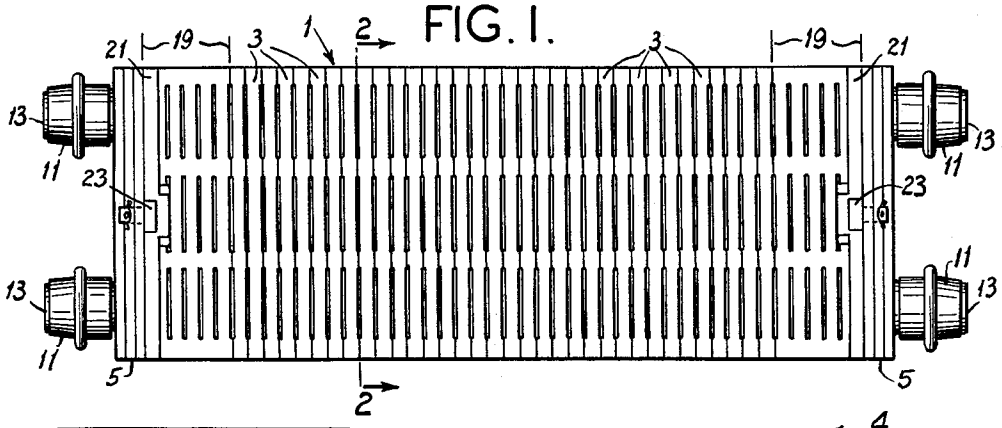
Nov. 13, 1962 J. H. CULLING 3,063,696

GRATE BARS

Filed March 9, 1959 2 Sheets-Sheet 1

FIG. 1.



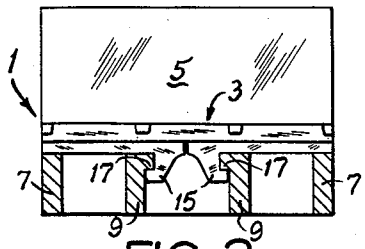


FIG. 2.

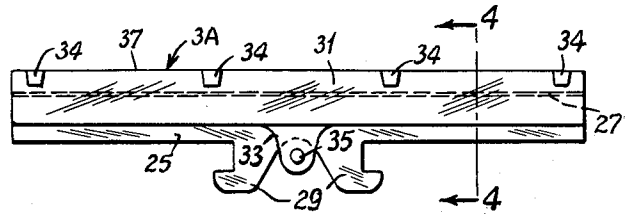


FIG. 3.

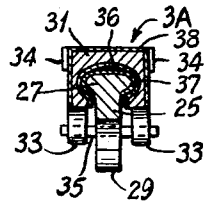


FIG. 4.

FIG. 6.

FIG. 5.

