Dec. 31, 1968 R. HOLSTEIN ETAL 3,418,997

REFUSE BURNING GRATE PARTICULARLY DESIGNED FOR THE COMBUSTION OF WET REFUSE

Filed March 16, 1967 Sheet 1 of 2

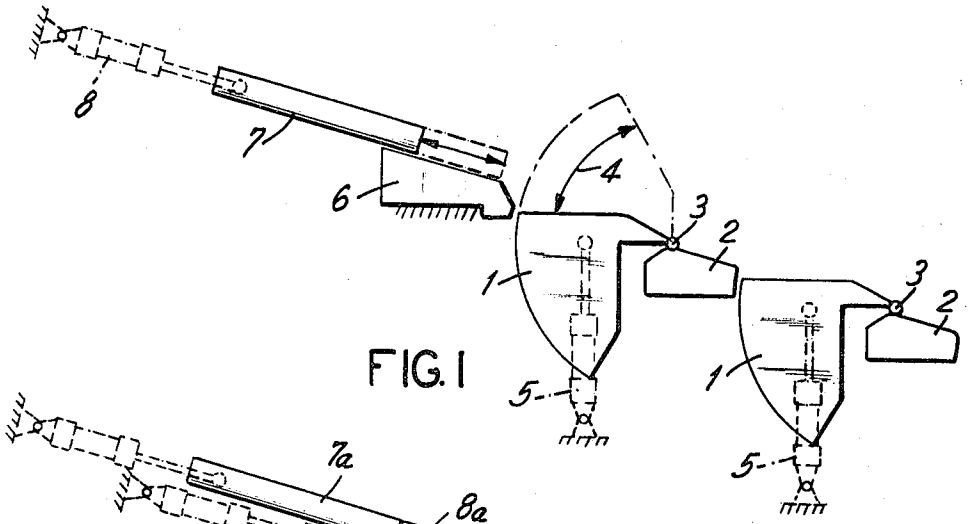

