United States Patent [19]

Chernichenko et al.

[11] **3,901,662**

[45] **Aug. 26, 1975**

[54] **METAL INGOTS**

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[21] Appl. No.: **464,981**

Related U.S. Application Data

[63] Continuation of Ser. No. 269,186, July 5, 1972, abandoned.

[30] **Foreign Application Priority Data**

July 7, 1971 U.S.S.R. 1678086

[52] **U.S. Cl.** **29/187**; 29/187.5

[51] **Int. Cl.** **B22d 7/00**

[58] **Field of Search** 29/187, 187.5

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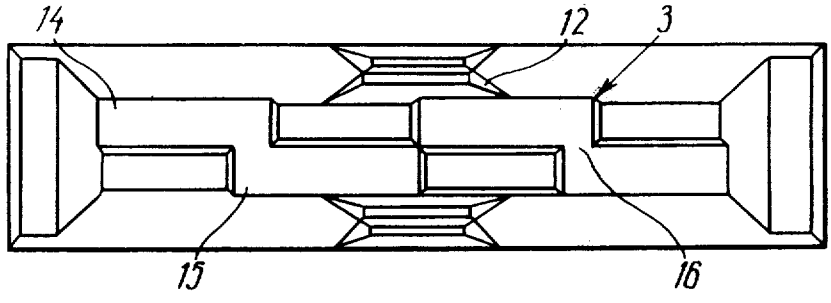
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Primary Examiner—L. Dewayne Rutledge
Assistant Examiner—O. F. Crutchfield
Attorney, Agent, or Firm—Holman & Stern

[57] **ABSTRACT**

A metal ingot (pig) of a trapezoidal cross section having on each oblique side face at least one tooth and a recess for interlocking a plurality of the ingots in a row through similar teeth and recesses, said ingots being laid alternately so that the adjacent ingots are inverted relative to each other. The teeth and recesses prevent adjacent ingots in one row from longitudinal and transverse displacement.

