United States Patent [19]

Sigg

[11] **3,841,242**

[45] **Oct. 15, 1974**

[54] **APPARATUS FOR BURNING WASTE MATTER**

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[52] **U.S. Cl.** ..... **110/8 R,** 110/38

[51] **Int. Cl.** **F23g 5/00**

[58] **Field of Search** ..... 110/8 R, 8 A, 8 C, 38, 110/165 R

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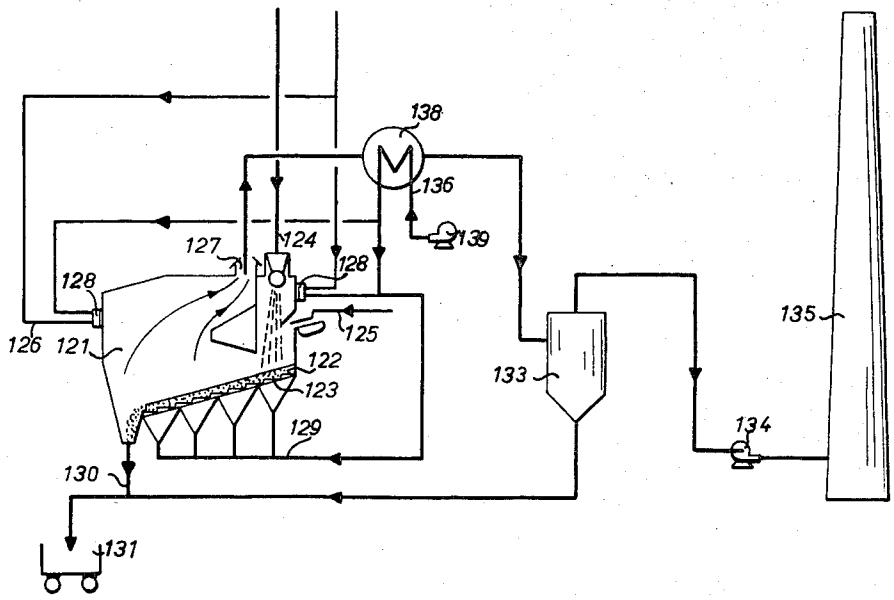
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Primary Examiner—Kenneth W. Sprague
Attorney, Agent, or Firm—Flynn & Frishauf

[57] **ABSTRACT**

In a combustion chamber, an inclined feed bed with a plurality of stepped sections is vibrated and the burning waste matter proceeds down the steps of the feed bed to the ash discharge. Combustion air is introduced at the bottom of the risers of the steps through arrangements for protecting the air down along the surface of the bed. The stepped sections are hollow and are formed by overlapping plates having a rear extension that rises obliquely upward inside the next higher section to oppose flow of the waste material into the air supply. The forward end of the step may be provided with a rim, but the top of the rim is lower than the upper end of the rearward extension of the same step. The rim is perforated with horizontal slots at the step level.