FIG. 1

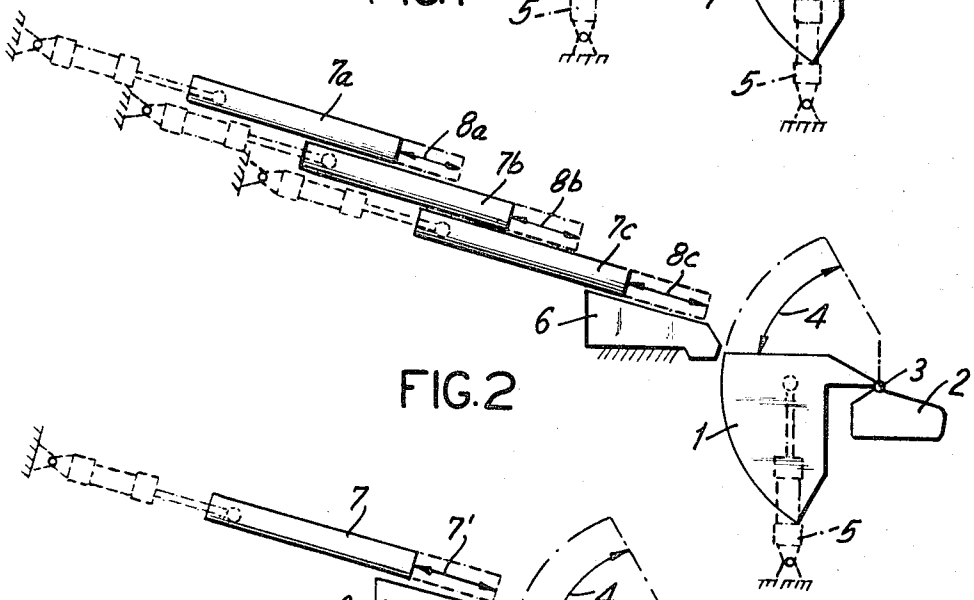

FIG. 2

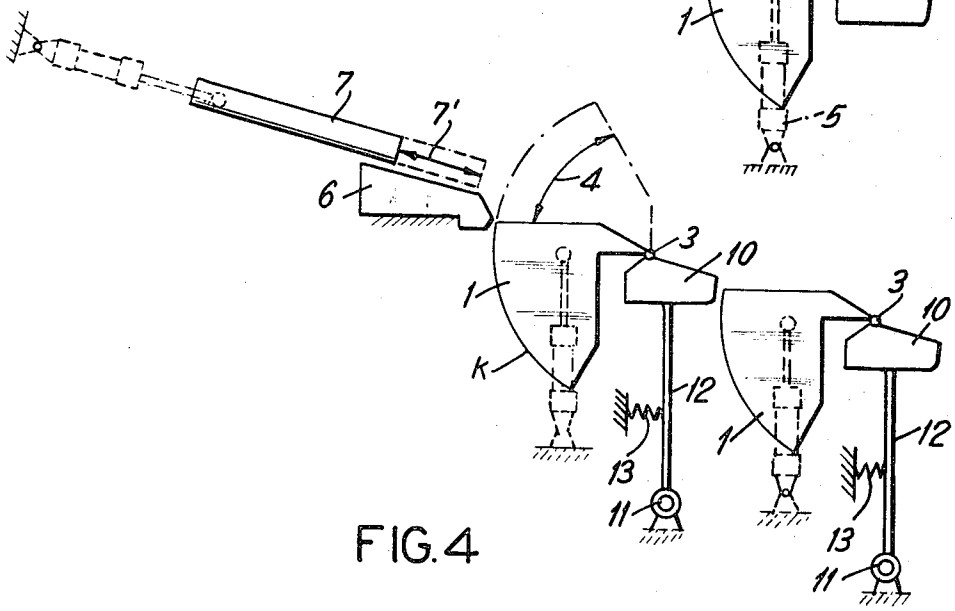

FIG. 4

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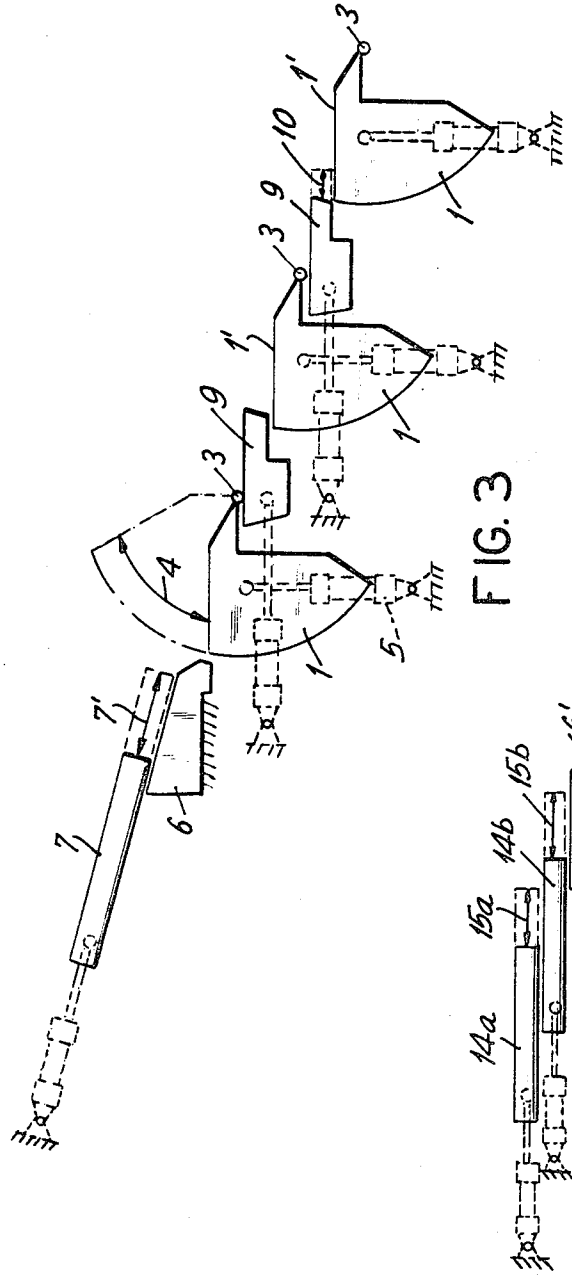

