

July 5, 1955

E. R. CORNEIL
HANDLING METALLIC SODIUM

2,712,384

Filed Sept. 27, 1952

2 Sheets-Sheet 1

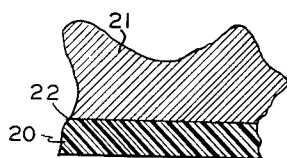


FIG. 1

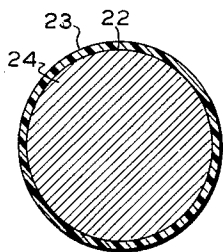


FIG. 3

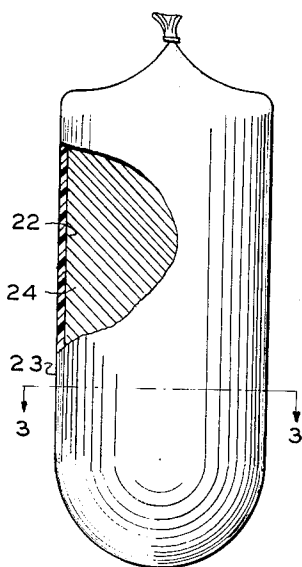


FIG. 2

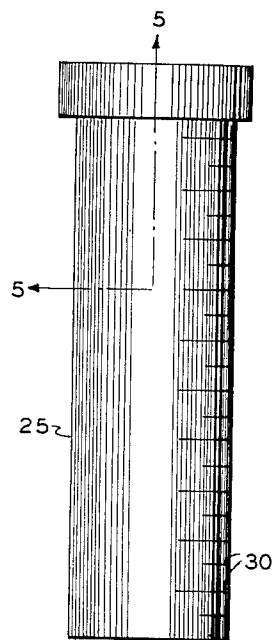


FIG. 4

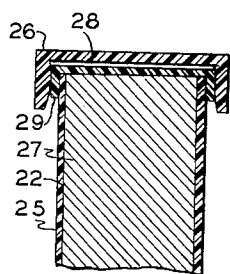


FIG. 5

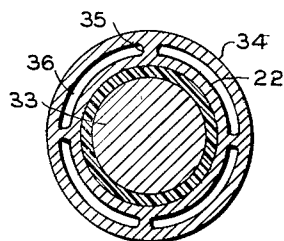


FIG. 8

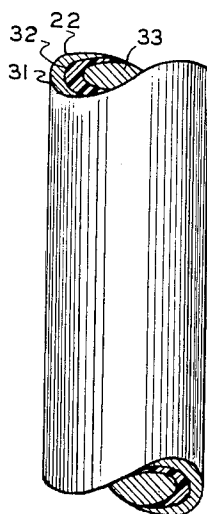


FIG. 6

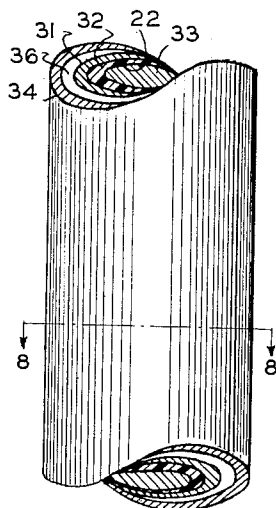


FIG. 7

INVENTOR.
ERNEST R. CORNEIL
BY *James H. Ryan*
ATTORNEY

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E. R. CORNEIL

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2 Sheets-Sheet 2

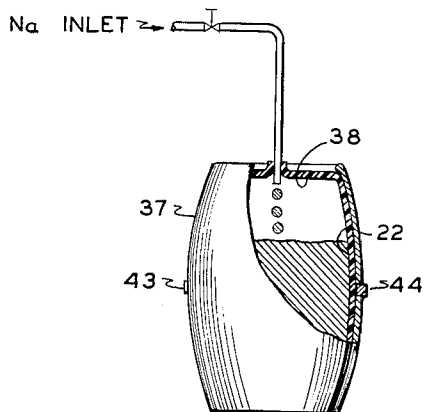


FIG. 9

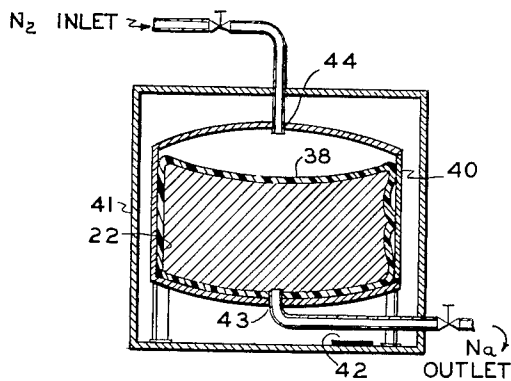


FIG. 10

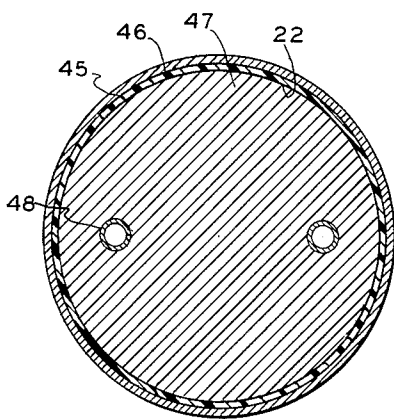


FIG. 11

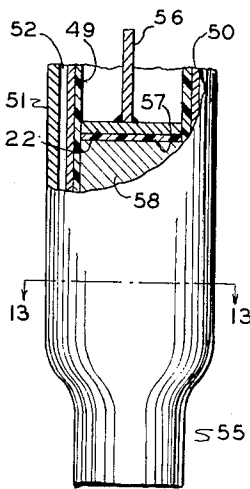


FIG. 12

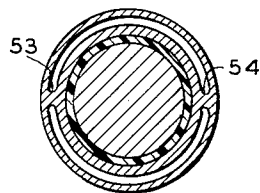


FIG. 13

INVENTOR.
ERNEST R. CORNEIL
BY *James H. Ryan*
ATTORNEY

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2,712,384

HANDLING METALLIC SODIUM

Ernest R. Corneil, Stamford Centre, Ontario, Canada,
assignor to E. I. du Pont de Nemours and Company,
Wilmington, Del., a corporation of Delaware

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17 Claims. (Cl. 206—84)

This invention relates broadly to the application of certain common industrial bulk operations such as molding, packaging, transporting, storing and the like to the alkali metals and more particularly to means for protecting these metals, sodium especially, during such operations.

The alkali metals are in general soft ductile solids which melt below 100° C. One of these elements, lithium, is well known to possess exceptional properties and will be omitted from further consideration in this specification unless mentioned by name. Sodium on the other hand may be taken as a typical representative of the group, which also includes potassium, rubidium and caesium, and will be chosen as the basis for most of this disclosure. Sodium is likewise the most important of these elements commercially since millions of pounds of the pure metal are produced each year.

