MECHANICAL GRATE FOR INCINERATORS

An improved mechanical grate means of novel design is disclosed, for use particularly in refuse incinerators for refuse of all kinds, said grate means comprising inclined grate sections disposed in stepped arrangement, means for supporting and transporting refuse thereon across the combustion chamber of such an incinerator and for supplying combustion supporting air and means for mechanically raking or agitating the fire bed to achieve complete incineration.

5 Claims, 14 Drawing Figures
MECHANICAL GRATE FOR INCINERATORS

BACKGROUND OF THE INVENTION

The present invention relates to an improved combustion grate of novel design, for use particularly in incinerators for waste materials, such as municipal refuse and others of the like, hereinafter generally referred to as "refuse." As is well known, refuse is a heterogeneous mass or mixture comprising combustible components of materials including but not limited to, paper, cardboard, wood, textiles, rubber, plastics, household garbage and street sweepings, junk and rubbish, waste oil, sediments from fuel-oil and other tanks and minerals, ceramics, glass, metals and possibly other materials as uncombustible matter, besides a variable content of humidity, depending on the local climate and standard of living and on the manner in which said refuse is collected and stored prior to incineration.

Refuse as such is a very poor fuel. That is why burning thereof is referred to not as combustion but as destructive incineration, carried out in specially designed incinerators. In an incinerator the grate is the heart of the plant, whereon the refuse is first pre-dried and ignited and then has its volatile parts driven out and burnt and its fixed carbon content eventually consumed.

Broadly speaking, incineration is a three-phase process, the various phases taking place successively during a certain period of time and, in the case of modern incinerators of high ratings and continuous operation as are considered here, at places or stations adjacent to but nevertheless different from each other. In such incinerators, the refuse is deposited on the grate, forming thereon a more or less continuous and cohesive layer of intricate structure.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide in an incinerator, a mechanical grate means serving as a support for the layer of refuse thereon and causing same to travel along it at a convenient speed, which, in conjunction with the length of the grate, allows sufficient time for the achievement of the various phases of incineration. Further, the grate means of the invention is of such structure as to reduce to a minimum the amounts of minute or small size refuse passing across its various openings, as so-called "riddlings," which would by-pass the incinerating process.

Another important object of the invention is to provide a grate means ensuring optimum conditions for the various process phases of incineration, by conveniently supplying and distributing combustion supporting air to the layer of refuse. Yet another important object of the invention is to provide means for raking or agitating the layer of refuse on the grate, particularly during the last phase in the process of incineration, thereby activating and accelerating the burn-out of the fixed carbon in the refuse, said means being hereinafter referred to as "raking blades."

A further noteworthy feature of the invention is the particular design of the grate components, to enable economical manufacture and easy assembly and to reduce wear during service.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, objects and advantages of the invention will become apparent, when reference is made to the appended drawings, which schematically illustrate a preferred embodiment of the invention, wherein:

FIG. 1 is a fragmentary view partly in elevation and partly in longitudinal section of the lower portion of the combustion chamber of an incinerator and diagrammatically illustrating the grate means of the invention as comprising two sections in downwardly inclined and spaced relation and extending across the lower portion of such combustion chamber from an upper inlet opening to a lower outlet or discharge opening.

FIG. 2 is a plan view of a plate or block element of the grate means of the invention.

FIG. 2a is a vertical sectional view taken along line 2a—2a of FIG. 2.

FIGS. 2b and 2c are fragmentary transverse sectional views taken, respectively, along lines 2b—2b and 2c—2c of FIG. 2a.

FIG. 3 is a fragmentary longitudinal sectional view illustrating how the plates or blocks are mounted on the frame of the grate means.

FIG. 3a is a transverse sectional taken along line 3a—3a of FIG. 3.

FIG. 4 is an isometric view illustrating the uppermost grate section shown diagrammatically in FIG. 1.

FIG. 5 is a perspective view, with parts removed, illustrating the frame and actuating mechanism for the grate section shown in FIG. 4.

FIG. 6 is a view similar to FIG. 4 illustrating the lowermost grate section shown diagrammatically in FIG. 1.

FIG. 7 is a view partly in plan and partly in horizontal section illustrating one of the rakes or agitating blades and the actuating mechanism therefore, in lowered and elevated positions, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 schematically illustrates an arrangement including two grate sections of the invention installed within the combustion chamber of a conventional incinerator.

In this drawing, the refractory brickwork of the combustion chamber 102 is marked 101, with the two inclined reverberatory vaults or roof portions 110 and 111. The refuse to be incinerated is charged into the receiving hopper 106 and drops through the charging chute 107 onto the first and uppermost grate section A, to pass thereover and, thereafter, to drop along the vertical (or nearly vertical) wall 105 onto the second grate section B. The path of the refuse is marked by the thick arrows. The grate sections A and B are two types of the inventive grate and will be referred to hereinafter as Type A and Type B grate sections.