3 Claims, 13 Drawing Figures



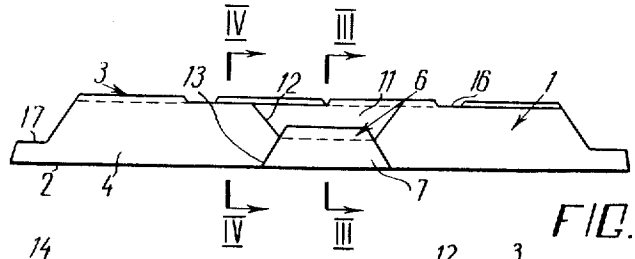


FIG. 1

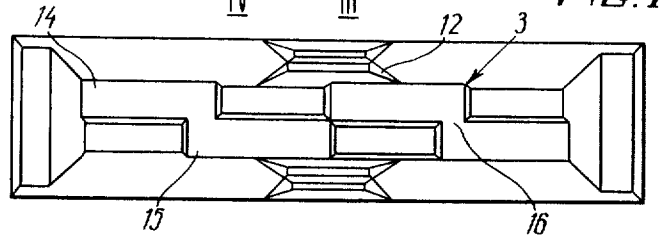


FIG. 2

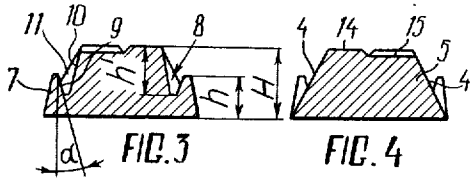


FIG. 3

FIG. 4

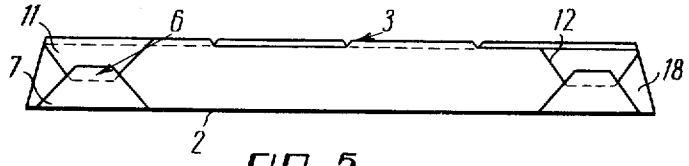


FIG. 5

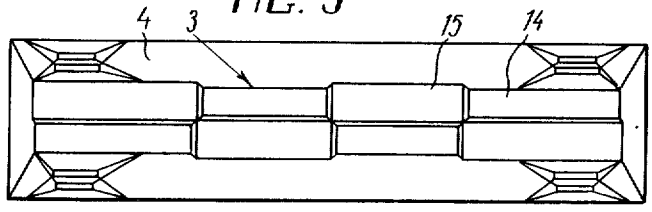


FIG. 6

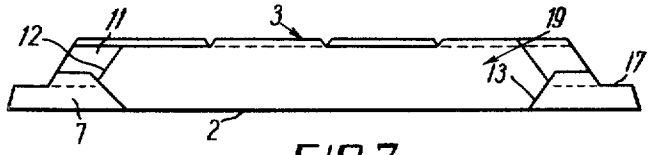


FIG.7

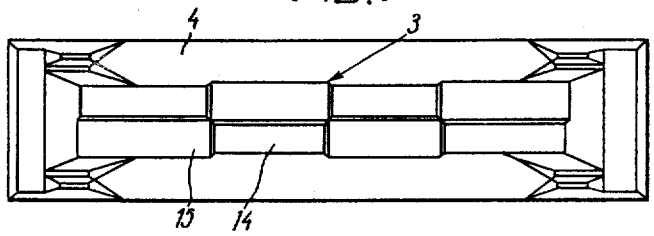


FIG.8

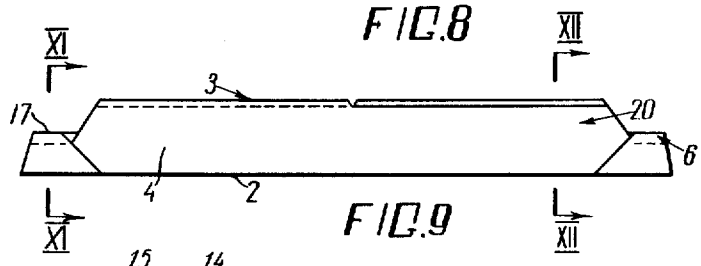


FIG.9

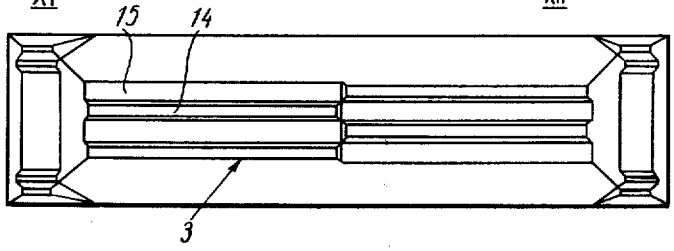


FIG.10

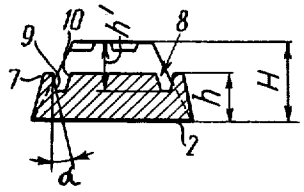


FIG.11

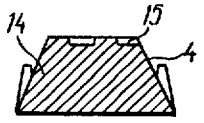


FIG.12

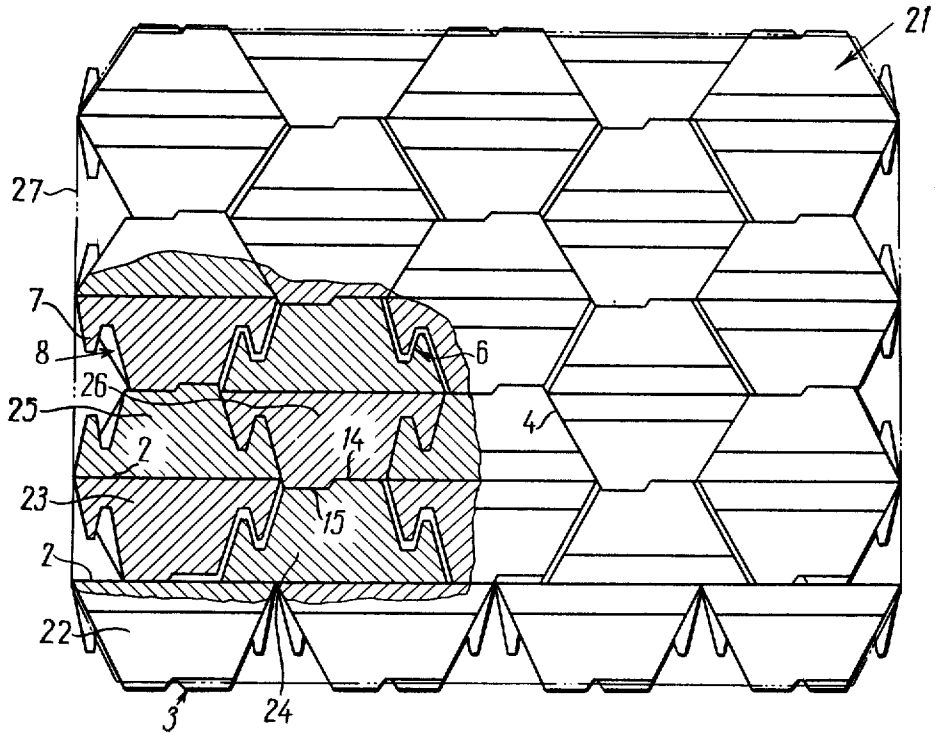


FIG. 13

METAL INGOTS

This is a continuation of application Ser. No. 269,186 filed July 5, 1972, now abandoned.

FIELD OF THE INVENTION

The present invention relates to metallurgy or foundry and, more particularly, the invention relates to metal, for example aluminium, ingots or pigs adapted for assembly in stable stacks or bundles to be transported by any suitable transport means.

BACKGROUND OF THE INVENTION

On casting ingots in non-detachable open-type moulds, technologically advantageous are pigs of a trapezoidal cross section with rectangular bases and oblique side faces. Such ingots are easily removed from the moulds. The stacks are assembled from these ingots and laid in horizontal rows in which the ingots are inverted with respect to each other and the ingots have a high density and, therefore, a high specific weight.

However, such ingots have no elements for their interconnection in the transverse direction in one horizontal row so that the stacks formed of these ingots are likely to become loose. Therefore, when forming stacks, the ingots are laid crosswise so that the ingots of the upper layer are turned at an angle of 90° to those in the next lower layer. Yet, even such composition of the ingots combined with binding by high-strength metallic bands does not provide the strength required so that the stacks, in the process of transportation and during the loading and unloading the stack are maintained integral and breaks and the ingots become loose.

The increasing rise of production of pig metal and the high cost of loading and unloading operations (time expended) present a problem in the development of an ingot that will ensure formation of a strong and a compact stack requiring no complicated and expensive, high-strength durable binders.

The basic difficulty in the development of such an ingot consists in that it is to be cast in an open-type and nondetachable mould.

