Aug. 2, 1960 G. C. MADIGAN ET AL 2,947,124

PROCESS FOR TUMBLE FINISHING

Filed Sept. 8, 1959 3 Sheets-Sheet 1

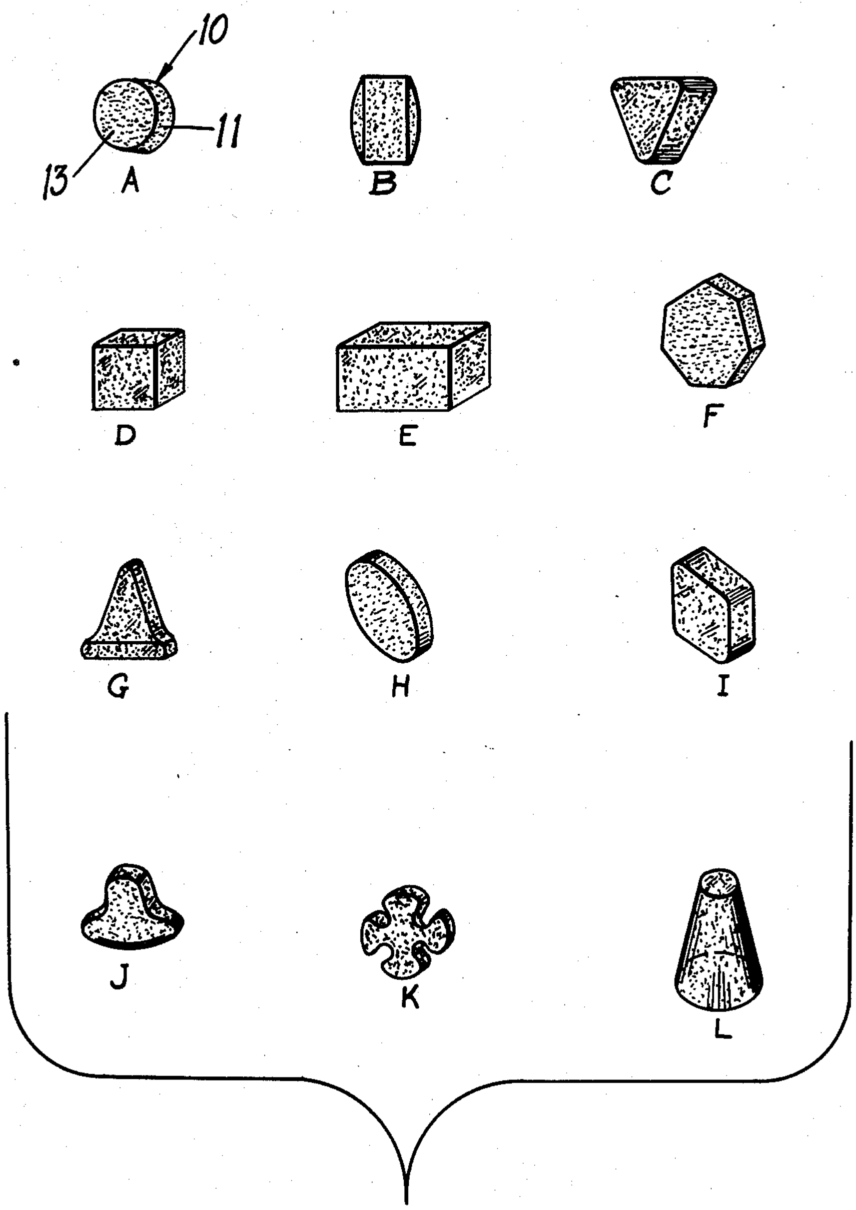

Fig. 1

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Filed Sept. 8, 1959 3 Sheets-Sheet 2

