Dec. 20, 1966 K. H. SANDMEYER ETAL 3,292,333

WEAR-RESISTANT REFRACTORY LINING ARTICLE

Filed May 1, 1963 2 Sheets-Sheet 1

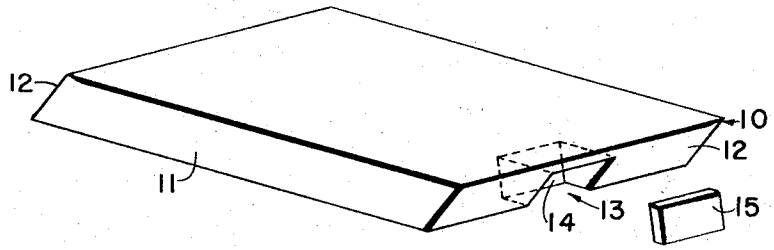


Fig. 1

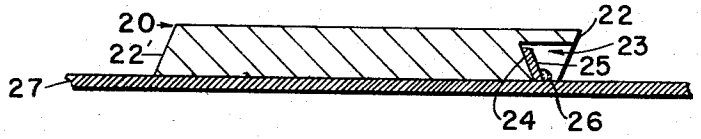


Fig. 2

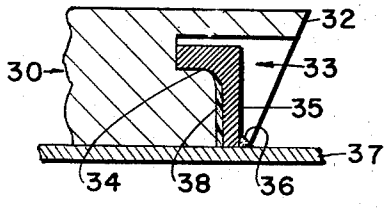


Fig. 3

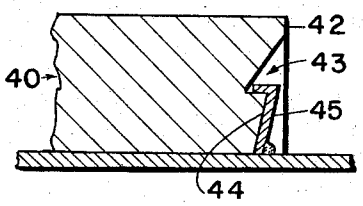


Fig. 4

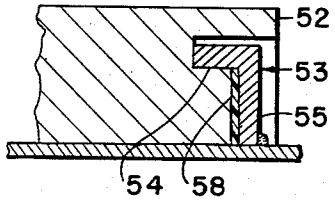


Fig. 5

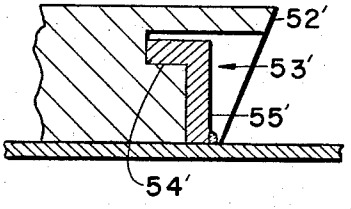


Fig. 5a

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WEAR-RESISTANT REFRACTORY LINING ARTICLE

Filed May 1, 1963 2 Sheets-Sheet 2

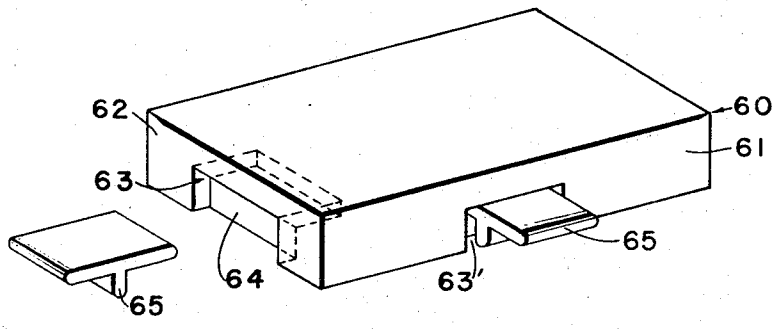


Fig. 6

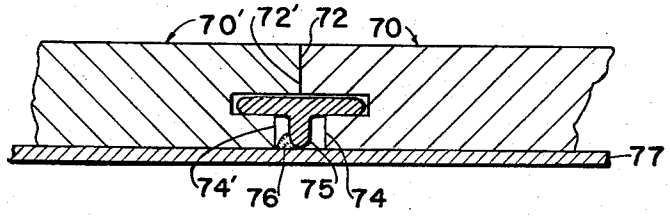


Fig. 7

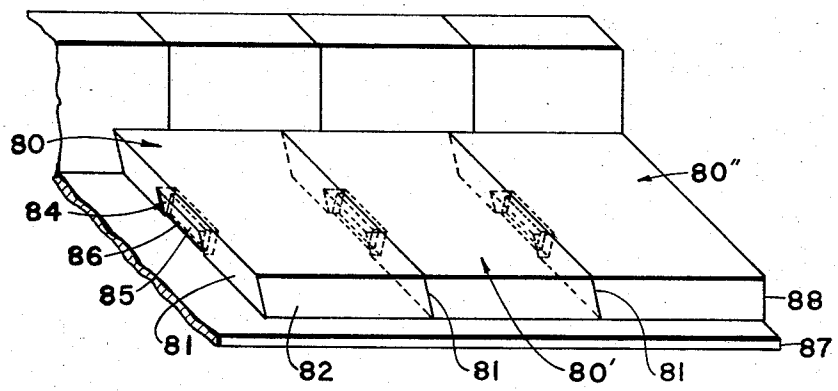


Fig. 8

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United States Patent Office 3,292,333
Patented Dec. 20, 1966

3,292,333

WEAR-RESISTANT REFRACTORY LINING ARTICLE

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Filed May 1, 1963, Ser. No. 277,359
3 Claims. (Cl. 52—509)

This invention relates to improvements in refractory articles of manufacture adapted for use as wear-resistant elements in any construction in which resistance to wear is a principal requirement. More particularly it relates to a fused cast refractory block suitable for use as a lining block, having an improved means for securing the block to a metal base. This invention is particularly adapted for use in conjunction with the discharge chute of a furnace where abrasion is especially severe. However, this invention is not to be construed as limited to any particular type of chute but has application in conjunction with any structure in which resistance to abrasion is a principal requirement. One example of such an application is the fabrication of a wear-resistant lining on the discharge chute of a coking furnace.

In the carbonization of coal by the by-product process, from 10–16 tons of coal are charged to an elongated coking chamber measuring about 10 to 14 feet in height, 30 to 43 feet in length and 15 to 19 inches in width. After the oven is sealed, the charge is heated to about 2000° F. for 16–20 hours to form a mass of coke in the oven. This mass of coke, weighing approximately 10 tons, is removed from the oven by means of a pusher, which is an electrically powered, rack-and-pinion-operated ram which pushes the coke cake from the oven, down a discharge chute, and into a quenching car. As is readily apparent, the discharge chute must be extremely resistant to wear in order to withstand the sliding action of the huge, intensely hot, coke mass without failure.

The selection of materials for use in constructing such a discharge chute has confronted the industry with two problems. First, an extremely abrasion resistant material must be used and secondly, suitable means must be employed to hold the lining material securely in position, even when a large mass slides across its surface.