During operation, the chute 107 is filled with refuse, whereby air-tight sealing of the combustion chamber 102 is ensured at the charging end. Recirculated hot combustion gases and hot air are blown through grate section A into the layer of refuse thereon, from the chamber 108. The refuse is thereby dried and further ignited under the influence of radiant heat emanating from both the flames in the combustion chamber 102 and the incandescent reverberatory vault 110.

In dropping along the wall 105, the already burning refuse is loosened up, catches fire throughout and achieves combustion on grate section B. The volatile parts burn with long flames in the upper half of said grate section B, whereas the fixed carbon is consumed in the lower half. During the last phase, the combustion is activated by radiant heat emanating from the overhanding reverberatory vault 111 and by the effect of the raking or agitating blades 109, as will be described in detail later. Hot and/or cold combustion air is supplied to the refuse on grate section B from the chamber 113 in usual ways by means not shown.

The combustion flames develop in the combustion chamber 102, which is of ample cross-section and height to allow total consumption thereof. The gaseous products of the pre-drying and combustion phases (water vapor, fumes and excess oxygen) flow upwards, as schematically represented by the thin arrows. In order to simplify the drawing, nearly parallel arrows have been used, this however should not lead to the belief of laminar flow, since, in fact, the flow of the gases is pronouncedly turbulent (and caused to be so) to promote and accelerate the consumption of the flames.
The uncombustible residues of incineration leave grate section B at its lower end and drop through the discharge chute 112 into a water basin, usually shaped like a trough. From here, said residues are discharged continuously by convenient mechanical means (not shown in the drawing). With the lower end of the chute 112 submerged in the water, air-tight sealing of the combustion chamber 102 is ensured also at its discharge end.

With these basic facts in mind, and remembering the specific requirements, as enumerated at the beginning, the inventive grate will now be described in detail.

Essentially, each grate section consists of a plurality of fixed and mobile longitudinal beams, carrying plates or blocks, which constitute the active surface of the grate, with the refuse layer supported and burning thereon. The grate section is placed with a moderate slope of 12°-14°, which facilitates the progress of the layer of refuse along it, without, however, endangering its stability. Combustion supporting air is supplied abundantly through wide slot-like nozzles in a substantially horizontal direction. By this, most efficient use is made of the air and, besides, the amount of possible riddlings is reduced to a minimum. The inventive grate and the blocks therein used ensure, in an almost ideal way, the fulfillment of the set requirements, and moreover present important constructional advantages.

FIGS. 2a, 2b, 2c and 2d illustrate a grate plate or block in top plan, longitudinal section and two fragmentary transverse cross-sections AA and BB. Each block is a casting of high alloy refractory and wear resisting steel. The upper ‘faces’ 201 and 202 are flat, being continued laterally by the side walls 211 and 212. At the rear end of face 201 a narrow tongue 203 is provided, whereas face 202 is curved downwards at its front end, forming a ‘nose’ 204. Between the faces 201 and 202, a wide slot-like nozzle opening 205 is provided as an outlet for the combustion supporting air. The transverse rib 206, and vertical ribs 207 and 208 ensure rigidity, whereas the shaped shoulders 209 and 210 serve for the support and adjustment of the blocks on the grate beams, as will be explained hereafter.

For a clearer image of the blocks assembly in both type A and type B grate sections, some of these blocks have been represented in FIG. 3 in working position on a grate beam 301 (merely indicated), the blocks being arranged in succession like roof tiles, with the adequate slope. Arched brackets 304 and transverse braces 303 are welded to the side plates 305 of beam 301, at intervals corresponding to the length of the blocks. The shoulders 209 and 210 respectively, embrace the beam 301 and abut against the transverse stops 303, thus holding the blocks in position on the beam. Furthermore, with the tongues 203 engaged in the arched brackets 304 and the nose 204 of each block resting on the rear face 201 of the preceding block, the blocks are secured in their reciprocal position, their faces 201 and 202 forming a continuous grate surface to carry the layer of refuse.

As may be seen from the preceding, no mechanical fastening devices, such as bolts, rivets or the like are used for attaching and fixing the blocks. This is an important feature, since mounting and/or dismantling the block system on and from the beams, as well as the removal of some of the blocks for inspection, repair or replacement can be carried out easily and quickly, even by hand, without the need of special tools.

The layer 300 of refuse travels downwards along the grate, as explained below.