FIG. 3

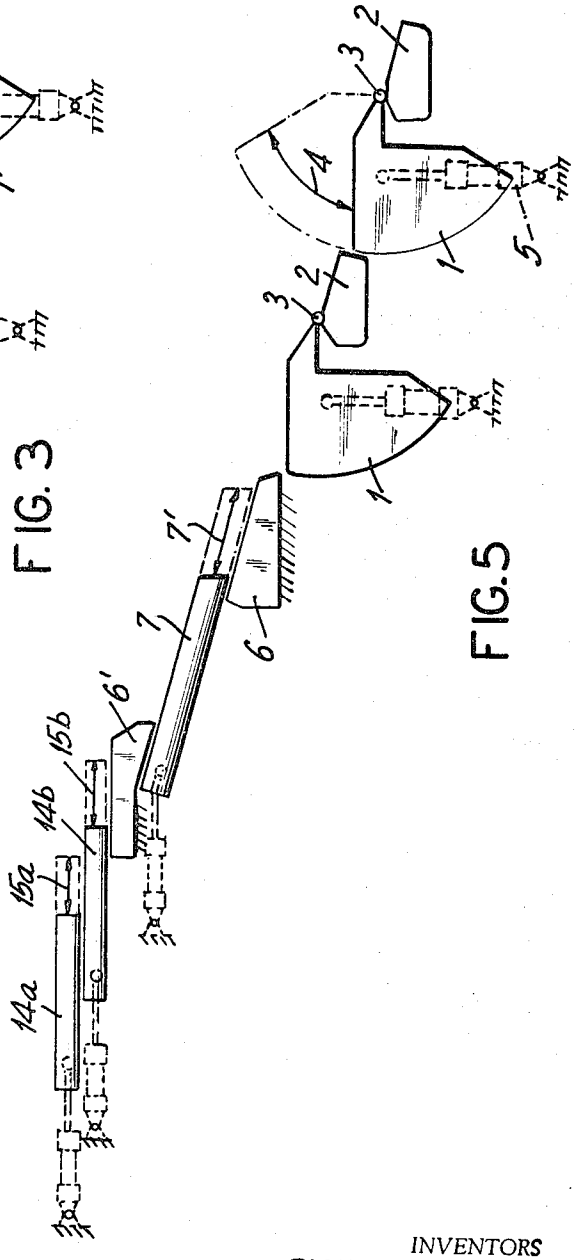

FIG. 5

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REFUSE BURNING GRATE PARTICULARLY DESIGNED FOR THE COMBUSTION OF WET REFUSE

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ABSTRACT OF THE DISCLOSURE

A refuse burning grate is divided into a pre-drying zone, a main combustion zone and a burning-out zone. The feeding zone includes one or more feed sections each having a rectilinearly reciprocable pusher. The main combustion zone includes plural oscillatable grate sections arranged serially in the direction of fuel conveyance, and stationary bridging sections may be interposed between the oscillatable grate section. The bridging sections may also be mounted for movement relative to the oscillatable grate sections, being spring biased so as to move away from the associated grate section to release any jamming.

The burning-out zone following the main burning zone may be provided with resiliently biased bridging grate sections arranged between the oscillatable grate sections in this zone. As an additional feature, the fuel feed zone may include at least one feed section including a pusher which is rectilinearly reciprocable, arranged before the pre-drying zone. The pre-drying zone, including at least one feed section, may also serve as a fuel feed zone.

Background of the invention

The invention is directed to combustion grates particularly designed for the combustion of wet refuse and, more particularly, to an improved combustion grate of this type provided with improved feeding means.

