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W. E. SCHMERTZ ET AL

2,743,493

INGOT MOLD INSERT MAT

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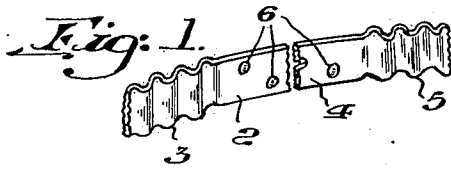
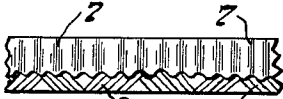


Fig. 3.

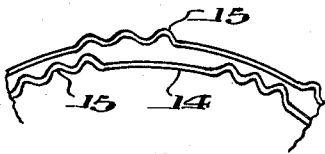


Fig. 6.

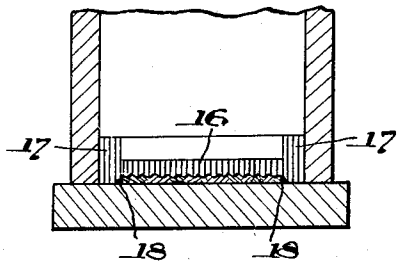


Fig. 7.

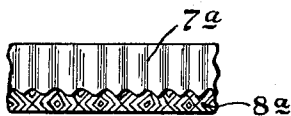


Fig. 12

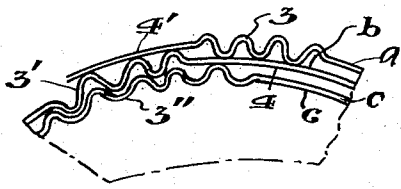


Fig. 2.

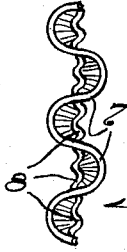


Fig. 4.

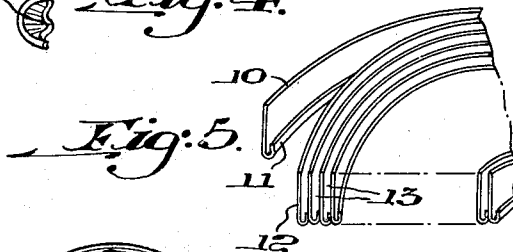


Fig. 5.

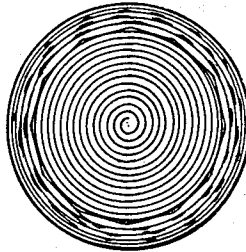


Fig. 8



Fig. 9.



Fig. 10.

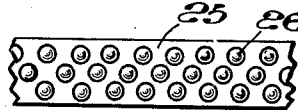


Fig. 11.

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INGOT MOLD INSERT MAT

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11 Claims. (Cl. 22—139)

This invention relates to ingot mold inserts of the type placed on the stool or bottom of the cavity of a top pour ingot mold to protect the stool or bottom and reduce erosion at the bottom of the mold itself.

Mold inserts of this character have heretofore been developed in many forms. One of the most successful is that disclosed in the patent to William E. Schmertz, No. 2,453,643, granted November 9, 1948, but the high cost of such an insert is a detriment to its widespread use.

In the aforesaid patent, the insert comprises a mat formed by simultaneously coiling a corrugated ribbon of metal and a flat ribbon of metal into a circular disc. The flat ribbon of metal, being thus interposed between the convolutions of the corrugated ribbon, maintains uniform spacing of the convolutions, and the corrugations of one convolution cannot mesh or nest into those of adjacent convolutions. This is important because the successful performance of such a mat is based on having in the mat over its entire area, small spaces or pockets. When the molten metal is poured from an elevation, it strikes the bottom of the mold or stool with great force, and has a great erosive action that hollows out and destroys the stool, and undercuts the lower end of the mold. The mat, setting on the stool, provides a kind of a porous heat conducting surface so that when the pouring starts, the hot metal, striking with force on the mat, penetrates the little pockets or cavities and is almost instantly chilled, and heat is carried away so rapidly that the mat is not destroyed. Additional metal poured into the mold thus strikes a mat having its cavities filled with solidified, though extremely hot, metal. This protects the stool or mold bottom as the case may be, from erosive action. At the initial pouring, it also tends to break the force of the lateral flow of metal or splash or side wash of the metal until there is enough molten metal to form a pool. It may be here stated that most steel is poured in big end down molds, where the bottom of the mold cavity is closed by a stool, but that to a lesser extent, big end up molds having a closed bottom are used. Our invention has utility with either type, but for convenience reference is here generally made to the use of the mats on mold stools.

