

Sept. 7, 1954

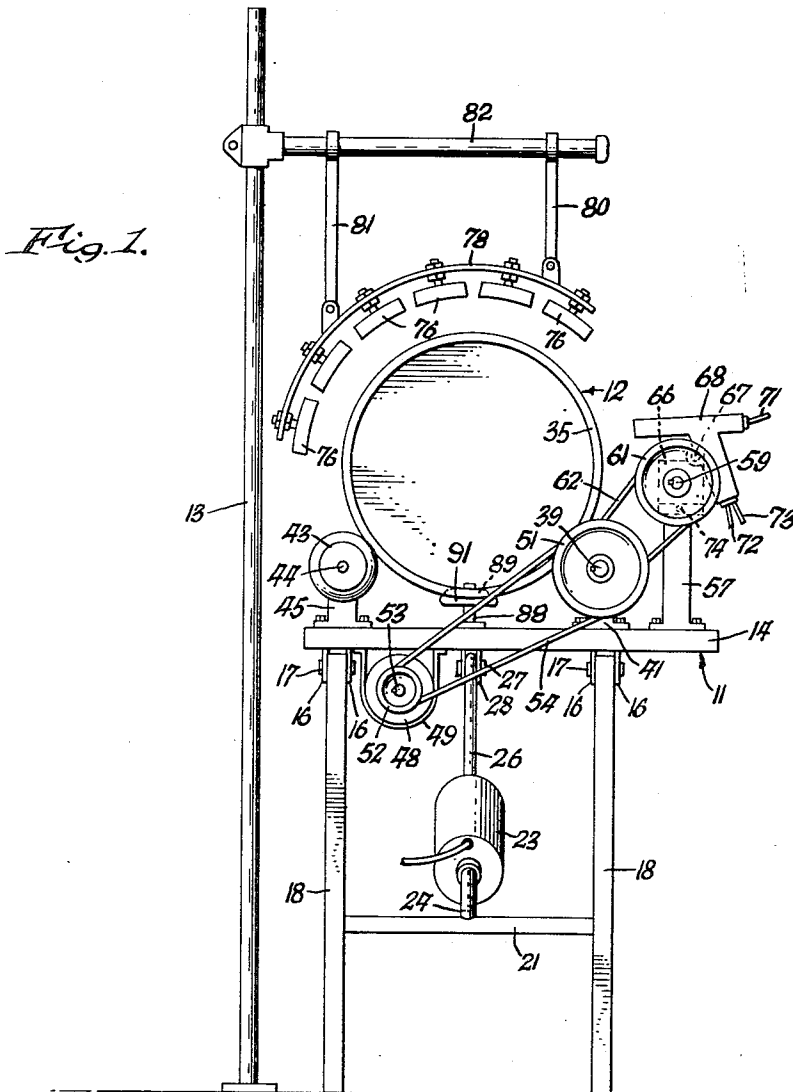
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2,688,563