Metallic sodium has a melting point of 97.5° C. but is so soft at normal temperatures that it can be cut with a knife. A freshly cut surface is silvery white and lustrous but rapidly changes on exposure to air through shades of pink to an eggshell grey. The element is in fact very reactive and unites vigorously with water to produce caustic and hydrogen. Since this gas readily forms explosive mixtures with air, its evolution not only indicates a waste of sodium but presents a definite safety hazard. Reaction may also occur when sodium touches organic materials such as plastics. "Teflon," polytetrafluoroethylene, a substance usually considered exceptionally stable, may actually burst into flame when contacted with sodium at a temperature around the melting point of the latter. The same phenomenon may occur when liquid sodium contacts chlorinated hydrocarbons.

In addition to being extremely reactive, liquid sodium tends to wet and adhere to almost all foreign surfaces touched regardless of the quality of the surface finish. If the sodium solidifies in contact with the foreign surface, it forms an adhesive interface therewith which can be broken only with the expenditure of some effort. This adherence is so tenacious that the fracture or breaking occurs within the sodium corpus itself rather than at the interface. Loss of metal and formation of dangerous waste products may result from such fracture. Ordinary materials of construction including metals such as iron and steel products, graphite, ceramics such as glass, natural polymers such as rubber and artificial polymers or plastics such as the well-known commercial "Bakelite," "Transite," "Lucite," "Teflon," and nylon form this type of adherent interface with sodium.

