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O. LELLEP

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HEAT EXCHANGER AND CLINKER COOLER

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Fig. 3.

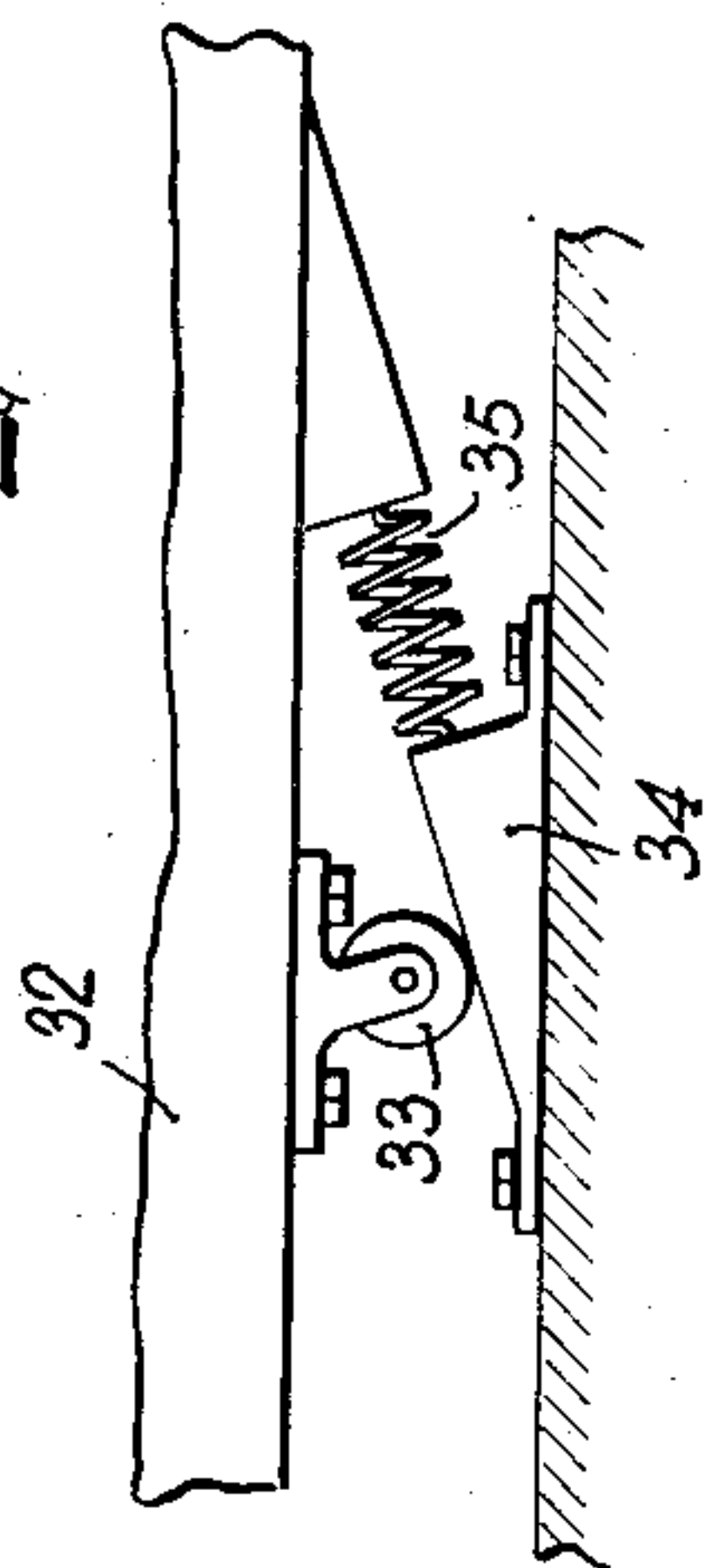
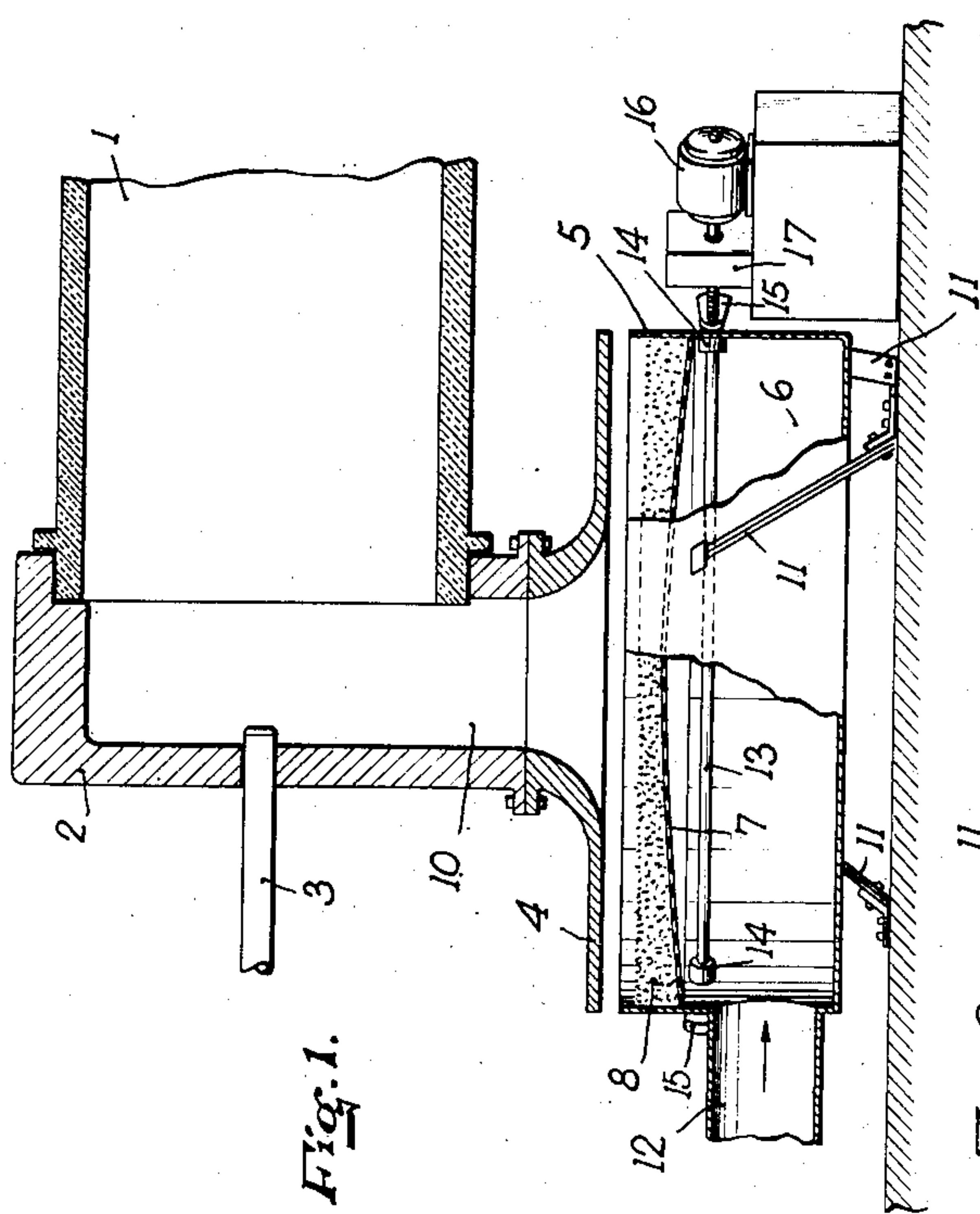


