Sept. 29, 1953 T. HEILMANN 2,653,810

APPARATUS FOR BURNING FUEL

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Fig. 1.

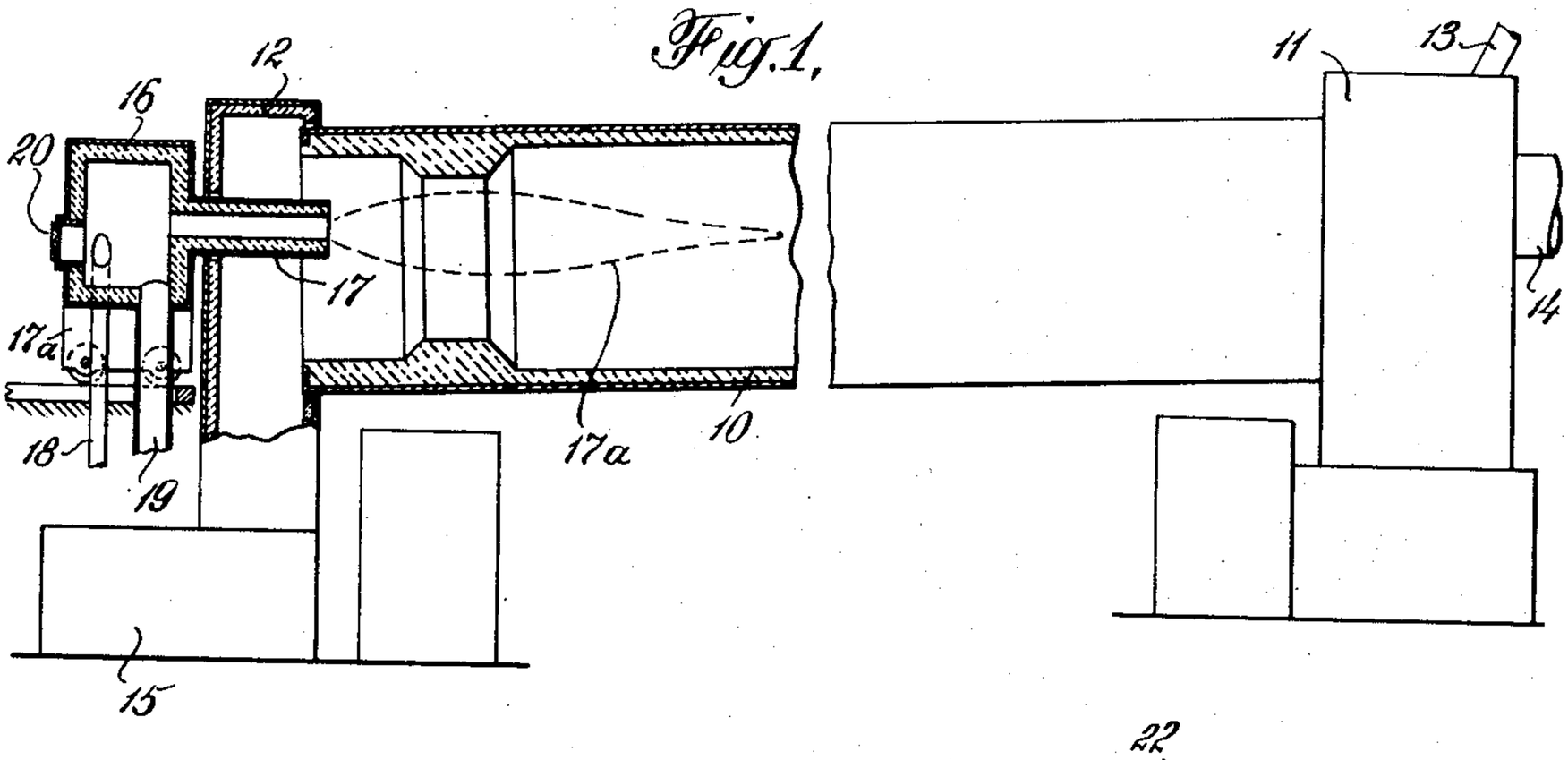


Fig. 2.