PROCESS OF COATING METAL STRIP WITH POLYETHYLENE

Filed Nov. 28, 1951

3 Sheets-Sheet 1



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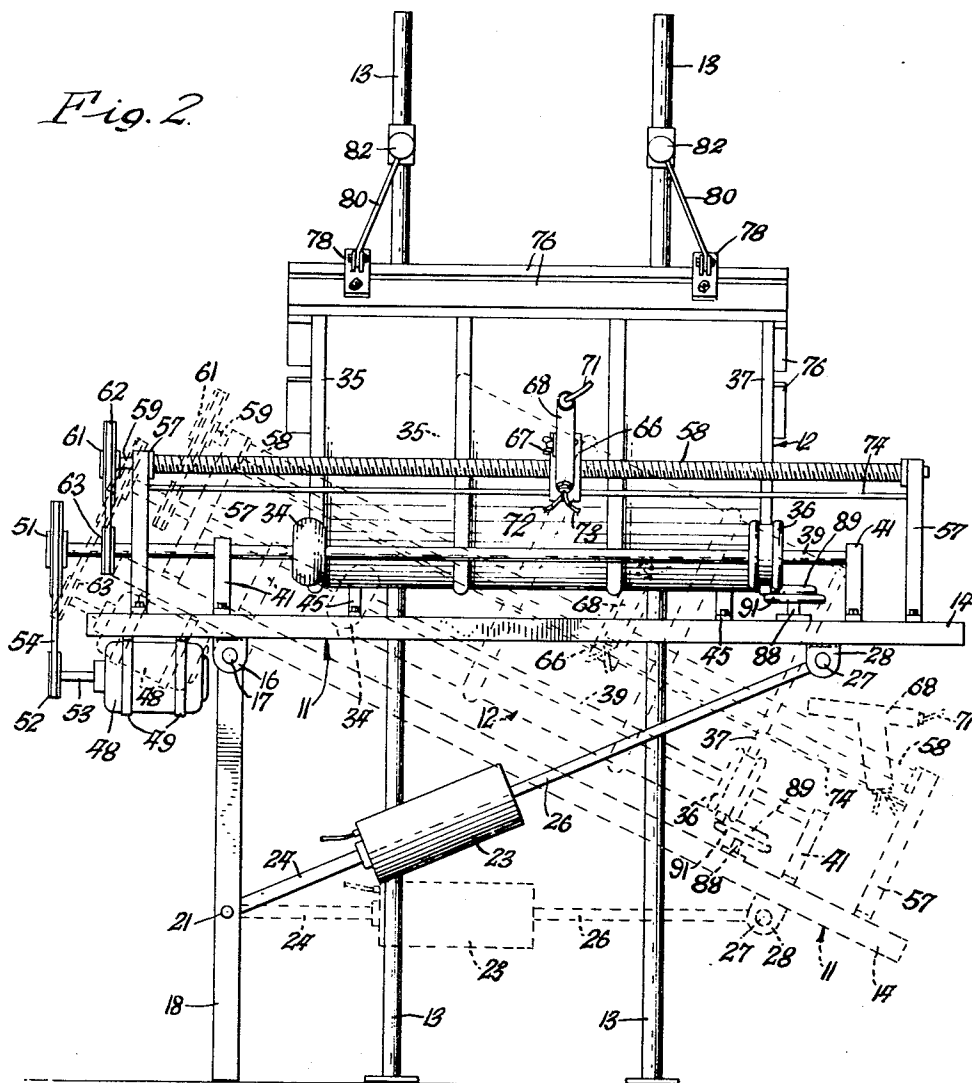
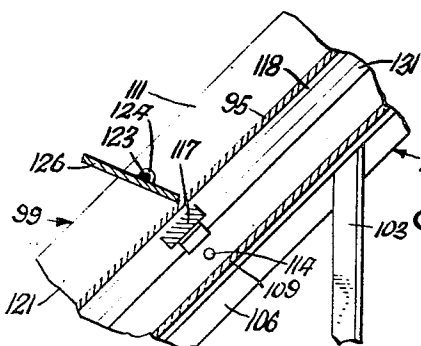
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 3.