In the burning of refuse and other garbage of any type, which usually are inferior and ballast-containing fuels, it is essential not only that the fuel layer be moved but also that it be loosened up. Consequently, combustion grates have been developed for use in garbage burning plants, these combustion grates comprising movable grate sections which, in side elevation, have a circular sector profile and which are arranged serially in the direction of fuel conveyance. The movable grate sections are oscillatable upwardly and downwardly about respective oscillation axes which extend transversely of the direction of fuel conveyance.

Particular difficulties are encountered when burning wet refuse such as, for example, that emanating from food markets or slaughter houses, as well as refuse to which sediments, or waste oils and the like, have been added. In order to burn such refuse, a pre-drying grate has been arranged in advance of the combustion grate. However, the provision, in the pre-drying area or zone of a grate comprising the oscillatable sections like the grate sections used in the combustion area or zone, is not sufficient to overcome these difficulties in a satisfactory manner. For example, difficulties have been encountered due to the tendency to compress or condense the wet refuse in the pre-drying area. Also, irregularities in the fuel bed result from the present practices in the pre-drying area or zone.

Summary of the invention

In accordance with the invention, advantageous results are obtained with respect to movement of the fuel layer in the pre-drying area by providing in the pre-drying area or zone, at least one fuel feed section including a linearly reciprocable pusher. This pusher is arranged before the oscillatable or swingable grate sections of the combustion zone, the feed section generally being arranged in the pre-drying zone. Thereby, it is possible to attain that the fuel layer will be carried by the feed section or sections in the direction of fuel conveyance, and will not be pushed or pressed. Thus, the fuel in the pre-drying area is prevented from being condensed or compressed disadvantageously.

If several feed sections are provided in series, in accordance with the invention, all sections may be designed to move simultaneously in the fuel feeding direction, but to perform separate, such as successive return movements. Thereby, the carrying effect of the feed section and the protection of the fuel against condensation and compression are advantageously benefited.

The stroke lengths of respective rectilinearly reciprocable pushers arranged serially preferably increase in the direction of fuel conveyance, in order to separate and level the fuel layer in the pre-drying area or zone. This is paticularly important with respect to garbage and in connection with feeding the garbage at the inlet to the grate. Additionally, the setting of different stroke lengths permits, at all times, reduction or complete elimination of irregularities in the fuel bed.

In further accordance with the invention, feed sections advantageously may be provided in the main combustion area or zone between the oscillatable grate sections. These feed sections thus assist the conveyance of the fuel in the combustion area. However, the same effect is insured by feed sections in the combustion area or zone adjacent the pre-drying area or zone, whether or not the latter is provided with a feed section.

As another feature of the invention, the burning-out area or zone following the main burning area or zone may be provided with bridging grate sections arranged alternately with the oscillatable grate or swingable sections and resiliently biased into cooperative relation with adjacent oscillating grate sections.

The advantageous features of the invention may also be applied to the fuel feed zone by providing that the fuel feed zone includes at least one linearly reciprocable pusher arranged in a feed section. In general, such a fuel feed section is arranged before the pre-drying area. However, the pre-drying area or zone, comprising at least one feed section, may also serve simultaneously as a fuel feed area or zone. If, for example, the fuel feed chute is disposed in the furnace chamber, the grate elements of the fuel feed area or zone and the pre-drying area or zone will be integrated or equivalent to one another.

Accordingly, an object of the present invention is to provide an improved combustion grate particularly designed for the combustion of wet refuse.

Another object of the invention is to provide a combustion arrangement particularly designed for the combustion of wet refuse and including novel fuel-feeding means.

A further object of the invention is to provide a combustion arrangement particularly designed for the burning of wet refuse and in which the fuel feeding means includes one or more rectilinearly reciprocable pushers.

Yet another object of the invention is to provide such a combustion arrangement for the combustion of wet refuse in which the feed sections are arranged in a pre-drying area or zone.