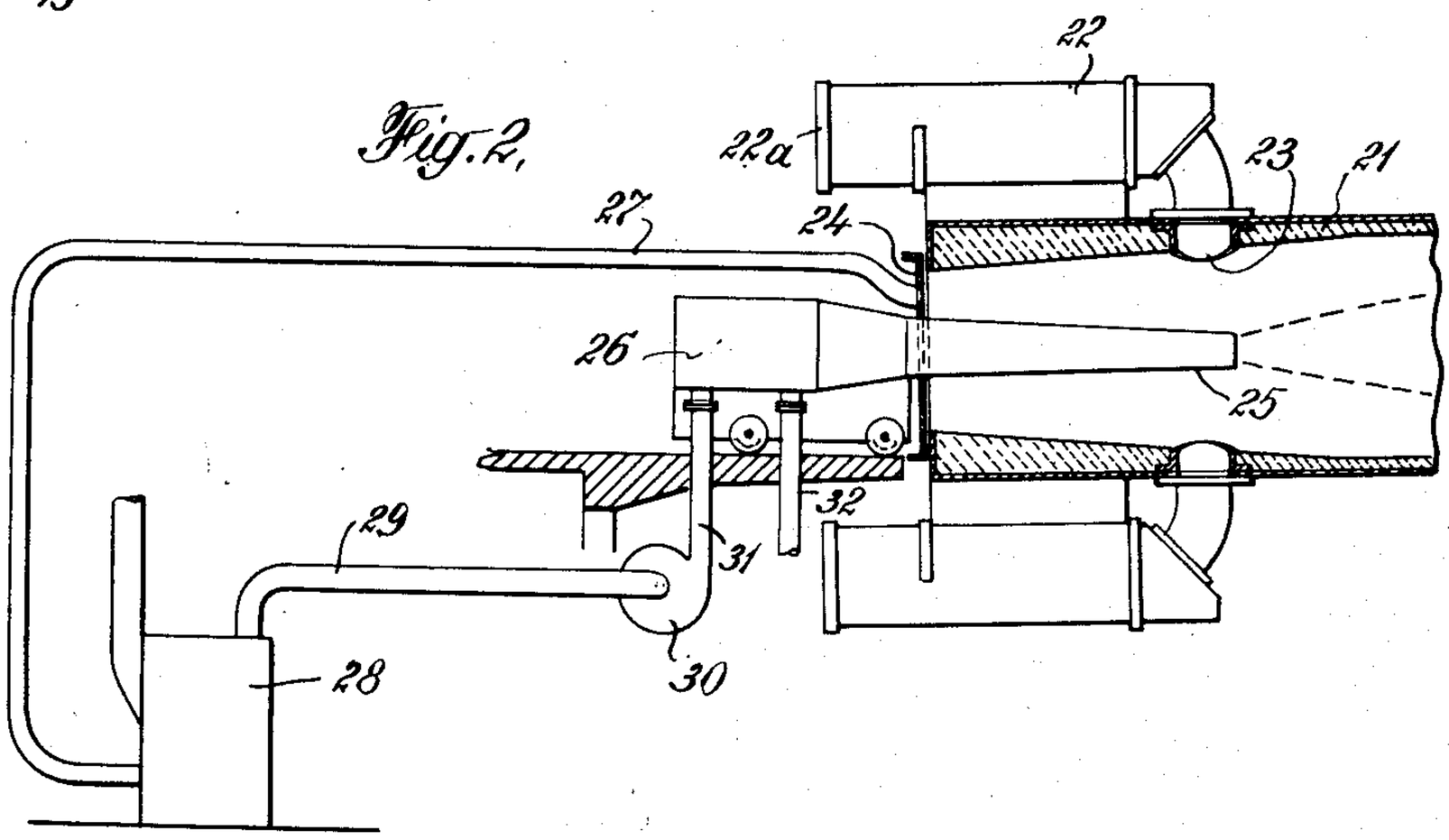
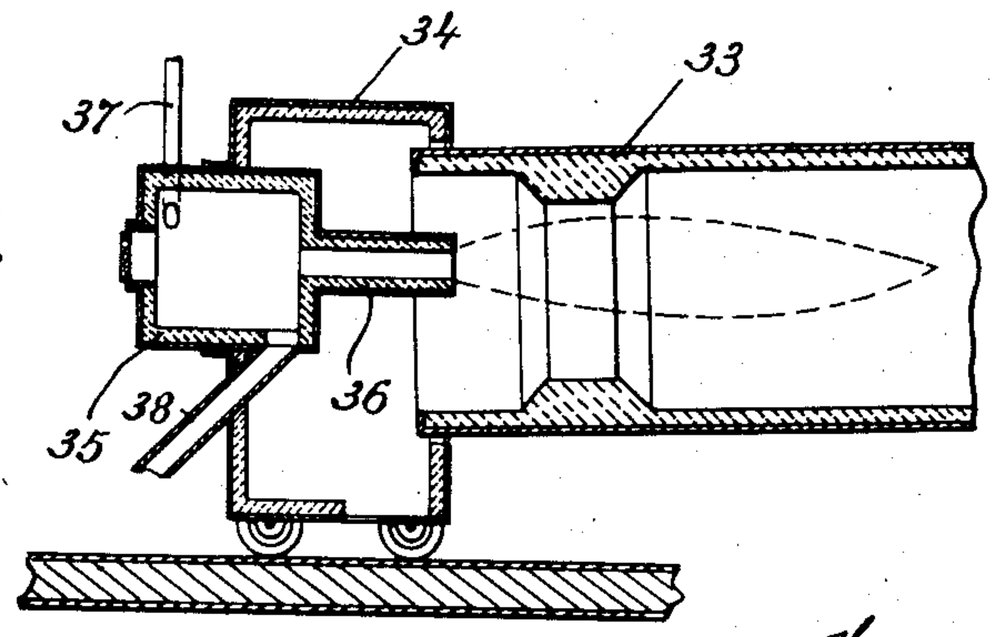