When casting metal in such a mould, the surface of the major base of the ingot is always a pouring surface, and no projections or recesses can be formed thereon. In this connection, the elements for connecting the adjacent ingots in one horizontal row and the adjacent horizontal rows (by a vertical line) can be made only on the longitudinal side faces of the ingot and on its minor base, in which case they can be oriented only to the side of the lower base (taking into account the technological casting angle to permit removal from the mold).

Known at the present time are pigs or ingots provided with elements for interlocking adjacent pigs in a single horizontal row. When the pigs are inverted with respect to each other, these elements provide for meshing of the pigs in the transverse and longitudinal directions. Such a pig, for example, is disclosed in Canadian Pat. No. 609,336.

The prior art pig has a rectangular base with an upwardly directed rectangular projection located along the base and has a lower width than that of the base so that at both sides of the projection, along the long sides of said rectangular base, there remain platforms which are inclined inside, to the rectangular projection. These oblique platforms form shoulders and grooves providing for an engagement of the pigs of one horizontal row when laying them alternately and inverted with respect to each other.

In order to prevent the ingots from longitudinal displacement in a horizontal row, at the midpoint of each platform there are provided horizontal portions, in which case on one side of the ingot the horizontal portion is made at the crest level of the shoulder, and on the other side thereof, it is made at the bottom level of the groove. The ingot is provided with teeth and respective recesses on the base of the rectangular projection used for connecting the ingots in the horizontal row and for forming a stack or bundle. The ingots in the horizontal row which are adjacent in a vertical line are disposed in the same direction.

The main disadvantage of such an ingot is, first, that, in laying each next horizontal row in a stack, the ingots must be turned in a horizontal plane through an angle of 180°; second, that the angle of engagement is much greater than the angle of friction of the metal of the ingot at a low meshing depth so that reliable bending of the stack is necessary; and, third, the platforms along the longitudinal sides of the ingot form cavities on the surface of the stack which reduce its specific weight.

