

Jan. 23, 1962

H. S. LINK ET AL  
ANTI-SKID TREAD PLATE

3,017,689

Filed March 27, 1958

2 Sheets-Sheet 1

FIG. 1.

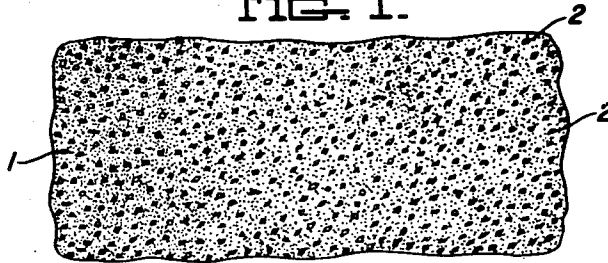


FIG. 2.

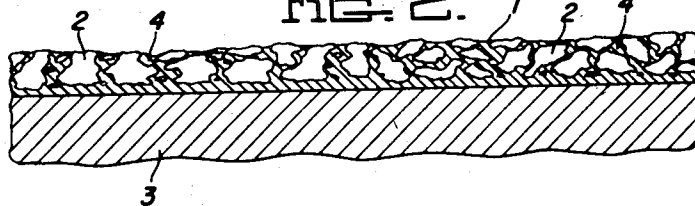


FIG. 3.

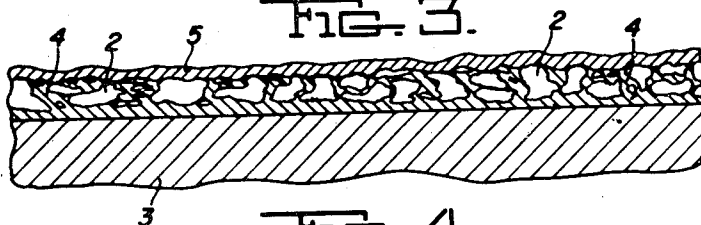


FIG. 4.

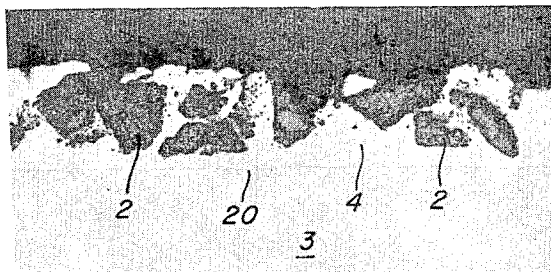
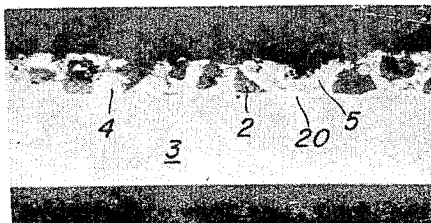


FIG. 5.



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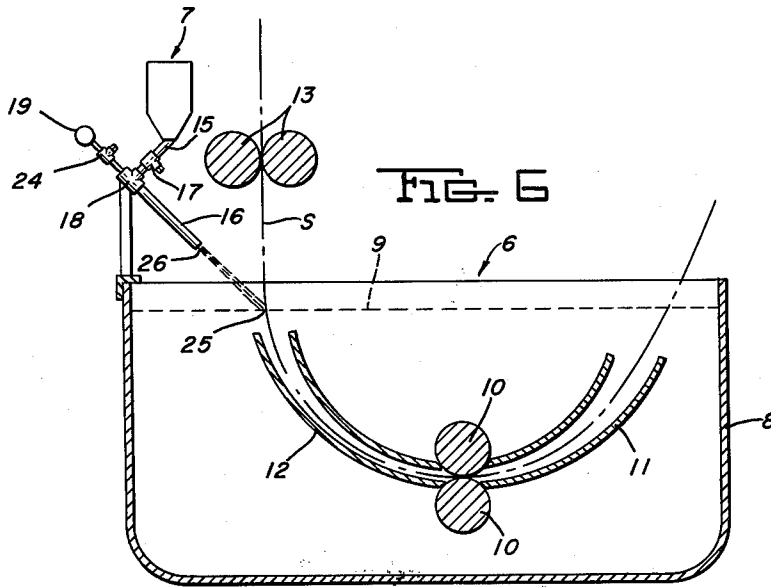