Fig. 3.



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APPARATUS FOR BURNING FUEL

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1 Claim. (Cl. 263—33)

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This invention relates to the burning of materials, such as cement raw materials, limestone, etc., in rotary kilns, drum furnaces, and like apparatus by the combustion of finely divided solid fuel mixed with air. More particularly, the invention is concerned with a novel process for burning raw materials by combustion of a fuel-air mixture, in the practice of which the ash and slag produced are kept from contaminating the raw material being burned. The invention also comprehends an apparatus by which the new method may be conveniently and advantageously carried on.

In the production of cement, for example, Portland cement, by the burning of cement raw materials in a rotary kiln, it is the usual practice to burn the kiln charge by supplying a mixture of finely divided solid fuel and air by means of a burner directed into the discharge end of the kiln. The flame extends up the kiln, and, in the combustion of the fuel, the ash and slag produced are deposited upon the kiln charge and incorporated therein. In some cases, the addition of the ash and slag to the material being burned would be useful, if the distribution were uniform, but this cannot be accomplished with an ordinary burner installation. Also, when white cement is being made, the ash and slag should be kept out of the kiln because of the resulting discoloration of the cement.

The present invention is directed to the provision of a novel process for burning raw materials in a rotary kiln or like apparatus, which is not subject to the objections above set forth. In the practice of the new process, the mixture of finely divided solid fuel and air is projected into an auxiliary combustion chamber and ignited therein and the burning fuel-air mixture travels in a whirling stream through the chamber. The movement of the stream through the chamber is prolonged, until the solid particles of fuel are consumed and converted into ash and slag, which are thrown out of the stream centrifugally. The volatile material and combustible gases produced by the partial combustion of the fuel-air mixture in the auxiliary chamber then pass into the kiln, where the combustion is completed. As the ash and slag are substantially completely discharged from the burning stream and collected in the auxiliary chamber, the contamination of the material being burned by admixture therewith of the ash and slag is avoided. Also, if the raw material product is one, which is improved by addition of the ash and slag, the addition can be made uniformly and before the raw material is fed to the kiln. As the ash and slag are not carried into the kiln with the stream from the burner, the formation of rings in the kiln is prevented.