Also known in the art are ingots having elements for interlocking the adjacent ingots in one horizontal row made on platforms or flanges provided along the longitudinal sides of the ingot (see U.S. Pat. Nos. 3,140,926 and 3,154,391; cl. 29-184). These ingots are disadvantageous in that they have no elements for interlocking the adjacent horizontal row in a vertical direction, and also in that the longitudinal platforms reduce the specific weight of the stack.

As mentioned above, the most advanced, from the viewpoint of the casting technology, are ingots having a trapezoidal cross section and rectangular major and minor bases which provide for the highest density and specific gravity of the stack. The disadvantage of these ingots is that up to now elements have not been developed which would provide for interlocking of the adjacent ingots in one horizontal row and of the adjacent rows in the stack in a vertical direction and elements will not protrude beyond the limits of the overall dimensions of the ingots, although attempts have been made to make such elements.

In this connection, of particular interest is the ingot having rectangular base portions and a trapezoidal cross section in which one oblique side face has a transverse shoulder through the whole height of the ingot, while the other face has a through groove (see U.S. Pat. No. 3,081,871, cl. 206–65). Said shoulder and groove have a similar shape, the groove being inverted with respect to the shoulder.

The ingots are laid in a single horizontal row and are inverted relative to each other so that the shoulder of one ingot enters the groove of the other thereby preventing them from relative longitudinal displacement.

This ingot is disadvantageous in that it has no elements providing for transverse engagement of the adjacent ingots in one horizontal layer as well as for engagement of the adjacent horizontal rows in a vertical direction. This makes it necessary to put one row on the other, while turning it through an angle of 90° in a horizontal plane so as to prevent transverse and longitudinal displacement of one horizontal row with respect to the other.

The disadvantages of this ingot are: in the first place, the absence of elements for interlocking the adjacent

ingots in one horizontal row in the transverse direction and, in the second place, and as a result, the necessity in cross-like laying of ingots in the horizontal rows adjacent along the vertical, in which case mechanization of the process of assembly of the ingot into a stack gives rise to considerable difficulties. Moreover, a stack of such ingots requires strong and complex binding means, while the presence of shoulders on the surface of the lower base portion hinders the transportation of the ingot during its manufacture and leads to an undesirable increase in the specific pressure on the supporting surface of the transport devices, for example, on the floor of a railway car.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a metal ingot (pig) which will have a shape ensuring tight assembly of the ingots into a stack having a higher density and strength than the stacks formed by known ingots.

Another object of the invention is to provide for interlocking elements for an ingot which do not project beyond the overall dimensions of the larger or major rectangular base of this ingot which has a trapezoidal section and rectangular base portions, and is most advanced and compatible to casting and stacking from a technological point of view.

Still another object of the invention is to provide for interlocking elements on the oblique side face of an ingot which would provide for rigid, locking, engagement of the adjacent ingots in a horizontal row in both longitudinal and transverse directions.

Yet another object of the invention is to provide for interlocking elements on an ingot on the minor rectangular base which will ensure uniform and permanent engagement of the ingots laid one upon another through said bases, in which case the assembly of the ingots is possible only when turning (rotating) the ingot being laid about its longitudinal axis through an angle of 180°, so that turning through an angle of 180° in a horizontal plane is not necessary.

These and other objects are attained by providing metal ingots (pigs) adapted for assembly in a stack (bundle), each ingot having rectangular bases, a trapezoidal cross section and oblique side faces provided with interlocking elements preventing two adjacent ingots in a common row from mutual longitudinal displacement. According to the invention, each oblique side face of the ingot has at least one said interlocking element or tooth and an adjacent recess, said teeth and recesses meshing with the corresponding teeth and recesses on the adjacent inverted ingots and preventing their mutual respective displacement in a transverse direction.

The ingots with the interlocking elements of said shape are laid as dense (tight) horizontal rows in stacks (bundles) which have adequate strength and do not tend to become disassembled during transportation and loading.

It is expedient that the tooth be formed normal to the major base of the ingot and partially protrudes beyond the oblique side face within the overall dimensions of the major base, while the recess adjacent to the tooth has a complimentary shape corresponding to that of the "inverted tooth" and is limited in a lateral direction of the ingot by the inner surface of the tooth and by the surface of a groove in the ingot body similar in shape to the projected portion of said tooth and disposed within the oblique side face of the ingot, while in the longitudinal direction the recess is limited by the lateral sides of said grooves.