Numerous industrial difficulties are attendant upon the reactivity and adhesive nature of bulk sodium. It must, for example, be protected at all times from contact with air and moisture. Such contact may sometimes be avoided by placing the material in conventional metal or ceramic structures. When this is done, however, the problem of loss and contamination due to the adherent interface arises. Adhesion is particularly undesirable

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when extruding or molding operations are to be carried out. Sometimes storage or transportation of sodium can be accomplished under kerosene or oil. After a time a sodium surface under oil acquires a grey deposit of unattractive appearance that may eventually spread throughout most of the metal. The primary object of the present invention is therefore development of general means for safely and efficiently handling bulk sodium in such industrial operation as extrusion, molding, storage, transportation and the like. Other objects of the invention will be evident hereinafter.

The basis of my invention is the unexpected discovery that metallic sodium and the commercial plastic polythene or polyethylene are mutually inert, chemically, and non-adhesive. The result is that a boundary or interface is possible between these materials more stable than other sodium interfaces. It is unimportant whether the sodium be a liquid or a solid or whether a solid interface be formed by freezing molten sodium or merely by contacting solid sodium and polythene. An oxide-free interface, however, is formed more easily if molten sodium be poured into polythene and allowed to congeal than if solid sodium is merely wrapped with the plastic.

The polythene or polyethylene of this invention is the well-known solid ethylene polymer with the empirical formula $(-CH_2-CH_2-)_n$. The value of "n" in the empirical formula, or the molecular weight, may vary so long as the polymer represented remains solid up to at least about 110° C. Various patents exist describing the production of polythene suitable for use in this invention, including for example U. S. P. 2,153,553 and U. S. P. 2,188,465. The material may be obtained commercially as a thermoplastic powder or in thin semi-transparent sheets. Cast and molded shapes formed of the plastic are also available.

The sodium referred to in this specification and claims is "bulk" material. The word "bulk" is intended to describe a single-phase macroscopic quantity of the element such as would be used in an ordinary industrial or laboratory operation, whether the actual weight involved be the few grams required by the student, the several pounds of the bricks or ingots of commerce, or the several tons of a tank-car lot. The word is not to be understood as referring to the sodium found in a two-phase system dispersed as microscopic particles in a foreign medium such as oil. Usually the polythene will be utilized substantially surrounding or enveloping the bulk metal. The phrase "substantially enveloping", however, is not to be understood as excluding provision of suitable sodium inlets or outlets in the protective material which may be closed in any suitable manner.

In general the contact between bulk sodium and protecting polythene will be sustained mechanically by the mutual configurations of the two materials or by external means, adhesion between plastic and metal surfaces being lacking. The polythene itself may be in the form of a thin paper-like sheet wrapped about bulk sodium or it may be a permanent relatively thick walled structure into which liquid sodium may be poured. The plastic may be strengthened mechanically by incorporation therein of glass fiber, wire or other filament reinforcement so that it has greater dimensional stability at high temperatures and greater mechanical strength. Such reinforcements may also serve as means for maintaining the contact between the materials in the two-phase polythene-bulk sodium system and may be supplied externally to the polythene as well as incorporated therein.

The practice of my invention may be understood in

more detail from the remainder of this specification and from the drawings, in which:

Figure 1 is a sectional representation of a body of sodium contacting polythene;

Figure 2 is an elevation of a polythene package containing sodium;

Figure 3 is a cross-section along line 3—3 of Figure 2;

Figure 4 is a perspective of a polythene container adapted for holding sodium;

Figure 5 is a section along line 5—5 of Figure 4;

Figure 6 is an elevation of a polythene lined pipe for transporting liquid sodium;

Figure 7 is an elevation of a jacketed pipe for transporting sodium;

Figure 8 is a cross-section along line 8—8 of Figure 7;

Figure 9 shows a plan view of a polythene lined drum being filled with sodium with part of the drum cut away to expose the interior;

Figure 10 is a section showing sodium being removed from the drum of Figure 9;

Figure 11 is a section of a tank suitable for storing sodium;

Figure 12 is an elevation of a die for extruding sodium with part of the die cut away to expose the working parts; and

Figure 13 is a cross-section along line 13—13 of the die of Figure 12.

