Aug. 21, 1962 M. O. FUNK 3,050,202

BARK-TYPE FUEL FEEDER WITH VIBRATING PROPORTIONING TABLE AND FLOW DIVIDING MEANS

Filed Nov. 18, 1958 4 Sheets-Sheet 1

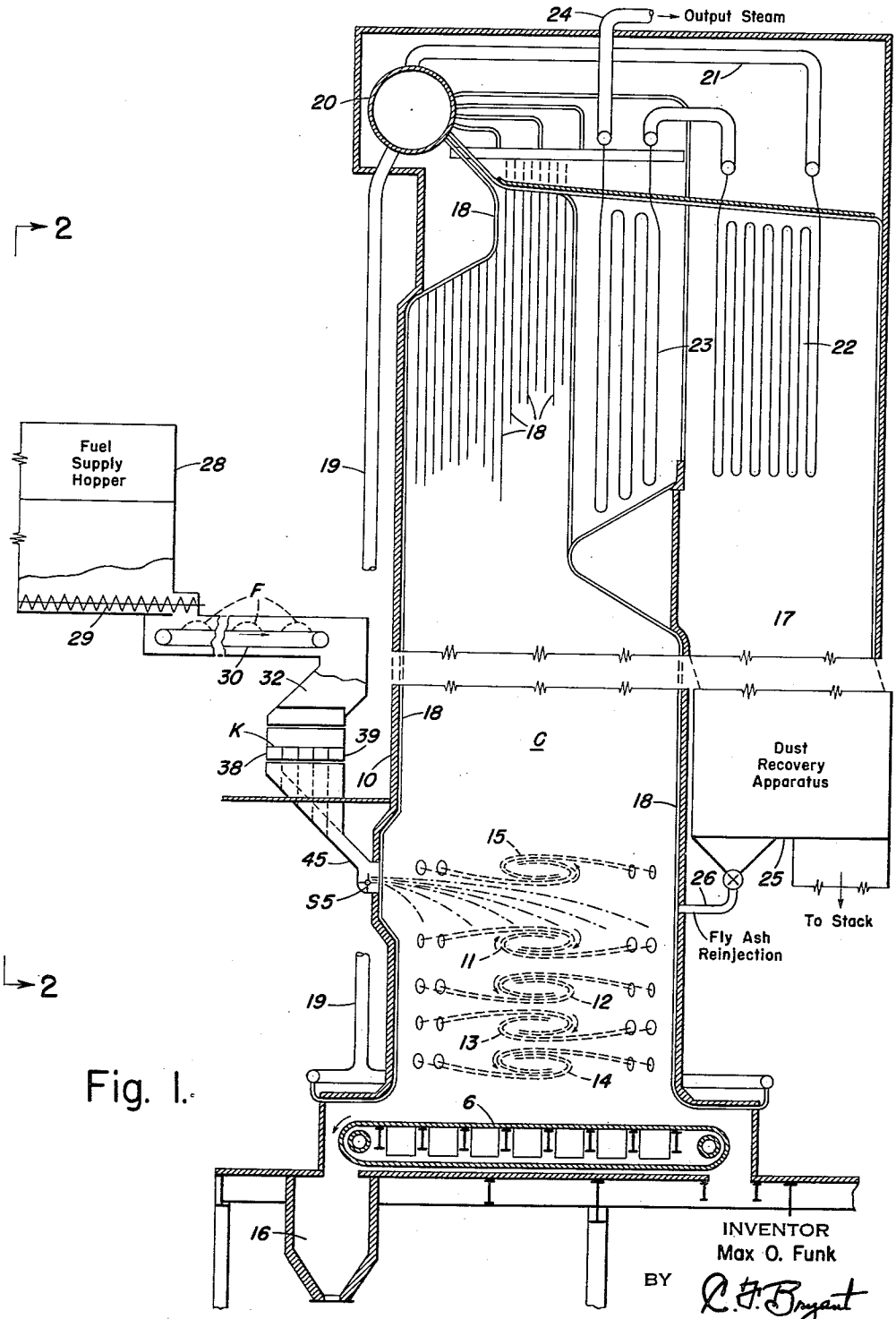


Fig. 1.