It has been recognized by industry that certain refractories have excellent resistance to wear and therefore are suitable for use in conjunction with structures which are subject to abrasion. However, the problem of a suitable means for securing the wear-resistant material in place has still remained and has been the subject of extensive investigation over the years.

One solution to the problem has proposed the use of fused cast refractory blocks or shapes as the lining material for a chute, said blocks being fastened in place by metallic elements which are embedded in the base of the block as it is cast. This proposed solution, however, has several disadvantages. In fabricating fused cast refractories, very high temperatures are used in order to obtain a molten material. Refractory blocks are poured at about 2000° C. and must be cooled very slowly in order to avoid cracking the block and to develop a strong block. However, when a metallic element is to be embedded in fused refractory as it is cast, heat must be dissipated as rapidly as possible in order to prevent excessive corrosion and oxidation of the metallic element. Therefore it is necessary to sacrifice either the strength of the block or the metallic element or both, when making such a block. Also, the high temperatures present during the casting of the fused refractory limits the choice of metals for use as hold-down elements to those metals which can withstand temperatures in excess of 2000° C. without excessive oxidation or other form of undesirable degradation. Furthermore, the embedding of the metallic elements within the cast refractory requires awkward production molding methods.

Other previously suggested means for securing wear-resistant materials in place on discharge chutes have not been satisfactory for various reasons, and the present invention is the result of further efforts to provide a more satisfactory solution to the foregoing and other problems relating to wear-resistant elements for this purpose.

It is therefore an object of this invention to provide an improved fused cast, abrasion-resistant block. Another object of the invention is to provide a wear-resistant article having an improved means for securing the block to a metal base. Another object of the invention is to provide an improved wear-resistant article having formed recesses or cavities in one or more sides or ends for receiving an anchoring clip which can be joined to a base plate to hold said article securely in position. A further object is to provide a fused cast refractory block having beveled sides or ends and having formed recesses in one or more sides or ends for receiving a metal clip which may be bonded to the back wall of the recess with a temporary bond and welded to a metal base plate.