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GRATE BARS

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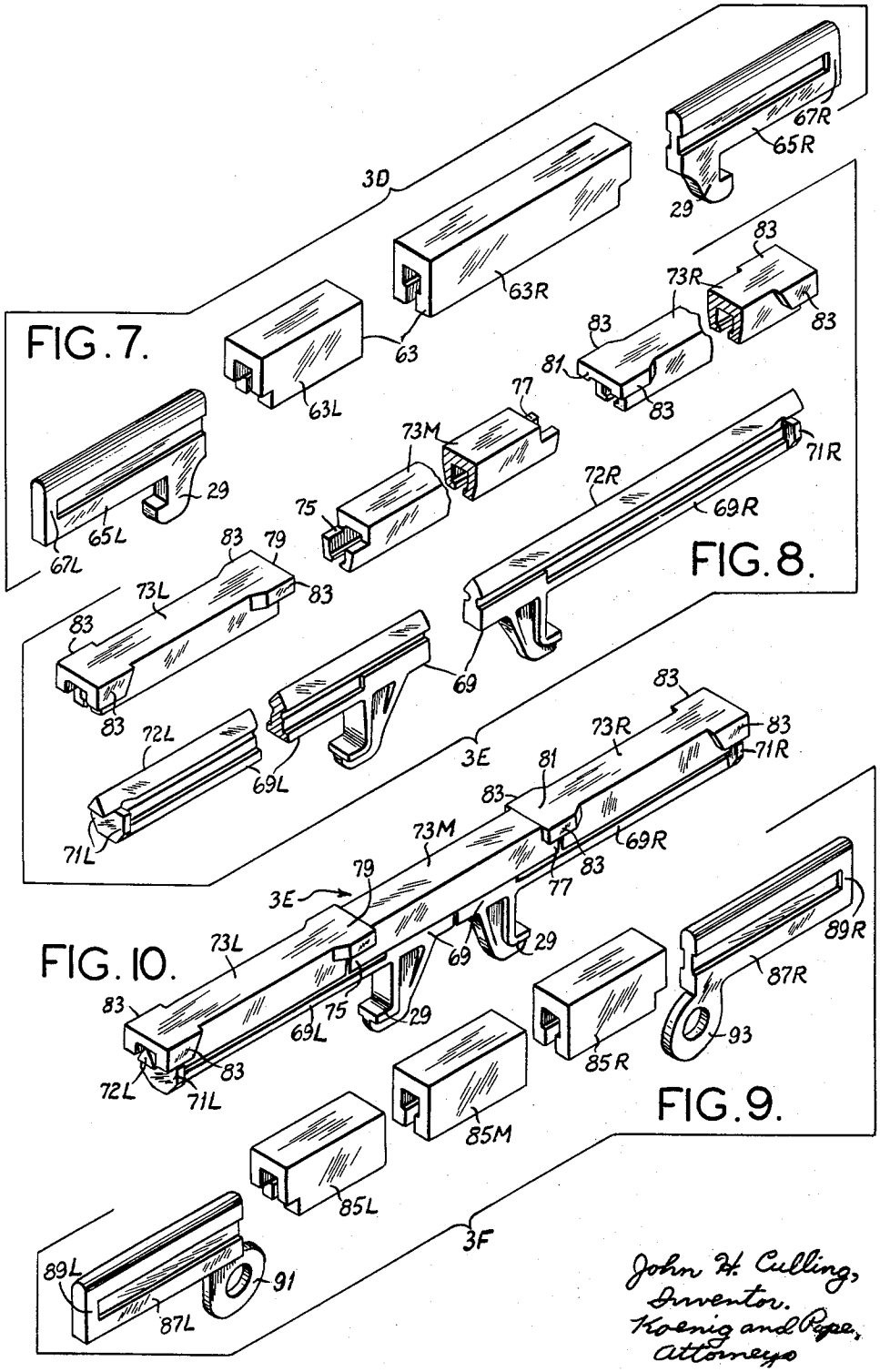

FIG. 7.

FIG. 8.

FIG. 10.

FIG. 9.

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GRATE BARS

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6 Claims. (Cl. 266—21)

This invention relates to grate bars, and more particularly to grate bars which are subjected in use to extreme conditions of temperature, corrosion, abrasion and physical impact.

Among the several objects of the invention may be noted the provision of grate bars which have improved mechanical and corrosion-resistant properties, and which will resist breaking, cracking, warping, chemical attack, and extreme temperature and wear conditions; the provision of such grate bars which may be used in moving conveyor furnaces and which will withstand both the mechanical and impact stresses and the extreme temperature and corrosion conditions present in such furnaces; and the provision of grate bars of the class described which are self-straightening and aligning, and self-cleaning, and which effect a substantial economy of manufacture and replacement, and which are flexible in design as to materials of construction. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments are illustrated,

FIG. 1 is a top plan view of a pallet of an endless conveyor of a sintering furnace or the like, carrying a plurality of grate bars of the present invention;

FIG. 2 is a cross section of line 2—2 of FIG. 1;

FIG. 3 is a side elevation of one embodiment of the present invention;