Such a shape of the ingot contributes to an increase in the specific weight of the stack (bundle) by eliminating hollow spaces between the projecting portions on the side faces of the stack and prevents the ingots from mutual longitudinal displacement in one horizontal row.

It is expedient that formed between the inner surface of the tooth and the line of its height is an angle of engagement which would be lower than the angle of friction of the ingot metal,

this provides for reliable engagement of the adjacent ingots of the row in a lateral direction.

The minor base of the ingot may be provided with projections and recesses arranged in a staggered order, in which case their total number, both across and along the base, must be even.

The provision of the projections and recesses on the minor base of the ingot provides for connection of the horizontal rows in the stack, in which case, the staggered order to disposition of the projections and recesses and their even number both along the length and width of the base makes it possible to lay the ingots in rows one upon the other without turning (rotating) them in a horizontal plane through an angle of 180° relative to each other, and ensures additional engagement of the ingots in the horizontal rows in a transverse direction.

Other objects and advantages of the invention will be apparent from the following detailed description of examples of making metal pigs or ingots, reference being made to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of a metal ingot with one interlocking element on each side face;

FIG. 2 shows the same metal ingot in a plan view;

FIG. 3 is a sectional view taken along the line III—III in FIG. 2;

FIG. 4 is a sectional view taken along the line IV—IV in FIG. 1;

FIG. 5 is a side elevational view of another metal ingot with two interlocking elements on each side face;

FIG. 6 is a plan view of the metal ingot shown in FIG. 5;

FIG. 7 is a side elevational view of still another metal ingot with two interlocking elements on each side face, said elements being open to the shoulders;

FIG. 8 is a plan view of the metal ingot shown in FIG. 7;

FIG. 9 is a side elevational view of still another metal ingot with two interlocking elements on each side face, said elements being disposed within the dimensions of the shoulders;

FIG. 10 is a plan view of the metal ingot shown in FIG. 9;

FIG. 11 is a sectional view taken along the line XI—XI in FIG. 9;

FIG. 12 is a sectional view taken along the line XII—XII in FIG. 9; and

FIG. 13 shows the metal ingots assembled into a stack (bundle) a portion shown in section made in a transverse direction to a vertical plane along the line of the interlocking elements.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A metal ingot **1** (FIGS. **1, 2, 3** and **4**) has a major rectangular base **2**, a minor rectangular base **3** and oblique side faces defining a trapezoidal cross section indicated at **5** in FIG. **4.**

Provided on each oblique side face **4** is an interlocking element **6** consisting of a tooth **7** and an inner recess **8** adjacent thereto in a transverse direction of the ingot **1**; said tooth and recess being engagable with a similar tooth and recess of an adjacent ingot, which is inverted relative to the former ingot, and preventing their mutual longitudinal and transverse displacement in a common horizontal row; see FIG. **13.**

The tooth **7** extends normal to the major rectangular base **2** of the ingot **1** and partially protrudes beyond the oblique side face **4** but within the overall dimensions of the major rectangular base **2.** The recess **8** adjacent to the tooth **7** has a shape corresponding or complimentary to that of the inverted tooth **7** and is limited in the transverse direction of the ingot **1** by an inner surface **9** of the tooth **7** and the surface **10** of a groove **11** formed in the body of the ingot **1** within the limits of the oblique side face **4** and corresponding in shape to the portion of the tooth **7** projecting beyond this oblique face, while in the longitudinal direction it is limited by side faces **12** of the groove **11.**

The tooth **7** is limited, in the longitudinal direction of the ingot **1**, by oblique faces **13** having the same angle of inclination as the side faces **12** of the groove **11.**

The height h of the tooth **7** and the magnitude h' of the recess **8** are equal to one half of the full height H of the ingot **1** so as to permit mutual engagement of the tooth **7** of the ingot **1** with the identical tooth of an adjacent ingot in a horizontal row, the corresponding tooth **7** of the adjacent ingot being inverted with respect to the former. The value (depth) of said engagement of the teeth must be at least twice as large as the maximum permissible height of the ingot **1.** In this case, when casting an ingot **1** having a minimum permissible height, the magnitude of engagement of the teeth **7** of the adjacent ingots inverted relative to each other and disposed on a single supporting surface is equal to one magnitude of the maximum permissible height H of the ingot **1** which is quite sufficient for stable engagement between the ingots.