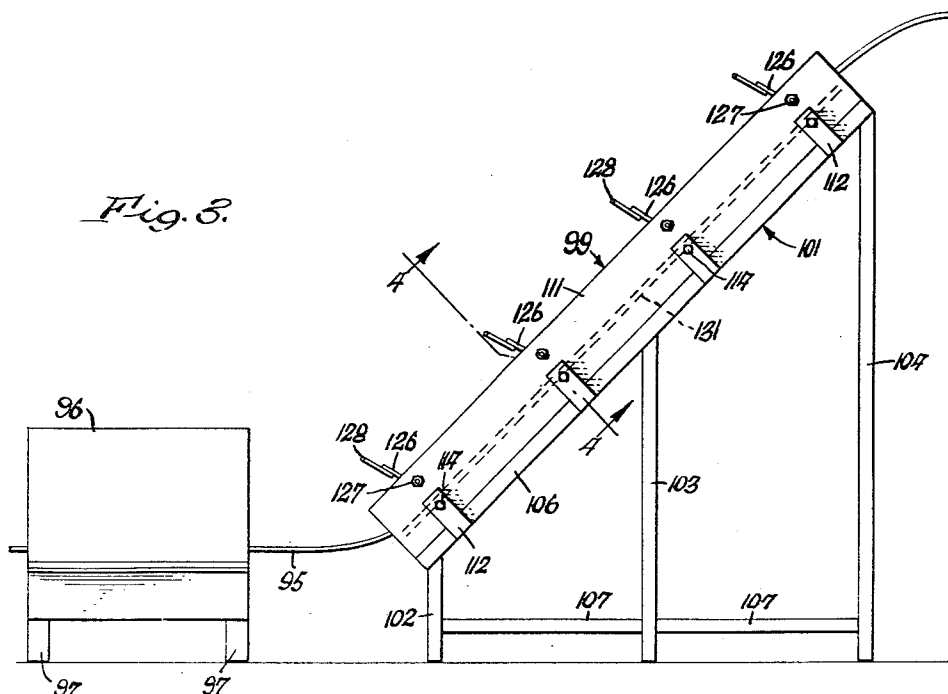
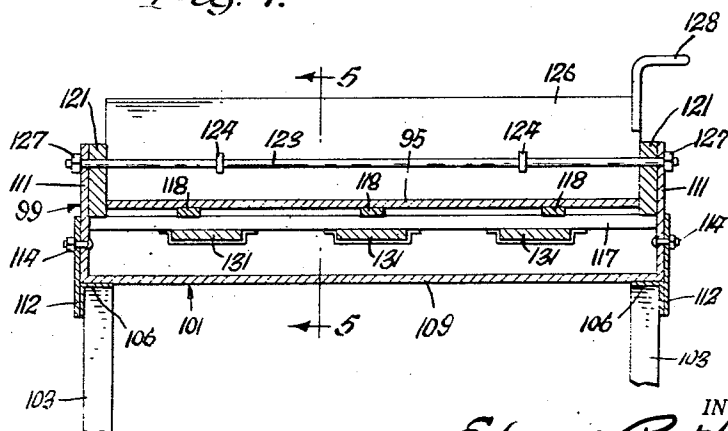


Fig. 4.



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UNITED STATES PATENT OFFICE

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PROCESS OF COATING METAL STRIP WITH
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2 Claims. (Cl. 117-21)

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This invention relates to the coating of metal surfaces and is particularly concerned with the formation thereon of durable, impervious, adherent coatings of polyethylene.

Among the objects of the present invention are to provide a novel process for coating metal articles, sheets, strips and the like with an impervious, adherent layer of polyethylene and to provide novel and convenient apparatus for carrying out such a process.

Another object of the invention is to provide a process of the type described which is particularly useful and efficient in forming a polyethylene lining in metal barrels, drums, and the like.

A further object of the invention is to provide a process of the character described by which the exterior and interior of a metal barrel, drum or the like may simultaneously be coated with impervious layers of polyethylene.

Still another object of the invention is to provide a process of the type described by which long strips of metal can be continuously coated with an adherent layer of polyethylene.

Additional objects and advantages of the present invention will be apparent from the following description when taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is an end view of apparatus adapted for carrying out the novel process of the present invention, the particular apparatus being adapted for the production of an impervious, adherent polyethylene coating on the interior of a barrel or drum or the simultaneous production of such coatings on both the exterior and interior thereof;

Figure 2 is a front elevation of the apparatus illustrated in Figure 1, broken lines being used to show the position of a portion of the apparatus during part of the process;

Figure 3 is an elevation of another form of apparatus adapted particularly for continuously applying impervious, adherent coatings of polyethylene to metal strip in accordance with the novel process of the present invention;

Figure 4 is an enlarged sectional view, taken on the line 4-4 of Figure 3; and

Figure 5 is an enlarged sectional view, taken on the line 5-5 of Figure 4, of a portion of the apparatus shown in Figure 3.

