June 3, 1952 J. NARSTED 2,598,931

CLINKER COOLER

Filed March 14, 1950 10 Sheets-Sheet 1

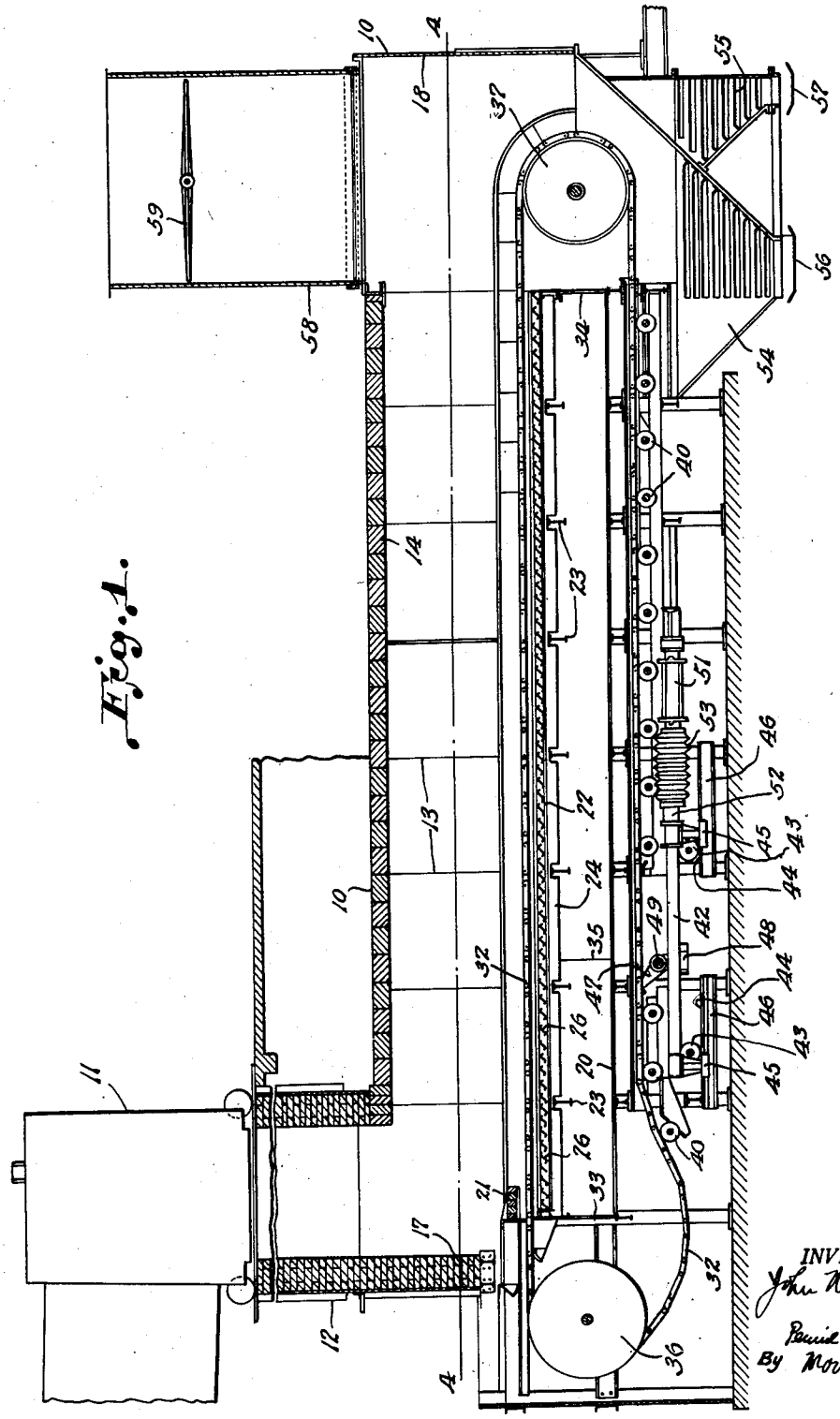


Fig. 1.

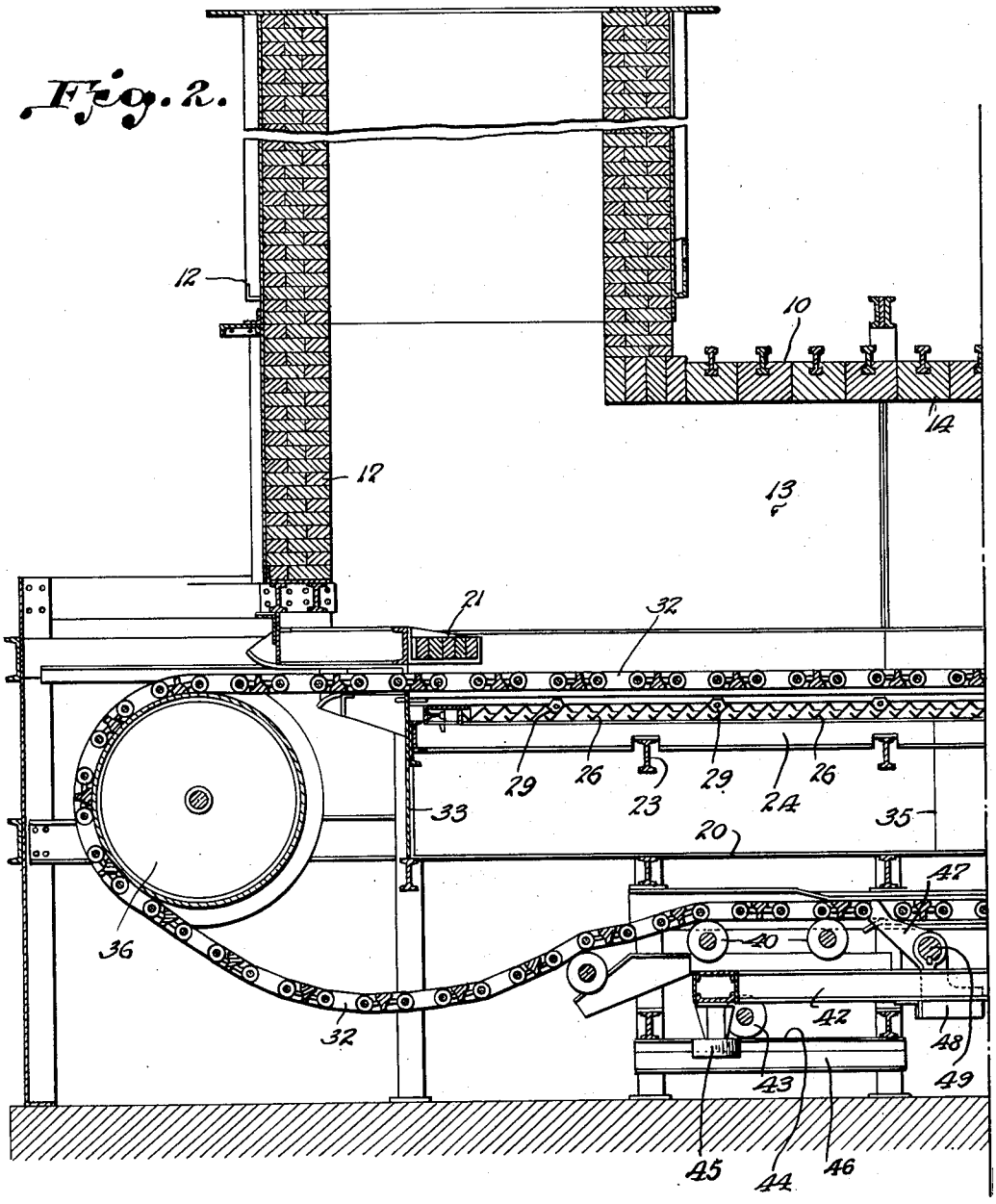
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June 3, 1952 J. NARSTED 2,598,931

CLINKER COOLER

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Fig. 2.