Because of the large area of strip metal provided by the mat, and its ability to conduct heat into the stool, the mat is not destroyed or eroded, but accelerates solidification of metal at the bottom of the mold cavity. Rolling mill practice involves the cropping of the bottom end of the ingot after it has been reduced to a billet. This mat does not interfere with the initial rolling of the ingot, and it is eliminated in the subsequent cropping and goes back into the open hearth as part of the scrap charge from which other ingots are made. Thus the mats, while used but once, eventually become a part of succeeding melts and no metal is lost.

The making of such a mat from two ribbons of metal, one flat and one corrugated, requires the use of carefully selected uniform strip material, relatively complicated machinery, and is relatively slow. We have attempted

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to use only a corrugated ribbon but because of the meshing of the corrugations, a great deal more strip metal is required, and too great an area of the mat is practically solid and most crevices are too small to be effective.

The present invention has for its object to provide a cheaper and equally effective mat which does not require the laminating of two strips, one smooth and one corrugated.

A further object of our invention is to provide a mat which will more effectively protect the sides of the mold near the bottom.

These and other objects and advantages are obtained, and the nature of our invention may be more fully understood by reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a section of metal ribbon for use in making a mat in accordance with our invention;

Fig. 2 is a fragmentary plan view of an area of the mat made from the strip of Fig. 1, the mats normally being twelve to fourteen inches or more in diameter;

Fig. 3 is a side elevation of a fragment of another form of strip for making the mat;

Fig. 4 is a top plan or edge view of a portion of the strip shown in Fig. 3;

Fig. 5 is a fragmentary perspective view of a portion of a mat with the end of the strip being shown uncoiled, showing still another form of strip;

Fig. 6 shows still another modification of strip, fragments of two convolutions in contacting relation being shown;

Fig. 7 is a transverse section through a completed mat in which the exterior is higher than the body of the mat, and showing how it is positioned in the mold;

Fig. 8 is a top plan view showing the preferred manner of making the mat shown in Fig. 7; and

Figs. 9, 10 and 11 are elevations of still other forms of strips.

Fig. 12 is a view similar to Fig. 3 of another form of strip.

According to the form of invention shown in Fig. 1, a ribbon or strip of metal of the proper width and gauge has alternate corrugated and uncorrugated areas. In Fig. 1 the strip designated generally as 2 is formed for example of iron or steel compatible in the ingot to be poured. It is shown as having a corrugated area 3, an intervening non-corrugated area 4, and another corrugated area 5. Throughout the length of the strip there are alternate corrugated and non-corrugated areas. Preferably the number of teeth or ridges in one group of corrugations may be different from the number in the preceding or succeeding group, although this is not necessary. It will be noted that in this particular form of strip the corrugations extend in both directions from the normal plane of the strip. The uncorrugated area 4 may have, but does not necessarily have to have, small projections embossed therein. These embossed projections may and preferably do extend in opposite direction from the plane of the strip.

The strip thus designed can be formed by passing it between rolls having alternate areas to form corrugations and uncorrugated or embossed surfaces, and the rolls may have the corrugation-forming portions so arranged as to have a different number of corrugations in each succeeding group. Also the pattern of embossing in each uncorrugated area may be different from that in the preceding or succeeding area. The variation which may be produced in a given length of strip before there is a repetition depends of course upon the diameter of the rolls and the choice of the designer.