FIG. 7

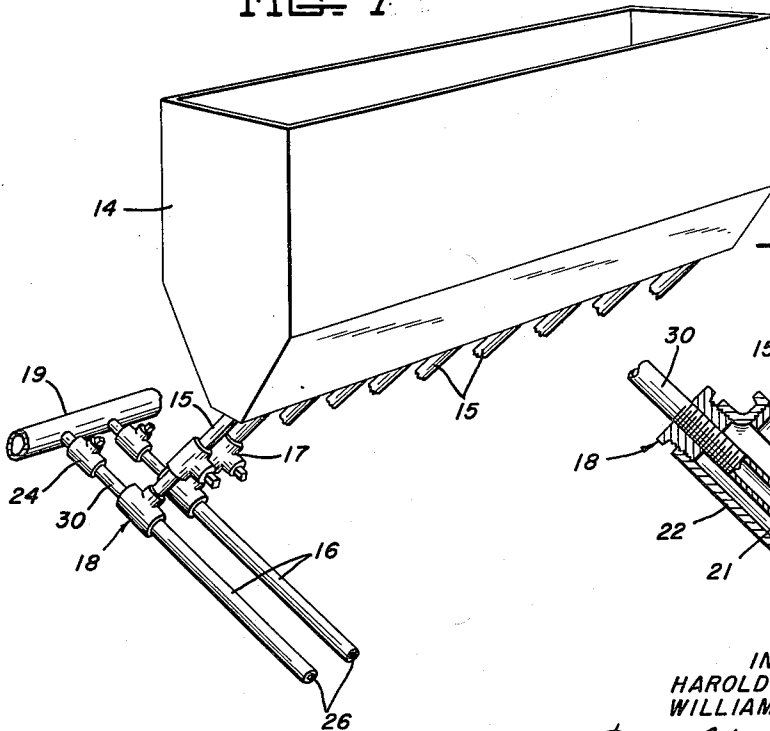
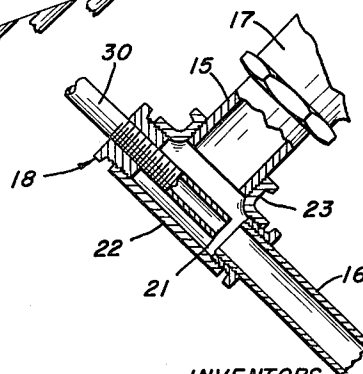


FIG. 8



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3,017,689

## ANTI-SKID TREAD PLATE

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Filed Mar. 27, 1958, Ser. No. 724,476

1 Claim. (Cl. 29—194)

This is a continuation-in-part application that is directed to subject matter divided out of our co-pending application, Serial No. 443,594, filed July 15, 1954.

The invention relates to an anti-skid tread plate and, more particularly, to one that is formed by projecting abrasive particles against a hot-dipped coating of non-ferrous metal on a metal base structure. In a manner to be described, the preferred embodiment is a galvanized steel sheet in which the spelter coating has a thickness greatly in excess of that applied by conventional galvanizing operations and which has abrasive particles uniformly deposited over and substantially entirely embedded in its spelter coating.