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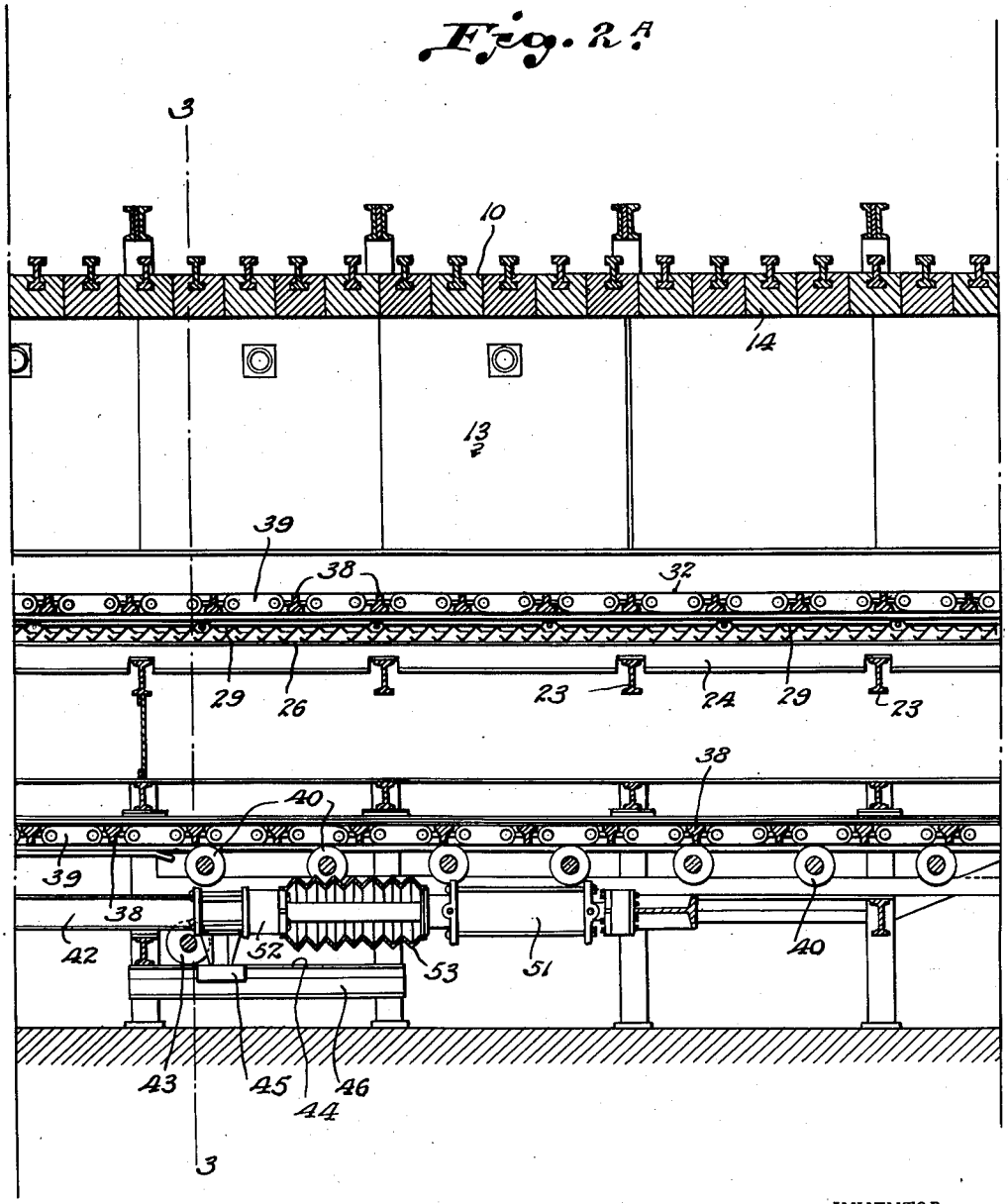
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CLINKER COOLER

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Fig. 2A



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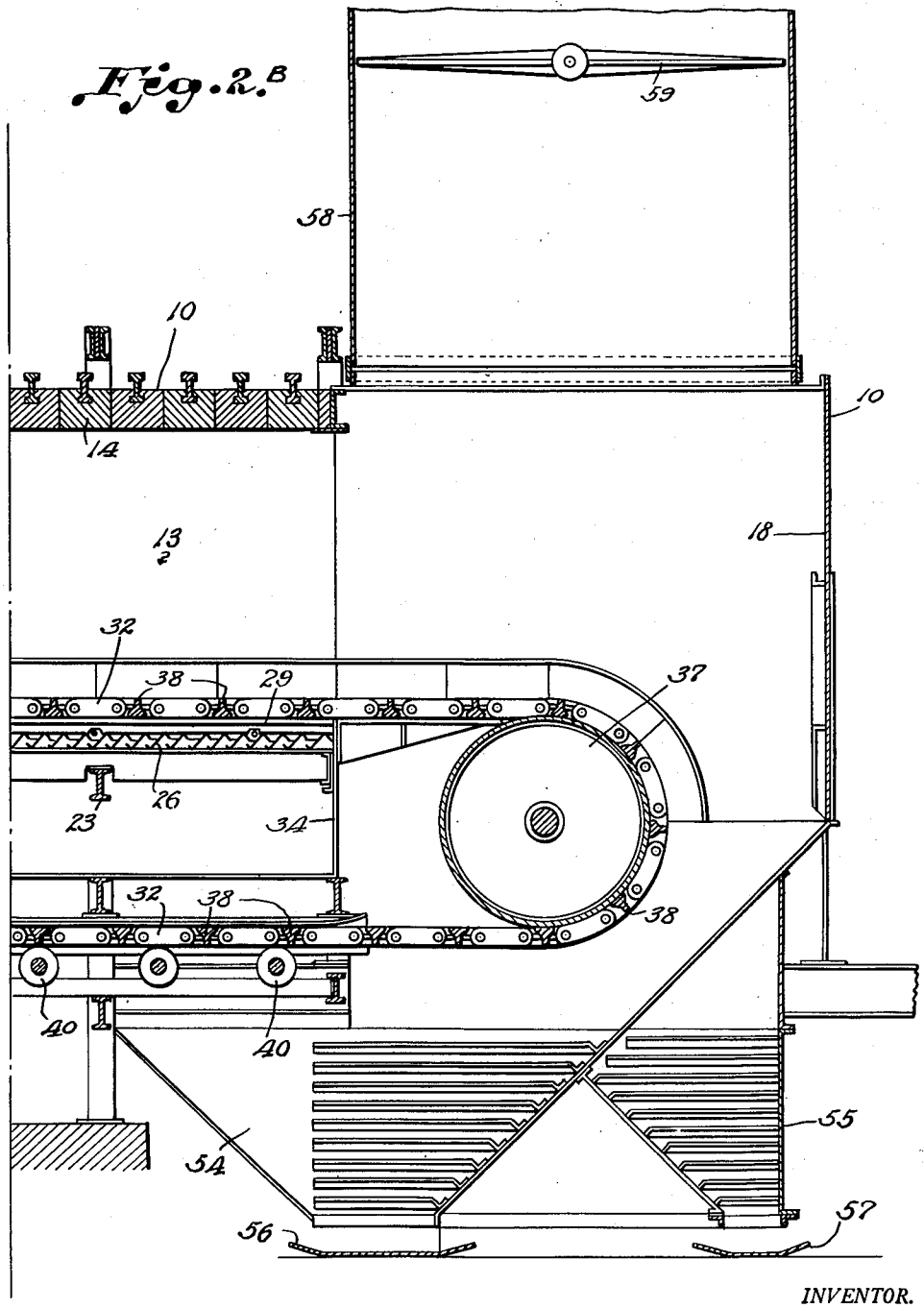
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CLINKER COOLER