A still further object of the invention is to provide an abrasion-resistant chute comprising a metal chute and a lining in said metal chute comprising a plurality of fused cast refractory blocks joined to the chute by separate metal clips.

Various other objects and advantages will appear from the following description of several embodiments of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

As was mentioned hereinabove, the concept of molding a fused refractory around a metallic insert has not proved satisfactory for the metal inserts of blocks formed in this manner are oxidized considerably making it difficult, if not impossible, to weld the inserts to the metal base of a chute. It has now been discovered that fused cast refractory blocks may be used to form an effective wear-resistant lining on a metal base by securing the blocks to a base by means of a separate anchoring clip which is inserted in the block after the block has been cast and has cooled.

In accordance with one embodiment of this invention, fused cast refractory blocks, suitable for use as wear-resistant elements in any construction in which resistance to wear is a principal requirement, are formed having top and bottom surfaces and edge faces, the edge faces comprising two substantially parallel side edge faces and two substantially parallel end edge faces. Each of the blocks is provided with a cavity or recess at the base of one or more side or end edge faces, the cavity or recess extending into the block and having side walls and a rear wall for receiving an anchoring clip. The anchoring clip is inserted in the recess after the block has cooled and engages the rear wall of the recessed portion of the edge face and is joined to a supporting base, as by welding, to prevent upward movement of the block. When a series of such blocks are placed on a supporting base and joined to the base so that the blocks abut one another, the blocks are restrained from movement in any direction, thereby forming a continuous durable wear-resistant lining on the base, protecting the base from abrasion.

In the construction described in the preceding paragraph the fused cast refractory blocks are held securely in position on the base without the disadvantages inherent in the prior art structures. Thus, since the anchoring clips are not inserted in the block until the block has been cast and has cooled, the refractory may be cooled

as slowly as desired in order to form a strong block without adversely affecting the anchoring clips. This not only permits a stronger block to be formed but also enables a stronger joint to be formed between the anchoring clip and the supporting base.

Another advantage of wear-resistant blocks made in accordance with this invention is that since the anchoring clips are not inserted into the block until the cast block has cooled, the clips need not be made of metals which must be able to withstand the high temperatures present in casting fused refractories. This permits a much wider choice of metals for use as the anchoring clips. This wider availability of metals results in another advantage in that the anchoring clips need not be joined to the base only by welding, as in the case of prior art devices. Thus, by a proper selection of metals for use as the anchoring clips, the blocks may be joined to the base by other methods, such as brazing or hard soldering.

In forming abrasion-resistant, lining blocks embodying this invention, a suitable molten refractory is poured into a mold, the mold having an insert on one edge thereof so that when the insert is removed a recess is formed at the base of the side of the cast refractory block, the recess having side walls, a top wall and a rear wall. The block is cooled and thereafter the mold is stripped, the insert is removed from the block and the block is then annealed. The insert may be of any desired shape but generally it is preferred to use an insert which results in the rear wall of the formed recess having a curved, sloping, or an irregular or a stepped profile.

In order to secure such a block to a metal base to form a wear-resistant lining thereon a metal anchoring clip, conforming substantially in profile to the profile of the rear wall of the recess, is then inserted at least partially within the recess of the block. The anchoring clip may engage the entire rear wall of the recess or it may engage only a portion of said rear wall. In order to facilitate handling of the block and clip, the clip may be bonded to the rear wall such as by means of an epoxy resin. The block is then placed on a metal supporting base and the anchoring clip joined to the base as by welding. This firmly secures the block in position on the base and prevents any upward movement of the block. A series of such blocks is secured to the base so that the blocks abut one another forming a continuous, durable wear-resistant lining on the base, held securely in position against lateral and upward movement.

It is apparent that this structure is capable of many variations and modifications without departing from the inventive concept. Thus, the fused cast refractory block may be molded with one or both of the end or side edge faces either straight or beveled and with one or more clip-receiving recesses in one or more of the edge faces. It is generally preferred to cast the block with two opposing parallel edge faces beveled in the same direction and with a clip-receiving recess at the base of one beveled edge face, preferably at the base of the beveled edge face which slopes beneath the overhanging top surface of the block. This construction facilitates the manufacture and installation of the blocks, for when the blocks are positioned on the base in side by side relationship with juxtaposed beveled edge faces parallel and the anchoring clip welded to the base, the top surface of the welded down end of one block overlaps the bottom surface of the abutting block thereby restraining the abutting block from the upward movement.