Fig. 1.

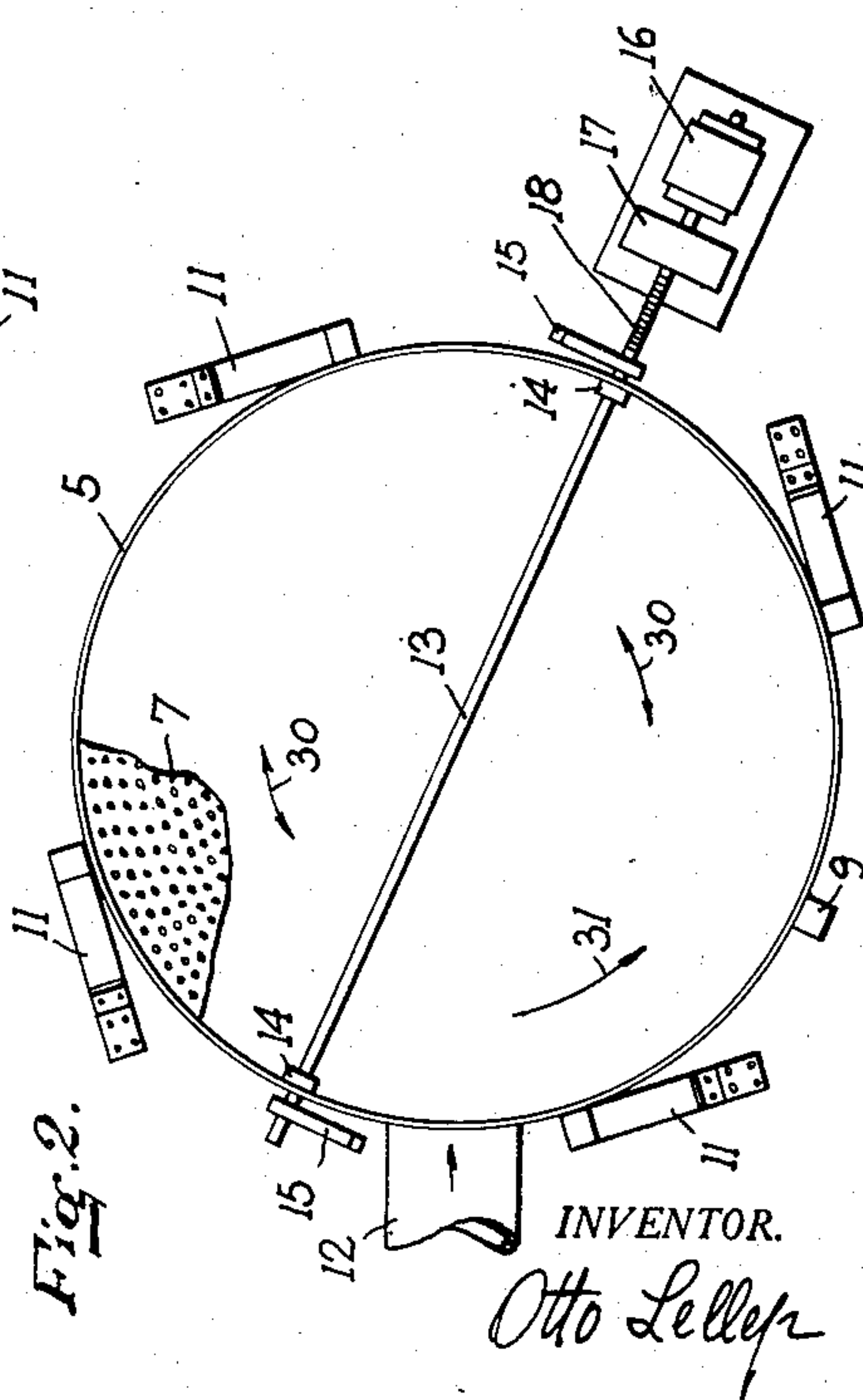


Fig. 2.

UNITED STATES PATENT OFFICE

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HEAT EXCHANGER AND CLINKER COOLER

Otto Lellep, New York, N. Y.