Anti-skid tread surfaces having high coefficients of friction are desirable from the standpoint of safety and convenience in many instances such as stair treads, walkways and floor plates, and are particularly desirable where the tread surface is subject to wet or oily conditions. Generally stated, conventional tread surfaces providing anti-skid properties are commonly as follows: abrasive impregnated cloth or paper cemented or otherwise secured in place; metal tread plates having patterned openings or metal protuberances therein; coatings of paints, plastics, or cements having abrasives incorporated therein; metals having abrasives cast or rolled therein; and treads having grooves or depressions filled with anti-skid materials. However, such conventional proposals individually considered have at least some if not all of certain well known disadvantages from the standpoint of wearability, inadequate anti-skid properties under wet and oily conditions, cost of manufacture, maintenance expense in cleaning and replacement, and inability to withstand high temperatures, impact, and the corrosive action of chemicals.

One of the principal objects of this invention is to provide an anti-skid plate which, in addition to eliminating the above mentioned disadvantages of conventional practices, has desirable features which are not provided by conventional tread plates. The tread plate of this invention has excellent anti-skid properties and wearability, can be bent severely without flaking or peeling at the surface, will resist damage from severe impact, can be produced on thin metal strips or sheets and on plates, has an attractive appearance and can be painted, will resist many corrosive media and separation by the action of solvents, will withstand relatively high temperatures, and can be produced on base sheets or plates of a number of different metals such as the ferrous metals and aluminum.

The tread plate of this invention, more particularly, has a laminated construction that is comprised of a base layer in the form of a metal plate or sheet, an intermediate layer or hot-dipped coating of non-ferrous protective metal bonded to the base layer, and an anti-skid tread surface layer composed of abrasive particles that are at least partially embedded and anchored in the coating metal. In a manner to be described, the abrasive particles are anchored in the coating metal by projecting them against its surface while it is in a molten condition. According to a preferred practice, this is accomplished by an apparatus that directs a stream of compressed air or other gas against the metal coating as it moves to a position above the surface of a molten coating bath, and by entraining the abrasive particles in the blast for pro-

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jection thereby against the coating metal. In addition to projecting the particles against the coating metal, the gas has a cooling action that reduces drainage of the coating metal and thereby produces a thicker coating than could otherwise be obtained. The apparatus for applying the coating is a conventional metal coating apparatus that is modified for the purposes of this invention by removal of the usual exit rolls to enable a thicker coating of covering metal and to provide for projection of the abrasive particles against such coating while it is still in a soft or molten condition.

Other objects and advantages of the invention will become apparent from the following description.

In the drawings there is shown a preferred embodiment of the tread plate of this invention and a preferred arrangement of apparatus for effecting its fabrication. In this showing:

FIGURE 1 is a fragmentary plan and somewhat diagrammatic illustration of an anti-skid tread plate corresponding to and produced in accordance with the principles of this invention;

FIGURE 2 is a sectional view showing diagrammatically the laminated construction of the tread plate shown in FIGURE 1;

FIGURE 3 is a view similar to FIGURE 2 showing the tread plate with a sprayed covering of a ferrous metal on the surface layer of abrasive particles;

FIGURE 4 is a photomicrograph showing in section the actual structure of a tread plate produced in accordance with the principles of this invention;

FIGURE 5 is photomicrograph of a similar tread plate that has a sprayed coating of ferrous metal thereon;

FIGURE 6 is a diagrammatic sectional view of a preferred form of apparatus for producing the tread plate of this invention;

FIGURE 7 is a perspective view of the abrasive particle spraying or projecting apparatus shown in FIGURE 6; and

FIGURE 8 is an enlarged fragmentary sectional view taken along a diameter of one of the spray nozzles shown in FIGURE 7.

From the standpoint of adaptability to commercial production, the preferred embodiment of tread plate of this invention is a galvanized plate comprised of a ferrous metal base sheet or plate having a coating of zinc thereon in which abrasive particles forming the tread surface are embedded and secured thereby to the base plate or sheet, and the immediately following description is specific to such embodiment and an apparatus and process for producing the same. However, and in a manner to be described, the invention is not limited to ferrous metal base sheets and to zinc coating metal or to galvanized products in general. Other metals may be used with equal effectiveness in a manner to be described, the only requirement being that the coating metal and base metal be metals which alloy with each other.