13 Claims, 11 Drawing Figures



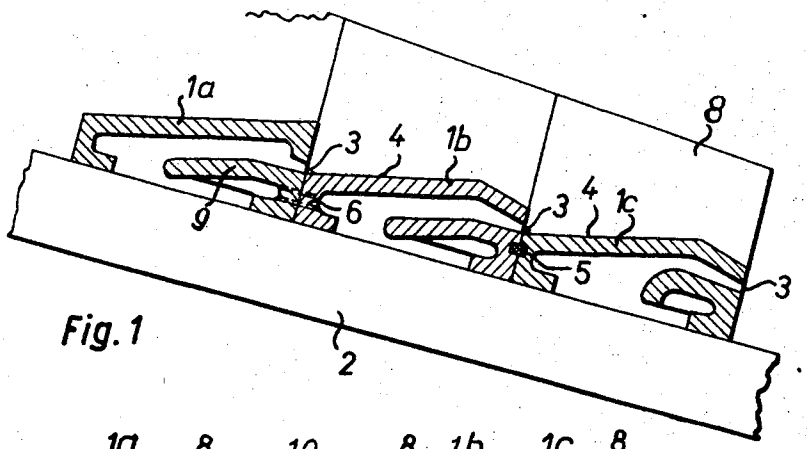


Fig. 1

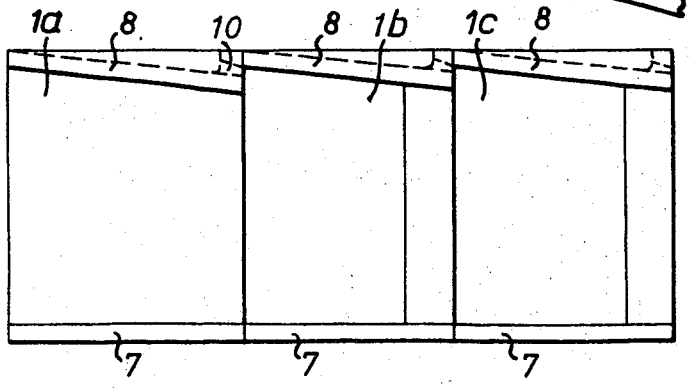


Fig. 2

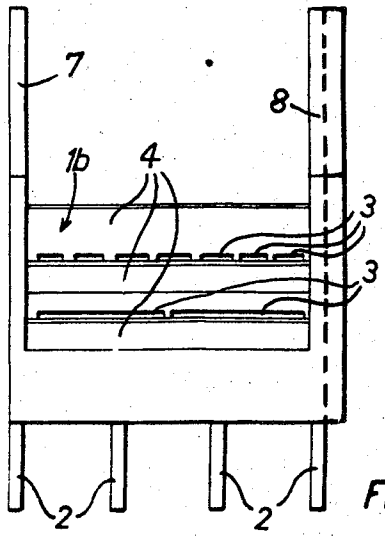


Fig. 3

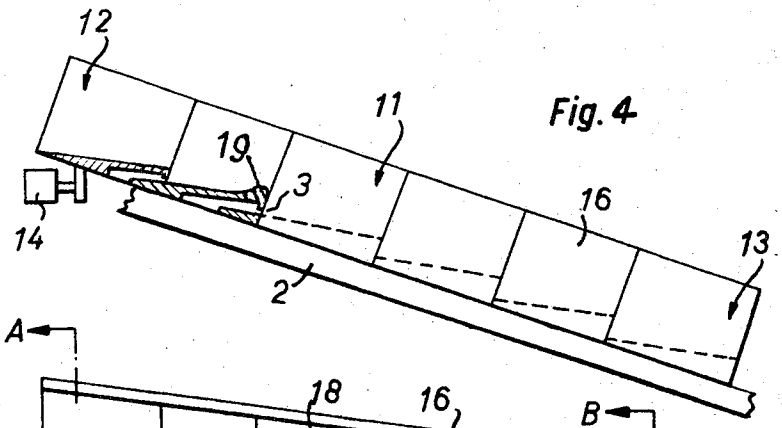


Fig. 4

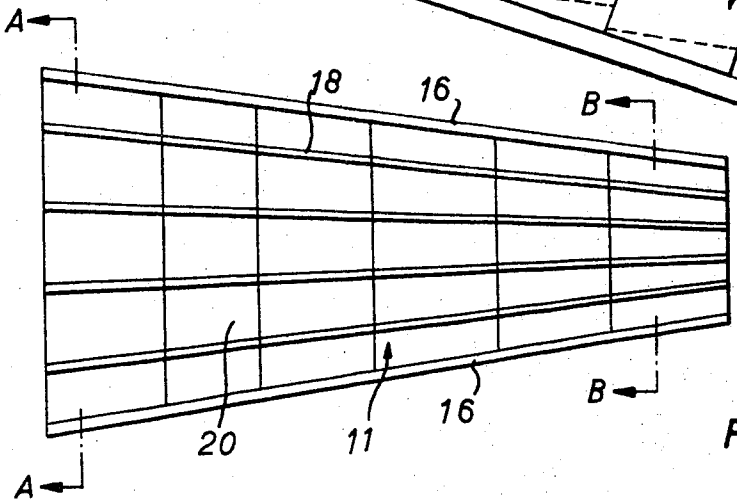


Fig. 5

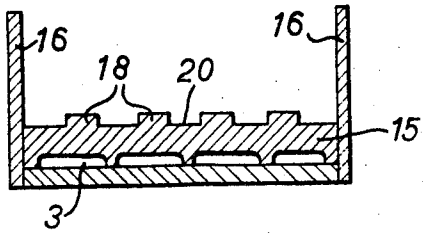


Fig. 6

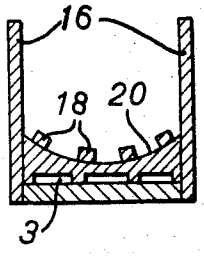


Fig. 7

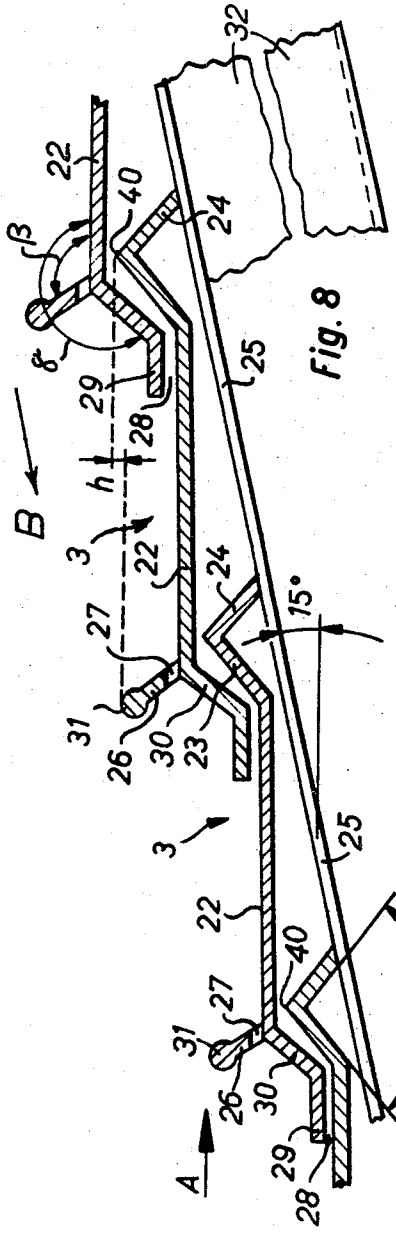

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Fig. 8

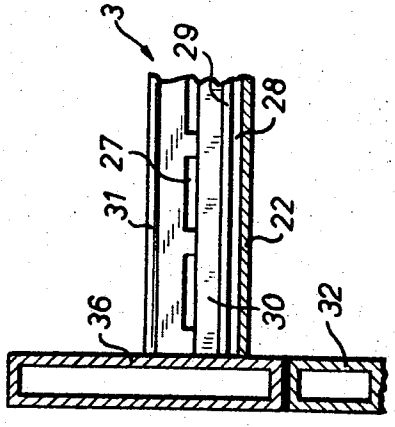

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Fig. 9

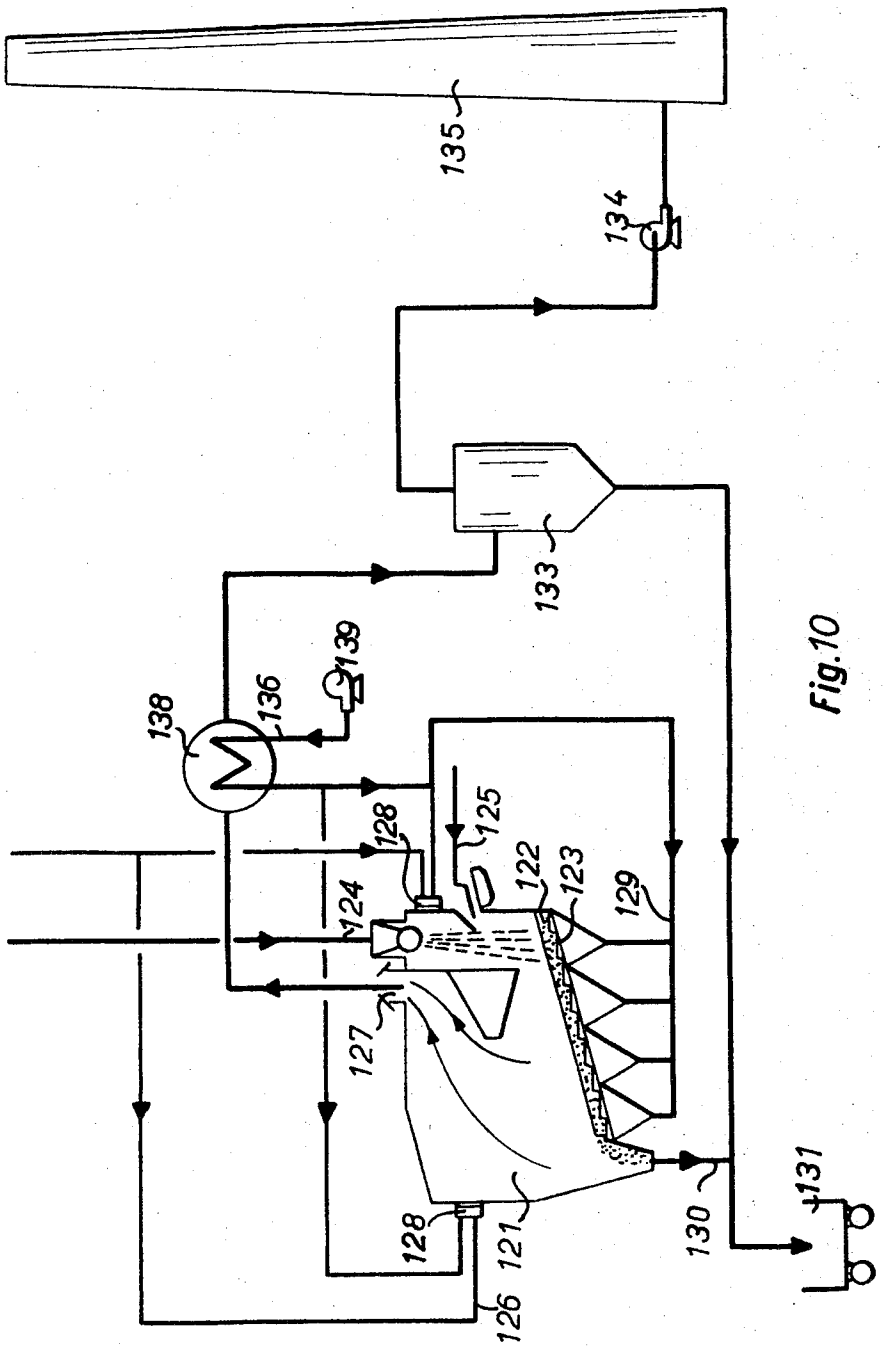

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Fig.10

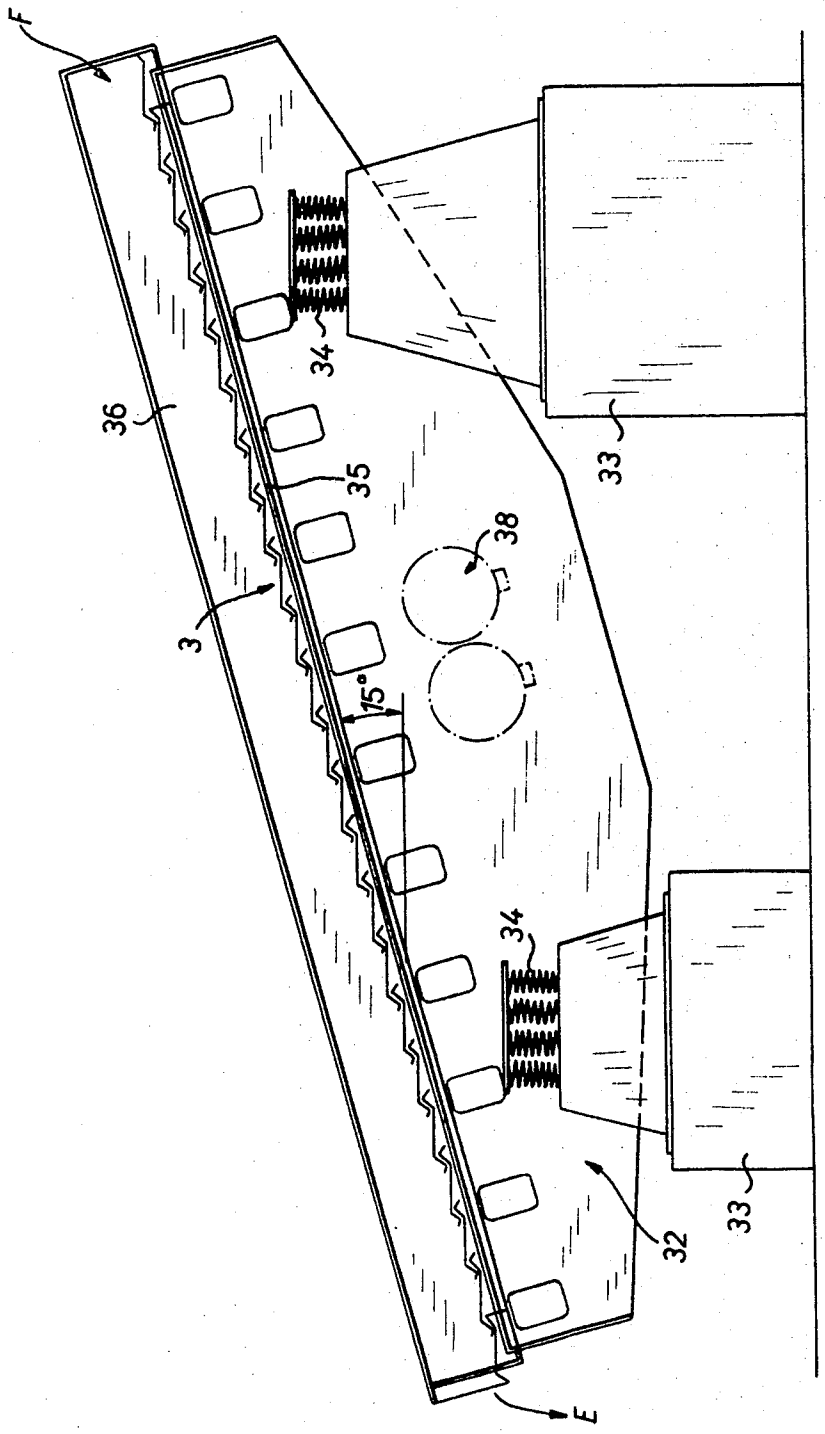


Fig.11

APPARATUS FOR BURNING WASTE MATTER

This application is related to application Ser. No. 239,418, filed Mar. 30, 1972, now U.S. Pat. No. 3,791,316.

The invention relates to an apparatus for burning waste matter, such as refuse, rubbish, garbage, sludge and the like.

PRIOR ART