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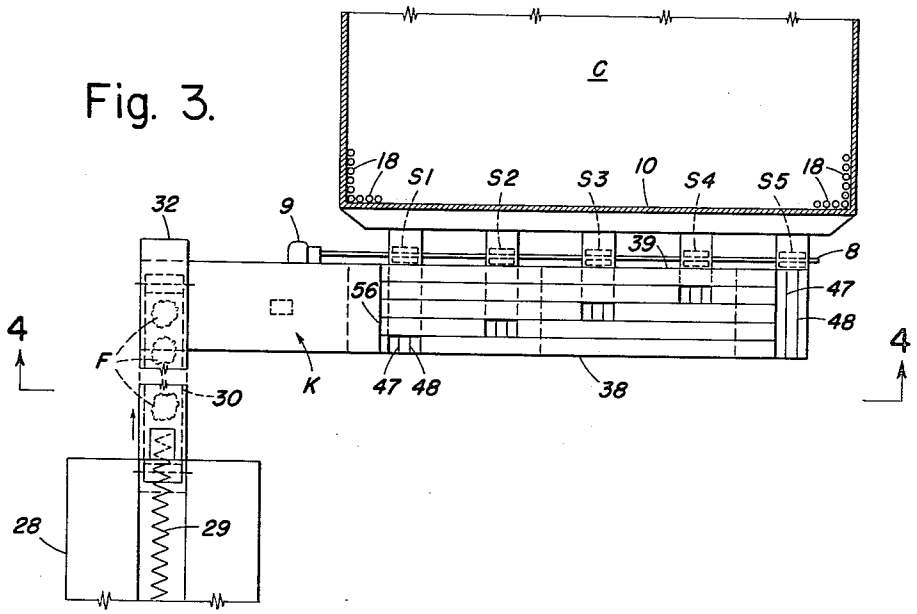
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Fig. 3.



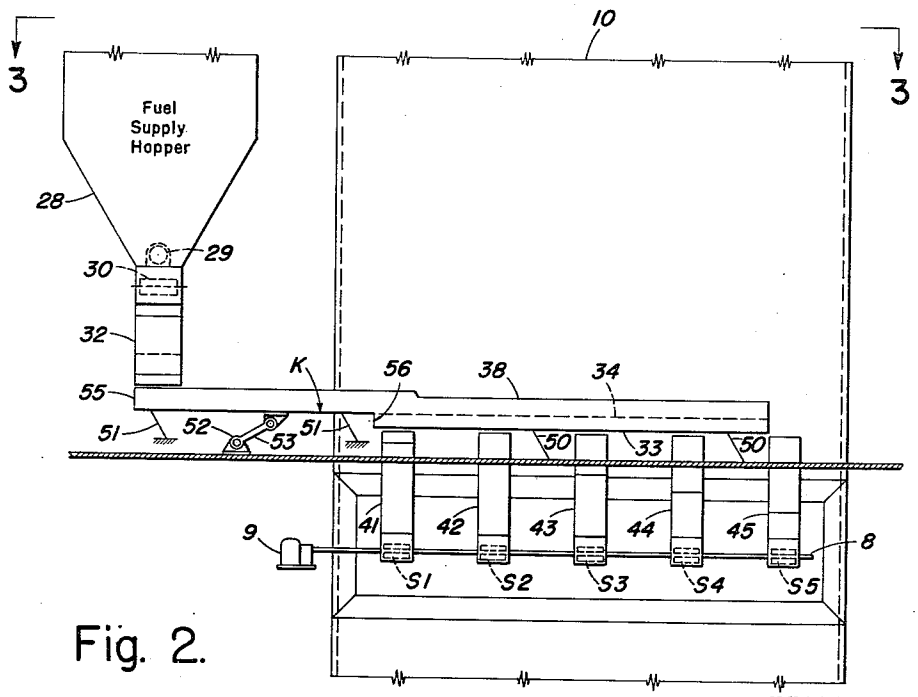


Fig. 2.