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Fig. 2.B



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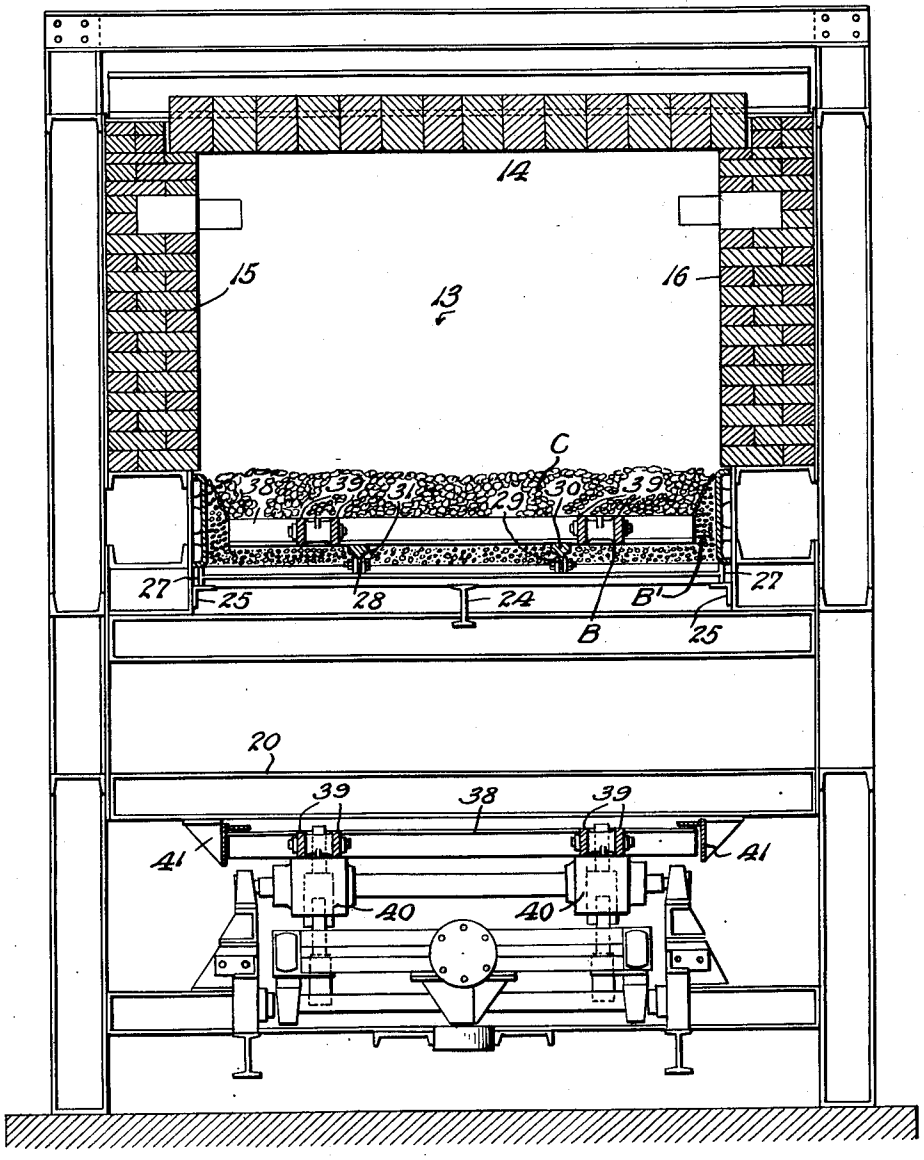
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CLINKER COOLER

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Fig. 3.



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CLINKER COOLER

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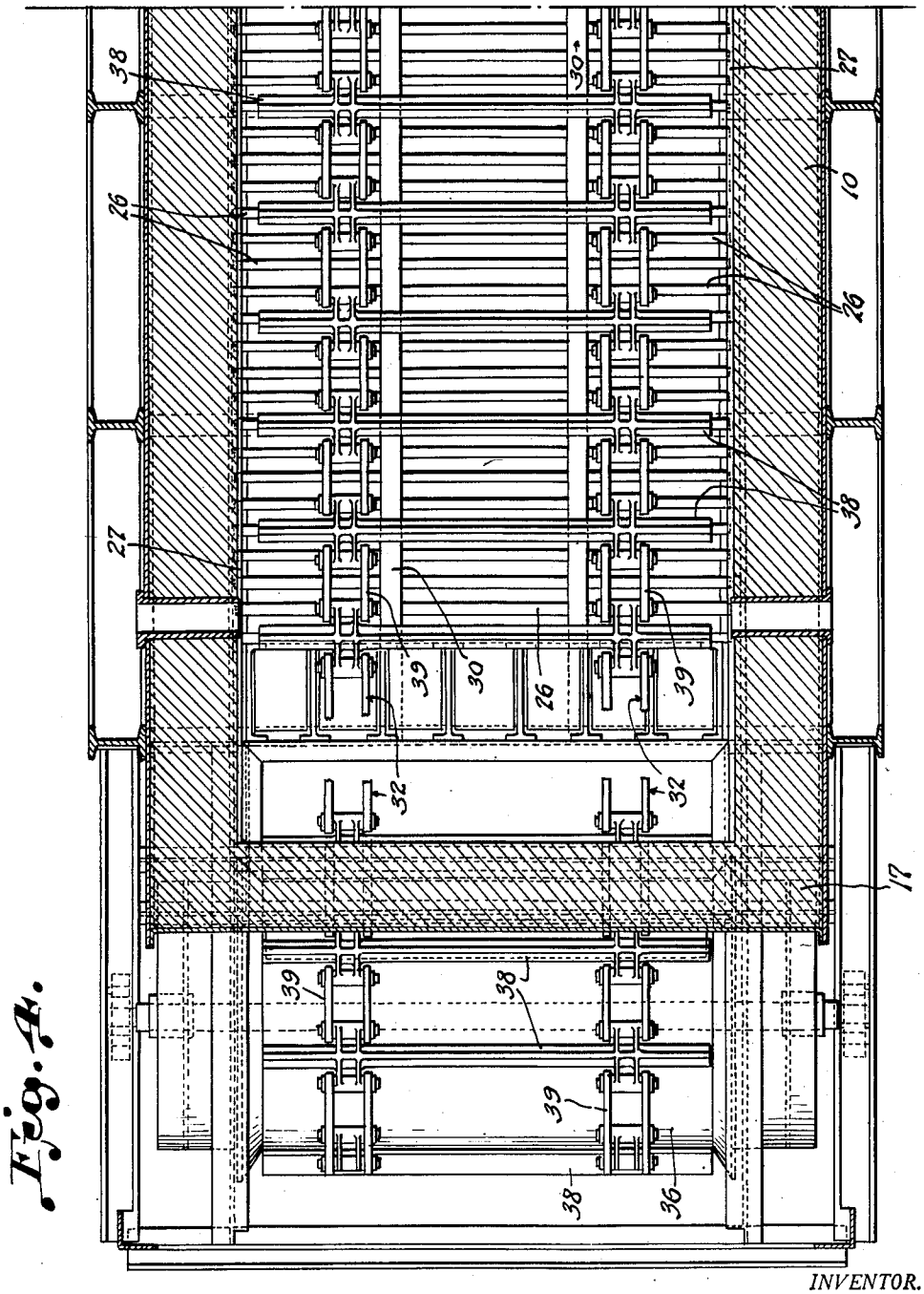


Fig. 4.