In previously known systems for burning waste matter the burning material generally lies on a grate which has downwardly directed openings through which the air for combustion reaches the burning material. This grate usually consists of stationary parts and movable parts. Through a suitable reciprocating movement the burning material is moved along the grate from an entry point to a discharge point.

The disadvantages of these known systems consist firstly in that, at the parts which move relative to one another, the moving grates have gaps which enable material to fall through, while on the other hand they are subject to considerable mechanical and thermal stressing and wear. Moreover, another disadvantage consists in that the feed mechanism for the burning material must be situated in the fire chamber and is consequently subject to thermal stressing.

It is accordingly a first object of the invention to provide an apparatus or equipment for burning solid waste matter, pulpy or pastelike substances and sludge, which hitherto entailed the risk that they might pass between the grate openings.

It is a further object of the invention to prevent the material from falling through the grate even when it forms slag or otherwise contains semifluid matter.

Another object of the present invention is the provision of an improved arrangement, which can be made mechanically very simple and can be produced at a relatively low cost.

A further object of the present invention is to provide an apparatus in which the speed for burning of waste matter can be substantially increased over that possible with prior art mechanism.

SUBJECT MATTER OF THE INVENTION

Briefly, apparatus for burning waste matter is provided which comprises a feed bed consisting of a plurality of hollow stepped sections, means for introducing combustion air in the region of the transition from one stepped section to the next, the upper sides of the stepped sections being closed, neighboring stepped sections overlapping to prevent the waste matter or the residue thereof from falling therebetween and with the end faces forming the risers of the steps having apertures for the supply of air to support combustion. The upper surface overlapped portion behind the riser face rises obliquely upwards and rearwards to prevent the material being burned from going through the grates.

The features of this invention together with further objects and advantages thereof, may be best understood by reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic vertical section through a first embodiment of an apparatus for burning waste matter, with stepped sections of different constructions,

FIG. 2 is a diagrammatic plan view of the apparatus shown in FIG. 1,

FIG. 3 is a diagrammatic front view of the apparatus of FIGS. 1 and 2,

FIG. 4 is a side elevation, partly in section, of a second embodiment of an apparatus for burning waste matter.

FIG. 5 is a plan view of the apparatus shown in FIG. 4,

FIG. 6 is a section on the line A—A in FIG. 5 and

FIG. 7 is a section on the line B—B in FIG. 5,

FIG. 8 is a diagrammatic vertical section through a third embodiment of apparatus for burning waste matter, showing an arrangement of stepped sections operating as a grate,

FIG. 9 is a front elevation, partly in section, of a portion of the embodiment shown in FIG. 8, viewed in the direction of the arrow A of FIG. 8,

FIG. 10 is a general view of a combustion installation and

FIG. 11 is a diagrammatic side elevation view of the stepped grate structure of an installation according to FIG. 10, including the means for vibrating the structure.