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Another advantage of the new process is that the fuel particles need not be so finely pulverized as is necessary, when combustion takes place wholly within the kiln. The fuel may have an average particle size of from 1 to 2 mm. and the use of such fuel makes possible substantial savings in grinding costs. If desired, the finely divided fuel produced in the crushing or grinding apparatus may be carried from the apparatus to the combustion chamber in a current of air, which serves as combustion air within the chamber. Such air may be hot air withdrawn from the kiln or auxiliary equipment, such as a clinker cooler, associated with the kiln.

For a better understanding of this invention, reference will be made to the accompanying drawing, in which

Fig. 1 is a view, partly in elevation and partly in longitudinal section, of a rotary kiln installation equipped with apparatus for the practice of the new method;

Fig. 2 is a similar view of the kiln equipped with a modified form of the apparatus; and

Fig. 3 is a longitudinal sectional view showing another modified form of the apparatus.

The installation shown in Fig. 1 comprises a conventional rotary kiln 10 mounted at a slight inclination to the horizontal for rotation on the usual supports. The upper end of the kiln extends into a gas chamber 11 and the lower end of the kiln enters a casing 12. The materials to be burned are introduced into the upper end of the kiln through a pipe 13 and the exhaust gases are led from the gas chamber 11 through a duct 14. The kiln charge passes down the kiln in the usual way and the burned product is discharged into casing 12 and may then pass into a cooler 15, the cooling air flowing from the cooler into casing 12 and entering the kiln to serve as secondary air for combustion.

An auxiliary combustion chamber 16 of cylin-

drical section is mounted on a carriage 17 at the discharge end of the kiln and the chamber is provided with a burner tube 17, which extends through an opening in casing 12 and enters the lower end of the kiln substantially axially thereof. A fuel-air mixture is supplied to the auxiliary chamber through a pipe 18, which leads the mixture tangentially into the chamber, so that the mixture travels through the chamber along the helical path and has a whirling movement. The chamber is provided near the wall, from which the burner tube projects, with an outlet pipe 19 and the chamber has an inspection opening 20 in its end wall.

In the operation of the kiln installation described in accordance with the process of the invention, the fuel-air mixture is ignited as it enters the auxiliary chamber and the solid constituents of the fuel are consumed within the chamber. Because of the whirling movement of the burning stream through the chamber, the ash and slag are thrown centrifugally from the stream and collect in the bottom of the chamber, whence they can be removed through pipe 19. The volatile components of the fuel and the combustible gases produced in chamber 16 pass through the burner tube 17 into the lower end of the kiln to form the burning flame indicated at 17*a*. Since the ash and slag have been removed from the fuel in the auxiliary chamber and do not enter the kiln, contamination of the kiln charge is avoided.

The auxiliary chamber has the usual refractory lining, which may be heated preliminarily by a special fuel. Thereafter, the heat radiated from the lining is sufficient to create auto-ignition of the entering fuel-air mixture.

If the ashes and slag collected in chamber 16 may be advantageously added to the kiln charge, they may be mixed homogeneously with the raw materials being supplied to the kiln. When white cement is being made, the collection of the ashes and slag in the auxiliary chamber prevents discoloration of the product. Also, the elimination of the ash and slag in the auxiliary chamber reduces the amount of dust carried out of the kiln.

In the practice of the process, the fuel used need not be so finely pulverized as in a conventional installation. Instead, the fuel may have an average particle size of from 1 to 2 mm. In some instances, it may be convenient to provide crushing or grinding apparatus adjacent to the kiln, in which event, the ground product may be carried from the grinding apparatus by a current of air passing therethrough and passed directly to the auxiliary chamber, the transport air then serving as air for combustion.