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CLINKER COOLER

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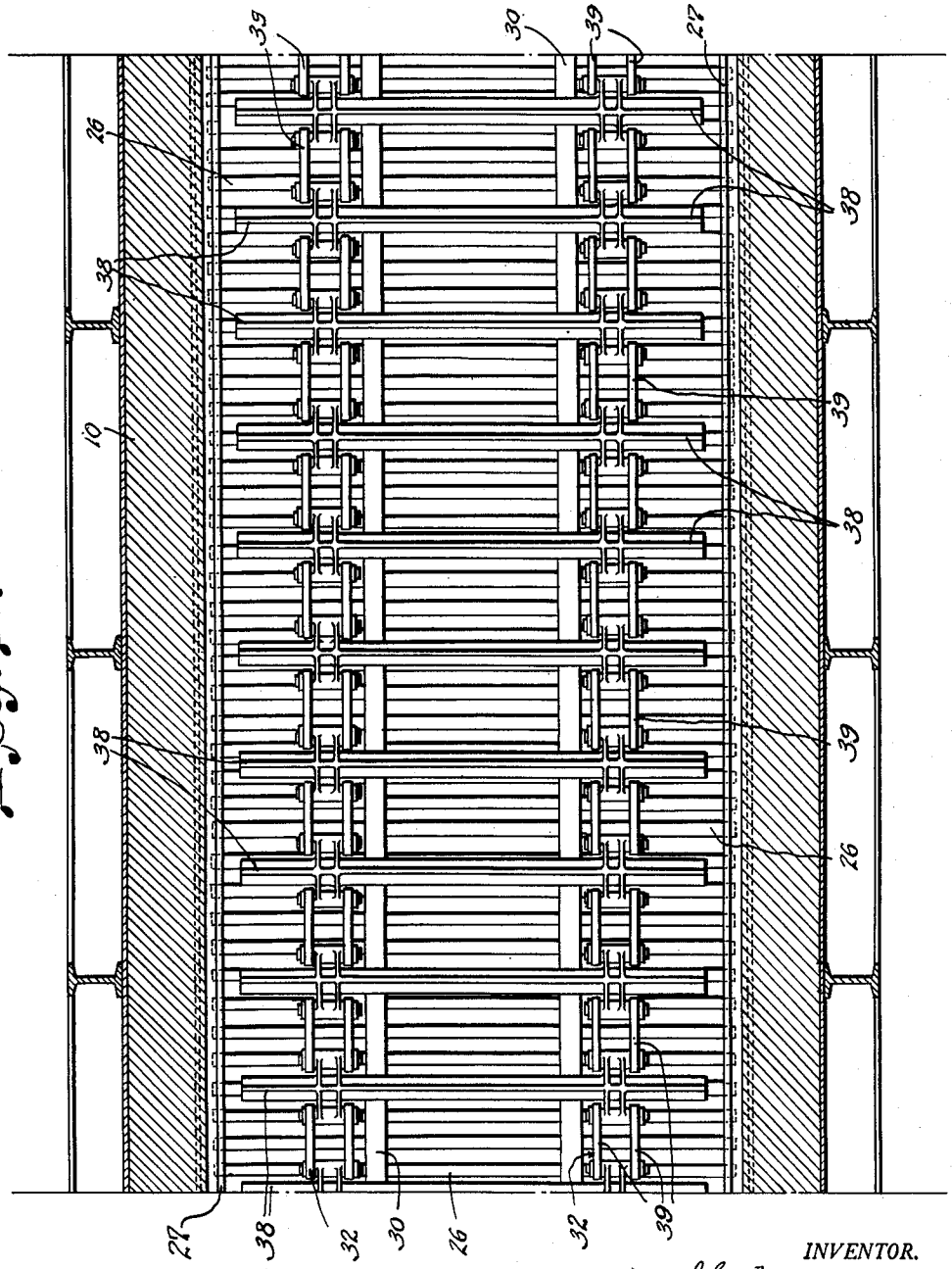


Fig. 4A

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CLINKER COOLER

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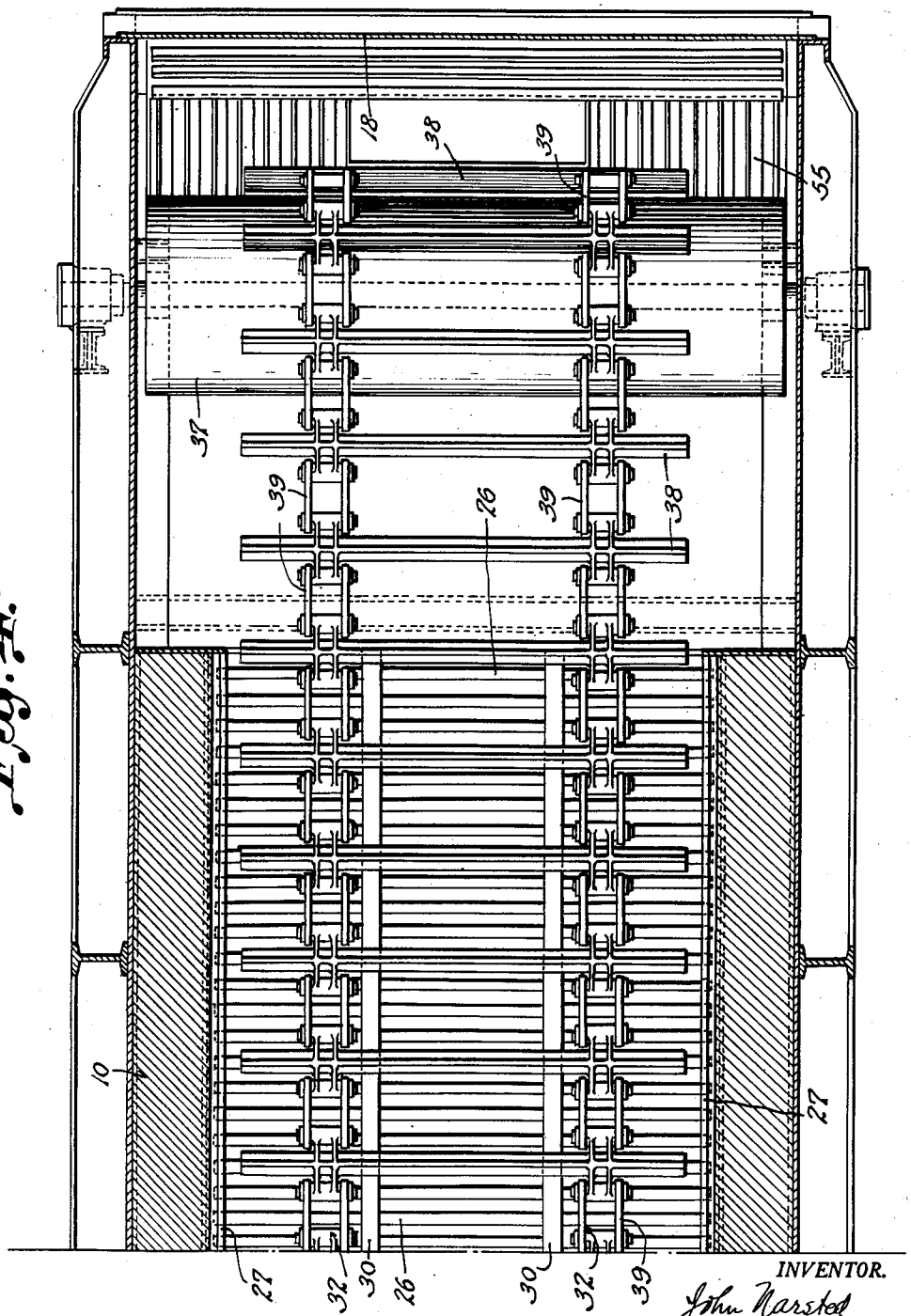