The embodiment of the apparatus for burning waste material, such as refuse, rubbish, garbage and sludge, illustrated in FIGS. 1 to 3 is incorporated in a combustion plant which may be provided with a multi-purpose burner. A combustion plant of this kind may however also be used for burning plastic materials, or for the cremation of animal corpses. It has a feed bed with a plurality of hollow stepped sections 1*a*, 1*b*, 1*c*, which are closed at the upper side 4 and are disposed like a staircase. These stepped sections are fastened rigidly on a vibrating frame 2. The waste material to be burned is poured onto the uppermost step 1*a* of the feed bed, and during burning passes downwards from step to step in the form of burning material or a fire bed. The required air for combustion is fed from below to the stepped sections through passages and passes out through slots 3 on passing from one stepped section to the next. These slots 3, or outlet nozzles, are situated directly at the height of the upper side 4 of the next following lower stepped section.

In FIG. 1 stepped sections with three different kinds of profiles 1*a*, 1*b* and 1*c* are illustrated. Still other kinds of stepped sections are shown in FIGS. 4 and 8 respectively. As a rule, however, only a single kind of stepped section is used in one combustion apparatus. The inclination of at least a part of the upper side 4 of the individual steps is oppositely directed to the inclination of the frame 2 which is preferably about 15°. In order to prevent waste material or the products of combustion from falling through at the divisions between the end faces of neighboring step sections 1*a*, 1*b*, 1*c*, the stepped sections are joined tightly to one another either by a traverse bar 5 or by being pulled close to one another by means of screws 6 or other fixing elements.

The individual stepped sections are hollow and, as the air for combustion enters from the lower side, heat exchange takes place. A deflector 9 projects into the interior of the cavity of the stepped sections and deflects the current of air, while at the same time enabling the air to flow in substantially without turbulence and practically parallel to the upper side 4 of the stepped sections.

The steps 1*b* and 1*c* have an upper side **4** with ribs. In the case of the combustion of liquid or paste-like waste matter it is however convenient for a transverse bead **19** to be provided at the outer end of the stepped sections (FIG. **4**). The deflector **9** is so shaped that over at least part of its length it is situated at a higher level than the upper surface **4** of the next lower stepped section, in order to prevent a return flow.

Upwardly projecting guide plates **7,** which are provided on one side of the stepped sections, form a flat wall, while guide plates **8,** which are provided on the other side, have a staircase-like stepped profile. Moreover, additional air for combustion may optionally pass out through gaps **10** between the guide plates.

In the alternative embodiment illustrated in FIGS. **4** to **7,** the waste material passes gradually from an inlet **12** to an outlet **13,** from which the residue, ashes or slag are removed. A feed bed **11** is provided with a vibrator **14,** by which it is kept in continuous or intermittent movement, so that the burning material moves downwards through the action of the vibrations. The individual steps are slightly inclined towards the outlet **13.**

Vertical side walls **16,** which laterally bound the burning material, converge in the direction of movement, the width of the feed bed decreasing in the direction of the outlet **13** in the embodiment illustrated in FIG. **5.** Since the height of the layer of waste material decreases as the combustion process progresses, it is convenient for the width of the feed bed to decrease in the direction of the outlet **13.**

When special circumstances exist, however, it is also possible for the width of the feed bed to increase in the direction of movement, that is to say in the downward direction.

In order to guide the burning material, which is moving downwards in the direction of movement through the action of the vibrations, towards the longitudinal centre, there are provided on the upper side **20** of stepped sections **15** ribs **18** which are likewise convergent in accordance with the varying width of the feed bed, as can be seen in FIG. **5.**

From FIGS. **6** and **7** it can be seen that not only the width but also the cross-sectional shape of the feed bed vary in the direction of movement. Near the inlet **12,** the upper side of the stepped sections **15** extends substantially horizontally and straight, viewed in cross-section, whereas in the direction of the outlet **13** it gradually merges into a curved, concave shape.

It is preferable for the stepped sections to be made of a compacted refractory mineral material which sets chemically. Ceramic compositions which have good resistance to acids have been found satisfactory as compacted materials. It is also possible for the individual stepped sections to be formed by producing a skeleton of metal which is enclosed in or lagged with a compacted material.