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5 Claims. (Cl. 34—38)

This invention consists in an improved heat exchanger between gas permeable solids and gas. Its main application is in connection with rotary kilns for burning of Portland cement, particularly for cooling clinker with air. It is of the so called air quench type in which clinker is cooled rapidly by forcing compressed air through a layer of hot clinkers.

A number of clinker coolers of the air-quench type has appeared on the market in recent years. The advantages of my invention consist in its compactness, efficiency and particularly low cost of installation in comparison with known clinker coolers.

Fig. 1 is a sectional elevation of one embodiment of the invention, Fig. 2 is a plan view of the table and its drive, most of the perforated table or grate being broken away, and Fig. 3 is an elevation of a detail showing a modified construction for effecting the up and down motion of the table.

Fig. 1 shows how the cooler is connected to the rotary kiln in cross-sectional elevation. 1 is the lower end of the rotary kiln, for instance for burning of Portland cement. 2 is the kiln hood. 3 is the burner, or pipe through which the fuel is injected into the kiln. To the lower end of the hood is suspended a funnel shaped cover 4, below which is the round table, or round pan, clinker cooler 5. The supports of the kiln and its hood are not shown on the drawing to avoid confusion. The clinker is falling on the center of the round table or pan cooler and is covering it with a layer, for instance, a few inches thick. It is kept moving to the periphery of the table by means to be described later, while the cooling air is forced from the wind box 6 through the perforated top 7 of the table or pan and through the layer of clinker 8.

The cooled clinker is discharged by suitable means from the edge of the table, for instance through an overflow spout 9 (Fig. 2). The air is coming from a fan through pipe 12 into the wind box 6 and is passing through the hot central part of the clinker layer, is heated to high temperature and is moving through the channel 10 into the kiln. Thus the heat of hot clinker is salvaged for the burning process. Usually more air is pressed through the clinker than is required for combustion of fuel. This excess air heated to a low temperature near the periphery of the pan may be utilized partly as primary air for combustion, or for other purposes. Or it may go to waste on account of its very low temperature and heat content.

The movement of clinker or hot furnace product from the center to the edge of round table may be obtained by different means and methods. For thermal and mechanical efficiency of the apparatus it is desirable that the thickness of material at equal distances from the center be equal and that the movement of material be regular. Figures 1 and 2 show one shape of the apparatus which has been found practical and efficient. It consists essentially of a double bottom pan mounted on inclined flexible legs 11. Fig. 2 shows, for instance, 4 legs (11) of the pan. On the elevation Fig. 1 only one of the legs is drawn out to avoid confusion in the drawing. The upper bottom 7 is a grate made, for instance, of perforated metal, or narrowly spaced grate bars for air passage. It is covered by a layer of clinker or material 8, to be cooled. The compressed air for cooling is entering through pipe 12. The grate may be flat or slightly cupped in the middle.

Through cupping, the hot material in the center is thinner, and the cooler material near the edges of the pan is thicker. By this means the air flow through the entire area of the pan may be equalized.

The flexible and springy inclined legs 11 are attached in such a way that the pan can have only a tangential, or annular shaking movement around its stationary center as indicated by arrows 30 on Fig. 2. A radial movement is hindered. By suitable means the pan is shaken or vibrated in the mentioned movement with a frequency which may be from a few strokes per minute up to the frequencies as employed in the alternating electrical current. The stroke of the movement on the edge of the pan may vary from 1/64 of an inch to a few inches. The higher the frequency of the shaking, or vibration, the smaller needs to be the stroke. I have discovered that shaking the pan in this way the material in it begins to rotate in a fairly regular motion around the center, as indicated by arrow 31 (Fig. 2). This peculiar movement of the material in the shaking pan is caused by the fact that during each stroke of the shaking movement each particle of the material is thrown in an inclined direction upward and tangentially forward as indicated by arrow 31. In case the pan is operated continuously, charging it centrally and discharging the material on the periphery any particle on the shaking pan is describing an almost regular spiral movement. Shaking motion keeps the

material to be cooled in motion and thus facilitates air passage at a low energy cost.