Fig. A.8

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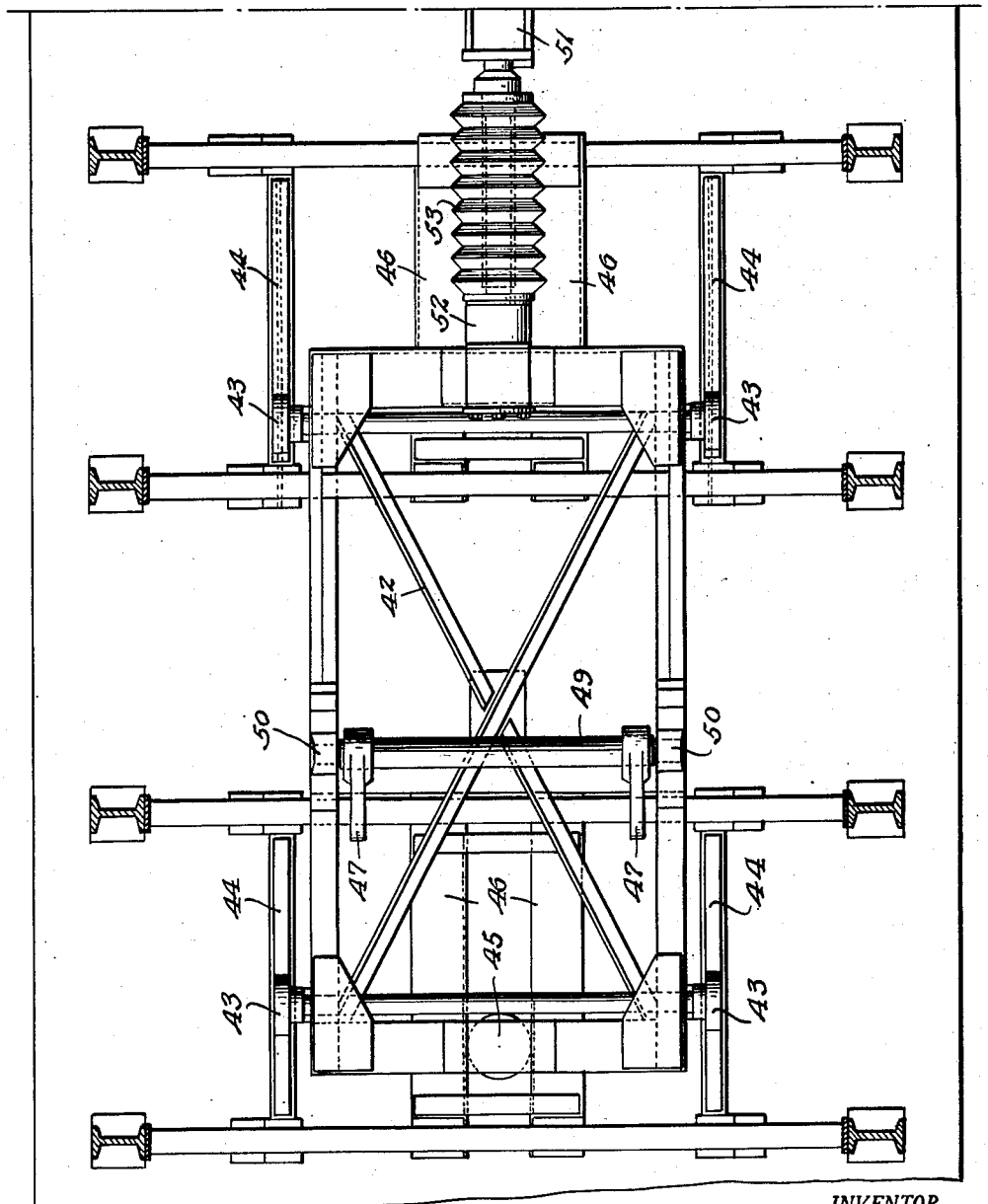


Fig. 5.

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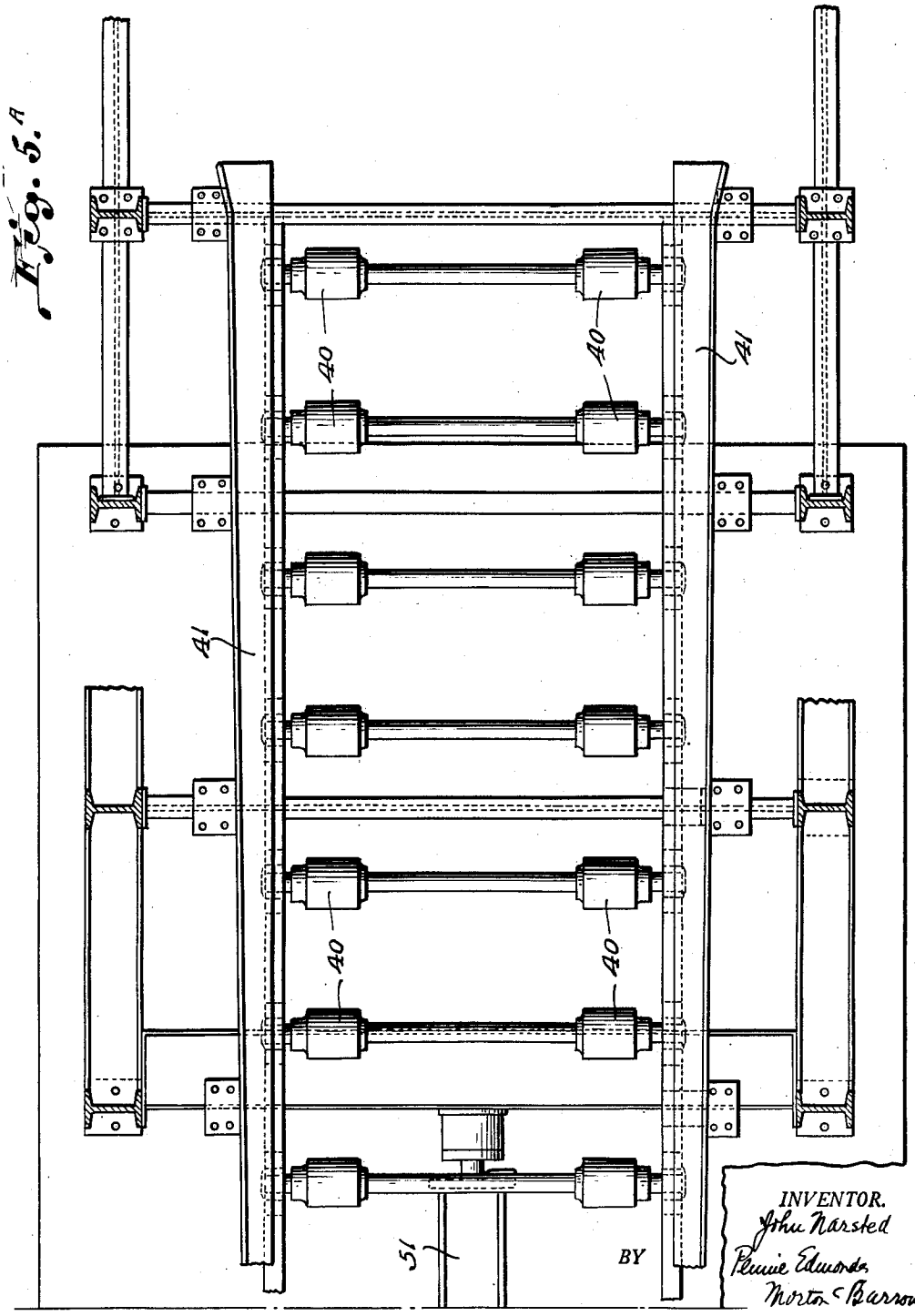
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CLINKER COOLER

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Fig. 5.A



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2,598,931

UNITED STATES PATENT OFFICE

2,598,931

CLINKER COOLER

John Narsted, Hampstead, Montreal, Quebec, Canada, assignor to Fuller Company

Application March 14, 1950, Serial No. 149,496

8 Claims. (Cl. 34—233)

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The invention relates to the cooling of refractory materials occurring in a substantial range of particle size, and more particularly to the rapid cooling of materials continuously formed into a moving bed, through which air, or other gas, is forced or drawn to extract heat therefrom. It has especially to do with the cooling of materials such as ores, lime, Portland cement clinker, or the like, when continuously discharged from furnaces, such as rotary kilns, for the rapid reduction of the temperature of the material, the recuperation of sensible heat, or both, or to complete the cooling of such materials discharged from a recuperator.

Heretofore, various methods of cooling material of this nature have been employed, such as the rotary shell type of cooler. There are a number of variations of this type of cooler, but the basic principle of the operation is the same, that is, passing cooling air through the interior of the cooling shell while the shell rotates, causing a cascading of material down the sides of the shell to contact the cooling air in one manner or another. There are a number of disadvantages to this type of cooler from an operational and a maintenance standpoint. The amount of air necessary to cool the material is great because of the poor contact of the cooling air with the material. Regardless of the type of rotary cooler used the area of material presented to the cooling air is small as compared to the total mass of the material. There is a relatively small amount of breaking up of the mass of material to present a greater area to the cooling air in the rotation of the shell, compared to the large amount of agitation and sliding of the material within, and on the liner of, the shell. Because of their relatively slow initial cooling rate, in the temperature range above 2200 degrees F., and their lower heat recuperation capacity, as compared with modern "air-quenching" coolers, the rotary coolers have now become practically obsolete, at least for the cooling of Portland cement clinker.