Referring now to the diagrammatic showings of FIGURES 1, 2 and 4, the tread plate of this invention is illustrated as having a tread surface 1 comprised of a layer of abrasive particles 2. As best shown in FIGURES 2 and 4, the tread plate has in effect a laminated construction comprised of a base layer 3 of ferrous metal sheet, a galvanized coating or layer 4 of zinc bonded with the base layer 3, and the tread surface layer of abrasive particles 2, the abrasive particles 2 being embedded in the intermediate zinc layer 4 and being secured thereby to the base layer 3. In a manner to be described, the particles 2 are preferably embedded in the coating layer 4 of zinc by being projected or sprayed against its outer surface while it is in a molten or semi-molten condition. By reason of the soft condition of the zinc layer 4 the inertia of the abrasive particles at the time of their impact therewith is

effective to embed them in the zinc metal. As will be apparent from FIGURES 4 and 5, most of the particles are completely embedded in the zinc and the remaining particles are at least partially embedded therein. With reference to the partially embedded particles it will be noted that the zinc has flowed over the edges of such particles and into the interstices therein and is effective to securely anchor them against movement away from the base plate. In this respect, and bearing in mind that some of the abrasive particles are partially covered by the coating metal, it will be apparent that the tread surface 1 may be comprised in part of the coating metal 4.

To more securely anchor the particles 2 against disengagement of their anchored connection with the coating metal by gouging, the tread surface 1 may be provided with a protective covering or coating 5. Such coating may be, for example, a coating of plastic or resin, paint, or a ferrous or other metal applied by conventional metal spraying equipment. The metal or material selected for the coating 5 will of course be determined by the conditions to be encountered in use.

A preferred form of apparatus for producing the tread plate described above is shown diagrammatically in FIGURE 6 of the drawings. It comprises a conventional galvanizing apparatus 6 that has been modified in a manner to be described for the purposes of this invention, and an abrasive particle spray unit 7. The apparatus 6 may be either a sheet or strip galvanizer that operates to apply a coating 4 of zinc to a metal base 3 in the form of a ferrous metal sheet S. The unit 7 operates in a manner to be described to project the abrasive particles 2 against the coating 4.

The galvanizer 6 comprises a spelter pot 8 which is filled with molten coating metal to a level indicated by the broken line 9. A pair of feed rolls 10 in the bottom of the pot receives the sheet S from guides 11 which direct its downward immersing movement into the molten spelter. From the rolls 7 the sheet is delivered upwardly through guides 12 to a set of withdrawal rolls 13 located well above the surface level 9. The relative arrangement of the guides 12 and rolls 13 is such that the sheet is withdrawn from the spelter along a vertical path that is normal to its surface level 9.

The spray unit 7 is mounted at one side of the tank 8 opposite the withdrawal rolls 13 and above the spelter in a position for spraying abrasive particles 2 against the coating 4 as it is removed with the sheet S from the bath of molten spelter in the pot 8. It comprises a hopper 14 for a supply of abrasive particles and a plurality of feed tubes 15 at spaced intervals along its bottom which respectively extend downwardly and are connected with projecting tubes 16. Each of the feed tubes 15 has a valve 17 for regulating the rate of flow of abrasive particles 3 therethrough to the projecting tube 16 with which it is connected and thereby the density of abrasive coverage on the surface 1. As best shown in FIGURES 7 and 8, the tubes 15 and 16 are connected by T-couplings 18 that further provide for connection of the projecting tubes 16 to a compressed air or other gas supply manifold 19. The latter connections are provided by gas supply tubes 30 of a relatively smaller diameter which respectively have one end connected with the manifold 19 and an opposite end 21 connected with a coupling 18. As shown in FIGURE 8, the ends 21 of the supply tubes 30 extend axially through the base leg 22 of the couplings 18 and to a position slightly beyond the vertical leg 23 that is connected with the abrasive supply tubes 15. With an arrangement of this character, gas flowing from the tubes 30 into the projecting tubes 16 aspirates abrasive particles from the lower ends of the feed tubes 15 into the projecting tubes 16. In this manner, the particles 2 are entrained in the gas flowing through each tube 16 and are projected in a spray from its outer end. Valves 24 regulate the flow of gas through the tubes 30 to the projecting pipes 16.