FIG. 4 is an isometric view illustrating a type A grate section fully assembled and ready to be installed within the incinerator. The grate is delimited by two lateral or side beams 401 and 402, by a front end plate 403 and by chute edge 405, with the corner elements 404 in it. Between these limits, the grate surface is formed by a plurality of blocks, as described above, said blocks being arranged in an odd number of longitudinal rows (15 rows in FIG. 4), in the way shown in the previous FIG. 3. Of these rows, the odd numbered ones are fixed, whereas the even numbered ones are movable in the longitudinal direction, that is, axially of their length, by two hydraulic actuators 406 and 407 provided to effect such movement. In FIG. 4 the slots defining the air nozzles 205 (see FIGS. 2a and 2c) are clearly visible.

FIG. 5 is another isometric view of the type A grate section, but in a simplified and schematic showing, with the grate blocks removed, to render the grate beams and the actuating mechanism visible. In this connection, the form and shape of the grate block supporting beams is diagrammatically indicated. It is to be understood that in practice these beams are constructed and shaped so as to cooperate with the shoulders 209 and 210 on the plates and also to include the arched brackets 304 and transverse braces or stops 303 shown in FIGS. 3 and 3c.

The fixed rows of blocks rest on the equally fixed beams 507 of which only two are shown and one of them only partly. These fixed beams 507 are supported by transverse beams 506, to which they are firmly bolted. The surface determined by the upper faces of the blocks lying on these fixed beams 507 will be referred to in the following as the ‘grate plane.’

The hydraulic actuators 406 and 407 are linked in the usual way with the transverse beams 506, but through sliding shoes 304 and 305, so that said movable beams 503 can effect an alternate translational motion in horizontal (or nearly horizontal) direction, as imparted by the actuators 406 and 407. Thereby the movable block rows are alternately raised above what has been defined as the grate plane and retracted below it. By this, the intricate and cohesive layer of refuse is successively raised from the grate and then redeposited thereon at a place somewhat further along. The slope of the grate facilitating the progress, the layer of refuse is thus caused to travel down along the combustion chamber, at a minimum expenditure of energy.

By means of a convenient control system for the hydraulic actuators 406 and 407, coinciding and parallel motion is achieved for all movable parts.

FIG. 6 is an isometric view of a fully assembled type B grate section, comprising the same elements as the foregoing type A, in similar arrangement and with the same functions, so that repetition of the detailed description given above can be dispensed with. For the same reason, all reference numerals given in FIG. 4 have been omitted in FIG. 6.

Besides the functions common to both types of grates, further function has to be fulfilled on the type B grate section, viz. raking or poking or agitating the fire during the last phase of incineration, on the lower half of said grate section, to stimulate the combustion of the fixed carbon.

For this, special blocks with movable raking blades therein, are provided on each of the fixed beams, which will now be described in detail on hand from FIGS. 7, 8 and 9.

In FIG. 7 one of these special blocks 700 is represented in longitudinal and horizontal section and view. This again is a casting of high alloy steel, with similar profile as the block of FIG. 2, but provided with mounting flanges 701 and 701a at the bottom, by means of which it can be firmly bolted to the respective fixed beam of the grate (FIG. 5). In this position, the upper faces 702 of these blocks coincide with what was defined as the grate plane. In said faces 702, slotted openings 703 are provided for the raking blades to pass through. Two through holes 706 and 707 are coaxially machined across lateral hubs 704 and 705, in a direction perpendicular to the block’s axis.

The blocks 700 are fitted on the fixed beams 507 in one of the two planes transversal to the grate’s axis, with their hubs 706 and 707 in coaxial alignment, to serve as bearings for a rotatable through shaft 802 (see FIG. 8), which is held in axial position by usual means (retaining rings, washers and pins) resting in the recesses 708 and 709 machined in the blocks or plates 700. On this shaft 802, a plurality of raking blades are keyed,
one for each fixed beam, at intervals corresponding to that between two consecutive fixed beams. Thus, each raking blade is located axially in the slotted opening of the respective block.

In FIG. 8 one of the raking blades 801 is illustrated. This is a sector shaped plate, concentric with the shaft 802. By means of a hydraulic actuator (not represented in the drawing) a swinging or pivoting motion is imparted periodically to a driving or rock shaft 803 and from it through the link 804 and the intermediate lever 805 to the shaft 802 and the raking blades 801 on the latter. In FIG. 8 a raking blade is shown in lowered position, with its upper radial margin in the grate plane. By the upward swinging motion, the raking blade is brought into its uppermost position, as represented in FIG. 9, thereby protruding through the slotted opening 703 and above the grate plane, as shown in FIG. 6.

As mentioned above, the swinging or pivoting motion of the raking blades is periodical, with its frequency and amplitude being regulatable. Due to their flat shape and to the powerful hydraulic drive, the raking blades 801 actually penetrate the refuse layer, like cutters or knives, thereby effectuating the desired poking of the fire. It must be remembered that at this stage of incineration, a high percentage of ashes and other uncontrollable matter is present in the layer of refuse, surrounding the still combustible particles therein and thereby constituting an obstacle to the access of oxygen and to the consumption of said combustible particles. By penetrating into the refuse, the raking blades bring about a loosening up of the overlying layer and, so to speak, free the combustible particles from their suffocating environment. By the agitation or shaking action thus obtained by the supply of hot combustion supporting air and by the effect of radiant heat from the overhanging reverberatory vault, complete burn-out of the refuse is achieved.