In the event that cement clinker, or other materials of similar abrasive characteristics, is the material being cooled a serious maintenance problem is presented. The abrasive qualities of the cement clinker are high and a great amount of wear will take place when the clinker moves over metal parts to any great extent. Such movement of clinker over the metal liner of a shell is present in a rotary cooler and therefore the wear, and replacement, of the parts of

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the cooler in contact with the clinker is a serious maintenance problem.

Another method of cooling is by passing air, or other gas, through the material formed as a continuously moving bed through a cooler housing. This continuously moving bed is supported by some form of grate through which the cooling air can pass up through the material.

One type of such cooling operates on the principle of a shaker conveyor. The shaker platform forms a support for the material bed, and provides the means for conveying the material through the cooler. Means are provided to impart a rapid shaking motion to the platform supporting the bed of material, with this shaking motion producing the movement of the bed of material toward the discharge end of the cooler. It is obvious that when material of an abrasive characteristic is cooled in this manner an excessive amount of wear of the supporting platform will be produced by the shaking motion.

Still another method of cooling employs a cooler consisting of a horizontal metal supporting grate over which the material is drawn by an endless continuously operating drag chain, and cooling air is passed up through the material bed from below the metal grates. The drag chain is in direct contact with the grate, and therefore the material being pulled by the drag chain is in direct sliding contact with the grate. Here again, if the material being cooled is of an abrasive characteristic, an excessive amount of wear will take place in the grate structure and the drag chain. A further disadvantage of the use of a continuously operating drag chain sliding across the supporting surface is that it tends to produce, due to its grinding action, an undesirable amount of fines. A still further disadvantage of the use of a continuously operating drag chain is the difficulty of maintaining an evenly distributed material bed. A kiln discharge is irregular, thus providing varying amounts for the drag chain to pick up. The drag chain operated at a constant rate of speed, so that as the drag chain pulls the material away from the opening into the cooler, there will be variations in thickness of the bed depending upon the rate of discharge of the kiln at any given element of time. This uneven thickness in the material bed creates an unsatisfactory cooling condition, since the cooling air will follow the path of least resistance, which will be through the thinner

areas of the material bed, and leave the thicker areas without the proper amount of cooling.

In the above mentioned material bed type of coolers, the particles of material are subjected to continuous agitation in their conveying movement. It has been found that this constant agitation causes the bed of material to become graded with the smaller particles at the bottom and the larger particles at the top. The process of grading of the various sized material begins immediately upon the movement of the material bed through the cooler. The cooling air is passed upwardly through the bed of material during its travel through the cooler, and due to the gradation of the bed, the smaller particles are the first to be contacted by the cooler air, and as the surface area of these small particles is large in comparison to the quantity of heat which they contain, they soon become cooled to the desired temperature. However, the particles of larger size have less surface area per unit volume and quantity of heat contained, and are located on top of the material bed at the point furthest from the cooler air. The result of this condition is that the discharge from the cooler will contain a large amount of material, in the large particle range, that has not been properly cooled.

The normal operation of the drag chain will in itself produce a disadvantage in this type of cooler. Most of the drag chains are of the link chain and sprocket wheel type and therefore the pitch of the links must remain constant in order to pass over the sprocket wheel teeth. The drag chain usually consists of two or more link chains connected together by a drag bar. Since the chains must run in unison with relation to each other, any variation in the chain links will produce a locking or binding of the drag chain. The variations in length may be produced by the links of chain expanding as they pass through the hottest zone of the cooler, thereby changing the pitch of the link chain, or, one of the chains riding over a large particle of material will produce a relatively uneven length between the two chains and cause a binding on the sprocket wheel.

Another feature of the type of cooler that forces air through the bed of material as it is being conveyed through the cooler, that is a disadvantage is that, as the material passes over the openings in the bed structure provided for the admission of air, particles of material fall through these openings and some means must be provided to remove these particles from the wind box, which usually entails taking the cooler out of service.

Air-quenching, inclined grate coolers, overcome many of the disadvantages described above; but this type requires substantial headroom in a space or basement below the kiln room or burner floor. This requirement makes their installation difficult in some existing plants where headroom is not available, and for new plants where ground water or rock make deep basements expensive.

Excepting for the rotary types, in most of the coolers of the prior art, fine clinker particles sift into the air or plenum chamber below the clinker bed. Since all cement clinkers contain a proportion of fines, and in some, the proportion represents a substantial part of the total clinker produced, the removal of fines from the plenum chamber presents mechanical and operating difficulties.

The invention will be described in its application to the cooling of Portland cement clinker, as discharged from rotary kilns, since it is especially appropriate for satisfying the peculiar cooling requirements of this material. This clinker is preferably discharged from the kiln at a temperature of at least 2500 degrees F.; and the objective is to cool it abruptly, within the temperature range 2350 degrees to 2200 degrees F., and within two to three minutes, to convert a maximum of the liquid phase compounds to undercooled liquid, or "glass," rather than to permit crystallization to take place, for reasons now understood in the art of cement manufacture. Rapid cooling should continue until the temperature is reduced to about 150 degrees F., at the cooler discharge, to facilitate grinding. The low commercial price of cement, and the large quantity of sensible heat available in the clinker, as discharged from the kiln, make recuperation of a maximum of the heat essential; and this is preferably accomplished by utilizing the kiln combustion air, or at least the quantity required as secondary combustion air, as part of the clinker cooler air and passing it through the hottest zone of the cooler, whereby a maximum heat transfer can be effected, and the combustion air may be delivered to the kiln at the highest possible temperature. The extreme temperature of the incoming clinker, and its highly abrasive nature makes maintenance of metal surfaces, which it may contact, both difficult and expensive.

It is, accordingly, among the purposes of this invention to satisfy these requirements by providing a substantially permanent layer of clinker, to form the principal wearing surface, over which the clinker to be cooled is conveyed, in the process of cooling. It is also a purpose to limit the surface of the conveyor metallic parts, exposed to heat and abrasive contact with the clinker to the minimum required to convey it; and to provide for easy replacement of these parts, after they pass the discharge end of the cooler, where their low temperature permits handling. It is a further purpose to so form and support this substantially permanent layer of clinker particles that voids between them form a multiplicity of passageways, through which cooling air is diffused, uniformly and continuously, in intimate contact with the individual particles of the moving bed of hot material, and throughout the bed, to provide for thorough and rapid cooling and maximum recovery of sensible heat. The supporting structure for the permanent layer is designed so that the fine particles of clinker cannot sift through the voids and support to accumulate in the plenum chamber. It is also an objective to provide a cooler requiring relatively little headroom, whereby it may be installed as a replacement for rotary coolers, without requiring substantial changes in existing buildings and their foundations.

In general, the apparatus comprises a generally horizontally disposed elongated chamber, having an inlet opening into the upper part, at one end, to receive hot clinker, and a discharge end opening at the other, from which the cooled material can discharge, preferably by gravity. The chamber is divided in a generally horizontal plane by a fixed supporting structure, to form an upper cooling chamber and a lower plenum chamber.

The supporting structure preferably comprises spaced bars, extending transversely of the chamber, for example Z bars, which may be inclined from the vertical, to avoid formation of free passageways through which fine particles may sift and gravitate to the plenum chamber,

without, however, obstructing the free upward passage of cooling air. Two longitudinal rails, disposed inwardly from the walls of the cooling chamber, and spaced above the supporting bars, to provide space for the permanent layer of clinker particles above the supporting structure, support an endless conveyor, which distributes the incoming clinker to form a relatively uniformly flat bed and conveys it along the upper surface of the permanent layer of clinker to the cooler discharge.

This conveyor comprises parallel chains connecting spaced drag bars riding upon the rails, the conveyor being caried over idler drums, preferably beyond each end of the cooling chamber, with the return strand carried below the plenum chamber on suitable idler rolls. The conveyor may be driven continuously, or by intermittent motion, which may conveniently be imparted by a reciprocating fluid motor, having an element engaging the lower strand of the chain and drag bar assembly.