The clip-receiving recess or cavity, formed at the base of an edge face of the block has side walls and a rear wall, the walls of the recess desirably terminating below the top surface of the block. The rear wall of the recess may be formed in a variety of shapes and forms. Thus, the rear wall of the recessed portion of the edge face may have a curved profile, an irregular or step profile or any shape which presents a surface which may be engaged by the anchoring clip to hold the block in position on a base. Generally it is preferred to cast the block so that the rear wall of the recessed portion of the edge face slopes into the block away from said edge face. In this manner an anchoring clip can be positioned against the sloping wall to hold down the block when the clip is joined to a base.

If the block is cast with the rear wall of the recess having a curved or an irregular profile, the anchoring clip is made so as to conform at least partially to the profile of the rear wall of the recess. When the back wall of the recess is in the form of a sloping wall, the anchoring clip may be merely a straight piece of metal which can be positioned against the sloping wall.

The anchoring clip may be positioned entirely within the recess of one block or it may be constructed so as to engage the rear walls of recesses of adjoining blocks. That is, the clip may engage the rear wall of one block, project from the recess of that block into the recess of an adjoining block and engage the back wall of the recess of the adjoining block, so that one anchoring clip effectively holds two adjoining blocks in position. For the purposes of this invention either type of anchoring clip is effective, for each type will serve to secure a wear-resistant block to a supporting base and prevent movement of the block on the base.

The anchoring clip may be positioned against the rear wall of the recess at the time of installation of the block on a base or it may be bonded to the rear wall of the recess prior to installation. Generally it is preferred to bond the clip to the rear wall of the recess prior to installation, for this facilitates handling, insures that proper anchoring clips are used in installation, and facilitates installation of the block. It has been found that clips may be firmly secured to the rear wall of the recess by means of a suitable adhesive, such as an epoxy resin. The use of such a resin gives a good bond between the anchoring clip and the block and holds up well even as the block is welded into place.

In order to understand more clearly the nature of the herein described articles, reference is made to the accompanying drawings showing specific embodiments of abrasion-resistant blocks made in accordance with the present invention, and in which:

FIGURE 1 is an exploded perspective view of one form of a wear-resistant block made in accordance with this invention showing the block and the anchoring clip, before the clip has been inserted into the recess of the block;

FIGURE 2 is a cross-sectional view of a block similar to that shown in FIGURE 1 and showing the clip inserted in the recess of the block and joined to a supporting base;

FIGURE 3 is a cross-sectional view of the end of a block showing a modification of the rear wall of the recess;

FIGURE 4 is a cross-sectional view of the end portion of a block made in accordance with this invention showing another modification of the anchoring clip and the rear wall of the recess;

FIGURES 5 and 5*a* are cross-sectional views of the end portion of blocks showing another modification of the anchoring clip and the back wall of the recess;

FIGURE 6 is a perspective view of another form of a wear-resistant block made in accordance with this invention;

FIGURE 7 is a cross-sectional view of abutting blocks similar to that shown in FIGURE 6;

FIGURE 8 is a perspective view of a plurality of wear-resistant blocks secured to a base forming an abrasion-resistant lining on the base.

Referring now more particularly to FIGURE 1, numeral **10** generally designates a fused cast refractory block suitable for use as a wear-resistant element such as for a chute lining. The block has top and bottom

surfaces and substantially parallel side edge faces **11** and substantially parallel end edge faces **12**. The side and end edge faces may be either straight or beveled and for the purpose of illustration only end edge faces **12** are shown as being beveled in the same direction, while side edge faces **11** are straight. An anchoring clip-receiving recess **13** is formed at the base of one beveled end edge face of the block and extends into the block. The recess has side walls and a rear wall **14**, the walls terminating below the top surface of the block. The rear wall **14** of the recess slopes into the block away from the edge face **12**. An anchoring clip **15** may be inserted into the recess **13** and positioned against the rear wall **14** so that when the anchoring clip is joined to a supporting base the clip will hold the block securely in position, restraining it from upward movement.