According to the invention of the present application, a durable, impervious, adherent coating of polyethylene is provided on the surface of one side of a metal article by contacting the surface while hot with finely divided, solid poly-

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ethylene to form a liquid polyethylene film on the surface and, while applying heat to the other side of said article, building up the coating to any desired thickness by causing adherence of finely divided, solid polyethylene to the liquid film. In Figures 1 and 2 of the drawings, there is illustrated apparatus particularly designed for producing a polyethylene coating on the inside of a metal barrel or drum and, if desired, simultaneously providing a polyethylene coating on the outside thereof.

As shown in Figures 1 and 2, the apparatus employed comprises a tilting table, designated generally by the reference character 11, adapted to support the barrel or drum 12 being coated and a plurality of posts 13 which support heating means employed in the coating process. The table 11 comprises a pivoted leaf or shelf 14 and a pair of legs 18. On the underside of the leaf 14, adjacent one end thereof are two pairs of spaced, depending lugs 16. Each pair of lugs 16 is adapted to be pivotally connected by a pivot pin or bolt 17 with the upper end of one of the legs 18 which are spaced transversely under the leaf 14. The other end of the leaf or shelf 14 is movably supported from a cross bar 21, pivotally mounted between the legs 18, by means of a fluid pressure motor 23 which carries at one end a fixed rod 24 connected to the cross bar 21 and which has projecting from its other end an extensible piston rod 26. The outer end of the piston rod 26 is pivotally connected by a pivot pin 27 to a pair of spaced lugs 28 depending from the shelf 14 at the end opposite the lugs 16.

A barrel or drum 12 may be removably mounted for rotation on a plurality of rollers above the shelf 14 of the table 11. Adjacent the front of the table, as viewed in Figure 2, a roller 34, having an outer surface which is convex in transverse section, supports the rim 35 around the open end of the barrel or drum 12. A roller 36 which is provided with a central circumferential groove is longitudinally aligned with the roller 34 and supports the chime 37 provided at the bottom of the barrel or drum 12. The rollers 34 and 36 are mounted for rotation with a shaft 39 which is supported adjacent each end of the shelf 14 on a pair of pedestals 41.

On the far side of the table 11, as viewed in Figure 2, there is provided a pair of idler rollers which may be, respectively, substantially identical with the rollers 34 and 36. As best shown in Figure 1, the roller 43, which corresponds to the roller 34 and is aligned with the latter transversely of the table 11, is mounted for rotation

on a pin or spindle 44 carried by a bracket or pedestal 45 extending upwardly from the leaf 14. The other idler roller, corresponding to the grooved roller 36, is similarly mounted on the leaf or shelf 14 in transverse alignment with the roller 36. The drum or barrel 12 may be caused to revolve on its supporting rollers by causing the shaft 39 to revolve.

Although other suitable or convenient means may be employed, as shown in the drawings the shaft 39 is rotated by an electric motor 48 mounted below the shelf 14 adjacent the legs 18 by brackets 49. Pulleys 51 and 52 are provided on the ends of the shaft 39 and the motor shaft 53, respectively, the pulley 51 being driven from the pulley 52 by means of a belt 54.

There is also provided on the shelf 14, toward the front thereof as viewed in Figure 2, a pair of longitudinally spaced pedestals or brackets 57 which rotatably support, parallel to the shaft 39, an elongated, screw-threaded rod 58. At one of its ends the rod 58 has a portion 59 of reduced diameter which extends outwardly beyond the bracket 57 and has fastened thereon a pulley 61. The screw-threaded rod 58 is rotated by the motor 48 through a belt 62 which connects the pulley 61 and a driving pulley 63 fixed on the shaft 39 inwardly of the pulley 51.

A travelling block 66 is carried by the rod 58 and has a bore threadedly engaging the rod. A flame spray gun or pistol 68, having an air connection 71 and connections 72 and 73 connected, respectively, to suitable sources of gas and polyethylene powder, is mounted on the travelling block 66 by a clamp 67. The block 66 and spray gun 68 are prevented from rotating on the screw-threaded rod 58 by a guide rod 74 which is supported at its ends in the brackets 57 below the screw-threaded rod 58 and which is slidably received in a guide bore in the block 66.