Air is supplied to the plenum chamber, preferably under positive pressure, the pressure required being sufficient to overcome the resistance of both the permanent layer of clinker and the moving bed. The draft of the kiln draws that quantity of the cooling air required to satisfy the combustion requirements, from the hottest zone of the cooling chamber, and this air preheated to the highest possible temperature, promotes rapid flame development within the kiln, permitting clinker "burning" near the discharge end, whereby the clinker will enter the cooler well above the temperature range of crystallization, and the effective volume of the kiln is increased. The amount of air necessary to reduce the temperature of the material to a desired extent for subsequent grinding is greater than that needed for secondary combustion air, and the excess can be vented to atmosphere through a stack controlled by a conventional damper.

For a better understanding of the invention, reference is made to the accompanying drawings, in which

Fig. 1 is an elevation, partly in section, of the apparatus and furnace,

Figs. 2, 2A and 2B are an enlarged sectional elevation of the apparatus,

Fig. 3 is a cross sectional elevation on line 3—3 of Fig. 2A, and showing a permanent layer or bed of clinker on the grate bars, as well as the cement clinker which is being subjected to cooling,

Figs. 4, 4A and 4B are an enlarged cross sectional plan view on line 4—4 of Fig. 1,

Figs. 5 and 5A are an enlarged plan view of the lower drag chain support and actuating carriage.

In the preferred construction, the material cooler 10 is positioned below a rotary kiln 11, and attached by a material passage, or throat 12, in such a manner as to allow the material being cooled to flow from the kiln into the interior of the cooler. The interior of the cooler, the cooling chamber 13, is defined by a top wall 14, two side walls 15 and 16, two end walls 17 and 18, and a bottom wall 20. Positioned below the throat 12, and extending into the cooling chamber 13, is a shelf 21 used as a means of preventing abrasive wear to the cooler elements beneath the throat 12, caused by the striking force of the falling cement clinker as it enters the cooling chamber. After the clinker particles have accumulated upon the shelf 21, and have formed a natural angle of repose, the descending clinker particles are distributed by the pile thus formed and pass on into the cooling chamber 13 without having come in contact with any of the cooler surfaces.

Located below the shelf 21, and extending the length of the cooling chamber, is a grate structure 22 used as a means of supporting the cement clinker bed formed in the cooler during the cooling operation. The grate structure is formed by lateral supporting members 23 positioned along the length of the cooler and extending from one cooler side wall to the other. Extending longitudinally through the center of the cooler is another supporting member 24 positioned above and supported by the lateral members 23. Two supporting flanges 25 are also provided on each side of the cooler wall at the same height as the top of the longitudinal member 24. Extending across the cooler from wall to wall, resting on the two flanges 25 and the longitudinal member 24, are a series of spaced grate bars, 26 of generally Z-shape, positioned at regular intervals for the complete length of the cooling chamber. These bars are held in a spaced relation by an end plate 27, to which each bar is welded, thereby forming a rigid grate structure. This grate structure is of such design that it affords a path for the air to pass up through the openings formed by these bars while at the same time preventing the cement clinker above the grates from falling down through the openings.

Located in a position inwardly from each cooler wall are two series of connection flanges 28 and 29. These flanges are welded along a longitudinal line to adjacent bars 26 at regularly spaced intervals along the length of the cooler. Attached to these flanges, and therefore running along the same longitudinal lines, are two rails 30 and 31, used as a riding support for a drag chain 32, to be described later.

An air chamber, located below the grate structure 22, is defined by two end walls 33 and 34 and the bottom wall 20 of the cooling chamber. Air under pressure, for the purpose of cooling the clinker, is brought into the air chamber at any convenient location from the discharge of a blower, not shown, and is discharged from the air chamber up through the openings, formed by adjacent grate bars 26, into the bed of hot clinker in the cooling chamber 13. The cooling chamber is divided into at least two compartments by a dividing wall 35. The clinker C as it first falls to the grate structure 22 is formed in piles, and is then spread out to a level bed B by the motion of the drag chain 32. Until this clinker is leveled off, the pile is thicker than the normal bed thickness in the balance of the cooler. This difference in the bed thickness will cause a greater resistance to the flow of air through the thicker bed, resulting in an uneven distribution of air, with the forward end of the cooling chamber receiving an insufficient amount of cooling air. To overcome this, the air chamber is divided into at least two compartments, one along each section of the clinker bed of different levels of clinker. The air pressure is so regulated in each of the compartments that an even flow of air is provided throughout the entire bed of clinker in the cooling chamber.

The conveying structure comprises an endless drag chain 32 supported at each end of the cooler by two freely rotating drums 36 and 37. The drag chain is made up of a series of drag bars 38, connected one to the other by links 39. The chain is supported by the two longitudinal rails

30 and 31 while traveling in the cooling chamber, and by a series of rollers 40 while traveling in the lower portion of the cooler. The chain is also adapted to travel in channels 41 which guides the chain while it is traveling in the lower portion of the cooler riding on the rollers 40. The drum 36 on the intake end of the cooler is provided with flanges through which the chain is held in the proper traveling position as it enters the cooling chamber 13 of the cooler.

The drag bars 38 normally tend to float in the clinker C and as they are free to lift, no crushing or grinding action takes place between the metal parts in the event a clinker particle passes between a drag bar 38 and the rails 30 and 31. As the grate is designed with a very liberal area, the drag bars are only required to move the clinker forward over the grate at a very slow rate of speed, thereby reducing the wear and resulting in a great increase in the life of the moving parts of the cooler.

The advantage of using the free rotating drums 36 and 37 at each end of the cooler for the chain to pass over is that the difficulties encountered with a power sprocket chain wheel, such as fouling and jumping of sprocket teeth, are eliminated. A further advantage of the drums over the sprocket chain wheels is that the pitch of the sprocket chain would vary while under the influence of the heat of the hot clinker and fail to properly engage the teeth of the sprocket chain wheel. Since the drag bar does not ride in any rigid position, any expansion due to heat does not affect the operation of the chain.

The drag chain 32 is moved over the stationary grate by the action of a reciprocating carriage 42, operating on the lower run of the chain. The carriage is located beneath the drag chain, and is provided with wheels 43 rolling on flanges 44. The carriage is kept in proper alignment by two center guide wheels 45, located at each end of the carriage, fitted between two guide flanges 46. The two center guide wheels 45 are free to rotate between the guide flanges 46 and maintain proper alignment of the carriage wheels 43 on the flanges 44. A drag chain engaging member is provided on top of the carriage and comprises two pawls 47, provided with counterweights 48, keyed to a shaft 49, mounted in bearings 50. The counterweights 48 are provided for the purpose of rotating the shaft 49 in such a direction as to always keep the pawls 47 engaged with the links of the drag chain.

The carriage is actuated by a variable speed reciprocating fluid motor 51, attached to the carriage by means of a shaft 52, and provided with a bellows protection 53 to prevent foreign matter from entering the motor.

As the motor 51 imparts a reciprocating motion to the carriage 42, the pawls 47 will engage corresponding links 39 of the drag chain and move the chain forward. When the motor reaches the end of its stroke, it will begin its return stroke bringing the carriage with it. Due to the design curvature of the pawls, they will not engage the link pins in the return stroke, but will slip over the pins and fall behind them in a position for the next power stroke. The length of the stroke of the motor is greater than the pitch of the chain links so as to assure that the pawls will always retract a sufficient distance to engage the next link pin for the power stroke. This is important when it is considered that the chain link will vary in pitch due to the expansion from the heat of the clinker, or the position of the chain may vary if the chain should be riding over a piece of large clinker in the cooling chamber.

Two discharging hoppers 54 and 55 are provided at the discharge end of the cooling chamber. Beneath the two hoppers are two conveyors 56 and 57 used as a means of transporting the cooled cement clinker away from the cooler for further processing.