The two side walls **16** and the stepped sections **15** are preferably in one piece.

The material to be burned is advanced continuously through the action of the vibrator. Brief interruptions, or the throttling of the vibrations, are also possible. Furthermore the vibrator may be operated with a variable amplitude or frequency in order to achieve slower or faster advance of the burning material. In addition it is also possible for the vibrator to be fastened pivotally, so that its vibrations act more in the direction of advance of the burning material or, for the purpose of throttling the advance, more in the vertical direction.

The stepped sections 1*a*, 1*b*, 1*c*, and the side walls **16** are conveniently made of heat-resistant cast iron, steel, or cast alloy steel.

Instead of the gap between two neighboring step sections being disposed at the step riser, a construction would also be possible in which the deflector **9** is in one piece with the part 1*a* or 1*b* or 1*c* following in the direction of movement. Here again the highest point of this deflector **9** should be at a higher level than the following upper side **4** or of the cross-rib **29,** where the latter is provided.

FIG. **8** chose a form of stepped structure that is particularly well suited for the practice of the invention. An apparatus using this type of stepped structure in connection with the burning of waste matter is usable for a wide variety of refuse, whether solid, granular, pasty or even fluid. This refuse may be household rubbish, industrial waste, or sediment or sludge or similar materials that may contain or be mixed with combustible matter. The plate portions **22** shown in FIG. **8** are tilted slightly from the horizontal, leading slightly down in the direction in which the material to be burned moves down the stepped structure. The plate portions **22** extend to the rear under a front lip **29** of the riser **30** of the next step up in sequence and are provided with a roof-like extension **23,24** behind the riser of the next step, instead of the other forms of the guide surface **9** shown in FIG. **1.** The two pitches **23** and **24** of the gable meet at an angle α measuring between about 70° and about 110° and preferably at 90°. At the front end of the plate portion **22,** where it meets the downwardly extending riser **30** is provided an obliquely rising retaining member **26** having openings **27** in the form of slits, the height of which is reduced in the advance direction designated by the arrow B. Its upper edge, which may, for example be beaded as shown at **31,** is lower than the peak of the rooflike extension **23,24** at the other end of the plate portions **22.** This relation is shown in FIG. **8** by the indication of the height difference h on the diagram. This height difference is important for preventing a rearward flow of the refuse material into the air supply channels and into the portion of the apparatus below the stepped structure.

The stepped riser surface is formed, as already mentioned, by a downwardly directed extension **30** of the plate portions **22** which, as shown in FIG. **8** is obliquely disposed and has at the bottom a lip **29** more or less parallel to the plate portions **22** of the next step down.

Between the step forming plates of neighboring steps there are accordingly provided tapered flat nozzles **28** for supplying air to support combustion. The angle β between the plate portion **22** and the retaining member **26** is, for example, about 120°, while the angle γ shown in FIG. **8** to define the relation of the plate portion **22** has its forward extension downwards is, for example, about 230°.

The grate is continuously vibrated during firing, so that the burning material is slowly propelled in the direction of the arrow B towards the ash discharge and E. The amplitude or direction of the vibration may be varied or the vibrations can be produced intermittently rather than continuously, in order to control the speed of advance of the material according to the combustibility and other qualities of the refuse to be burned.

The plates forming the stepped profile, namely comprising the portions **22,23,24,29** and **30** have unbroken surfaces and are tightly joined to the sidewalls **36** one of which is shown in FIG. **9,** being, for example, welded or screwed fast to the sidewall. These plates are preferably made of heat resisting sheet metal, with the portions **22,23,24,29** and **30** formed in one piece and the retaining members **26** welded on.

FIG. **9** shows a front view, partly in section, of a portion at one side of the apparatus of the structure shown in FIG. **8,** indicating the shape of the slits **27.**

FIG. **10** shows a schematic illustration of a combustion installation with a combustion chamber **121.** Solid waste is entered in the inside of the combustion chamber **121** by transporting means **125** and sludge or the like is entered by a pipe **124** at a predetermined rate. Fuel gas pipes **126** and air pipes **136** are discharging into burners **128,** so that a high temperature is generated in the combustion chamber **121.** The waste or sludge forms a burning fluidized bed **122** on the stepped sections **123,** which corresponds to the step sections **1***a*, **1***b* or **1***c* or FIG. **1.** To assist the burning process air is blown by a flower or fan **139** via a pipe **129** from the underside of the frame to the outlet nozzles or slots **3** of the stepped sections. The ash **130** is collected in a fly ash conveyor **131.** The uncleaned exhaust gas leaving the combustion chamber **121** is collected by a fuel or smoke gas cap **127** and passes then through a heat exchanger **138** and a multi-cyclone **133** and is then guided to an induced draught fan **134** into a chimney exhaust **135.**