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BARK-TYPE FUEL FEEDER WITH VIBRATING PROPORTIONING TABLE AND FLOW DIVIDING MEANS

Filed Nov. 18, 1958 4 Sheets-Sheet 3

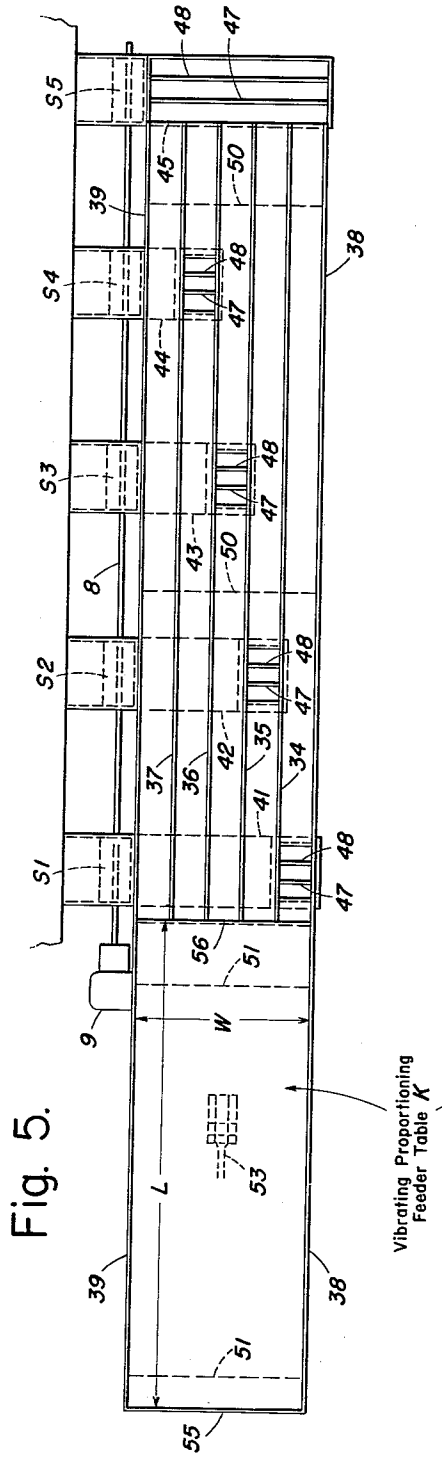


Fig. 5.