The mat itself is simply a flat coil formed, according to the preferred practice, by winding the strip upon itself,

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starting from the center, and winding outwardly until the desired diameter is reached. Because of the presence of corrugated and non-corrugated areas, and the fact that each convolution is longer than the preceding one as the mat increases in diameter, there will be only chance places where one group of corrugations can completely nest or mesh with another group in an adjacent convolution. This chance of complete meshing is further reduced by having different numbers of teeth or ridges in different succeeding groups of corrugations. It is obvious that if a group of three corrugations, for example, coincides with a group of five corrugations, there cannot be complete nesting. The character of the mat thus formed is clearly shown in the fragment in Fig. 2. Starting with the outer convolution marked *a*, the group of corrugations 3 falls upon a flat area 4, whereas the flat area 4' of convolution *a* rides over the teeth 3' of a next convolution inwardly, which is marked *b*. There is a third convolution marked *c*, and it will be seen that the group of three corrugations marked 3' of the convolution *b* line up with a group of six corrugations marked 3'' in the strip *c*. Complete meshing or contact will not occur, and desirable spaces or crevices will be formed.

With our invention, the single strip will produce a mat whose surface is open and full of small crevices, whereas if the strip were continuously corrugated, most of the corrugations in one convolution would mesh or nearly mesh with the adjacent inner and outer ones, and the yielding or stretching of the metal aggravates this condition of meshing or nesting. With our invention a very desirable mat is produced with a single strip.

In Fig. 2, for purposes of clearness, we have not shown the embossed projections 6 which appear in Fig. 1, but if desirable they may be provided. The primary purpose of so embossing the non-corrugated areas is that if the mat is wound under considerable tension, the smooth or uncorrugated areas tend to straighten out into a cord or tangent where they may stretch between two groups of teeth on the next adjacent convolution toward the center. By embossing projections in the manner described, the extent to which these areas can straighten out is restricted, and each convolution is more circular, and non-corrugated areas are prevented from coming together.

In the modification shown in Figs. 3 and 4 there are relatively large corrugations extending throughout the main width of the strip, these being designated 7, while there is a narrow margin at the bottom or stool-contacting edge of the strip which has very small corrugations in it preferably arranged in oppositely-sloping groups as indicated at 8. The strip shown in Fig. 3 may be continuously corrugated throughout its length, or it may be corrugated only at spaced intervals as in Fig. 1. The small corrugations in the margin 8 have a double purpose. First they compensate for the difference in length which would distort the strip if it had the large corrugations 7 extending part way across it, and a smooth bottom edge. Several small corrugations in the margin 8 require the same amount of metal as a single large corrugation, and hence the length of the strip at both edges can be kept constant. The small corrugations have the effect of thickening the bottom edge with very little opportunity for the meshing of the small convolutions in adjacent layers. Consequently, even though the large corrugations mesh, the increased thickness provided by the non-meshing margins 8 keep the meshed corrugations from closing. The top of the mat therefore presents parallel edges of metal with a slight crevice between, and this crevice exists even though the strip is continuously corrugated. By having it intermittently corrugated as in Fig. 1, additional open areas are provided. With this form of strip it is unnecessary to add any embossing in the non-corrugated areas above the margin as in Fig. 1, because the thickening provided by the margin 8 prevents the adjacent convolutions from coming in face-to-face contact, although such embossing may also be provided.

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In the modification shown in Fig. 5 a little channel similar to the rolled seam produced in making cans is formed along the bottom or mold-contacting edge of the strip. When the strip is coiled into a mat as shown, the folded metal or channelled bottoms of the several convolutions keep the top edges of the strip uniformly spaced. A mat is thus provided having in its top face a narrow spiraled channel between the narrow edges of the metal strip, this channel providing a crevice into which the metal flows and is chilled. In Fig. 5 the strip is designated 10, and the curled-over edge or channel is indicated 11. A fragment of a mat so formed is marked 12, and it is shown in section to more clearly illustrate the spaces 13 which are formed between adjacent convolutions. The strip thus formed may, if desired, be also corrugated or embossed, as the laterally thickened bottom edge, like that of Fig. 3, to keep the faces of the corrugations from meshing. A mat is thus provided which is of generally disk-like form having a top surface which has upstanding fins separated by grooves, the bottoms of which are substantially closed. Such a mat is also formed using a strip as disclosed in Figs. 3, 10 and 12 if the thickened lower marginal edge is sufficiently wide, except that using a strip as thus formed, the spaces between the upstanding fins will be less regular than shown in Fig. 5.