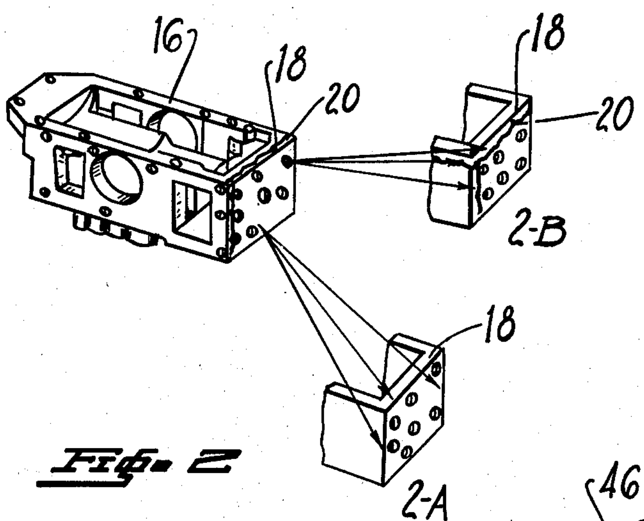

Fig. 2

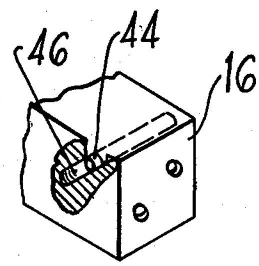

Fig. 6

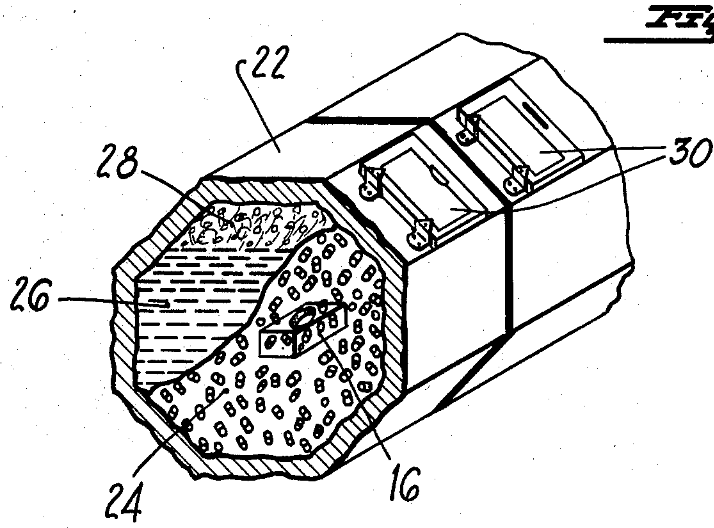

Fig. 3

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Filed Sept. 8, 1959 3 Sheets-Sheet 3