As can be seen in Fig. 3, there is a space defined by the bottom of the drag chain 38, the top of the grate bars 26 and the two cooler walls 15 and 16, in which there can be placed a clinker layer B' that will not be affected by the movement of the drag chain 32. This space extends the length of the cooling chamber and is the same depth as the height of the two rails 30 and 31 that are the support for the drag chain as it moves through the cooling chamber. In the preferred method, this clinker layer, or the permanent clinker layer as it will be called, is prepared before the cooler is placed in operation, but may be formed by the normal operation of the cooler. The particles of this permanent clinker layer are sized according to the normal size of the clinker discharged from the kiln and are placed in a layer over the entire surface area of the grate bars. With the permanent clinker distributed over the top surface of the grate bars, the cooling air that passes up through the openings in the grate from the air chamber is diffused as it passes through the permanent clinker layer, thereby preventing any jet action or spots of lower resistance for the cooling air flowing into the cooling chamber of the cooler. This arrangement will insure an even air distribution into the cooling chamber.

The advantage of this type of arrangement is that as the hot clinker is moved through the cooling chamber by the action of the drag chain, the hot clinker will move over the permanent clinker layer instead of the grate bars, thereby eliminating the wear, caused by the abrasive characteristics of cement clinker, found in the coolers of the prior art where the moving clinker is in direct contact with its supporting structure. In the present invention, the wear is clinker on clinker instead of clinker on elements of the cooler. It will also be noted that the ends of the drag bar 38 do not extend to the walls 15 and 16, therefore there is a deposit of permanent clinker formed in this space that will absorb the wear instead of wear being on the walls of the cooler. A further advantage of this permanent clinker layer is that the hot clinker to be cooled does not come into direct contact with the metal grate bars, thereby eliminating the cost of expensive heat resistant metal for these bars since, as they are protected from the heat of the hot clinker and by radiant heat from the discharge end of the kiln by the permanent clinker layer, they can be made from ordinary steel without any special treatment.

The operation of the apparatus will be generally apparent from the foregoing. The hot clinker falls from the kiln 11 to the shelf 21, through the throat 12 of the cooler. After the clinker particles have accumulated on the shelf 21, and have formed a natural angle of repose, the descending clinker particles are distributed by the pile thus formed and fall to the grate structure 22. As these particles of clinker form into a pile, they are moved further into the cooling chamber 13 by the action of the drag chain 32. The movement of the drag chain will

form the particles of clinker into an evenly distributed bed as they are moved through the cooler. Cooling air from the air chamber passes up through the grate openings, through the permanent clinker layer, into the moving bed of hot clinker. In passing through the particles of clinker in the permanent clinker layer, the air is diffused and reaches the hot clinker in an even blanket of air. The cooling air as it passes through the hot bed of clinker picks up the heat, thereby cooling the hot clinker, and flows into the throat of the cooler where it further contacts the hot clinker that is falling through the throat from the kiln. When this air contacts the falling clinker, the temperature of the clinker is reduced at a very rapid rate, or air quenched, thereby greatly increasing the quality of the cement. The cooling air then passes on into the combustion chamber of the kiln where it is utilized as secondary combustion air.

The moving clinker bed passes on through the cooling chamber where it is progressively cooled until it reaches the end of the grate structure. Here the drag chain pulls the clinker from the grate structure into the hopper **54**. The conveyor **56** takes the cooled clinker discharge from the hopper and transports it to another point in the plant where it is further processed. Any clinker particles that remain on the drag chain are discharged into the hopper **55** as the drag chain passes over the drum **37**, and are carried away by the conveyor **57**.

As previously stated, the cooling air is used as secondary combustion air in the kiln, but under normal operation, the kiln does not require the total amount of air used for cooling. A vent stack **58** is provided to exhaust the excess air, and a damper **59** is provided to regulate the draft pressure within the cooler.

It will be understood that a relative flat clinker bed forms on the grate surface, and is moved toward the discharge end of the cooling chamber at a regular intermittent rate. The thickness of the bed and the rate of travel are controlled by the rate of reciprocation of the fluid motor. The individual clinker particles are subjected to a continuous agitating and rolling movement as they are conveyed through the cooling chamber. Since the discharge from the kiln is not a constant flow of material, but an intermittent flow with different quantities of clinker falling, the operation of the drag chain is regulated to a speed that will allow an average deposit of clinker pile to form before it is moved through the cooling chamber. As the deposited pile of clinker is moved, it is levelled off by the agitation produced by the drag chain. This agitation is created by the forward motion of the drag bar on the static pile of material, that is, as the bottom of the pile moves with the drag bar, the top of the pile is rotated in a reverse direction to be moved forward by the next drag bar. This agitation is produced throughout the cooling chamber, but is not of sufficient magnitude to cause the sifting or grading, of the smaller particles of clinker to the bottom of the moving bed, thereby causing an uneven distribution of the clinker particles throughout the moving clinker bed.

I claim:

1. Apparatus for cooling material comprising an elongated cooling chamber having means for introducing material into one end thereof and for discharging material at the other end thereof, gas-pervious supporting means extending lengthwise of the cooling chamber and constructed and arranged to maintain a fixed layer of discrete particles of material thereon, guide rails extending lengthwise of the cooling chamber and having their guide surfaces spaced vertically above the supporting means, conveying means including chains and transversely-extending spaced drag bars for conveying material to be cooled through the cooling chamber, said conveying means riding on the guide rails and being vertically spaced above the supporting means a distance sufficient to permit a layer of discrete particles of material to be maintained on the supporting means and below the path of travel of the conveying means, whereby material being conveyed by the conveying means will be dragged along the upper surface of a fixed layer of material, and means for introducing air under pressure below the supporting means to pass upwardly therethrough and through the fixed layer of material and the material being dragged along the upper surface thereof.

2. Apparatus for cooling material as defined in claim 1 in which the ends of the drag bars are spaced from each side of the cooling chamber to provide spaces between the sides of the cooling chamber and the ends of the drag bars, during the passage of the drag bars along the guide rails, for fixed bodies of discrete particles of material.

3. Apparatus for cooling material as defined in claim 1 in which an intermittent motion is imparted to the conveying means.

4. Apparatus for cooling material as defined in claim 1 in which the conveying means is endless and the lower flight thereof passes beneath the cooling chamber, and means are provided for engaging the lower flight to impart an intermittent motion to the conveying means.

5. Apparatus for cooling material as defined in claim 1 in which the supporting means comprises spaced grate bars which are of generally Z-shape and are so positioned that they afford a path for the passage of air between them while substantially preventing overlying particles of material from falling through the spaces between them.

6. Apparatus for cooling material comprising an elongated cooling chamber having means for introducing material into one end thereof and for discharging material at the other end thereof, gas-pervious supporting means extending lengthwise of the cooling chamber, guide rails mounted on said supporting means and extending lengthwise of the cooling chamber, said guide rails having their guide surfaces spaced vertically above the supporting means, a fixed layer of discrete particles of material on the supporting means, conveying means including chains and transversely-extending spaced drag bars for conveying material to be cooled through the cooling chamber, said conveying means riding on the guide rails and above the upper surface of said fixed layer of material, whereby material being conveyed by the conveying means will be dragged along the upper surface of said fixed layer of material, and means for introducing air under pressure below the supporting means to pass upwardly therethrough and through the fixed layer of material and the material being dragged along the upper surface thereof.

7. Apparatus for rapidly cooling cement clinker comprising an elongated cooling chamber having means for introducing cement clinker into one end thereof and for discharging cement clinker at the other end thereof, spaced grate bars at the

bottom of the cooling chamber, guide rails extending lengthwise of the cooling chamber and having their guide surfaces spaced vertically above the grate bars, a fixed layer of cement clinker on the grate bars, conveying means including chains and transversely-extending spaced drag bars for conveying material to be cooled through the cooling chamber, said conveying means riding along the guide rails and above the upper surface of said fixed layer of cement clinker, whereby cement clinker being conveyed by the conveying means will be dragged along the upper surface of said fixed layer of cement clinker, and means for introducing air under pressure below the grate bars to pass upwardly therethrough and through the fixed layer of cement clinker and the cement clinker being dragged along the upper surface thereof.

8. Apparatus for rapidly cooling cement clinker as defined in claim 7 in which the grate bars are of generally Z-shape and are so positioned that they afford a path for the passage of air between them

while substantially preventing overlying particles of cement clinker from falling through the spaces between them.

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