A further object of the invention is to provide such a combustion arrangement for wet refuse and in which fuel in a pre-drying area or zone is not disadvantageously compressed or condensed.

Still another object of the invention is to provide a novel combustion arrangement for the combustion of wet refuse and including several feed sections each including a rectilinearly reciprocable pusher, with all of the pushers moving simultaneously in the fuel feeding direction but performing separate return movements.

A further object of the invention is to provide such a combustion arrangement for the combustion of wet refuse including a number of feed sections each comprising a linearly reciprocable pusher and in which the respective strokes of the pushers increase in the direction of fuel conveyance.

Yet another object of the invention is to provide a novel combustion arrangement for the combustion of wet refuse and including a novel feeding section or novel feeding sections by means of which irregularities in the fuel bed can be reduced or completely eliminated.

A further object of the invention is to provide a combustion arrangement of the type mentioned above including feed sections arranged in the main combustion area or zone between oscillatable grate sections.

Still another object of the invention is to provide a combustion arrangement of the type mentioned above in which feed sections are arranged in the combustion area or zone, which is adjacent the pre-dying area or zone, with the pre-drying area or zone either including feed sections or not including feed sections.

A further object of the invention is to provide a combustion grate for the burning of wet garbage including oscillatable or swingable grate sections arranged serially in the direction of fuel conveyance and further including bridging sections alternating with the oscillatable grate sections and being biased into cooperative relation with the adjacent oscillatable grate sections.

Yet another object of the invention is to provide a combustion arrangement of the type mentioned, including a fuel feed zone in which there is arranged at least one linearly reciprocable fuel pusher.

Brief description of the drawings

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a somewhat schematic side elevation view of a portion of a wet refuse combustion arrangement embodying the invention, and illustrating a portion of a combustion grate having oscillatable or swingable grate sections and a fuel feed section in advance of the combustion grate;

FIG. 2 is a view similar to FIG. 1 but illustrating several feed sections in advance of the combustion grate;

FIG. 3 is a view similar to FIG. 1 but illustrating feed sections arranged between the oscillatable or swingable grate sections of the combustion grate;

FIG. 4 is a view similar to FIG. 1 illustrating bridging grate sections alternating with the oscillatable or swingable grate sections and resiliently biased into cooperative relation with adjacent oscillatable grate sections; and

FIG. 5 is a view similar to FIG. 1 illustrating an additional feed section arranged in advance of the feed section illustrated in FIG. 1.

Description of the preferred embodiments

Referring first to FIG. 1, a combustion grate for the combustion of wet refuse is illustrated as including movable sections **1** alternating with relatively stationary bridging sections **2** in the direction of fuel conveyance. Each movable section **1** has, in side elevation, a circular sector profile, and is arranged to be oscillated or swung upwardly and downwardly about an oscillation axis **3** extending transversely of the direction of fuel conveyance. Such oscillation is indicated by arrow **4** which indicates the oscillator movement as well as the extent of such movement. Oscillation of each grate section **1** may be effected, by way of example, by a fluid pressure actuator **5** having a piston connected to the associated grate section **1**.

In accordance with the invention, fuel is fed from a pre-drying area to the first oscillatable grate section **1** over a stationary table **6**. The feeding is effected by a linearly reciprocable pusher **7** operated by a fluid pressure actuator **8**.

As a variation of the arrangement shown in FIG. 1, FIG. 2 illustrates a pre-drying area or zone having plural rectilinearly reciprocable pushers *7a*, *7b* and *7c* arranged successively in the direction of fuel conveyance. The pushers overlap and form an air-permeable support for the fuel layer. The fuel layer is advanced in the fuel conveyance direction by simultaneous feeding movements of all the plungers, and without any compression or condensation of the fuel. The fuel is fed to a table **6** and from table **6** to the combustion grate including the oscillatable grate sections **1**. As indicated by the arrows **8***a*, **8***b* and **8***c*, the respective strokes of the pushers *7a*, *7b*, and *7c* differ in length. In the illustrated example, the respective strokes increase in length from one plunger to the next in the direction of fuel conveyance.