The swivelling mechanism 803-805 as shown in FIGS. 7 and 8, is only an example of a possible embodiment and can be replaced by any other device or means of similar scope, without adversely effecting the purpose and effect of the inventive raking blades 801.

The possible arrangements of the inventive grate sections A and B within the combustion chamber of an incinerator, are not limited to that illustrated as an example in FIG. 1. In incinerators of high ratings, one or more type A grate sections may be provided as receiving stations for pre-drying and then igniting the refuse, with two or more type B grate sections arranged in succession constituting the combustion grate proper. The grate sections are positioned in stepped arrangement, with vertical (or nearly vertical) wall means between them, with possibly different slopes and with the motions of their beams and raking blades possibly different with regard to frequencies and amplitudes, all parameters being selected and adapted to best suit the specific requirements of the process phase occurring on the respective grate section.

It should be apparent from the foregoing detailed description that the objects set forth at the outset to the specification have been successfully achieved.

Accordingly, what is claimed is:

1. In an incinerator for waste material, such as municipal refuse and similar waste material, a mechanical combustion grate means comprising a plurality of separate and inclined grate sections disposed in consecutive and stepped arrangement, and an at least approximately vertical wall means between at least two successive sections, each said grate section comprises a plurality of longitudinally extending, alternately fixed and movable beams, rows of blocks fitted on said beams, said blocks comprising steel castings and including stepped upper faces and profiled protruding supporting parts and shoulders, and brackets and stops integral with said beams and cooperative with said profiled protruding supporting parts and shoulders for fixation of said blocks on said beams, said blocks having an open slot between said stepped upper faces defining an outlet nozzle for combustion supporting air, supplied as an underblast from below the grate section to a layer of refuse on the upper faces of said blocks, means for imparting an alternate least approximately horizontal translational movement to the movable beams, so that the rows of blocks thereon alternately protrude and retract above and below the grate surface as defined by the upper faces of the blocks in the fixed rows of blocks and said alternate translational motion being regulatable with regard to frequency and amplitude.

2. In an incinerator for waste material, such as municipal refuse and similar waste material, a mechanical combustion grate means comprising a plurality of separate and inclined grate sections disposed in consecutive and stepped arrangement, an at least approximately vertical wall means between at least two successive sections, in which a grate section comprises a plurality of longitudinally extending, alternately fixed and movable beams, rows of blocks fitted on said beams, said blocks comprising steel castings and including stepped upper faces and profiled protruding supporting parts and shoulders, and brackets and stops integral with said beams and cooperative with said profiled protruding supporting parts and shoulders for fixation of said blocks on said beams, and in which said blocks can be removed from said means without the need of loosening any mechanical fastenings.

3. In an incinerator for waste material, such as municipal refuse and similar waste material, a mechanical combustion grate means comprising a plurality of separate and inclined grate sections disposed in consecutive and stepped arrangement, an at least approximately vertical wall means between at least two successive sections, in which a grate section comprises a plurality of longitudinally extending, alternately fixed and movable beams, rows of blocks fitted on said beams, said blocks comprising steel castings and including stepped upper faces and profiled protruding supporting parts and shoulders, and brackets and stops integral with said beams and cooperative with said profiled protruding supporting parts and shoulders for fixation of said blocks on said beams, and further including profiled blocks, each including an upper face and opposite side walls, said blocks being firmly fitted on said fixed beams, said profiled blocks each having a longitudinally extended slotted opening in its upper face and two coaxial holes in its respective side walls extending in a direction perpendicular to the longitudinal axis of each block, said holes in all said profiled blocks being in coaxial alignment within one transverse plane to constitute bearings, a rotatable through shaft in said holes and sector shaped plates keyed to said shaft at such spaced intervals as to position said sector shaped plates centrally with respect to said slotted openings in the profiled blocks.

4. A mechanical combustion grate means as claimed in claim 3, and further including means for imparting oscillatory movement to said rotatable shaft and to the sector shaped plates keyed thereon between a lowermost position with said plates recessed within the grate surface and an upper position with said plates protruding above the grate surface and said oscillatory movement being regulatable with regard to frequency and amplitude.

5. A mechanical combustion grate means as claimed in claim 1, wherein said blocks are fixed on said longitudinally extending fixed and movable beams so as to provide respective longitudinally extending alternate rows of fixed and movable blocks, each alternate row of blocks extending in the lengthwise direction of its associated grate section.

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