The inner surface **9** of the tooth **7** (see FIG. **3**) forms with the vertical axis of or height of the tooth **7**, an angle of engagement α which is lower than the angle of friction of the ingot metal thereby ensuring transverse fixed engagement of the adjacent ingots which is practically nondetachable in this direction. The ingots can be disconnected only when the tooth **7** is completely withdrawn from the recess **8** in the direction perpendicular to the ingot bases. Provided on the minor rectangular base **3** of the ingot **1** are flanges (steps) **14** and grooves (recesses) **15** arranged in a staggered order. In this case, the total number of the flanges **14** and grooves **15** is equal both along and across the base **3**, these flanges **14** have a length and width less than the corresponding dimensions of the grooves **15** and are not connected with one another.

Such an arrangement and number of the flanges **14** and grooves **15** by the length and width of the minor rectangular base **3** provide for interlocking of the ingots laid (stacked) on each other through their rectangular bases **3** in the transverse and longitudinal directions, in which case engagement can be effected in any longitudinal direction, both by turning the ingots relative to each other in a horizontal plane through an angle of 180° and without this inversion, this facilitates mechanization of the operation of assembly of the ingots into a stack.

The length of some flanges **14** can be much less than the length of the grooves **15** so that a transverse gap **16** (FIGS. **1** and **2**) is formed between the flanges **14** which is sufficient to accommodate placing of binding material (steel band, wire, etc.) to retain a stack integral.

The grooves **15**, FIGS. **1-4** have a depth equal to the maximum permissible height H of the ingot **1**, in which case the magnitude h' of the recess **8** exceeds the height h of the tooth **7** by at least the depth of the groove **15.** Such a relation between the depth of the grooves **15**, the magnitude h' of the recess **8** and the height h of the tooth **7** provides for permanent and uniform engagement of the flanges **14** and grooves **15** of the ingot **1** with the similar elements of the ingot **1** laid on the former ingot with its minor rectangular base **3** along a vertical line of the horizontal row thereby connecting one horizontal row with the other; see FIG. **13.**

To ensure convenient transportation by a fork lift loader, the ingot **1** may be provided with end shoulders **17.**

In another embodiment of the invention (FIGS. **5** and **6**) each oblique side face **4** of the ingot **18** is provided with two interlocking elements **6.** This ingot is shown without shoulders **17** but can incorporate them as in the previously described embodiment.

The ingot **18** provides for greater stable and reliable engagement of the adjacent ingots in one horizontal row by preventing their rotation in the plane of the oblique side face **4.**

The ingot **19** (FIGS. **7** and **8**) also has two said interlocking elements **6**, however, these elements are located at the ends of the ingot so that the respective teeth **7** and the recesses **8** face the shoulders **17.** This improves the technology and facilitates casting of the ingot. In this case the recess **8** is limited in the longitudinal direction of the ingot only by one side face **12** of the groove **11.**

The final modification of the invention is shown by an ingot **20** (FIGS. **9, 10, 11** and **12**) which, like the ingots **18** and **19**, has two interlocking elements **6** arranged on each oblique side face **4** within the zone of the shoulders **17** at the extreme ends of the ingot. In this embodiment of the invention, that functions as do the other embodiments the shoulders **17** are equal to the height of the tooth **7**, while the recess **8** is formed in the shoulders **17** and in the cross section of the ingot **20** (FIG. **12**) is beyond the zone of the oblique side face **4.** The disposition of said interlocking elements **6** is advantageous from the technological casting point of view compared to the ingots **18** and **19** both during the casting and in the process of making the casting moulds.

In this embodiment the flanges **14** and grooves **15** are arranged in a staggered relation on the minor rectangular base **3** so that in the longitudinal direction of said base there is one flange **14** and one groove **15**, while in the transverse direction there are two flanges **14** and grooves **15.** Such an arrangement of the flanges and grooves, while having all the advantages of the above-

described modifications, features another technological advantage in the process of casting which consists in that at longitudinal disposition of one flange **14** and one groove **15** along the entire length of the minor rectangular base **3**, the shrinkage of the ingot in the casting mould offers no difficulties.

The above-described ingot **1** and its modifications, i.e., the ingots **18, 19** and **20** are adapted for assembly in a stack (bundle) **21** (FIG. 13), in which case the stacks formed from said ingots have the same specific weight and strength and are superior to the identical characteristics of the stacks of the prior art ingots mentioned in the introductory part of this description.