FIG. **11** shows the arrangement for moving the fluidized bed on which the material burned in the apparatus proceeds from the feed end F to the exit end E from which the ashes discharge. Between **10** and **30** steps are provided for support of the burning fluidized bed, preferably about **20** to **25** steps over a length of preferably around **25** to **30'** altogether. As shown in FIG. **11,** a vibration frame **32** is supported by spring mountings **34** respectively on two stationary pedestals **33.** The frame **32** has inclined carrier rails **35** inclined between 13° and 17° to the horizontal, preferably about 15°. The two sidewalls **36** are firmly affixed to the carrier **35** and converge somewhat in the downward direction in the manner shown in FIG. **5.** That is, at the feed point F for the refuse, the spacing of the sidewalls is greater than at the ash exit E. The vibrator **38,** by which the entire vibration frame **32** the carrier **35** and the stepped structure affixed to the sidewalls **36** is set into motion, is located between the two spring mounts **34.**

Although the invention has been described with reference to particular embodiments, it will be understood that variations and modifications may be made within the inventive concept.

I claim:

1. Apparatus for burning waste matter comprising:

a longitudinally inclined feed bed carrier (**35**) provided with means (**38**) for vibrating said carrier;

a plurality of hollow step-forming sections mounted in fixed positions transversely on said carrier so as to present a support surface for said waste matter that is substantially continuous except for openings in the risers of said stepped surface;

said step-forming sections being formed of overlapping plates of fire-resistant material arranged with their long dimension transverse to the longitudinal direction of said feed bed carrier and being bent on a plurality of lines substantially parallel to their said long dimension, and having an obliquely rising rear extension (**23**) under the overlap of the next higher plate for opposing flow of waste matter from the stepped surface rearwardly into the openings;

means for introducing combustion air into the space between said carrier and said stepped sections for supplying said air through said riser openings to the combustion of said waste matter, and

retaining side walls (**36**) mounted in fixed positions on said carrier and extending above said stepped surface on either side to prevent sideways escape of said waste matter.

2. Apparatus according to claim **1** in which said obliquely rising rear extension (**23,24**) has a further downard extension (**24**) giving it roof-like shape.

3. Apparatus according to claim **1** in which said plates are provided in the forward portions of their upper surfaces each with an upwardly obiliquely extending retaining member (**26**) disposed in the long dimension of the plate with its upper edge (**31**) lower (h) than the upper end (**40**) of said obliquely rising rear extension (**23**) of the same plate.

4. Apparatus according to claim **1** in which said plates each have a forward lip portion (**29**) directed approximately parallel to the principal upper surface of the next lower plate and spaced therefrom so as to provide the aforesaid riser openings of said stepped surface in a form constituting laterally extensive and vertically narrow nozzle passages (**28**) for combustion air.

5. Apparatus according to claim **4** in which the cross-section of said nozzle passages (**28**) is tapered and narrows towards the discharge opening.

6. Apparatus according to claim **1** in which said carrier (**35**) has an inclination of between 13° and 17°.

7. Apparatus according to claim **6** in which the inclination of said carrier (**35**) is approximately 15°.

8. Apparatus according to claim **1** having not less than 10 nor more than 30 of said step-forming sections.

9. Apparatus according to claim **1** in which said carrier (**35**) is mounted by spring mounts (**34**) on two stationary supports (**33**) substantially between which are located said means (**38**) for vibrating said carrier (**35**).

10. Apparatus according to claim **3** in which said obliquely upwardly extending retaining members (**36**) are provided with slot-shaped openings (**27**) at about the level of the surface of the principal portion (**22**) of the plate to which it is affixed.

11. Apparatus according to claim **1** in which the downwardly deflected portion (**30**) of each of said plates which forms the riser for said stepped surface has an external angle (γ) to the principal portion (**22**) of said plate of between 200° and 260°.

12. Apparatus according to claim **11** in which said external angle (γ) is about 230°.

13. Apparatus according to claim **1** in which said plates are each formed in one piece having an unbroken upper surface out of metal plate or sheet material and which are rigidly affixed to said retaining side walls (**36**).

* * * * *