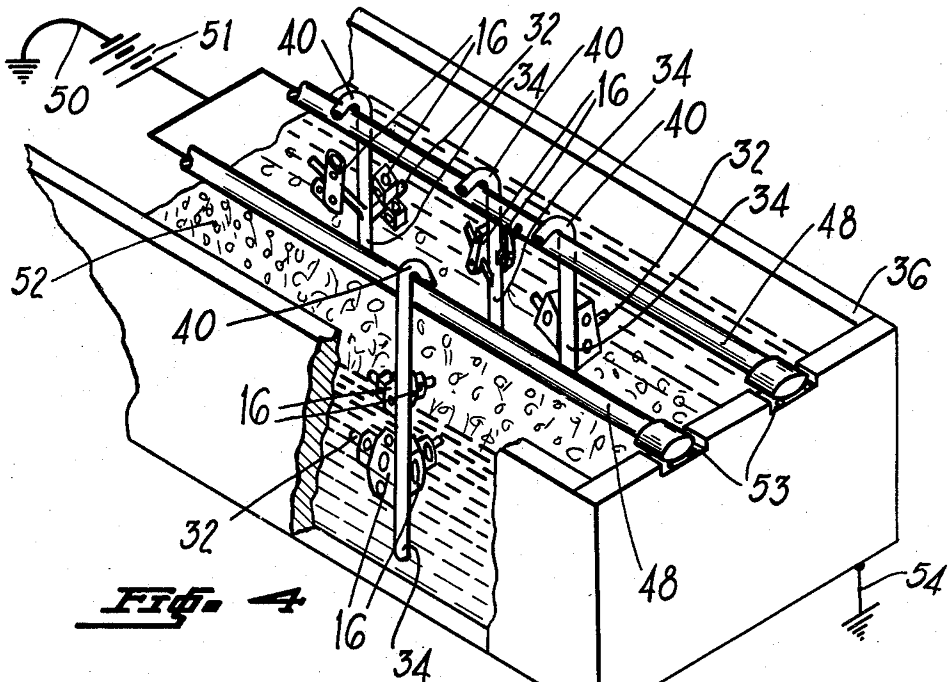

FIG. 4

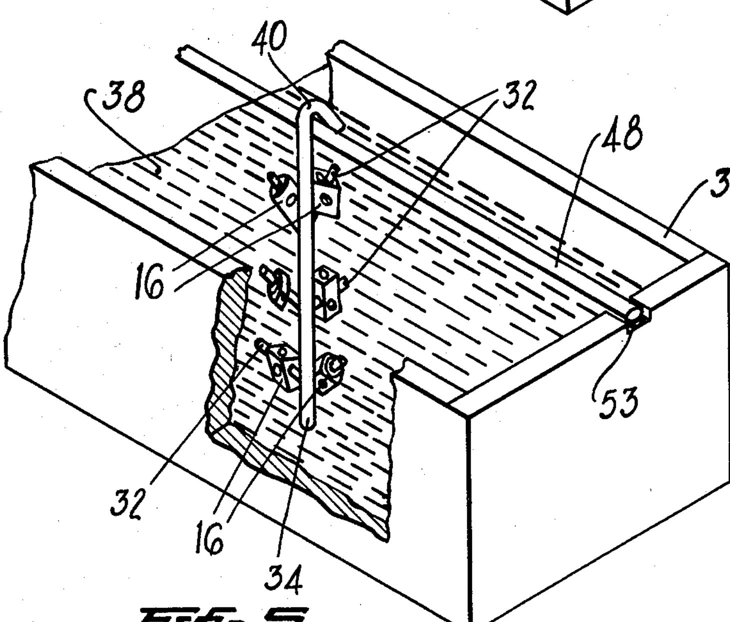

FIG. 5

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PROCESS FOR TUMBLE FINISHING

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Filed Sept. 8, 1959, Ser. No. 838,801

8 Claims. (Cl. 51—282)

This invention relates to abrasive tumbling pellets which are usable in operations known as "tumble finishing" and to a process for tumble finishing in which pellets that have become lodged in the finished article during tumbling may be easily removed. The present application is a continuation in part application of our application Serial Number 613,026, filed October 1, 1956, now abandoned.

Previously used tumbling pellets which provided sufficient grinding or abrasive action were usually made up wholly from ceramic particles. The shortcoming of this material was that the pellets could become lodged in the part which was tumble finished and it was very difficult to remove the ceramic pellet without damaging the part. Also, the lodged ceramic pellet might be undetected to produce inoperativeness. The art has also used solid metal pellets which were easier to remove because they were partially solubilized during subsequent processing steps. These metallic pellets are unsatisfactory because they lack sufficient grinding or abrasive effect on the part.

The present invention proposes to provide tumbling pellets having abrasive particles bonded together by means of a matrix material which can be readily dissolved out of holes in castings, which castings are made of a material which will not be "touched" or affected by the dissolving agent used to dissolve the matrix.

Tumble finishing consists of embedding unfinished parts in a mass of abrasive media and agitating the two together to accomplish removal of flashing, burrs, sharp radii, and also to impart a desired surface finish to the article. It has been found that tumble finishing is a more economical technique for accomplishing these ends than manual grinding because a greater number of parts can be processed simultaneously. Also, the time for accomplishing the necessary processing result is reduced, and a more uniform product treatment is obtained.

It is recognized that some materials such as soft aluminum do not lend themselves to tumble finish processing, because the burrs or flash at the edges of the piece become "peened" over and beaten flat against the surface of the article instead of being removed by abrasion. If the edge flashing is driven flat against the adjoining surface, it is very difficult to remove and must be done by hand grinding. It is also recognized that for some materials tumble finishing is not practical either because the materials resist the abrading action of the abrasive pellets or the pellets will fracture during operation owing to their poor impact resistance.

Other shortcomings of tumble finishing pellets include the occasional lodging of pellets within the processed article. Removal of these lodged pellets sometimes causes damage to the article, and undetected lodged pellets usually result in defective operation of the article.

It is an object of the present invention to provide tumbling pellets which will provide improved abrading action in operation so that they will be capable of honing off objectionable burrs and flashing without objectionable "peening." With the tumbling pellets of this invention,

it is possible to employ tumble finishing with soft materials which heretofore have not lent themselves to this process with prior art tumbling media.