A stack of the above-described ingots may be formed in two ways:

In order to provide for convenient transporation of the stack by a fork lift loader without using special pad members (bars, pillows), the first row is formed of four ingots **22** (FIG. 13) laid with their minor base **3** on a supporting surface. The second row is formed of five ingots laid in the same direction as the ingots of the lower row, in which case the extreme (outer) ingot **23** of the second row is laid with its minor rectangular base **3** on the major rectangular base **2** of the extreme ingot **22** in the lower row. The ingot **24** of the second row is inverted relative to the ingot **23** through 180° about its longitudinal axis and is connected thereto through an interlocking element **6**, in which case the tooth **7** of the ingot **24** enters the recess **8** of the ingot **23**, while the tooth **7** of the ingot **23** enters the recess **8** of the ingot **24**. The next ingot of the second row is laid and connected similarly to the ingot **23** to the end of the row. In this example the second row is not connected with the first row by means of the above-described flanges **14** and grooves **15** on the minor rectangular base **3** and binds it only due to overlapping the joints of the ingots **22** by the ingots **23, 24**, etc. of the second row, in which the ingots are connected to each other through the above-said interlocking elements **6**.

The third row is formed in the same manner as the second row of five ingots laid in the same direction as the preceding rows. The ingot **25** of this row is laid with its major rectangular base **2** on the major rectangular base **2** of the ingot **23** of the second row, while the ingot **26** of the third row is (inverted) turned about its longitudinal axis through an angle of 180° and is laid so that its interlocking element **6** enters into engagement with the identical element **6** of the ingot **25**, while the flanges **14** and the grooves **15** on the minor rectangular base **3** engage the identical flanges **14** and grooves **15** of the ingot **24**. In this case, owing to the fact that the ingot **26** descends below the ingot **25** by the depth of the groove **15**, the teeth **7** and the recesses **8** of these two ingots will come into a tight contact, while their oblique side faces **4** will be wedged relative to each other.

Due to the fact that the connection of the ingots of third horizontal row is identical to the connection of the ingots **25** and **26**, this row rigidly binds the stack in the transverse direction like all the rows uneven by height in this modification of the stack.

The stack **21** is bound by a band or wire **27** in one direction in one or two rows, in which case the binding material must have a strength sufficient only for holding the lower and upper rows of the stack during sea transportation. When these stacks are transported by a surface transport, the binder means may not be necessary.

In the second modification of the stack of the abovedescribed ingots (not illustrated), the first (lower) row is formed in the same manner as the second row of the first modification. In this case it is necessary to use pad materials both directly at places of forming the stacks and on the transport vehicles.

The stack of the above-described ingots may have a high volume due to a great number of ingots in the horizontal rows and the number of the horizontal rows in the stack.

Since in the process of the assembly in a stack, the proposed ingots do not require manipulation in a horizontal plane either through an angle of 180° or through an angle of 90° with respect to the adjacent ingot, the process of stacking can easily be mechanized.

We claim:

1. An ingot adapted for assembly in a stack comprising: a transverse trapezoidal cross section including a flat major base of rectangular shape, a rectangular minor base and oblique side surfaces; engagement elements at opposite sides on each of said oblique side surfaces and comprising at least one tooth (**7**) disposed outside the oblique side surfaces and arranged in a transverse direction relative to said ingot, and a recess (**8**) adjacent said tooth and complimentary in shape to the latter for engagement with a similar recess and a corresponding tooth of an adjacent identical ingot which has been inverted and engaged when forming a stack of ingots; said recess comprising a groove (**11**) inwardly of the tooth and limited by two flanking surfaces (**12**) and by an inner surface (**9**) of the tooth in the transverse direction and a portion of a side surface (**10**) of said ingot corresponding to the length of said tooth; the minor base including flanges (**14**) and grooves (**15**) in alternating relation with one another, the number of flanges and grooves being equal.

2. An ingot as claimed in claim **1**, in which the height (h) of said tooth and height (h') of each said recess (**8**) is greater than half the height (H) of said ingot.

3. An ingot as claimed in claim **1**, in which the inner surface (**9**) of said tooth (**7**) relative to a plane coinciding with height (H) of the tooth is inclined at a prescribed angle, whereby interdigitated teeth and recesses in a stack are firmly wedged together.

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