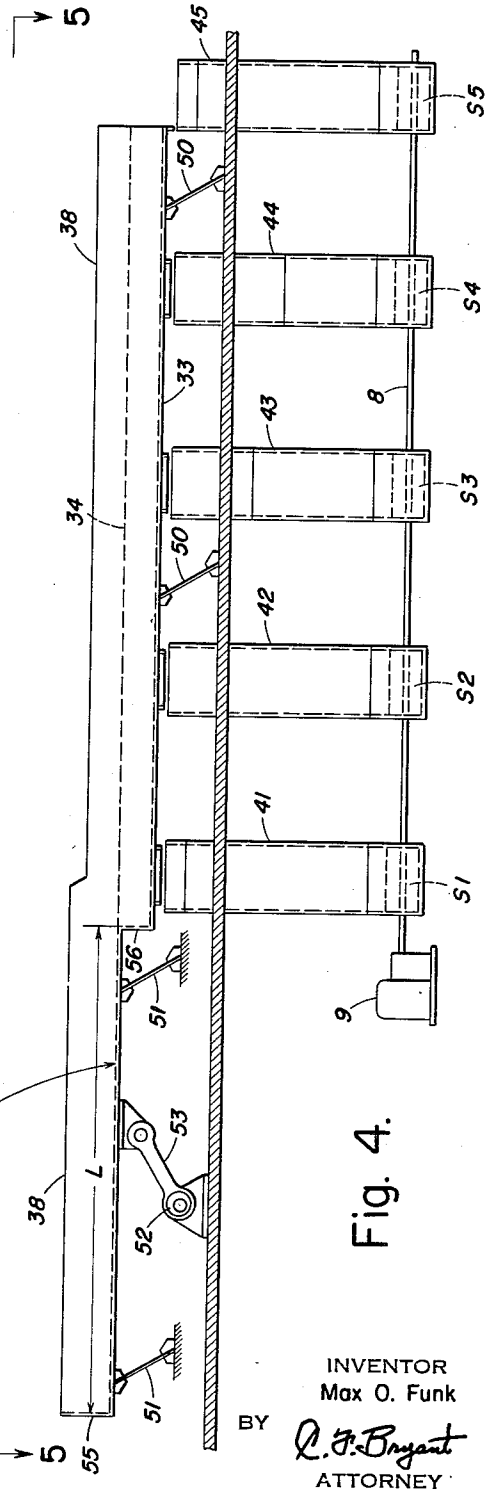


Fig. 4.

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BARK-TYPE FUEL FEEDER WITH VIBRATING PROPORTIONING TABLE AND FLOW DIVIDING MEANS

Filed Nov. 18, 1958 4 Sheets-Sheet 4

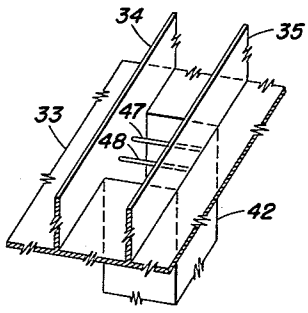


Fig. 7.

Fig. 6.

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3,050,202

BARK-TYPE FUEL FEEDER WITH VIBRATING PROPORTIONING TABLE AND FLOW DIVIDING MEANS

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4 Claims. (Cl. 214—18.38)

My invention relates to the feeding and burning of bark and other cellulose fuels of similar character and it has special reference to improved feeder facilities by the aid of which such bark and wood-type fuels can successfully be delivered to and burned in furnaces for the generation of steam and other purposes.

Broadly stated, the object of my invention is to enable bark and other comparable fuels to be so fed into a furnace more uniformly and otherwise more satisfactorily than has been possible heretofore.

A more specific object is to produce a continuous flow of such fuels into the furnace under conditions when the fuel is supplied at an erratic rate that normally results in fuel delivery pulsations which are highly objectionable.

Another object is to achieve such dependable uniformity in the feeding of bark and other fibrous fuels into furnaces which utilize a plurality of spreader-type injectors that are positioned substantially above a bottom grate of the furnace and that serve to bring the fuel into the furnace combustion chamber.

A further object is to provide such multi-spreader type furnaces with new and improved feeder apparatus which upon receiving the bark or other fuel at a non-uniform or variable rate serves to deliver that fuel to the several furnace injectors in streams which are of equal size and in each of which the original supply rate variations mentioned above have been evened out if not completely eliminated.

Other objects and advantages will become apparent from the following description of an illustrative embodiment of the invention when taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a longitudinal section through a steam generating furnace that is equipped with fuel feeding apparatus wherein my inventive improvements are incorporated;

FIG. 2 is a section in front elevation through my new feeder apparatus, as viewed from line 2—2 of FIG. 1, showing further details of this improved equipment;

FIG. 3 is a top plan view, taken from line 3—3 of FIG. 2, showing the furnace front wall with the several fuel injectors therein, and also a portion of the feeder;

FIG. 4 is a view in side elevation, taken on line 4—4 of FIG. 3, indicating how vibration is imparted to my new proportioning platform or table and to associated parts of the feeder;

FIG. 5 is a top plan view, taken from line 5—5 of FIG. 4, of the vibrating platform and flow-dividing channel elements of FIG. 4;

FIG. 6 is a simplified perspective representation of the entire feeder assemblage as interposed between the fuel-supply source and the several furnace injectors; and

FIG. 7 is an enlarged showing of the entrance to one of the injector feed chutes and of the bars that are positioned thereacross to prevent unduly large pieces of fuel from passing into the chute.