It is a further object of the present invention to improve the abrading action of the tumbling pellets so that the tumble finishing time can be materially decreased.

It is a further object of the invention to provide a tumbling media which will reduce and even eliminate any requirement for preliminary burr polishing by hand with the result that the cost and time involved in this step can be saved.

An important feature of this invention is that the tumbling media has a low rate of wear and can thus be used for extended periods of time. Moreover, the pellets which make up the tumbling media possess impact resistance and, therefore, do not chip or shatter into smaller parts which are less efficient in abrasive action and are more likely to become lodged within the article to be finished.

Another important feature of this invention is that a ceramic abradant may be selected for its cutting action and combined with a sintered metallic matrix, thus giving the opportunity to select the optimum abradant and combine it with the most desirable metal so that the size, strength, cutting action and solubility of the pellet are thus made matters of choice. Previously used abrasive media comprised pellets which typically were either wholly metal or wholly ceramic, but the advantages of both were not realized in the same media.

It is another object of the invention to obtain tumbling pellets, which can be dissolved in a suitable solubilizing agent and are thus removable. The solubilizing agent may consist of the anodizing or immunizing solution in which the finished article is dipped after the tumble finishing operation. Because there are considerable difficulties involved in removing the lodged pellets which have become stuck in the article during tumble finishing operation, we propose the use of pellets which are soluble to facilitate their removal and thus we avoid damage to the article. It is possible to obtain this solubilizing of the pellet by either providing an additional processing step in which the finished article is dipped into a pellet-solubilizing solution, or by solubilizing the pellet concurrently with the anodizing or immunizing operation which is provided to condition the outer surface of the tumble-finished article. As a result very intricate parts can be tumble finished without causing inoperability due to lodging the tumbling media within internal passageways, crevices, etc.

Other features and objects of the invention will become apparent from a consideration of the following description, which proceeds with reference to the accompanying drawings wherein:

Figure 1 illustrates a few of the susable shapes for the tumbling media pellets;

Figure 2 illustrates a casting which may be tumble finished, Figures 2A and 2B being enlarged detail views of the edges of the casting. Figure 2A illustrates the finish obtained with a suitable media and Figure 2B shows an unsatisfactory finish obtained with an objectionable media;

Figure 3 shows a tumbling barrel, with a portion thereof cut away to show the tumbling pellets, the part being finished, and the tumbling solution;

Figures 4 and 5 illustrate the anodizing and immunizing equipment used following the tumble finishing operation; and

Figure 6 shows, in fragmentary view, a tumble finished part having a pellet lodged therein.

Referring to Figure 1, it will be seen that the pellet can vary considerably in shape. There is a wide assortment of shapes for tumbling pellets which can be formed by the processing technique disclosed herein. Usually, the shape of the pellet is dictated by the article to be finished.

Also, there are inherent limitations on the shape of the pellet depending upon the material used in manufacturing the pellet. In prior art usage where stone was used as the tumble finishing media, it was the usual practice to use it in its naturally occurring shape or to reduce its size by crushing to assorted size. With the present invention, it is possible to obtain the desired shape because the constituency of the pellet permits its manufacture to the shape desired. Also, mixtures of different size and shape pellets may be used.

By applying the well known sintered powder metallurgy techniques, it is possible to obtain the desired shape of the pellet. The preferred pellet shape is the one having most efficient abrading action and is least likely to become fractured and/or lodged in the finished article. It is known, for example, that with the pellet shown in Figure 1C there is less likelihood of accidentally lodging pellets within the passages of a casting than with a pellet having the shape shown in Figure 1B.

It is not to be construed that by specific reference hereinafter to the pellet in Figure 1A that there is any limitation of the invention to any particular shape of the tumbling pellet. Referring to Figure 1A, the pellet will be described in detail. The pellet **10** consists of a sintered metallic binder **11** which may consist of copper, lead, iron, aluminum, or alloys of these metals and a ceramic abradant **13** which is distributed in finely divided form throughout the binder.