FIG. 4 is a cross section on line 4—4 of FIG. 3;

FIGS. 5–9 are exploded perspective views of five other adidtional embodiments of this invention; and,

FIG. 10 is an assembled perspective view of the grate bar embodiment of FIG. 8.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now more particularly to FIGS. 1 and 2, a pallet of a sintering furnace conveyor is indicated generally at reference numeral 1. A large number of these pallets are linked together to form a continuous articulated moving conveyor adapted to transport finely divided material, such as ores or other chemical material layerwise, or as a moving bed, through heating or reaction zones to effect a desired chemical or physical change in the properties thereof. Such a sintering furnace is well known to those skilled in this art, a specific example of such apparatus being a Dwight-Lloyd type machine. A grille for supporting this bed of material is provided by mounting a number of grate bars 3 side-by-side in the pallet. More specifically, the pallet includes a rectangular open frame comprising two spaced-apart side members 5 connected rigidly together by two outer cross beams 7 and two inner cross beams 9. The pallet is adapted for movement along continuous parallel tracks by means of four flanged wheels 11 journalled on shafts 13, which are affixed to and project outwardly from the outer surfaces of pallet side frame members 5.

Grate bars 3 are conveniently mounted within the pallet by lowering them individually with a twisting motion so that their lower portions which constitute hooked foot members 15 lock under lips 17 of the cross members 9. This prevents the grate bars from moving in a vertical plane and falling out when the pallet traverses the ends and under reach of the conveyor at which times it is either tilted or upside down. A sufficient number of grate bars 3 are assembled side-by-side to form a grille substantially across the width of the pallet. In order to prevent sidewise movement of the bars in the pallet, two identical end bar units 19 are provided as filler blocks. These end bar units do not include any foot members but rest on the upper surfaces of cross bars 7 and 9. One outer side of each of the end bars 19 has a horizontal flange 21 which is engaged by the head of retaining pin 23. The shanks of these pins 23 project through holes in the pallet sides 5 and are provided with a cotterkey to prevent their becoming disengaged from the pallet.

During operation of the sintering furnace, finely divided raw material to be heated and/or chemically reacted is dropped as a layer on the moving pallet grille and heated by flames impinging on the upper surface of the moving bed and/or passing heated air through the grille and the bed. Inasmuch as the upper surfaces of the grate are covered by the material, they are subjected to extreme temperature, abrasion and corrosion conditions which constitute a serious problem as to warping of the bars 3 and a corroding and abrading away thereof. Moreover, because of the mecahnical stresses on the grate bars and the repeated physical impacts as the pallet moves from the upper reach of the conveyor to the lower reach, these grate bars tend to break and crack. It is difficult to provide a single material or composition that is corrosion, abrasion, and heat resistant and still able to withstand the physical impacts and mechanical stresses to which these moving grate bars are subjected. Thus material which is sufficiently malleable or ductile to possess the necessary impact strength usually has poor heat, abrasion, and corrosion resistance properties, and vice versa.

In accordance with the present invention, grate bars are provided which can be subjected to and which will withstand these extreme conditions of temperature, corrosion, abrasion, impact and mechanical stresses. Moreover, my grate bars are self-straightening and aligning, as well as self-cleaning, and are economical to manufacture and replace. One embodiment of a grate bar of the present invention is shown generally at 3A in FIGS. 3 and 4 to include an elongate rail or base component 25 having an upstanding longitudinal rib 27 extending along the top edge substantially the entire length of and integral with the grate base or body 25. Extending from but integral with the base 25 is a foot member 29 constituted by two hooks or lugs adapted to engage the pallet frame of a sintering machine conveyor or the like. Grate 3A also includes an elongate channel-shaped cover 31 slidably and loosely engaging rib 27. Means are provided by downwardly depending integral ears 33 and a pin 35 for locking ocver 31 to base 25. This prevents separation of cover 31 and base 25 but permits relative longitudinal movement and thermal expansion of cover 31. In order to assure a slight spacing and form slots between sides of adjacent bars 3A when assembled in the pallet, a number of integral abutments 34 are provided. Also to minimize mutual areas of contact between cover 31 and base 25 it will be noted that the cross section of rib 27 is of somewhat different shape than the cross section of the generally C-shaped channel of cover 31. This decreases the thermal transfer or exchange of heat between these two components of grate bar 3A.