Suspended above the barrel or drum 12 on the pair of posts are a plurality of radiant heating elements 76. Preferably, as best seen in Figure 2, each of the elements 76 is somewhat longer than the barrel 12 and is attached, adjacent each of its ends, to a supporting strip 78. The latter are in turn supported by hangers or straps 80, 81 from a pair of arms 82, each of which extends forwardly over the table 11 and is adjustably mounted on one of the posts 13. The supporting strips 78 are curved so that the heating elements 76 will have their lower surfaces substantially normal to radii of the barrel; and it is preferred to have the heating elements close together and arranged to radiate heat upon at least one quarter of the outer surface of the cylindrical wall of the drum or barrel. While the heating elements may be of desired type, electric resistance heaters of well known construction are convenient and are preferred. Moreover, although the heating elements 76 may be suspended in other ways than by the means described above, it will be appreciated that they should be adjustably mounted so that they may be positioned properly with respect to barrels or drums of different diameters.

It has been found that by the novel process of the present invention, which is hereinafter described, there may be produced a very smooth, impervious, adherent coating of polyethylene on the inside of a barrel or drum. The apparatus above described and illustrated in the drawings has been found convenient for carrying out such a process but it will be realized that other apparatus may also be employed.

When using the apparatus above described, the interior of a metal drum or barrel is sand blasted or prepared in other suitable manner to have a clean surface and the drum or barrel is then heated to a temperature of from 300° F. to 500° F. The temperature should, of course, be below that which causes decomposition of the polyethylene, this varying with the molecular weight of the polyethylene. The heating may be conveniently carried out in a gas oven (not shown) and this is preferred since, as a result of the non-oxidizing atmosphere in a gas oven, no oxide film is formed on the surface of the drum. When the drum has reached the desired temperature, the higher end of the above-mentioned range being preferred, it is removed from the gas oven and placed on the supporting rollers on the table 11 where it is revolved by the electric motor 48 through the pulleys 51, 52 and the belt 54.

A charge of finely powdered, solid polyethylene is then placed in the interior of the drum 12. A sufficient amount of polyethylene powder is used to maintain a surplus thereof as a loose pile at the lowest portion of the drum throughout its length. The heat stored in the drum is sufficient initially to melt the particles of polyethylene which come into contact with the drum surface. Since the drum is being revolved, the pile of polyethylene powder is brought by gravity continuously into contact with a fresh portion of the interior drum surface. Thus a continuous liquid film of polyethylene to which solid particles of polyethylene adhere is produced on the interior of the cylindrical wall of the drum or barrel 12. Heat from the metal, however, soon causes the adhering particles to melt into and form part of the liquid film.

Heat is applied in controlled amount to the outside of the metal drum or barrel 12 by the heating elements 76 in order to maintain the temperature of the metal above the melting point (about 230° F.) of polyethylene. In the lack of an external source of heat the drum cools to a temperature below the melting point of polyethylene in a comparatively short time and thereby brings to a halt the formation of the desired coating. As the drum 12 continues to revolve with the necessary heat being supplied, particles of the finely divided polyethylene therein adhere to the sticky liquid film of polyethylene already coating the metal surface each time they come in contact with it. The adhering particles absorb heat from the film and metal and in turn are melted, thus gradually increasing the thickness of the molten film. However, only the particles of polyethylene in contact with the liquid film will adhere and build up the film, the major part of the loose, finely divided polyethylene in the drum continually falling down the side of the drum as it revolves. The polyethylene coating therefore tends to be quite uniform in thickness and smooth surfaced. The revolution of the drum is continued until the desired thickness of the polyethylene coating therein has been obtained. It may then be removed from the apparatus and be permitted to cool.