The simplest and general embodiment of my invention is shown by Figure 1. In this figure a polythene sheet 20 is seen contacting a body of sodium 21 at a common interface 22. It will be understood that the plastic need not be in the form of a thin sheet since all bodies of polythene contacting a sodium corpus will form the same interface. The sodium-polythene interface is, consequently, represented throughout this specification by the single numeral 22. This particular interface is, as noted, different from other known sodium interfaces in that it is both inert and non-adhesive. Sodium will thus remain unchanged for months at a time when placed in contact with polythene alone and the latter will strip away from the former without pulling any of the metal with it.

Figures 2 and 3 represent a simple elongate package formed of a sausage-shaped polythene covering 23 enveloping and protecting sodium 24 and forming therewith interface 22. This package is convenient for dispensing sodium in small amounts as for example in the commercially used one pound lots. Once encased in the polythene the sodium can be preserved indefinitely. The casing may be filled with liquid metal poured directly thereinto while it is supported, preferably, by a liquid cooled iron vessel. The open end of the polythene is then sealed mechanically or by a combination of heat and pressure. Both air and moisture are thus excluded from the sodium. The polythene-sodium package may be formed as a sausage, as shown, or as a cube, cylinder, cone or other convenient geometrical body. Use of heavier polythene walls in the package can eliminate the need for cooling during the filling operation.

The package of Figures 4 and 5 is particularly advantageous for laboratory use. A cast or molded polythene container 25 closed except for a removable top 26 is filled with sodium 27 joining the container at the interface 22. Top 26 may be crimped as at ridge 28 to hold a thin polythene sheet 29 tightly about the container. Grease, not shown, may be added to ensure an air and moisture-proof seal. The container may possess externally indicia such as graduations 30 so spaced as to indicate equal amounts of sodium. When small pieces of the metal are needed it is only necessary to cut off the volume between two graduations to obtain a known weight thereof. The sodium between the graduations may easily be pushed out of the encircling cylinder or band because of the non-adhesive nature of the interface. Top 26 and protective sheet 29 may be fitted over the truncated container to reseal it after a cut has been made.

The container 25 may be of any physical configuration but an elongated cylindrical shape is preferred. The advantages inherent in this variable volume container are obvious. A container of fixed dimensions will in general permit air contamination over large exposed sodium surfaces. A sealed container of constant volume possesses a space refilled with an active atmosphere every time a portion of sodium is removed. Such an atmosphere is entirely eliminated by fitting the dimensions of the container to the bulk of the metal contained therein.

The pipes of Figures 6-8 represent convenient means for transporting molten sodium over short distances. Conduit 31 is lined with polythene 32 and filled with sodium 33. Ordinary polythene tends to soften at temperatures above about 40° C. and may become quite soft above 97.5° C., the melting point of sodium. Hence it may be desirable to add to pipe 31 a jacket 34 held on supports 35 and enclosing a space 36 through which cooling water or other fluid can circulate. This type of cooling can strengthen the polythene sufficiently without solidifying the sodium.

A steel drum 37 with a polythene liner 38 is shown being filled with sodium in Figure 9. It may be weighed at the same time. When top 40 is put in position on the full drum, the sodium is ready for storage or transportation. To empty (Figure 10) the drum it may be placed in a heater 41 with heating element 42 and the sodium melted. A hole may be pierced in the liner 38 at the bung 43, nitrogen under pressure admitted through bung 44 and the liquid metal forced out. The polythene liner prevents waste of sodium by formation of sludge in the barrel. If the drum is frusto-conical in longitudinal section the sodium may be emptied without melting.

Figure 11 is a cross-section of an otherwise conventional storage tank adapted for storing bulk sodium according to the teachings of this invention. Strengthening shell 45 encloses a polythene casing 46 containing metallic sodium 47. Steam may be passed through pipes 48 to melt the metal. This type of tank may be employed on a tank-car, the usual conveyance for large quantities of sodium. Normally small amounts of sodium accumulate in tanks with bare steel walls because of the wetting action of liquid sodium on steel. This results in a sludge accumulation which cannot be safely removed by washing with water. The build-up of sludge is discouraged by use of the polythene liner which is not wetted by liquid sodium.