FIGURE 2 shows more clearly the manner in which the anchoring clip holds the block in position on a base. This figure shows a block similar to that shown in FIGURE 1, the block **20** having substantially parallel edge faces **22** and **22'** beveled in the same direction and a recess **23** formed at the base of one beveled edge face. The rear wall **24** of the recess slopes into the block away from the edge face **22** and the anchoring clip **25** is positioned against the sloping recess wall. When the anchoring clip is welded, as at **26** to a supporting base **27** the anchoring clip restrains the block from movement on the base and holds the block securely in position. When a series of such blocks are secured in abutting relation on a base, the blocks are restrained from movement in any direction.

FIGURE 3 illustrates a modification of the wear-resistant block shown in FIGURES 1 and 2. In this figure a block **30**, having edge faces **32** beveled in the same direction, is provided with a recess **33** formed at the base of one beveled edge face, the recess extending into the block. In this illustration the rear wall **34** of the recessed portion of the edge face has a curved profile. The anchoring clip **35** conforms substantially in profile to the profile of the rear wall **34** and engages a portion of the curved rear wall. The anchoring clip is bonded to the rear wall by means of an epoxy resin **38** to hold the clip in position. Upon welding, as at **36**, the clip **35** to a supporting base **37**, the block is restrained from upward movement on the base.

In the modification shown in FIGURE 4 the block **40** has straight edge faces **42** and a recess **43** formed at the base of the edge face, the recess terminating below the top surface of the block. In this illustration the rear wall **44** of the recess has a step or irregular profile and the anchoring clip **45** conforms substantially in profile to the profile of the rear wall. The anchoring clip engages a portion of the rear wall so that when the clip is welded to a base the block is held securely in position on the base.

FIGURE 5 shows a modification of the block in which the rear wall **54** of the recess **53** has a step profile and the anchoring clip **55** conforms substantially in profile to the profile of the rear wall. The clip is bonded to the rear wall by means of an epoxy resin **58** and the anchoring clip engages a portion of the rear wall. FIGURE *5a* is a variation of the block shown in FIGURE 5 in which the anchoring clip **55'** engages the entire rear wall **54'** of the recess **53'** which is formed at the base of beveled edge face **52'**.

FIGURE 6 illustrates another modification of an abrasion resistant block made in accordance with this invention. In this modification the block **60** is cast with substantially parallel straight side edge faces **61** and substantially parallel straight end edge faces **62**. Anchoring clip receiving recesses **63** and **63'** are formed at the bases of adjacent edge faces **61** and **62**, the rear walls of the recesses having an irregular or step profile, as shown at **74** and **74'** in FIGURE 7. An anchoring clip **65**, conforming substantially in profile to the profile of the rear recessed wall **64** is inserted partially within each recess and engages a portion of the rear wall thereof. A portion of the anchoring clip projects from the recess of one block and the projecting portion of the anchoring clip extends into the corresponding recess of an adjoining block to engage a portion of the rear wall of the recess of the adjoining block. In this manner a single anchoring clip **65** effectively secures two abutting blocks in position on a base.

The manner in which a single anchoring clip secures two abutting blocks in position is more clearly illustrated in FIGURE 7. In this figure abutting blocks **70** and **70'**, similar to block **60** in FIGURE 6, are held in position on a base **77** by means of an anchoring clip **75** welded at **76** to the base. The anchoring clip engages a portion of the rear walls **74** and **74'** of the recesses formed at the base of abutting edge faces **72** and **72'** of blocks **70** and **70'** so that when the clip is welded to a base, movement of the blocks is prevented.