Preferably the shield or cover 31 is made of a different material than that of base 25. A metallic, or nonmetallic, corrosion, abrasion, and heat resistant material which may be relatively brittle is used for the cover 31 while an impact resistant, malleable or ductile metal or metallic

alloy is employed in the material of construction for base 25. For example, I may use a high-silicon cast iron (such as the Silal type), an aluminum cast iron (such as a Tschugal type), other ferrous alloys of aluminum, silicon and chromium, or nonferrous alloys. Also, materials such as Monel, Hastelloy and Inconel, too expensive to use for the entire grate bar, may be advantageously used for cover 31. Materials of low coefficients of thermal conductivity and expansion to resist transfer of heat and warpage may be advantageously used for cover 31. For the base or body 25, plain carbon or mild steel, ductile iron, spheroidal or nodular graphite cast iron, high strength grey iron (such as acicular ferritic iron, malleable cast iron, copper and aluminum alloys, etc.) are all impact resistant (although adversely affected by high temperatures, abrasion and corrosion) and thus could advantageously be utilized.

In some instances it may be desirable to further increase the thermal isolation or minimize the heat transfer between the cover and base components of the grate bar, and for this purpose a coating or layer of an insulating material on the interior surface of the channel of cover 31 may be provided as indicated at 36. Such coatings, which may be any refractory material such as a ceramic or cermet material, additionally decreases heat exchange beyond the decrease affected by the loose fit (e.g., 1/16" average spacing between the surface of the rib and the interior channel surface). An exterior insulating, or corrosion, or abrasion resistant coating may also be applied to the exterior surface of the base 25, particularly to rib 27, as indicated at 37, or to the exterior surface of cover 31, as indicated at 38.

In the operation of this device the separate cover and base portions and their loose interlocking provides important advantages. For example, the temperature of the base is maintained at a low level relative to the highly heated, abraded and corrosion-exposed cover 31. The limited relative longitudinal movement of the cover and base permits thermal expansion without tendency to warping and misalignment, while still locking the two components of grate bar 3A together.

Another novel feature of the grate bars of this invention is illustrated in FIG. 5 in which a grate bar 3B is shown to comprise a body or base 39 including symmetrical left and right hand rail or base sections 39L and 39R of approximately equal length positioned in an end-to-end relationship. In addition to longitudinal upstanding rib portions 41L and 41R which rib portions are on the upper edges of sections 39L and 39R and separated therefrom by a groove, the sections 39L and 39R are provided with thickened integral longitudinal reinforcing flanges 47 and 49 along their lower edges. The coaxial ribs 41L and 41R are distinctly rounded at their top surfaces so as to minimize areas of contact with the channel of a grate bar cover 51. This cover is provided with a tab 53 at each of its outer ends. Upon sliding cover 51 onto base sections 39L and 39R, it is loosely locked in place by bending tabs 53 downward so as to provide limited relative longitudinal motion between the base and cover components of bar 3B. This grate bar generally has the various operational and structural advantages of grate bar 3A, but in addition provides an economy of replacement in that upon damage to base member 39 replacement of only one part thereof may be accomplished.

The FIG. 6 grate bar, indicated at 3C, differs from bar 3B in that a one-piece base member 57 is employed and the locking means are constituted by ears 55 at each of the outer ends of base component 57. Also, a multiple-piece cover component comprising a left section 59L, a midsection 59M and a right section 59R are employed. These cover sections are slidably engaged in an end-to-end relationship on upstanding rib 61 of base 57. It will be noted that the loose locking action provided by bent-over tabs 55 provides a relative longitudinal movement and the loose fit on rib 61 provides some lateral play, which actions make bar 3C substantially self-cleaning and self-aligning when used in the pallets 1. Moreover, the use of a multiple-piece cover further insures against warpage.