The usual method of manufacture of a metal matrix pellet article is to intimately mix in a cone blender for about two hours, a quantity of the ceramic abradant and powdered metal until uniform dispersion is obtained. The mixture is then compressed in a die at about 80,000 to 100,000 p.s.i. to form the shape of the pellet, and the pellet is next heat treated at about 180° F. in a reducing atmosphere to sinter the binder. During sintering, the metal particles constituting the binder coalesce to form a continuous metallic phase which provides a cohesive matrix for the ceramic abradant.

A specific formula which has been used in making tumbling pellets is as follows:

	Percent
Copper (−200 mesh)	75
Calcined kyanite (−40 to +80 mesh)	20
Silica (−140 mesh)	5

In this formula the ceramic abradant is kyanite ($Al_2O_3.SiO_2$) which has been calcined to form mullite ($3Al_2O_3.2SiO_2$) according to the formula:

$$3(Al_2O_3.SiO_2)+\text{Heat}=3Al_2O_3.2SiO_2+SiO_2$$

The resultant mullite is usually referred to as calcined kyanite and is in composition between about 70% to about 85% mullite.

In the finished product, the ceramic abradant is exposed at the surface of the pellet and provides the abrading or cutting action which removes the burrs and/or flash on the article. We have found no single desirable combination of binder and ceramic which is "best" for finishing all materials. For some forms of steel and aluminum, we have found that calcined kyanite (which is predominately mullite) is satisfactory material.

The ceramic particle size is selected on the basis of the principal purpose in tumble finishing. The larger the ceramic particle size, the more suitable the material for deburring; the smaller ceramic particle sizes are used where the principal objective is to obtain a surface finish with a desired lustre, smoothness, gloss, etc.

Another factor which must be taken into account when choosing the appropriate binder and ceramic abradant is the likelihood of corrosion. If the tumbling media is used in combination with water and a secondary abrasive (which is usually included in the tumbling barrel in the form of a loose powder), then it is desirable to choose a binder which is not corroded by the other constituents used in the tumbling operation. For details of secondary

abrasives and other design factors, reference may be made to the publication "The Lorco Method of Precision Barrel Finishing for Metals and Plastics," by Lord Chemical Corporation, 1950.

We have found that, when a metal is used as a matrix, the metallic binder portion of the pellet provides a mechanical bonding of the ceramic during usage. It is to be desired, therefore, that the metal be cold workable. During compacting the metal particles may thus be shaped around the ceramic to lock the ceramic particles in place. By thus conforming the metallic particles around the ceramic, it has been possible to achieve a dense compact in which the metal particles are in close contact and form a continuous phase with the ceramic abradant dispersed therein. Thus, when the compact is sintered, the adjoining metal particles coalesce to provide a tenacious binder serving to position the ceramic during usage.

A further requirement of the binder is that it possess impact resistance in order to prevent fracture and thus fragmentation of the pellet as it cascades against the part finished.

The binder must further possess sufficient strength to retain the ceramic in place during usage and prevent the ceramic particles from being dislodged easily. If the ceramic is very easily removed from the binder, then the pellet will very shortly lose its abrading effect since no ceramic is exposed at the outer surface thereof.

A further factor in the proper selection of the binder is its solubility in various solutions. In this invention, we introduce the novel concept of removing the pellets by partially dissolving the matrix or binder to reduce the size of entrapped or lodged pellets and thus facilitate removal of the pellet from the finished article. It will, therefore, be seen that the binder material is selected on the basis of its solubilizing rate as compared to the solubilizing rate of the article in the selected solution.

As explained previously, the constituency of the binder and ceramic is dictated by the properties of the part which is to be finished. We have successfully finished steel, auminum, and magnesium castings and forgings by using a copper binder with the aforementioned calcined kyanite or mullite as the abradant. We have also satisfactorily finished steel, aluminum, and magnesium parts with the following compositions having alumina, kyanite and silica as the abradants:

	Percent
Copper (−200 mesh)	75
Kyanite (−40 to +60 mesh)	20
Silica (−140 mesh)	5
	100
Copper (−200 mesh)	75
Alumina (−40 to +60 mesh)	20
Silica (−140 mesh)	5
	100
Copper (−200 mesh)	75
Silica (−40 to +60 mesh)	20
Silica (−140 mesh)	5
	100
Copper (−200 mesh)	65
Kyanite (−40 to +60 mesh)	35
	100

Referring to Figure 2, a steel casting **16** is originally formed so that edges **18** have an objectionable flash or burr formed along the edges thereof. The object of the tumble finishing operation is to remove this burr without pounding it over the adjacent surface as shown in Figure 2B. Note in Figure 2B that the flash **20**, instead of being removed, has been pounded tightly against the surface of the part because the tumbling media lacked cutting or honing effect and served merely to turn the flash over under this pounding effect. What is desired is the finish shown in Figure 2A. It will be noted that the edge **18** in Figure 2A has the flash completely removed and possesses a smooth finished edge.