It is often desirable to have the exterior of a metal drum as well as the interior covered with a corrosion-resistant coating. The apparatus illustrated in the drawing consequently includes, as apparatus for forming such a coating, a flame spray gun 68, which may be of conventional well-known type, arranged to progressively cover the outside of the drum with a coating of polyethylene while the inside is being coated in the manner

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described above. The spray gun 68 is held by the clamp 67 in desired position on the travelling block 66 which is threadedly engaged on the screw-threaded rod 58. As the barrel or drum 12 revolves in consequence of the rotation of the shaft 39 and the driving rollers 34 and 36, the rod 58, which is driven from the shaft 39, also rotates and causes longitudinal movement of the block 66 carrying the flame spray gun 68. The thread on the rod 58 extends at each end beyond the drum 12 and is designed to produce a relatively small longitudinal movement of the block 66 and gun 68 with each rotation so that as the barrel revolves polyethylene powder fed into the spray gun through the connection 73 will be deposited as a continuous coating of polyethylene on the outer surface of the cylindrical wall of the barrel or drum 12.

If a greater thickness of exterior coating is desired than may be obtained during the travel of the flame spray gun 68 from one end of the barrel or drum to the other, the flame spray pistol or gun may be caused again to traverse the length of the drum by reversing the direction of rotation of the screw-threaded rod 58. This may be accomplished by either reversing the electric motor 48 or by twisting the belt 62 by which the pulley 61 is driven from the pulley 63. It will be understood that if the outside of the drum 12 is coated with polyethylene from a flame spray gun or pistol at the same time that the inside of the drum is being coated, additional heat will be supplied to the drum by the flame spray gun 58. Consequently, the amount of heat which must be supplied from the heating elements 76 to maintain the drum 12 at the proper temperature to form the interior coating will be reduced.

When the interior cylindrical wall of the drum 12 has been provided with a coating of polyethylene of desired thickness the bottom may likewise be given such a coating. This may be done conveniently with the apparatus above described and shown in the drawings when the shelf of the table 11 is tilted downwardly to the position shown in broken lines in Figure 2 of the drawings by actuation of the fluid pressure motor 23 to cause inward movement of the piston rod 25. Sufficient finely divided, solid polyethylene is then placed in the drum to cover the bottom to a point slightly above the center thereof. The heat required for forming the coating of polyethylene on the interior of the bottom of the barrel or drum 12 may conveniently be supplied by a flame spray pistol or gun 68 directed against the lower face of the drum bottom. Revolution of the drum while heat is so supplied will cause a film of molten polyethylene to be established on the bottom and to be increased in thickness as the drum continues to revolve in the same manner that the coating was formed on the cylindrical wall of the drum. If desired, the flame spray gun 68 may also apply an exterior coating of polyethylene to the drum bottom while the coating is being applied to the interior face of the bottom. It will be understood, however, that if found more convenient other methods of heating the drum bottom during the formation of the interior coating of polyethylene may be employed.

When the shelf 14 is tilted, as shown in broken lines in Figure 2, it is desirable to provide additional means to prevent the drum 12 from being displaced from the rollers that support it and cause it to rotate. There is, therefore, provided on the top of the shelf 14, adjacent the free end thereof, a spindle or post 88 upon which a sup-

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porting roller 89 is mounted for rotation around a vertical axis. The roller 89 is provided with a bore (not shown) for mounting it on the post 88 and a basal peripheral flange 91 which extends outwardly under the chime 37 at the bottom of the barrel or drum. Accordingly, when the table is tilted the drum is held against downward movement longitudinally of the table 11 by the roller 89 but may revolve freely.

Obviously, other metal articles and metal in the form of sheets, bars and the like may also be provided with durable, impervious, adherent coatings of polyethylene by the novel process of the present application. In Figures 3-5 there is illustrated apparatus for carrying out the process by continuously coating lengths of metal in strip form with polyethylene.

As shown in the drawings, metal strip, designated by the reference character 95, fed from a roll or some other source (not shown) and cleaned, preferably by sand blasting, is first passed through an oven 96 which may be supported on legs 97. The oven is preferably heated by gas burners but may be heated either with other fuels or electrically if desired. The strip 95, which is heated in the oven 96 to a temperature of at least 300° F. and preferably somewhat hotter though not above about 500° F., then passes into an upwardly inclined coating machine designated generally by the reference character 99 which comprises a body 101. Again, this temperature should not exceed that at which the particular polyethylene being applied decomposes. A plurality of legs 102, 103, 104 are employed to support the body 101 at an angle which may vary within rather wide limits but must be greater than the angle of repose of the bodies of comminuted polyethylene supported thereon and is preferably in the neighborhood of 45° from the horizontal. The legs may conveniently be formed of angle iron and may be firmly secured, as by welding, to the longitudinal supporting rails 106 of the body 101. Braces 107 may be attached to the legs 102, 103, 104 by suitable means.