The Illustrative Furnace to Which the Bark Fuel Is Fed for Burning Therein

The fuel feeder improvements of my invention are disclosed by FIG. 1 and the other drawing views as being utilized with a steam generator furnace whose combustion chamber C has fuel in the form of wood bark or the like introduced thereinto by five spreader injectors S1–S2–S3–S4–S5. In the arrangement shown, these fuel spreaders S are mounted in the furnace front wall 10 at an elevation substantially above a traveling stoker grate 6 at the furnace bottom. All five sets of the spreader blades may be carried on a common drive shaft 8 that is rotated by a motor 9 at some suitable speed such as several hundred revolutions per minute; or each set of spreader blades may be equipped with an individual drive motor.

In gravitating downwardly into and successively through tangential air swirls represented at 11—12—13—14, the so introduced pieces of bark or other fuel are kept in suspension for a substantial length of time. During that time the finer fuel particles are fully burned, while the larger fuel pieces in partly burned state fall upon the traveling grate 6 where combustion thereof is completed. Ash resulting from such burning of the larger fuel pieces falls from the discharge end of grate 6 into a disposal passage 16.

Hot combustion gases produced by this burning of the bark or other fuel (both on the grate and in suspension) rise upwardly through further tangential air swirls 15 (only one is shown here); and after reaching the upper portion of furnace chamber C those gases leave the furnace via flow to the right into a discharge passage 17 that leads to dust recovery apparatus shown generally at 25, and thence to the furnace stack (not shown).

Water tubes 18 lining all four walls of the furnace chamber C are connected, via downcomer 19 and other conventional elements, into circulation with a steam and water drum 20 at the furnace top. By absorbing heat from the burning fuel and hot combustion gases these tubes 18 convert the boiler water therein into steam which rises therethrough and collects in drum 20. From the drum that generated steam flows via conduit 21 into and through superheater sections 22 and 23, and thence via output conduit 24 to a turbine (not shown) or other point of use.

Explanation of the advantages that result from interposing tangential air swirls such as 11—12—13—14 between high-set fuel spreaders such as S1–S5 and a traveling grate such as 6 at the furnace bottom is given by U.S. Patent 2,483,728 which issued on October 4, 1949 to A. L. Glaeser and which is entitled "Method and Apparatus for Burning High Moisture Content Fuel." Especially significant benefits to the efficiency both of fuel combustion and of steam generation are realized when this burning technique is applied to cellulose fuels of high moisture content such as the wood bark here under consideration.

Supply of Bark to the Fuel Feeder Typically Is Erratic

Furnaces of the type just described by reference to FIG. 1 find extensive use in paper mill and other comparable installations where wood materials such as logs are converted into various products such as the pulp from which paper is manufactured. Such logs as brought from the forest first have the bark removed therefrom. This removal operation produces large quantities of bark, which takes the form of pieces of widely assorted sizes, shapes and lengths. It is with the problem of burning such bark in furnaces of the FIG. 1 type that the present invention is concerned.

This bark is taken from the de-barking machines (not shown) through which the logs are passed, is dropped into a suitable fuel supply hopper which is represented at 28 in each of FIGS. 1, 2, 3 and 6 and which is located somewhere between the debarking drums and the furnace C. In many instances hopper 28 may be a considerable distance from the furnace, such as 100 feet or more. As shown it utilizes a screw or spiral member 29 by which the assorted pieces of bark are discharged from the hopper

28 upon the top of a belt 30 that runs to the furnace location. That belt 30, in turn, delivers the fuel via a casing 32 upon the entrance end of a proportioning table K which is incorporated into my new feeder apparatus in the novel and advantageous manner to be described presently.