An installation, which includes associated grinding apparatus, is illustrated in Fig. 2. In that installation, the kiln 21 is of the type provided with planetary cooling chambers 22, the inlets 23 to which are disposed upwardly from the lower end of the kiln a substantial distance. The lower end of the kiln is closed by plate 24 having an opening, through which extends the burner tube 25 of an auxiliary combustion chamber 26. Air is drawn from the lower end of the kiln through plate 24 and passes through duct 27 to grinding apparatus 28, which may be of a type including a separator operating in closed circuit with the grinding elements. The air stream, in which the sufficiently ground materials are carried from the apparatus 28, passes through a duct 29 to the suction side of a fan 30, the delivery side of which is connected by a pipe 31 to a tangential inlet opening through the wall of chamber 26. The chamber is provided with an outlet pipe 32 for removal of ash and slag.

In the operation of the installation shown in Fig. 2, the mixture of hot air and suspended fuel particles is projected tangentially into the auxiliary combustion chamber and travels through the chamber in a whirling stream. During such travel, the solid constituents of the fuel are consumed and the ash and slag thrown centrifugally from the stream are collected in the bottom of the chamber and discharged through pipe 32. The volatile content of the fuel and the combustible gases pass through the burner pipe and into the kiln. The secondary air for combustion is that, which passes through the cooling chambers 22 counter-current the discharging burned product.

In some installations of the kind shown in Fig. 2, the cooler tubes may be mounted with their outlet ends 22*a* farther up the kiln than their inlets 23. In that event, the length of the burner 25 may be reduced with a corresponding reduction in the length of the kiln between the cooler inlets 23 and the end plate 24.

In the form of apparatus shown in Fig. 3, the kiln 33 is equipped with a movable casing 34 enclosing its lower end and corresponding to the stationary casing 12. An auxiliary combustion chamber 35 is mounted in an opening in the wall of casing 34, the chamber having a burner tube 36, which extends through the casing and into the lower end of the kiln. The chamber is supplied with a fuel-air mixture through a pipe 37, which projects the mixture tangentially into the chamber, and ash and slag are withdrawn from the chamber through the outlet tube 38.

In the practice of the new method by the use of apparatus of any of the forms shown, the fuel is partially consumed in the auxiliary chamber, the combustion continuing until the solid particles have been converted into ash and slag, which is deposited in the bottom of the chamber and withdrawn. The combustible entering the kiln is consequently entirely gaseous and contamination of the kiln charge is avoided. Since the ash and slag are collected in the chamber, they are available for addition to the kiln charge, if desired.

In the foregoing, it has been pointed out that the method and apparatus of the invention may be employed to advantage in the production of cements, such as Portland and white cements, and in the burning of limestone. It will be apparent that the method and apparatus may be used to equal advantage in the burning of dolomite and the roasting of ores to avoid contamination of the burned product by the ash and slag resulting from combustion of the fuel.

I claim:

In a kiln installation, the combination of a rotary kiln, a combustion chamber adjacent the lower end of the kiln and movable toward and away from the kiln in a direction generally lengthwise thereof, the chamber having an exit opening in its end facing the end of the kiln and an inlet opening in its side wall, an outlet tube mounted on the chamber to surround the exit opening, the tube extending substantially axially of the kiln and terminating within the kiln upwardly from the plane of the lower end thereof, means for projecting a primary air-fuel mixture tangentially into the chamber through the inlet opening for consumption of the solid constituents of the fuel within the chamber, the

volatile constituents of the fuel and the burned gases passing into the kiln through the outlet tube, means for passing secondary air for combustion in heat exchange relation to hot products discharged from the kiln to preheat the air and for introducing the preheated air into the kiln around the outlet tube, and means for withdrawing ash and slag from the bottom of the chamber.

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