting material, for instance, carborundum, nickel chromium or the like. The highly heated refractory 20 is cooled by the incoming air which not only cools the ribs 43, but also cools the main body in passing the admission channels.

It will be understood that the mixing of some air and dispersion of fuel particles and the setting up of an initial whirling action is effected in the antechamber. The fuel air mixture is directed toward the main combustion chamber by the inclination of the fuel streams and by the direction of the air streams 26 and 27. The stream 27 directly attacks the point of impingement of the fuel streams and supplies air at this point forming in effect an air core for the fuel air mixture. This mixture also has an air envelope provided by stream 26.

Subsequently in the main combustion chamber, the balance of the air is supplied for effecting the more complete and intense combustion. The tangential streams 28 act to supplement the whirling action and afford an air envelope for the burning mass. Ultimately the whirling action is broken up by the radial streams 29 which cause extreme turbulence and very rapid and intense burning. Intense radiation and high heat conditions are maintained in the main combustion chamber and relatively cooler conditions are maintained in the antechamber.

All parts subject to heat are adapted for expansion independently of the other parts and at the same time these parts are kept in place by the hanger construction spacers and like parts which are employed. The expansion of the various parts furthermore does not distort the supporting housing or casing parts.

I claim:

1. A combustion apparatus including in combination, a chamber, means for directing thereinto fuel in impinging streams, and means for directing air streams against said fuel in tangential directions with respect to the chamber to set up a revolving action of the impinging fuel.

2. A combustion apparatus including a chamber, means for directing fuel in impinging streams therein, means for directing air streams toward the point of impingement of the fuel, and means for further directing air tangentially with respect to the chamber and upon the aforesaid fuel to cause a revolving action thereof.

3. The invention set forth in claim 1, in

which means is provided for inclining the fuel streams which impinge in said chamber.

4. A combustion apparatus including in combination, a mixing chamber and a combustion chamber, means for directing a fuel air mixture in a diverging and rotatably whirling manner from the mixing chamber into the combustion chamber, and means for attacking the said mixture after its entry into and while it burns in the combustion chamber by additional air streams.

5. The invention set forth in claim 4, in which means is provided for directing the attacking air streams tangentially and radially with respect to the mixing chamber to cause whirling and turbulence.

6. A combustion furnace including a combustion chamber, means for initially mixing fuel and air for supply to said chamber, said means comprising means for causing a revolving action of the fuel and air mixture entering the chamber, and means comprising parts which are radially disposed with respect to the main axis of flame propagation of the burning mixture for breaking up said revolving action by further air supply.

7. A combustion apparatus including a chamber into which a fuel mass is introduced, means for directing air centrally in said chamber to provide an air core for the fuel mass, and means for directing air about the outside of said fuel mass in a tangential direction with respect to the combustion chamber to set up a whirling action of the fuel mass therein.

8. A combustion apparatus including a main combustion chamber having enclosing wall portions, means adjacent the combustion chamber for directing fuel in impinging streams and for inclining the direction of said streams toward the main combustion chamber, means for conducting an air stream through the wall portions and at points adjacent the aforesaid means to cool the wall portions, and means for directing an air stream toward the point of impingent and toward the main combustion chamber.

9. The invention set forth in claim 2 in which the fuel introducing means is inclined with respect to the axis of the chamber to thereby direct the fuel in inclined as well as in impinging streams in said chamber and to also control the main direction of dispersion of the fuel in said chamber.

10. A combustion furnace having in combination, a main combustion chamber in which combustion of burning mixture takes place, fuel introducing means for introducing fuel into said chamber, means disposed in said chamber at a point beyond the point where the fuel is introduced therein for introducing air substantially tangentially thereinto and with respect to the burning mass of fuel to cause a revolving action of the burning mixture at points beyond the point of introduction of the fuel, and means for causing turbulence by introducing supplemental air streams thereinto.

11. A combustion furnace having in combination, a combustion chamber in which fuel mixture burns, means for introducing air to the combustion chamber in a direction which is substantially tangential to the mass of burning mixture to cause a whirling action of said mixture, and means for directing additional air to support combustion into said chamber, said means directing said last mentioned air in a direction generally perpendicular to the tangential air streams and in a direction co-axial with the main axis of flame propagation of the burning mixture.

12. A combustion furnace having a chamber, means for forming therein a fuel air mixture including air supplying means for supplying air to the outside of a fuel cloud inside the chamber and air supplying means for supplying air to the center of said cloud, means for supplying further air to the mixture after it has commenced to burn, said means comprising air supplying means for admitting air in a direction to create a whirling action of the burning mass and also including air supplying means for admitting additional air to break up the whirling action.

13. A combustion apparatus including a chamber into which fuel is introduced, means for directing air centrally into said chamber to provide an air core for the fuel means, and means for introducing air tangentially with respect to and into said chamber to set up a whirling action therein.

In testimony whereof I hereto affix my signature.

KARL A. MAYR.