FIGURE 8 illustrates the manner in which fused cast refractory blocks are assembled on a base, such as a chute, to form a wear-resistant lining on the chute. In this illustration a series of blocks **80**, **80'** and **80''**, similar to that shown in FIGURE 1, are secured on a base **87**. The blocks **80** and **80'** have substantially parallel straight side edge faces **82** and substantially parallel end edge faces **81**, the end edge faces being beveled in the same direction. An anchoring clip receiving recess **84** is formed at the base of a beveled end edge face of each block, the back wall of the recess sloping into the block in the same manner as shown in FIGURES 1 and 2. An anchoring clip **85** is positioned against the sloping rear wall of each recess and the clip is welded at **86** to the base **87**. In order to form a continuous lining on the base, block **80''** is first placed on the base and the anchoring clip welded to the base. In the embodiment illustrated, block **80''** has straight side edge faces, one straight end edge face **88** and one beveled end edge face. Since this block is the first block in the course it is necessary to secure both ends of the block to the base. Therefore, end edge face **88** is provided with an anchoring clip receiving recess (not shown) and secured to the base by means of an anchoring clip (also not shown) inserted in the recess and welded to the base. The beveled end edge face is also provided with a recess (shown in dotted lines) and an anchoring clip is inserted in the recess and welded to the base. In this manner block **80''** is held securely in position on the base. Block **80'** is then positioned on the base so that the beveled edge faces of blocks **80'** and **80''** are juxtaposed with the beveled edge faces parallel. In this manner the top surface of the end of block **80''** which is secured to the base overlaps the end of the abutting block **80'** which has no recess thereby restraining this end from movement. The opposing parallel end edge face of block **80'**, having a recess (shown in dotted lines), is then secured to the base by means of an anchoring clip, engaging the rear wall of the recess, being welded to the base. Block **80** is then secured to the base in a similar manner so that the beveled end edge face which has no recess abuts and overlaps the juxtaposed end edge face of block **80'**, so that the end of block **80'** effectively holds the end of block **80** securely in position on the base.

Example

A fused cast refractory block, 12" x 6" x 2", composed of crystalline phases of zirconia and alumina in a glassy siliceous matrix, was made according to the disclosure of U.S. Patent No. 2,903,373. The molten refractory composition was poured into a graphite mold having graphite inserts located at the base of one side of the mold. The block thus formed consisted essentially of crystalline alumina and crystalline zirconia embedded and dispersed throughout a siliceous glassy matrix. The block was left in the mold for heat treatment and was carefully cooled

by methods well known in the art. After the block had cooled, the mold and insert were stripped from the block so that when the insert was removed a recess was formed at the base of an edge face of the block. A metal anchoring clip, conforming in profile to the profile of the rear wall of the recess, was inserted in the recess and bonded to a portion of the rear wall by means of an epoxy resin. A series of such blocks was then fastened in abutting relation by welding the metal clips on a metal chute, thereby forming a wear-resistant lining on the chute.

It will be understood that the refractory mix described in the example was given merely for the purpose of describing a suitable mix and this invention is not intended to be limited to fused cast refractory blocks made from this specific composition. Rather, any fused cast refractory having abrasion-resistant properties may be used in forming the blocks.

The size of the fused cast blocks will of course vary depending on the intended use of the blocks. Similarly, the size of the anchoring clip recess is not a critical feature of this invention other than to provide sufficient surface to enable the anchoring clip to hold the block securely in position.

While the specification has primarily been concerned with the use of the fused cast refractory blocks as chute lining elements, the invention is not intended to be limited to such a use alone. Rather, the blocks made in accordance with this invention are suitable for any use in which resistance to wear is a principal requirement, such as, for example, crusher housings, feeder tables, downcomers on blast furnaces and the like.

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses or adaptations of the invention. It will therefore be recognized that the invention is not to be construed as limited to the precise embodiments shown and described but is to be interpreted as broadly as permitted by the appended claims.

We claim:

1. An abrasion-resistant article which comprises a fused cast refractory block having top and bottom surfaces, side edge faces and end edge faces, said side edge faces being parallel and in spaced relation and said end edge faces being parallel and in spaced relation, one set of said edge faces being beveled and having, at the base of that edge face which the top of said block overhangs, a recess, said recess extending into said block, having side walls, a top wall, and a rear wall, and a metal anchoring clip adhesively bonded solely to said rear wall of said recess, said clip being free of contact with the top wall of said recess.

2. An abrasion-resistant article as defined in claim 1 in which said anchoring clip is wholly within said recess and has a portion flush with the bottom surface of said block.

3. In a furnace chute having a metal base, the combination with said base of an abrasion-resistant lining comprising a series of fused cast refractory blocks, each of said blocks having top and bottom surfaces, side edge faces and end edge faces, said side edge faces being parallel and in spaced relation and said end edge faces being parallel and in spaced relation, one set of said edge faces being beveled and having, at the base of that edge face which the top of said block overhangs, a recess, said recess extending into said block, having side walls, a top wall, and a rear wall, said blocks being held in place on said base by a plurality of metal anchoring clips attached to said base, each of said clips being wholly within a said recess of one of said blocks and being bonded to said block solely by adhesive attachment to said rear wall of said recess.

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