The bark fuel so delivered via hopper 28 and screw 29 upon the supply belt 30 is not always in the form of a uniform stream; indeed, normal operation of the paper mill installation frequently results in the bark fuel being deposited upon the slowly moving belt 30 in an erratic manner, such as in spaced piles F that are separated by intervening lengths of belt surface on which there is no fuel whatever.

Furnace C Responds Unfavorably to Erratic Fuel Delivery

When conventional feeder apparatus is utilized between supply belt 30 and the spreader injectors S1–S2–S3–S4–S5 of the FIG. 1 furnace, such a non-uniform distribution (separated piles F) of the incoming bark fuel along the length of said belt 30 will be accompanied by a delivery of that fuel to those spreaders S and thence into the furnace C which is correspondingly erratic and non-uniform.

The effect on the furnace of such erratic fuel feeding is not good. Each time that a concentrated quantity (such as the contents of one of the piles F) of the fuel comes into combustion chamber C via the spreaders S, the intensely accelerated burning produces a "puffing" action that is accompanied by sharp rises in the heat release and in the internal furnace pressure and in the volume of hot gases which pass through the dust recovery apparatus 25 on their way to the furnace stack. Overloading of said dust recovery apparatus 25 and associated fly ash reinjection equipment 26 is found to occur on the occasion of each of these intense furnace puffs; moreover, the furnace walls and casing are subjected to objectionable mechanical strains, produced by the recurring pressure rises in combustion chamber C, when the fuel is brought into the furnace in such an erratic and non-uniform manner.

Avoidance of such erratic fuel feed is therefore an objective which is highly to be desired but which prior to the availability of my invention has not been attainable in any commercially satisfactory manner.

The New Fuel Feeder Apparatus With Proportioning Table K

Referring to FIGS. 2 through 7, my new feeder apparatus utilizes the earlier mentioned proportioning Table K plus an associated floor 33 of lower elevation that has upstanding flow-dividing partitions 34—35—36—37 with outer side walls 38 and 39. Between these walls and partitions there are formed five fuel channels represented as respectively communicating with the spouts or conduits 41—42—43—44—45 that lead to the five spreader-injectors S1–S2–S3–S4–S5 of the FIG. 1 furnace C.

Screen bars shown at 47—48 permit pieces of the bark within an acceptable size range to drop from said feeder channels downwardly through openings in floor 33 and thence into said five spreader supply spouts 41—45, while at the same time these bars reject bark pieces which are excessively large and which thereupon advance to the discharge end of the feeder (right in FIGS. 1–2–3–4–5) where they are manually collected and disposed of by an operator (not shown).

From FIGS. 2 through 6 it will be seen that the side walls 38 and 39 of the partitioned feeder floor 33 continue back therefrom along the two sides of the proportioning Table K and join with an upstanding transverse wall 55 at the extreme rear end of the table (beneath the fuel entrance casing 32); also that at the opposite or fuel delivery end of Table K there is a second transverse wall 56 which extends downwardly from the table level to the lower level of feeder floor 33 and which serves to close the rear ends of the five fuel channels as formed above said floor 33 by the partitions 34—35—36—37.

The entire assemblage consisting of proportioning Table K and the partitions 34—35—36—37 plus their floor 33 and side walls 38—39 is arranged to vibrate in such a way that bark or other fuel fed upon the table at entrance casing 32 will slowly advance along the full table length, and after dropping from the table's discharge end (right in FIGS. 1 through 5) into the five channels formed by partitions 34—35—36—37 will further advance through those channels to the floor 33 openings therealong that respectively are above the supply spouts for the associated fuel spreaders S.