As stated above, Fig. 1 and Fig. 3 show the corrugations offset to each side of the plane of the strip. However, in some cases, it may be desirable to offset the corrugations only to one side of the strip as shown in Fig. 6. Here, as in Fig. 1, there are alternate corrugated and uncorrugated areas, and there may be different numbers of corrugations in succeeding corrugated areas. In Fig. 6 the strip is designated 14, and the corrugations are marked 15. It will be noted that all of them project to the same side of the plane of the strip 14. However our invention contemplates that the teeth of some groups might all project in one direction, and succeeding groups project in opposite direction from the face of the strip.

The feature shown in Fig. 6 may be combined with the embossing shown in Fig. 1, or with the margin arrangement shown in Figs. 3 or 5. Various other expedients may be used whereby the ribbon, when coiled upon itself, will not form a solid mat, but rather a mat which throughout the greater portion of its area, contains small cells or slits or grooves into which the metal will flow and solidify.

Some such other arrangements are illustrated in Figs. 9, 10 and 11. In Fig. 9 the strip is corrugated with groups of corrugations, the corrugations of adjacent groups being differently inclined with respect to the transverse axis of the strip. In Fig. 9 the strip is designated 21, and 22 is a group of corrugations inclined in one direction, and 23 a group of corrugations inclined in the other direction. It will be seen that when such a strip is coiled upon itself to form a mat, there is little chance of the groups of corrugations falling into register or nesting. This is generally similar to the principle shown in Fig. 3 where the margin only has such differently inclined groups of corrugations.

Fig. 10 shows a strip similar to Fig. 3, but in which the width of the strip is non-uniform, and in Fig. 10 we have also shown the corrugations being continuous along the length of the strip, instead of in groups as in Fig. 3. In this view 7' designates the large corrugations and 8' are the small corrugations along the bottom edge, while as shown, the top edge is waved. An advantage of this strip coiled into a mat is that the edge of the ribbon of metal, being uneven, forms a top surface on the mat which is uneven, and which tends to break up the lateral flow or wash of the metal. Also it tends to form a less dense top face for the mat. The feature of using a strip of non-uniform width can be used in the various other modifications of the strip herein disclosed.

Fig. 11 shows the use of a strip 25 having its entire area covered with little embossed projections 26 which

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may be embossed all in one direction from the plane of the strip, or which may project each side from the plane of the strip. These laterally offset projections keep the strip from contacting the face of an adjoining convolution when the strip is shaped into a mat.

Fig. 12 shows a strip similar to Fig. 3 differing therefrom only that instead of the marginal edge being embossed with small corrugations, a kind of a herringbone type of embossing is used to provide the thickened bottom margin. In this figure, 7a indicates the upper portion of the strip and 8a is the embossed margin having reverse V-shaped or herringbone indentations and ridges formed thereon. The strip 7a is corrugated upwardly from the margin across the width of the strip.

When the strip is formed into a mat or coil, it is tack welded along the bottom edge at intervals to prevent it from uncoiling, and to enable it to be handled and shipped without danger of the center of the mat being pushed out of the original plane of the mat to such an extent that the mat would fall apart.

When the hot metal, poured from an elevation, strikes the mat, it tends to spray out in all directions. The continuity of this stream is less where a mat is used than where the metal strikes the solid surface of the ingot stool. This outward spraying or surging of the metal has a destructive erosive effect on the side walls of the ingot mold. It will reduce this erosive effect and at the same time further reduces splashing in the initial part of the pour. Our invention contemplates that the periphery of the mat may have a few convolutions of sheet metal somewhat wider than the thickness of the mat itself. These upstanding thin convolutions of metal, being more remote from the stool, and being more deeply embedded in the molten metal, are designed to be melted away after the first part of the pouring, but they will be effective during the initial portion of the pour to break the surge or spray and also interrupt the splash.