Referring next to Figure 3, the part **16** to be finished is placed in a barrel **22** where it is embedded in a mass **24** of abrasive pellets. An aqueous solution **26** is next added and for some articles, a detergent is added to the aqueous solution to provide suds **28** which serve to cushion the impact of the pellets against the part **16**. The barrel **22** is turned to agitate the bed of abrasive media **24** so that the pellets will cascade over the part **16**. The cascading movement of the pellets over the part **16** produces a surface abrasion that will deburr and remove flash and rough portions of the surface of part **16**.

The time during which the barrel is agitated can vary considerably depending upon the initial condition of the part **16**. Tumbling for about eight hours is typical for steel castings using a pellet consisting of 75% copper, 20% calcined kyanite, and 5% silica. The tumbling barrel is loaded and discharged through the doors **30** which are opened to fill the barrel with the tumbling media, parts, aqueous solution, and detergent. When the tumbling operation is completed, the doors **30** are opened to remove the part or parts **16** and, if desired, the solution can be drained and prepared for a new operation.

Eight soft aluminum carburetors, weighing about three pounds apiece, have been simultaneously tumble finished in a six cubic foot barrel compartment. In this case the tumbling barrel was filled to about 65% of its volume with pellets comprising 75% copper, 5% silica and 20% calcined kyanite.

The tumbling barrel **22** can, of course, be loaded with more than one part **16**. The number of parts which can be processed together depends upon the part size and the capacity of the barrel **22**.

When the parts **16** are removed, they are hung on the prongs **32** of dipping sticks **34**. As indicated in Figure 5, a plurality of parts **16** can be hung on each dipping stick **34** and then (in the case of stainless steel parts) dipped into a tank **36** containing a solution of nitric acid **38**. The dipping stick **34** has a hook **40** at the end thereof which is fitted over a cross bar **48** so that the parts **16** are suspended in the nitric acid bath **38** for the desired length of time. Nitric acid attacks the surface of the stainless steel and imparts a finish which "immunizes" the part to increase its corrosion resistance.

If during the tumbling operation any of the pellets have become lodged in any of the interior recesses of the part (as indicated in Figure 6), the metallic matrix (copper, aluminum, lead, iron, etc.) of the pellet **44** is simultaneously dissolved by the nitric acid, thus reducing the size of the lodged pellet **44**. This reduction in size of the pellet frees the pellet within the recess **46**, thus permitting its removal when the part **16** is removed from the nitric acid solution. It has been a considerable problem how to detect and dislodge tumbling pellets which have become lodged in the part during the tumble finishing operation. Because there are intricate passages which are formed in the part to be finished, it is quite possible to lodge pellets and/or chips of pellets within these inaccessible passageways. When this occurs, it is quite difficult to remove them without injuring the part. It is not uncommon to cause damage to the part when trying to pry the lodged pellet loose. With the present process, however, concurrently with the immunizing step, the pellet is reduced as described so that it can be easily removed. Also, if the pellet is lodged within the part and would escape undetected, there would be an obviously defective part. If the pellet were immune to the nitric acid bath, there would be no indication that there was an existing pellet and/or pellet chip lodged within the part. With the present process the pellet is solubilized in the nitric acid bath and is freed and can be shaken out or heard upon shaking the part to indicate that there is entrapped therein a pellet of the abrading media.

If the part **16** is a magnesium casting or forging, then a hydrofluoric acid solution is provided in place of the nitric acid solution **38** but the dipping operation is the same. In this case, the hydrofluoric acid will at least partially dissolve the aluminum or matrix of the pellet to reduce its size in the same manner as accomplished by the nitric acid solution. With the reduction in size, the pellet can be removed the same as described with the immunizing process having the nitric acid solution.