After the simultaneous forward or feeding movement of all of the pushers, the pushers preferably execute return movements in succession. Normally, plunger *7c* initiates its return stroke first, and the fuel carried is scraped off against the adjacent pusher *7b*. After plunger *7c* has terminated its return stroke, plunger *7b* begins its return stroke and, analogously, scrapes off fuel against pusher *7a*. Finally, pusher *7a* executes its return stroke and, in turn, strips fuel off against the rear wall of the feeding chute.

As a variation from the above operation, which may be termed the "normal" operation, there can be effected an operation with the plungers moved individually in order to adapt the movement of the fuel to operational conditions, such as, particularly, the nature and consistency of the fuel, and in order to control the performance and efficiency of the combustion process.

Pushers *7a*, *7b* and *7c* are provided with a covering which may comprise a one-piece plate or which may be assembled from several adjacently arranged plates or individual bars. The sub-division of the covering and the configuration of the air slots are selected in dependence on the thermal stresses involved, which vary with the type of fuel being burned.

FIG. 3 illustrates a modified construction in which the movement of the fuel, in the combustion area or zone adjacent the pre-drying area or zone, represented by the table **6**, is assisted. For this purpose in the arrangement of FIG. 3 bridging grate sections **9** are provided between the oscillatable or swingable grate sections **1**. The bridging sections **1** are formed as linearly reciprocable pushers having a stroke **10** smaller than the strokes **7'** of feed pusher **7**. In their return or retracted position, pushers **9** permit the succeeding oscillatable section **1** to swing upwardly. On the other hand, each oscillatable

section 1, in its initial position as shown in FIG. 3, permits a forward stroke of the associated pusher 6. This, incidentally, also provides for cleaning of the surface 1' of the associated oscillatable grate section 1. The oscillatable grate sections 1 thus act alternately with the bridging grate sections 9. An operating cycle, involving forward and return strokes, of pusher 9, may be associated with an oscillating movement of grate section 1. Alternatively, a reciprocation of the pusher 9 may occur only after several oscillating movements of a grate section 1, or pusher 9 may perform several linear reciprocations after each oscillation of a grate section 1.

FIG. 4 illustrates a further modification of FIG. 1, and which is intended to prevent or remedy difficulties which may be caused by incombustible elements in the fuel, such as screws, bolts, steel balls, spark plugs, etc. These elements may cause trouble by becoming stuck or jammed between a bridging section and the following swingable or oscillatable section.

For this purpose, FIG. 4 illustrates an arrangement in which bridging sections 10 may yield against a resilient bias. Thus, each bridging section 10 includes a support arm 12 which is pivoted at 11 and biased by a spring 13. Each spring 13 holds the respective bridging section 10 in operative contact with the circular arc portion of the succeeding oscillatable or swingable grate section 1.

In response to potential jamming or sticking of an incombustible element, a bridging section 10 may yield rearwardly compressing the associated spring 13, so that the potential jamming or sticking is eliminated. The resiliently biased arrangement is advantageous furthermore in those cases where the circular arc *k* of each oscillatable section 1 is eccentric relative to the axis of oscillation 3 thereof. If it is desired that the bridging sections 10, as biased by the associated springs 13, should not abut the circular arc of the succeeding oscillatable grate section 1 in order, for example, to keep wear and tear of the parts at a minimum when burning harmless fuel, a stop (not shown) may be provided to limit the movement of a bridging section toward the succeeding oscillating grate section under the bias of the associated spring 13. Such a stop may also be adjustable in order to limit the restoring force.

FIG. 5 illustrates an arrangement in which linearly reciprocable pushers are used to feed fuel at the inlet to the combustion grate. Referring to FIG. 5, several pushers, for example, two pushers 14*a* and 14*b*, which are linearly reciprocable, are positioned before the feed pusher 7 of the pre-drying area or zone. The fuel then moves from a feed table 6' into the pre-drying area or zone. In the illustrated embodiment, which is analogous to that of FIG. 2, the stroke 15*a* of pusher 14*a* is shorter than the stroke 15*b* of pusher 14*b*. The description with respect to FIG. 2 applies also to the fuel feeding arrangement shown in FIG. 5. In this connection, it should be pointed out that careful transport of fuel is of increased importance with respect to raw refuse.