The projecting tubes 16 are preferably mounted relative to the sheet S and surface 9 as shown in FIGURE 6. As there shown, the axis of each tube 16 is aimed at a point 25 which is at the intersection of the surface 9 and sheet S. At this point, the coating metal 4 applied to the base 3 by its movement through the bath is just rising above the surface 9 and is in a molten or at least a semi-molten condition such that the impact of the particles 2 projected against the coating metal is effective to embed and anchor them therein. Test results have proved this arrangement of the tubes 16 relative to the surface 9 and sheet S is best from the standpoint of obtaining the most effective anchorage of particles 2 in the coating metal 4. In this respect, aiming the tubes 16 at points on the sheet S above the surface of the bath was found to materially decrease the abrasive embedded in the zinc, while aiming at points on the surface 9 in front of the sheet S produced lumpy and uneven coatings. Although the effect of the angle of the tubes 16 was not examined, good results were obtained with an angle of about 45° as shown in FIGURE 1.

By way of example, a spray unit 7 that was found to provide good abrasive covering and anchorage in the coating metal had the tubes 16 spaced laterally at intervals of six inches and their outer or nozzle ends 26 spaced a distance of 10 inches from the points 25. The projecting tubes 16 and gas supply tubes 30 had inner diameters of 1/4" and 1/8" respectively and gas in the form of compressed air was supplied from a manifold supply pipe 19 that had a diameter of one inch. In this arrangement, compressed air at a pressure of 20 p.s.i. in the tubes 30 produced the best results. When the air pressure was substantially more than 20 p.s.i. the coatings were ripped; and when the pressure was substantially less than 20 p.s.i., the abrasive particles were not as firmly anchored in the zinc. As indicated above, the valves 24 regulate the pressure and the rate of air flow through the pipes 16, and a regulation of this character in turn controls the blast velocity and thereby the force with which the particles 2 are projected against the coating 4. This force controls the penetration of the particles 2 in the spelter coating and is regulated in such manner that it is effective to embed and anchor the particles 2 in the coating metal 4 as explained above. The density of the covering of abrasive particles applied to the coating 4 is regulated by adjusting the valves 17.

Referring again to FIGURES 4 and 5, it will be noted that the line of intermetallic alloys, designated by the numeral 20, is well defined and that all of the particles 2 are positioned or spaced outwardly with respect to such line. This may be accounted for by the fact that the metal in the region of the alloys of zinc and iron along the line 20 is solidified and harder than the softer metal outwardly therefrom and thus resists penetration by the particles 2. In any event, there is a definite spacing of the particles 2 with respect to the surface of the base plate or sheet 3 indicating that the particles do not penetrate to or contact the base 3.

As indicated above, the modification of conventional galvanizers that is required to provide the galvanizer 6 resides in the omission of the usual exit rolls. In conventional apparatus for galvanizing sheet and strip, exit rolls partially submerged in the spelter are universally employed to obtain a clean finish and uniform coating; in addition, they are used to control the thickness of the zinc coating and this is done by regulating the pressure of their engagement with the strip. The thickness or weight of coating metal in commercial operations varies from a minimum of 0.5 ounce per square foot to a maximum 2.5-2.75 ounces per square foot, these weights being that of the coating metal applied to both sides. Such exit rolls thus render conventional apparatus unsuitable for this invention since the thickness of the heaviest coating customarily produced thereby is slightly more than 0.002 inch, which is inadequate for the purpose of anchoring,

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for example, 60 mesh abrasive particles that have an average particle size of 0.010 inch. In addition, trials proved that spraying strip as it emerged from the exit rolls did not produce good results since the coating metal at this point had solidified by cooling to an extent such that very little abrasive adhered thereto.