It is desirable to provide a pellet which does not shatter or fracture in any way during the tumble finishing operation since the smaller chips of the pellet are more likely to become stuck within passages formed in the interior of the parts finished. With a sintered metal matrix, there is reduced any likelihood of pellet chipping because the matrix is malleable and has sufficient cohesiveness to resist fracture during agitation of the barrel **22**. With the "all-ceramic" pellet there is the obvious limitation that the ceramic lacks impact strength and is more prone to undergo fracturing and chipping which will result in greater number of lodged pieces. Also, the decrease in chip size reduces the abrasive effectiveness of the pellets. With the present invention, there is less tendency for breakage of the pellet into smaller parts so that the abrasive rate remains constant.

It is possible to use pellets for tumble finishing which are composed solely of metal to obtain the advantage of greater cohesiveness of the pallet and its dissolution concurrently with the immunizing stage, but it has been our experience that these metallic pellets lack abrasive effect and tend to pound the flashing rather than cut it so that the burrs and flashing are folded over the edges as indicated in Figure 2B rather than being honed off as shown in Figure 2A.

In the case of aluminum parts which are tumble finished, the tumble finishing process is followed by an anodizing step, which will next be explained. The aluminum parts are removed from the tumbling barrel **22** after they are completely finished and they are hung on the prongs **32** of dipping stick **34** as indicated in Figure 4. The dipping stick is metallic and is hung over a support bar **48** which is made of electrically conductive material and is connected to the positive terminal of a voltage source **51**. The negative terminal of voltage source **51** is connected through the conductor **50** to ground as shown in Figure 4. Support member **53** is provided at each end of each support bar **48** and is made of electrically insulating or nonconductive material and is provided to support the bars **48** in relation to the tank **36**, such that the parts **16** may be immersed in the solution **52**.

The tank **36**, which is also constructed of electrically conductive material, contains a solution of chromic acid **52** and is connected to ground potential by the conductor **54**.

When the parts are immersed in the solution of chromic acid **52**, the dipping stick hook **40** makes contact with supporting bars **48** and current flows through the aluminum parts and solution to anodize the aluminum part. As the aluminum part is being anodized, the metallic matrix of any lodged pellets is corroded to reduce the size of the lodged pellets, thus freezing the pellet within the aluminum part. When the dipping stick **34** and appended parts are removed from the solution, the now freed chip or pellet can be removed by shaking the anodized aluminum part.

Instead of dissolving the lodged pellet concurrently with the anodizing treatment, it is possible to provide a separate step for this by dipping the tumble finished aluminum part into a solution to dissolve the pellet before anodizing; the solution will vary depending upon the binder constituent. For copper and iron binders, solutions of chromic acid, nitric acid, sulfuric acid, oxalic acid and a combination of oxalic acid and sulfuric acid can be used.

It is not always desirable to remove lodged pellets from aluminum parts during the anodizing treatment, the reason being that the binder of the lodged pellet can, under some circumstances, impede proper formation of finish at the surface of the part. It is possible to avoid this by dipping the aluminum part in a suitable solution, depending on the pellet binder (as indicated in the following chart) and removing the pellet before the anodizing step. The anodizing procedure is well known and follows generally the accepted anodizing procedures for which no invention is claimed herein.

When the pellet is removed preliminary to anodizing, a nitric acid solution is usable. Where an iron and/or copper pellet is used, the nitric acid will dissolve the binder without attacking the aluminum part at an excessive rate.

To summarize the various processing steps so far described for removing lodged pellets from the article, the following chart is provided. It should be noted that under the heading "Part Finished," this refers to the member being tumble finished. Under the heading "Solution" there is listed the reagent used for solubilizing the pellet and conditioning the surface of the part. The heading "Binder" designates the sintered metal phase which serves as a binder for the ceramic abradant in the pellet. The various solutions are provided in the concentrations and temperatures indicated, and the part is soaked for approximately the stated times.