This arrangement is shown in Figs. 7 and 8 wherein the mat, preferably formed as hereinbefore described, is designated 16 and the relatively few outer convolutions, designated 17, are welded at 18 to the periphery of the mat. The central area of the mat 16 may be formed in the manner hereinbefore described in connection with the several figures. Whereas the thickness of the mat may be of the order of one or one and one-half inches, the outer convolutions may be of the order of eight or ten inches, more or less. In Fig. 7 we have shown the contour of the ingot mold to show the relation of the mat to the mold and the mold stool.

The convolutions 17 may be wrapped in face-to-face contact. Preferably we form these convolutions by wrapping strip of sheet metal about a mandrel comprised of a series of spaced pins. This causes the inner convolutions of metal to be somewhat polygonal while the outer ones become substantially circular as best shown in Fig. 8. This has the advantage of spacing the sheets forming the outer guard or outer convolutions so as to more readily melt and be absorbed into the ingot after the initial pouring operation.

While it has heretofore been proposed to use splash guards in ingot molds, they have heretofore had to be of a height approximately twenty-four inches, to be effective. Because of the fact that in the present invention the guard 17 is secured to the mat 16, the mat reduces the splash and surge so that the guard 17 can be substantially lower and extend less far upwardly into the mold cavity. This is of course quite important from the standpoint of economy, handling, and for other reasons.

In the drawings we have shown the mat as being circular, but it may be formed square or rectangular by folding the metal back and forth on itself instead of being spiraled. In either case, the mat is comprised of layers or convolutions comprised of strip metal, each layer being similarly formed with lateral offset portions to prevent one layer or convolution from lying in face-to-face con-

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tact with adjacent ones, and thereby provide a mat having a large exposed metal area and crevices of small cross section into which the metal may initially flow and freeze.

While we have shown and described certain specific embodiments of our invention, it is understood that this is by way of illustration and that various changes and modifications may be made within the contemplation of our invention and under the scope of the following claims.

We claim:

1. An ingot mold insert comprising a single strip of sheet metal arranged into a mat formed of several convolutions of the strip in face-to-face relation, said strip having laterally projecting offset portions over a part only of the entire area of the strip constituting each convolution effective in each convolution to keep the principal area of the convolutions out of contact whereby crevices and pockets are formed between the convolutions.

2. An ingot mold insert mat comprising a strip of sheet metal folded upon itself to form a succession of convolutions, said strip having dissimilarly-formed areas over its surface with one area giving an increased thickness over adjacent areas to preclude the convolutions from making full face-to-face contact and form between them crevices of small section into which metal will penetrate.

3. An ingot mold insert made as defined in claim 2 in which the thickened area is along the bottom edge.

4. An insert mat as defined in claim 2 in which the thickened area is formed by transverse corrugations separated by areas in which the strip is not corrugated.

5. An ingot mold insert mat as defined in claim 2 in which the bottom edge is effectively thickened by embossing, and in which the area above the bottom edge has transverse corrugations.

6. An insert mat as defined in claim 5 in which the corrugations are arranged in groups with non-corrugated areas between successive groups.

7. An ingot mold insert mat as defined in claim 2 in which the effective increase in thickness is secured along the area constituting the bottom edge, and in which the area above the bottom edge also has portions laterally offset from the plane of the strip.

8. An ingot mold insert mat comprising a strip of metal wound upon itself to form a tightly wrapped spiral, the bottom edge of the strip being deformed laterally from the plane of the strip to provide an effective increase in the thickness of the bottom edge of the strip whereby adjacent convolutions will make contact along the bottom edge and the metal of the strip which is not distorted from the original plane of the strip above said bottom edge will be spaced from adjacent convolutions.

9. A mold insert mat as defined in claim 8 in which portions of the area above said thick bottom edge are corrugated with groups of corrugations separated by non-corrugated areas.

10. A mat as defined in claim 8 wherein the strip above the distorted bottom edge is transversely corrugated throughout its entire area, the contacting distorted bottom edges of adjacent convolutions precluding the corrugations in adjacent convolutions from completely meshing.

11. An ingot mold insert comprising a strip of metal coiled to provide a mat having several convolutions, the bottom edge of the strip being laterally deformed to form a margin which is effectively thicker than the remainder of the strip whereby the mat has upstanding spaced fins substantially closed at the bottom by said thickened marginal portions.

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