Since a supply of combustion air may be dispensed with in the area of the fuel feed zone, air slots are eliminated in the covering of fuel pushers 14*a* and 14*b*. This is advantageous, since raw refuse thus may not get underneath the feed elements. For use with particularly highly combustible industrial refuse, pushers 14*a* and 14*b* may be water cooled in order to protect them against overheating due to back burning of the fuel.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A refuse burning grate comprising, in combination, plural grate sections arranged in succession in the direction of fuel conveyance, the grate sections including oscillatable grate sections which, in side elevation, have a circular sector profile and which are swingable about oscillation axes extending transversely of the direction of fuel conveyance; plural feed sections arranged in series in a pre-drying area upstream of the initial oscillatable grate section, each feed section including a linearly reciprocable pusher operable to feed fuel in the direction of fuel conveyance to advance fuel to the initial oscillatable grate section; and plural drive means each operatively associated with a respective pusher, for independent or conjoint operation of said pushers.

2. A refuse burning grate, as claimed in claim 1, in which said respective driving means are operable to advance all of said pushers simultaneously and to retract said pushers in separate and successive return movements.

3. A refuse burning grate, as claimed in claim 2, in which said pushers are arranged in descending order in a direction toward the initial oscillatable grate section, such successive retraction of the pushers beginning with retraction of the lowermost pusher followed successively by retraction of the pushers in the ascending order of the pushers.

4. A refuse burning grate comprising, in combination, plural grate sections arranged in succession in the direction of fuel conveyance, the grate sections including oscillatable grate sections which, in side elevation, have a circular sector profile and which are oscillatable about oscillation axes extending transversely of the direction of fuel conveyance; plural feed sections arranged in series in a pre-drying area upstream of the initial oscillatable grate section, each feed section including a linearly reciprocable pusher operable to feed fuel in the direction of fuel conveyance to advance fuel to the initial oscillatable grate section; each pusher having a respective stroke differing in length from the stroke of the other pushers.

5. A refuse burning grate, as claimed in claim 4, in which the respective strokes of said pushers increase in length in the direction of fuel conveyance.

6. A refuse burning grate comprising, in combination, plural grate sections arranged in succession in the direction of fuel conveyance, the grate sections including oscillatable grate sections which, in side elevation, have a circular sector profile and which are oscillatable about oscillation axes extending transversely of the direction of fuel conveyance; a feed section arranged in a pre-drying area upstream of the initial oscillatable grate section of said grate, said feed section including a linearly reciprocable fuel pusher operable to advance fuel to the initial oscillatable grate sector; and feed sections, each including a linearly reciprocable pusher, located in the main combustion zone between said oscillatable grate sections.

7. A refuse burning grate, as claimed in claim 6, in which the lengths of the strokes of said pushers located in the main combustion zone is less than the length of the strokes of the pushers located in said pre-drying area.

8. A refuse burning grate comprising, in combination, plural grate sections arranged in succession in the direction of fuel conveyance, the grate sections including oscillatable grate sections which, in side elevation, have a circular sector profile and which are oscillatable about oscillation axes extending transversely of the direction of fuel conveyance; a feed section arranged in a pre-drying area upstream of the initial oscillatable grate section of said grate, said feed section including a linearly reciprocable fuel pusher operable to advance fuel to the initial oscillatable grate sector; bridging grate sections arranged in alternation with said oscillatable grate sections; means mounting each bridging grate section for swinging movement, about a pivot spaced therefrom, relative to the adjacent oscillatable grate sections; and means biasing each bridging section toward the circular arc portion of the oscillatable grate section immediately succeeding the respective bridging section.

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