The body 101 comprises an elongated, open-ended trough having a bottom 109 and vertically disposed sides 111. Plates 112 secured by welding on the outer faces of the longitudinal supporting rails 106 extend upwardly on either side of the trough and the trough is held in place by bolts 114 which extend through the plates 112 and the adjacent sides 111. Within the trough and extending transversely between the sides 111 a plurality of spaced supports 117 are provided. These supports carry a plurality of spaced longitudinal runners 118 which serve to support the metal strip 95 in its passage through the trough.

Also resting on the upper surface of the transverse supports 117 and against the inner face of each side 111 of the trough is a longitudinal guide member 121. The guide members are of such thickness as to contact the edges of the metal strip 95 which slides on the runners 118 and extend the entire length of the body 101. Since the guides 121 are removable, adjustment for metal strip of different widths may be made by the selection of guides of suitable thickness. At spaced intervals along the length of the trough 111 the guides 121 and the sides 111 are provided with registering holes adapted to receive rods 123. Each of the rods 123 has threaded end portions and, extending transversely of the body 101, supports by means of perforated lugs 124 a pivoted gate 126. The lugs 124 are attached, preferably by welding, to one face of each gate 126.

The gates 126 are the same length as the width of the metal strip 95 and their ends are therefore in contact with the longitudinal guide members 121. Consequently, they may be held in adjusted position by friction which, if necessary, may be increased by tightening the nuts 127 on the threaded ends of the rods 123 against the sides 111 to pull the guide members toward each other. If desired, however, any suitable latch mechanism (not shown) may be employed to maintain the gates 126 in adjusted position. Each of the gates 126 is provided with a handle 128.

The heated metal strip, which may be moved by any suitable means such as driving rolls (not shown), passes into the lower end of the trough of the coating machine 99 where it is supported by the runners 118 as it advances upwardly through the trough beneath the gates 126. The gates, being pivotally supported on the rods 123, are adjusted with their lower edges extending in the direction of movement of the strip 95 and with a pre-determined small clearance above the strip. A mass of finely divided polyethylene is placed in the coating machine 99 on the inclined shelf formed by each of the gates so that polyethylene particles will fall by gravity into contact with the top surface of the heated metal strip 95. Since the temperature of the strip is above the melting point of the polyethylene, a thin film of liquid polyethylene will be formed on the metal surface and additional solid particles of polyethylene will be carried along on the strip adhering to the molten film.

To insure that the metal strip remains hot enough to melt the solid particles of polyethylene held on the molten film, heating means is provided in the coating machine 99 beneath the runners 118. Preferably electrical strip heaters 131 are employed which may conveniently be suspended from the transverse supports 117 to extend longitudinally of the body 101. The heaters 131 are provided with suitable electrical connections and regulators (not shown) which permit their control so as to supply sufficient heat to the bottom of the metal strip 95 to maintain a liquid film of polyethylene on the metal surface and to cause the finely divided, solid polyethylene particles which adhere to the liquid film to melt, thereby increasing the thickness of the film.

A mass of finely divided polyethylene is carried on each of the gates 126 so that the hot strip of metal, in moving continuously beneath each successive gate, receives a fresh, thin deposit of solid particles of polyethylene which melt and further increase the film thickness. Since the metal strip 95 is inclined upwardly at an angle greater than the angle of repose of the bodies of polyethylene only those particles of polyethylene which adhere to the sticky, liquid film will be carried along with the strip and the rest of the mass of finely divided polyethylene particles will fall back onto a lower portion of the film-coated strip. Thus the liquid film is built up evenly and without the inclusion of pockets or large air bubbles. As shown in the drawings, the strip heaters 131 extend for substantially the full length of the body 101 but if the metal strip entering the coating machine 99 is sufficiently hot additional heat will not be necessary in the lower portion of the machine.