Polythene may also be used in sodium extrusion and molding operations. Figures 12 and 13 show schematically a die lined with polythene. The plastic liner 49 is held within a barrel 50 tapering to an orifice 55. A metal jacket 51 encloses a space 52 within which a cooling fluid such as water or oil can circulate and is held in place by supports 53 and 54. A plunger 56 carrying a protective layer of polythene 57 slides in the liner 49 and forces sodium 58 through the orifice 55. While cooling is optional in the case of the pipes of the previous figures, it is almost essential in a die. Polythene is so soft at temperatures around 100° C. that pressure stretches and breaks it. If cooling is omitted at the pressures required for sodium extrusion, the lining quickly tears and is therefore inoperative. Extrusion of sodium can be carried out much more smoothly and evenly from a die containing a polythene liner than from a die formed of a material wetted by the liquid sodium.

Additional embodiments of my invention will be evident to those skilled in the art. Almost any application, in fact, that requires or can utilize the inert, non-adhesive interface between bulk sodium and polythene lies within the scope of the invention. The use of polythene is, furthermore not strictly limited to sodium. It can, for example, be employed with other alkali metals, especially potassium, and forms with them other unique polythene-alkali metal interfaces. Lithium, because of its high melting point, is not suitable for pouring into

polythene which, as pointed out above, softens appreciably as the temperature rises above 100° or 110° C. Polythene, being essentially a hydrocarbon, may also ignite if heated too greatly in air or oxygen. It is of course possible to wrap solid lithium in polythene sheets and form therewith a stable package of the metal. Formation of the polythene alkali metal interface with the metal in the solid state however represents a less preferred embodiment of the invention.

The polythene articles which have been disclosed in the several physical embodiments of my invention are of course useful with many chemicals. Elements which melt below about 100° C. can, in general, be treated like sodium, i. e. can be melted and allowed to solidify in contact with polythene. The basis of the present invention is, however, the unique alkali metal-polythene interface and more particularly the oxide-free, stable and non-adhesive sodium-polythene interface. Consequently polythene articles containing materials other than the alkali metals, and preferably alkali metals fusing below 100° C. at standard pressures, are outside the scope of the invention.

Having now described my invention,

I claim:

1. A package containing sodium contacting substantially enveloping polythene at a stable non-adhesive interface and protected from oxygen and moisture by said polythene.
2. The package of claim 1 in elongated sausage-like form.
3. The package of claim 1 in the form of a closed elongated cylinder.
4. The package of claim 3 possessing a removable top.
5. The package of claim 4 possessing indicia regularly spaced externally thereon.
6. A package comprising externally a substantially closed hollow container, a polythene liner in said container and a sodium body within said liner and contacting the same at a stable non-adhesive interface.
7. The package of claim 6 in which the container is formed of a ferrous metal.
8. An article of manufacture comprising a hollow ferrous metal container, a polythene liner for said container and a body of sodium metal within and contacting said liner.
9. An article of manufacture comprising a hollow cylindrical ferrous metal pipe, a polythene liner within said pipe and a body of sodium metal within said liner contacting the same at a sodium-polythene interface.

10. An article of manufacture comprising a hollow cylindrical barrel, a polythene liner within said barrel and a body of sodium metal within said liner contacting the same at a sodium-polythene interface.

11. An extrusion die for sodium comprising a hollow generally cylindrical ferrous metal wall possessing an extrusion orifice, a cooling jacket surrounding said wall and a polythene liner within said wall adapted to contact sodium at a stable, non-adhesive interface.

12. A method for extruding sodium which comprises forcing the same through a die orifice whose surface, in contact with the sodium, is composed of polythene.

13. The method of protecting sodium against corrosion by air and moisture and adhesion to construction materials while processes requiring the handling of sodium are being carried out which comprises interposing between sodium and said air, moisture and construction materials polythene substantially enveloping said sodium and forming therewith a stable, non-adhesive interface.

14. The method of forming a stable, non-adhesive sodium interface which comprises contacting liquid sodium with polythene in the substantial absence of moisture and air.

15. The method of claim 14 including the additional step of solidifying said sodium.

16. The package formed by contacting liquid sodium with substantially enveloping polythene and subsequently freezing said sodium, the resultant interface between the sodium and the polythene being non-adhesive and chemically stable.

17. A package which comprises an elongated polythene envelope with indicia regularly spaced thereon encasing sodium metal, the polythene and sodium contacting at a chemically stable, non-adhesive interface formed by pouring molten sodium into and allowing it to freeze in the envelope, said package being capable of being cut through at the indicia and thereby delivering measured quantities of sodium.

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