In the illustrative vibrating arrangement of FIGS. 2–3–4–5, the partitioned floor 33 is supported by leaf springs 50 which are inclined to the rear in the manner indicated; the integrally associated proportioning Table K is similarly supported by leaf springs 51 which also are inclined to the rear; and through an eccentric drive 52, plus a link connection 53 with the underside of platform K, the aforementioned assemblage is repeatedly pushed upwardly ahead and withdrawn downwardly back at some suitable frequency such as 25 or 60 cycles per second. As can be seen from FIGS. 2 and 4, these push and withdraw movements cause the floor 33 and Table K to flex their support springs 50—51 around the represented stationary mountings at the lower ends of those springs.

By each such upward-forward movement, all of the bark or other fuel on table K and floor 33 is advanced by a small amount forwardly, or to the right in FIGS. 2–3–4–5; and during each subsequent downward-rear movement, this advancement by the fuel is lost only slightly if at all. The result thus is a slow but steady forward moving of said fuel along the table and floor due to subjection of these assemblage parts to vibratory action such as is explained above.

As the description proceeds it will become apparent that other means for inducing comparable vibrations in the assemblage parts also may be substituted and utilized in the improved feeder apparatus of my invention.

New Proportioning Table K Evens Out Supply Variations

Wood bark or other fuel F received upon proportioning table K from supply belt 30 via casing 32 in the form of a primary supply stream is spread by the table vibrations laterally across the table width into a layer of uniform thickness. Upon arrival at the table's discharge end (right in FIGS. 2–3–4–5) the material of this layer drops into the five fuel channels (formed by partitions 34—35—36—37) and thereby supplies those channels with individual streams of the fuel. These five divided streams are substantially equal, due to the uniformity in fuel layer thickness across the table K (between side walls 38 and 39) at its discharge end. Each of said five streams, in turn, moves forwardly along the vibrating feeder floor 33 and drops from its channel through the floor opening that is above the duct (41 or 42 or 43 or 44 or 45) for the associated furnace spreader S1 or S2 or S3 or S4 or S5.

The lateral-spreading function just explained is accomplished in only a comparatively short length of the proportioning table K, which need be only the same as or even less than the width W (see FIGS. 5 and 6) of that table. Under optimum conditions, therefore, wherein the fuel comes upon the table K from supply belt 30 as a uniform and non-erratic primary stream, the length of this table can be comparatively short without sacrifice in the quality of feeder performance.

Prior to my invention the length of a proportioning table such as K was limited to not more than the table's width dimension W. But, as already pointed out, fuel feeding and firing installations of the type herein considered frequently have the unhogged bark or other fuel brought to the FIG. 1 furnace as a non-uniform erratic primary stream of which the spaced piles of fuel F on supply belt 30 is typical; and in those situations a feeder proportioning table of the limited length just stated is

ineffective for evening out objectionable hills and valleys in the rate of original or primary fuel supply, as from belt 30.

In an effort to overcome the foregoing difficulty, I conducted a series of experiments aimed at determining whether a proportioning table such as K might somehow be made to average out primary fuel supply unevennesses in an advantageous way. Fuel material of the wood bark type was used during these experiments. They clearly indicated that if the length dimension L of table K is increased to the general order of three or more times the width dimension W, the table then is eminently effective for converting an uneven supply of fuel upon its receiving end (under casing 32) into a relatively uniform and even rate of material dropping from its discharge edge (right in FIGS. 2–3–4–5) into the fuel channels between partitions 34—35—36—37 along the vibrating feeder floor 33.

On the basis of these experimental findings, I caused to be built the full-sized feeder which the drawings hereof show and in which the proportioning table K has a length L that is substantially three times its width W. This so-improved feeder then was made a part of the furnace installation of FIG. 1 and there subjected to the severe tests of practical operation.