When the coated strip leaves the machine 99 it quickly cools to a temperature at which the polyethylene film becomes solid, impervious, and extremely adherent to the metal surface. The

coated strip is then ready for use and may be either cut into sheets of desired size or blanks of suitable configuration may be punched therefrom. Both cutting and punching may be done without disturbing the polyethylene coating and the coating will firmly adhere to the metal surface along the cut edge.

From the foregoing description of the application of an adherent coating of polyethylene to metal articles such as drums, barrels, and the like and to metal strip, it will be apparent that by the process of the present application it is possible to produce smooth coatings of uniform thickness and any desired depth. The apparatus employed may be formed of any suitable materials but, because of the elevated temperatures employed, it is preferably constructed of metal. As pointed out above, the heating of the metal to be coated prior to and during coating may be by any suitable heating means and it will be understood that the apparatus used may be modified as required when heat is supplied from other types of heating units.

In the case of drums or barrels the continuity of the coating applied to the interior and/or the exterior may be tested in known manner such as by use of a high voltage electrical spark which will detect any imperfections or pin holes in the coating. If desired, a spark testing device may be installed on the coating machine 99 shown in Figures 3-5 so that the continuity of coating on the metal strip 95 is continuously checked. Imperfections are exceedingly rare because of the evenness with which the polyethylene coating is applied by the present method; but any imperfections which may be found can be readily patched by flame spray application of polyethylene to the area involved.

Various grades, colors and types of polyethylene may be employed in carrying out the method of the present application and mixtures of polyethylene and other compatible substances may be used when desired. It has been found that when very smooth and dense coatings are desired, best results are obtained with extremely fine particles of polyethylene as there is less chance of including air bubbles or forming cavities in the coating. However, when extreme smoothness is not required, larger particles may be used. The inertness and corrosion resistant properties of polyethylene are well known and metal coated with polyethylene by the present process is well adapted for use in contact with corrosive chemicals and vapors of various kinds.

The speed with which the metal strip moves through the coating machine 99 and the speed with which the barrel or drum 12 revolves may vary within wide limits but will be subject to some variation depending upon the amount of heat supplied and other factors. It will be understood that various changes and modifications may be made in the method of the present application to provide for the coating of articles of particular shapes and sizes or as required by other contingencies. Accordingly, the invention should be interpreted broadly and not be limited by the applications thereof described in the foregoing specification, but only by the terms of the appended claims. In the claims, the term "drum" is used generically to include drums, barrels, cans and the like.

What I claim is:

1. A process for providing one side of a metal strip with a strongly adherent coating of polyethylene, which comprises continuously moving

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said metal strip upwardly along an incline greater than the angle of repose of a mass of comminuted polyethylene, retaining said mass of comminuted polyethylene on the upper surface of said strip at said incline and against sliding down said incline whereby successive portions of said strip are brought into contact with the underside of said mass of polyethylene and maintaining said strip at a temperature between the melting point of said polyethylene and the higher temperature at which decomposition of said polyethylene occurs thereby to melt the particles of said mass of comminuted polyethylene in contact with said strip and to adhere to said melted particles the particles in contact with said melted particles, and continuing maintaining the temperature of said strip after passing beyond said mass to melt said adhered particles.

2. A process for providing one side of a metal strip with a strongly adherent coating of polyethylene, which comprises continuously moving said metal strip upwardly along an incline greater than the angle of repose of a mass of comminuted polyethylene, retaining a plurality of bodies of said mass at spaced intervals on the upper surface of said strip along said incline and against sliding down said incline whereby successive portions of said strip are brought into contact with the underside of each of said bodies, maintain-

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ing said strip at a temperature between the melting point of said polyethylene and that higher temperature at which decomposition of said polyethylene occurs thereby to melt the particles of each of said bodies of comminuted polyethylene in contact with said strip and to adhere to said melted particles the particles in contact with said melted particles, and continuing maintaining the temperature of said strip after passing beyond each of said bodies to melt said adhered particles.

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