Round or spiral motion of the material is caused by the inclination of the flexible legs of the shaking table. This motion makes the layer of material uniform and submits each particle to a fairly uniform cooling time.

Support of the tangentially shaking pan is not restricted to the flexible springy legs 11. Fig. 3 shows for instance another way of reaching the same effect. 32 indicates the pan, which is supported on a number of rollers 33 along the edge of the pan. The rollers rest on inclined elements 34. Coil springs 35 of suitable strength fastened between the shaking table and the stationary support facilitate the shaking.

The shaking of the table in tangential motion may be obtained by different means or methods. For instance a rotating, horizontal shaft 13 (Fig. 2) may be attached to the pan through its center with bearings 14 in the side walls of the pan. Near the periphery of the pan two eccentric weights 15 (Fig. 2) are fastened to the shaft and are offset under 180 degrees to each other. The shaft is rotated through motor 16, speed reducer 17 and flexible coupling 18. Due to centrifugal forces of the eccentric weights the pan is shaken in an angular or tangential motion. The table could be shaken also for instance by reciprocating pushers, fastened to eccentrics on a rotating shaft, or directly by electromagnets as employed in vibrating screens.

The table may be subdivided into a disc-shaped central part and into a ring-shaped part adjacent to the central part. Both parts could be shaken separately in order to obtain a more uniform linear stroke on the entire area of the table.

The described methods of moving the material to be submitted to heat exchange on a table or pan do not preclude other methods or means in order to accomplish the same task. For instance, the flexibly supported table may be shaken in a sieving motion in a horizontal plane, so that each point of it, including the center, will describe a small circle; or it may be supported by vertical springs and shaken up and down, or any kind of combined motion between the three different shaking motions may be applied. The table or pan may be charged on the periphery and discharged centrally.

The apparatus described is not restricted to the cooling of cement clinker. It may be used for any material, for instance burned lime, dolomite, sintered flue dust of blast furnaces, calcined hot ores, chemical products, or any other gas permeable material.

The apparatus described does not serve only

for cooling the mentioned materials, but at the same time it is also a very efficient heat exchanger between the heat in the hot material and the cooling gas. This heat may be transferred with up to 90% efficiency and the hot gas may be utilized for combustion purposes, for drying the materials, or any heating purpose.

The pan or table is not restricted to the round shape, which form, however, is preferable. Oval, square, polygonal or ring shaped tables or pans could be used.

I claim:

1. The method of cooling hot granular material and obtaining heat therefrom consisting in forming a substantially circular bed of the material with portions at the same distance from the center of the same thickness, oscillating the bed to cause each particle thereof to travel in a spiral path, supplying material at one end of the path, discharging it at the other, blowing air through the bed throughout its area and utilizing the exit air heated by its passage through the bed.

2. The method according to claim 1 wherein the bed of material is formed with its upper surface flat and horizontal and its lower surface concave.

3. Apparatus for cooling hot granular solid material and obtaining heat therefrom comprising, in combination, a convex substantially circular foraminous table mounted to oscillate about a vertical axis and having an upstanding peripheral flange provided with an overflow spout, a disk like hood disposed over said table and slightly spaced from the top surface of material on the table, said disk having a central aperture through which material is fed to said table, means to oscillate said table to cause particles of material thereon to travel in a spiral path, and means to blow air through the perforations in said table and material thereon.

4. Apparatus for cooling solid granular material and obtaining heat therefrom, comprising, in combination, a substantially foraminous circular table, means to supply material to be cooled to the center of said table, means to maintain portions of said material on the table at the same distance from the center of the same thickness, means to oscillate said table to advance the particles of material on the table step by step in a spiral path from the central part of the table to its periphery, and means to blow air through the perforations in the table and the material thereon.

5. Apparatus in accordance with claim 4 with means to give the table an up and down movement during each oscillation.

OTTO LELLEP.