The FIG. 7 embodiment discloses a two-piece cover 63 comprising a left section 63L and a right section 63R of unequal lengths. The base member of this grate bar includes a left rail or section 65L and a right rail or section 65R. These base sections are of equal length and are symmetrical. The locking means of this grate bar is constituted by the integral abutments or stops 67L and 67R formed at the outer ends of base sections 65L and 65R. When these base sections are axially slidably engaged in the channel of cover 63 and the foot members of 65L and 65R are engaged between the pallet cross members 9, separation of all components is prevented while relative longitudinal movement and thermal expansion are permitted. The grate bar of this embodiment, indicated generally at 3D, functions in generally the same way as the preceding grate bar embodiments and has the same general advantages, but in addition has a locking arrangement that is preferable in certain ways to those illustrated and described above.

Another embodiment, indicated generally at 3E (FIG. 8), comprises a modified base member 69 made up of a left rail or section 69L and a right rail or section 69R of equal length and symmetrical. In this exemplary grate bar, the locking means comprise a pair of shoulders 71L at the outer end of 69L and a similar pair of shoulders 71R at the outer end of base section 69R. Also, the cross section of ribs 72L and 72R is of generally triangular shape. Another additional feature of this grate bar 3E is its cover which includes three sections 73L, 73M and 73R arranged axially end-to-end. The abutting ends of 73L, 73M and 73R are made mutually overlapping by providing cut-away portions or notches 75 and 77 at the outer upper ends of cover section 73M, and by providing the inner ends of 73L and 73R with tongues 79 and 81 adapted to mate and overlap therewith. Also, a number of laterally extending integral spacers 83 are provided along the upper surfaces of cover sections 73L and 73R for sidewise spacing of adjacent grate bars when assembled to form the grille of a movable pallet. When these components of grate bar 3E are assembled as shown in FIG. 10, they are all held loosely locked together by the engagement of the foot member inside the flanges of members 9 of pallet 1. This embodiment has the additional structural advantage of being able to replace any one, two or three sections of the grate bar cover, or one or two sections of the grate bar base, separately depending on the relative wear or damage thereto, and effects a substantial economy in repair and maintenance. Parts stocking problems and costs are further minimized because the two sections of the grate bar are identical and two of the three cover sections are the same.

A still further embodiment is illustrated in FIG. 9 in which grate bar 3F includes a three-section cover indicated at 85L, 85M and 85R adapted to be slidably engaged on the upstanding rib of a two-piece base comprising a left rail or section 87L and a right rail or section 87R. It will be noted that locking means 89L and 89R of these grate bar sections are similar to those shown at 67L and 67R in FIG. 7, but that the foot member differs somewhat. The foot member in this embodiment is constituted by two eyes 91 and 93, which are adapted to be engaged by a pallet which would have transverse rods instead of L-shaped cross members 9 as shown. It is to be understood that grate bars having foot members of a variety of configurations other than those specifically illustrated and described herein are within the scope of the present invention.

It will be understood that the interlocking relationship between the cover sections and base sections of the various embodiments prevents lateral separation of the cover sections and the base sections.