These tests have convincingly confirmed what my preliminary experiments had predicted; namely, that even though the wood bark or other fuel comes into the feeder in the form of time-spaced concentrated batches such as FIGS. 1, 3 and 6 represent at F, the vibrating action of proportioning table K when carried out during the greatly increased table length L does in fact average out the original supply unevennesses in a most advantageous way. Each individual pile F of the supplied fuel in advancing along the vibrating surface of said lengthened table K spreads itself out thereover in the end-to-end direction as well as from side to side; and due to the prolonged continuance of this action which my elongated table K makes possible, each such individual fuel pile F has been distributed over a considerable span of the table by the time it reaches the table's discharge end (right in FIGS. 2–3–4–5).

Practical Operating Advantages

Successive piles of the fuel F as dropped from belt 30 upon the entrance end of elongated table K in time-spaced relation thus tend to merge one into the other as they progress along the vibrating table surface; so that upon arrival at the discharge end the original supply unevennesses have been either fully eliminated or greatly minimized.

The FIG. 1 furnace C when supplied with wood bark or other fuel by my improved feeder is accordingly no longer subjected to the objectionable "puffing" which an earlier section of this specification has described, and the dust recovery and fly ash reinjection portions 25—26 of the installation are no longer periodically overloaded by reason of such puffing.

My inventively new feeder thus betters the performance of the overall furnace installation wherein the improved feeder is employed; moreover, it broadens the capability of the feeder itself for use in possible other applications wherein elimination of fuel supply unevennesses likewise is important.

Summary

The inventive improvements herein disclosed and claimed are therefore extensive in their adaption and hence are not to be restricted to the specific form here disclosed by way of illustration.

What I claim is:

1. In a system comprising a furnace having a combustion chamber that is equipped with a plurality of fuel-injecting spreaders and fuel conveying means which bring to the location of said furnace cellulose fuel such as wood bark in the form of a primary supply stream that is non-uniform and erratic both as to flow volume and continuity, the combination of feeder apparatus for receiving said non-uniform primary stream of supply fuel and for converting it into a plurality of divided individual streams which are equal in size and relatively non-interrupted in flow continuity and which are respectively delivered by the apparatus to the furnace's said plurality of fuel-injecting spreaders, said feeder apparatus comprising an assemblage of parallel flow channels which are in respective supply communication with said plurality of furnace spreaders and which have upstream ends that are defined by a floor plus left and right side walls and intervening partitions upstanding from the floor; a proportioning table which extends away from said upstream channel ends in a horizontal plane that is at an elevation above the level of said floor and at least as high as the top edges of the said partition upstream ends and which is flanked by left and right upstanding side walls that merge with the corresponding side walls of said channel assemblage the discharge edge of said table being in feed communication with said upstream ends of all of said flow channels and the opposite or receiving end of the table being in feed communication with said fuel conveying means; means for imparting both to said table and to said flow channel assemblage a form of vibration which slowly advances said received fuel along said extended length of the table towards said discharge edge thereof and thence over that edge down into the upstream ends of all of said assemblage channels; the length of said table being such with respect to the width thereof that the vibrations produced in the table by the vibration means will spread the non-uniform primary stream of supply fuel evenly thereon, such that said fuel is spaced substantially evenly across the entire table width and length, as said fuel progresses along the length of the table, said fuel arriving at said discharge edge in a substantially continuous layer of uniform thickness.

2. The system set forth in claim 1 wherein said proportioning table is provided at its fuel-receiving end with a transverse wall that extends between said left and right side walls of the table and stands upwardly from the table so as to prevent fuel as delivered upon the table surface in the vicinity of said receiving end from spilling over the edge of that end.

3. The system set forth in claim 1, wherein the recited floor of said fuel channel assemblage lies in a generally horizontal plane and is provided with openings through the individual channel portions of that floor, and further wherein ducts extend down from those channel openings to the said plurality furnace spreaders and serve to carry fuel from those channels to those spreaders.

4. The system set forth in claim 1, wherein the length of said table is at least three times the width thereof.

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