The omission of the exit rolls and the use of an air blast from the tubes 16 result in thicker coverings of coating metal 4 compared to those produced by conventional galvanizing apparatus using exit rolls for the usual purposes as explained above. The removal of the exit rolls of course enables free withdrawal of the coating metal 4 with the strip S and thus results in a heavier coating. In addition, the blast of air from the tubes 16 acts mechanically to push the molten coating metal onto the surface of the sheet S and exerts a cooling action that reduces drainage of the metal 4 in a downward direction and its return to the pot 8. These features of course mutually contribute to the production of thicker coatings of covering metal 4. With a constant temperature and velocity of air blast from the tubes 16, the weight or thickness of the metal in the coating 4 may be regulated by adjusting the temperature of the bath of molten coating metal and the speed at which the sheet S travels therethrough.

Investigation of several tread plates, which were produced for test purposes on a galvanizing apparatus 6 as explained above and with tread surfaces according to the principles of this invention, developed that the weight of zinc in the coating 4 should be in excess of 2.0 ounces per square foot of tread surface area, and, more particularly, should be in the range of from 2.0 to about 6.0 ounces per square foot of tread surface area, these weights again being those of the metal applied to one side or surface only of a steel sheet S. Expressed in terms of thickness, the weights 2.0 and 6.0 ounces of zinc per square foot indicate respectively coating thicknesses of 0.0033 inch and 0.01 inch. In explanation of the latter range of thicknesses, measurements of such tread plates showed zinc coatings varying in weight from 2.45 ounces to 4.35 ounces per square foot, or thicknesses varying from 0.00412 inch to 0.0073 inch respectively. Examination of the lightest coatings showed that the covering was so thin that the anchorage of the abrasive particles was not as good as in the heavier coatings, and that the zinc covering could probably not be decreased below 2.0 ounces and still obtain an effective anchorage for the abrasive particles. Examination of the heavier coatings indicated that the anchorage would not be improved materially by increasing the covering beyond 5.0-6.0 ounces per square foot. While still heavier coatings would increase the life of the tread plates from the standpoint of wear, coatings heavier than 5.0-6.0 ounces will be difficult to obtain in practice.

Any of a number of abrasives, which are available on the market and have the hardness required to produce wearability, may be used as the particles 2. Typical of such abrasives are the materials flint shot, Alundum or aluminum oxide, Carborundum, emery, corundum, tungsten carbide, silicon carbide, and the like. Most of these materials have rough surfaces which are effective to provide a secure anchoring connection in the coating metal 4 when embedded therein before it has solidified by cooling. The mesh size of the particles 2 may be varied in accordance with the type of anti-skid surface desired, the smaller mesh sizes forming smoother surfaces and the larger sizes providing rougher surfaces. The particles may be of mixed sizes and a satisfactory tread surface will be provided by a mixture of particles varying from 20 to 80 mesh. In this respect abrasive with a particle size of from 36 to 60 mesh is preferred from the standpoint of a surface of satisfactory roughness and in which the particles have a good anchored connection in the coating metal. Generally stated, the upper limit of particle size is determined by the thickness of the coating metal layer 4 since there must be sufficient coating metal for the par-

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ticles to be embedded therein to a depth providing an adequate anchoring connection therefor. If excessively large particles are used on thin coatings, the particles will project above the surface of the coating metal to an extent such that they may break away or be gouged out of the relatively soft coating metal in the course of normal use and the particle size must therefore be selected according to the thickness of the coating metal to avoid this condition. In general, larger sizes of particles require thicker layers of coating metal. A surface coating 5 of resin or sprayed metal as explained above is highly effective in eliminating loss of abrasive particles 2 by gouging and will be found to materially increase the life of the tread plates.