The cover and base components of the grate bars may

be manufactured by any of a number of conventional processes. For example, they may be cast by conventional sand-molding or permanent molding methods or by shell molding, die casting, stamping, forging, or extrusion. The coatings, such as ceramic, or a metal or metal alloy, which may be applied to the outer surfaces of the cover component for enhancing the corrosion inhibition features of the bar; interior coatings of the cover channel; and exterior coatings of the base member for diminishing the heat transfer from the cover to the base components, may be formed by any of the customary coating methods such as sprayings, anodizing, vapor-phase deposition, fusion welding or brazing, electroplating, sintering, etc. Also, it is to be understood that the grate bars of this invention are useful not only in sintering furnaces, but in all types of apparatus in which grate bars are moved and subjected to high temperature and mechanical impact and abrasion and chemically corrosive conditions. For example, these grate bars would be useful in equipment used in many industrial processes such as in the roasting or sintering of ores of ferrous and nonferrous materials, in the cement industry for cooler conveyors from calcining kilns, etc.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A grate bar comprising an elongate base having an upstanding rib extending substantially the entire length of said base and a foot member extending from the edge of the base opposite said rib, said base including a left and a right section positioned in an end-to-end relationship, an elongate cover of channel shape slidably engaging said rib, said cover comprising three sections positioned in end-to-end abutting relationship and covering said rib, said rib having an outer surface thereof which differs in configuration from that of the inner surface of the channel of said cover sections whereby areas of lineal contact between said cover sections and rib are minimized and heat exchange between said cover sections and base is decreased, and means for locking said cover sections to said base to prevent both substantial relative longitudinal movement and lateral separation of said cover sections and base while permitting thermal expansion of said cover sections.

2. A grate bar as set forth in claim 1 in which the outer surface configuration of said rib is generally triangular and the inner surface configuration of said channel shaped cover is generally C-shaped.

3. A grate bar as set forth in claim 1 in which the outer two sections of the cover are identical and in which portions of the upper surfaces of said outer two cover sections and the interposed third section are relatively overlapped so as to form one continuous substantially flat upper surface of said cover.

4. A grate bar as set forth in claim 1 in which the base and cover comprise different metallic materials, the base material being of a high impact strength and the cover material being corrosion and heat resistant.

5. A grate bar comprising an elongate base and an elongate cover of channel shape for the base, said base comprising two rails arranged in end-to-end relation with adjacent ends of said two rails in contiguous relation, each of said rails having at least one groove extending longitudinally thereof along one side, the portion of each rail above the groove constituting a rib, the grooves in said two rails being aligned, said cover being of channel shape straddling said ribs in endwise slidable relation thereto and having a portion extending into said grooves slidably keying said cover and rails together, the configuration of the outer surface of said ribs being different from that of the inner surface of the channel-shaped cover whereby areas of lineal contact between the cover and ribs are minimized and heat exchange between said cover and ribs is decreased, and interengaging parts on said cover and rails adapted to hold said cover and rails against substantial endwise sliding movement relative to one another, each rail having a depending foot at its end adjacent the other rail, said interengaging parts including a stop at each of the outer ends of said base rails, each stop comprising an abutment integral with said respective rails adapted to project laterally from said rails and to loosely engage a respective end of said channel-shaped cover.

6. In a furnace including a series of pallets linked together to form an articulated moving endless conveyor, each of said pallets carrying a plurality of grate bars arranged side-by-side to form a substantially flat grill adapted to support a layer of finely divided material; each of said grate bars comprising an elongate base and an elongate cover for the base, said base including two rails arranged in end-to-end relation with adjacent ends of said two rails in contiguous relation, each of said rails having a dependent foot at its end adjacent the other rail, said foot members engaging said pallet and securing said grate bar to said pallet, each of said rails having at least one groove extending longitudinally thereof along one side, the portion of each rail above the groove constituting a rib, the grooves in said two rails being aligned, said cover being of channel shape straddling said ribs in endwise slidable relation thereto and having a portion extending into said grooves slidably keying said cover and rails together, the configuration of the outer surface of said ribs being different from that of the inner surface of the cover whereby areas of lineal contact between the cover and ribs are minimized and heat exchange between said cover and ribs is decreased, and interengaging parts on said cover and rails adapted to hold said cover and rails against substantial endwise sliding movement relative to one another said interengaging parts including a stop at each of the outer ends of said base rails, each stop comprising an abutment integral with said respective rails adapted to project laterally from said rails and to loosely engage a respective end of said channel-shaped cover.

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