As indicated above the valves 17 are adjusted to regulate the quantity of particles 2 projected by the tubes 16 and thereby the density of the particles on the surface of the sheet 7. While the anti-skid properties increase with the density of the particles 2 in the coating 4, the quantity of abrasive is limited by the number of particles that can be anchored in the coating metal. Using alundum in the production of the tread plates, which had zinc coatings varying from 2.45 to 4.35 ounces per square foot as mentioned above, satisfactory tread surfaces were obtained by applying the particles 2 in quantities from 0.5 to 2.0 ounces per square foot, about 1.0 ounce per square foot being adequate for good anti-skid properties and being preferred. Such tread plates, with coatings of zinc and alundum particles applied in the ranges mentioned above, had tread surface thicknesses that varied from 0.014 inch to 0.022-0.025 inch.

From the standpoint of adaptability to commercial production and cost of producing tread plates, it will be apparent that a galvanizer 6 for applying coatings 4 of spelter has obvious advantages that render its use preferable. While the foregoing description is specific to an apparatus of this character, it will of course be understood that the principles of the invention are applicable to other metals and that it is not limited to ferrous metal base sheets and to zinc coating metal or to galvanized products in general. In this respect, other metals may be used with equal effectiveness, the only requirement being that the coating metal and base metal be metals that will alloy with each other. Examples of other coating metals which will bond with ferrous metal bases 3 in this manner are aluminum, tin, and terne metal. While still other metals are known to have similar bonding characteristics, they are in general too expensive to be practical and tin may well be included in this classification. From a practical standpoint, zinc and aluminum are preferred because of the availability of commercial coating apparatus that is adapted for use with an abrasive particle spray unit 7. In the same sense, other metals may be substituted for the base 3 although aluminum is the only other metal which from the standpoint of expense would be practical.

When using other metals such as aluminum, the weights of coating metal 4 given above in ounces per square foot of tread surface area will change in accordance with the density of the coating metal being used. In this respect it will be apparent that a lesser weight of aluminum would be required to provide the same volume of coating metal and thickness of the resulting coating 4. Since the coating metal must have sufficient thickness to provide an effective anchor for the particles 2, it will be further apparent that the coating 4 in the case of aluminum or other metals should be applied with a thickness in the range of from 0.0033 inch to 0.01 inch as explained above in connection with hot-dipped zinc coatings.

A tread plate in which aluminum is used as the coating metal forms the subject matter of application Serial No. 127,918, filed July 31, 1961, to which reference is hereby made.

Although a hot-dipping or galvanizing apparatus of the type shown in FIGURE 7 will apply the coating metal to both sides of the base metal, the coating metal for the

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purposes of this invention need be applied to only one side of the base. Accordingly, and if desired, the other side of the base may be coated or painted with a material which will prevent adherence of the coating metal thereto. In addition, and while the apparatus shown in FIGURE 1 is particularly adapted to coating sheet metal, it will be understood that the principles of the invention are adaptable to the application of coating metals and abrasive particles to structural sections, and that in such case galvanizing or coating apparatus suitable to the structure of the base will be employed.

The apparatus and process described above form the subject matter of our co-pending application, Serial No. 724,362, filed March 27, 1958, now Patent No. 2,964,419, to which reference is made.

While the foregoing describes the essential features of the tread plate of this invention, it will be understood that other adaptations and modifications may be made without departing from the scope of the following claim.

We claim:

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An anti-skid tread plate comprising a steel base providing a tread surface area on one side thereof, a hot-dipped coating of spelter covering said area in an amount from about 2.0 to about 6.0 ounces per square foot of said area, and abrasive particles of a mixed size from 20 to 80 mesh uniformly distributed over said coating area, said particles being embedded in and substantially entirely covered by the spelter in said coating and being anchored thereby against movement relative to said steel base.

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