Part Finished	Solution			Binder
I. Steel (Stainless)	Nitric Acid	Concentration—20% (by volume) of 1.42 sp. gr. HNO_3 (or equivalent acid concentrations) and 2% (by weight) of sodium dichromate. Temperature—140° F Time—15 to 30 Minutes	50% (by vol. of 1.42 sp. gr. HNO_3). 80° F 30 to 60 Minutes	Copper, Iron, Lead or Alloys of these metals.
II. Magnesium	"Dow 7 Treatment"—Hydrofluoric dipping 5 Minutes followed by— Sodium dichromate boiling for 30 to 45 Minutes.	Concentration—HF (10–20% by weight) Temperature—Room Temperature Time—5 Min. (removes pellet) Concentration—dichromate—10–20 oz. per gallon. Temperature—230° F. (rolling boil) Time—30 to 45 Minutes		Aluminum.
III. Aluminum:				
A. Anodizing and Simultaneously Removing Pellets.	Chromic Acid	Concentration—3–10% by weight Temperature—95° F Time—at 40 volts for 30 Minutes		Copper, Iron.
	Sulfuric Acid	Concentration—15–18% by weight Temperature—68–85° F Time—12 amps per sq. ft. for 30 Minutes		
	Oxalic Acid or Oxalic Acid combined with Sulfuric Acid.			Do.
B. Removing Pellets Before Anodizing.	Nitric Acid	Concentration—50% nitric acid Temperature—room temperature Time—30 to 60 Minutes		

Other parts which could be finished are brass, zinc die casting, ordinary steel, plastics (phenol formaldehyde, etc.).

Parts	Solution	Binder
Brass	Hydrochloric or sulphuric acid	Iron or Aluminum.
	Any strong caustic	Aluminum.
Ordinary Steel	Any strong caustic	Do.
	Inhibited hydrochloric or sulphuric acid.	Do.
Plastic	Any suitable binder solubilizing solution which will not attack plastic.	Iron, Aluminum or Copper.

When selecting the binder material, proper regard must be taken of galvanic corrosive effect of the binder on the part being finished. For example, when a magnesium part is finished, the metallic binder is selected on the basis of its position in the electromotive series relative to magnesium and it must be of such nature that it will not corrode the magnesium by virtue of "battery" or "electrolytic" effect on the magnesium. Suitable metal binders which do not have excessive corrosive effect on the magnesium include aluminum. When the magnesium part is dipped in the hydrofluoric acid solution, a protective coating is formed on the surface of the magnesium to limit corrosive effect of the acid, but the aluminum binder is not so protected and, hence, it can be solubilized and removed if lodged within the magnesium part.

It is further contemplated by the present invention that still other types of dissolvable materials can be used for the matrix of the tumbling pellets. Various plastics can be dissolved by organic solvents; and inasmuch as organic solvents do not usually attack metals, the use of plastic pellets and organic solvents may be preferred in certain instances. Organic solvents have the further advantage that they can be distilled, and so can be recovered from their plastic laden solutions.

For the most part, thermal plastic resins tend to be more soluble in organic solvents than do most thermal setting resins. Tumbling operations are usually performed at low temperatures, and sometimes in a soapy water solution, so that the thermal plastic resins can in most instances be used as a suitable binder for the tumbling pellets.

Tumbling pellets having a plastic matrix can be made in several ways, as for example by hot or cold pressing, or by extrusion. One suitable method of making the plastic pellets is to "hot extrude" a mixture of plastic and abrasive into rods about ½" in diameter and to cut the rod into pellets as it leaves the extrusion machine.

By way of example, a 50–50% by volume mixture of high impact polystyrene powder and No. 16 silicon carbide grit may be thoroughly mixed in a cone blender and then fed to a hot extrusion machine of the type used to extrude plastics generally. The plastic grit mixture is heated up in the machine to the softening point of the plastic, after which it is forced out of the extrusion die of the machine. Various shapes can be extruded; and for most applications a round die for making a cylindrical shape will be acceptable. After the material leaves the die in the shape of a ½" rod, it may be sheared into ½" lengths by conventional shearing techniques so that pellets of ½" diameter and ½" length are formed. Articles made of any of the above described metals can be tumbled with the above described plastic pellets; and particles of the pellets which become lodged in holes in the articles can be easily removed by agitating the articles in most any commercial ketone solvent.

In general, most any type of thermoplastic material which is readily dissolvable by a suitable solvent can be used as a matrix material; and other examples of thermoplastic materials which are soluble in ketones and which may be used are: methyl metacrylate, cellulose acetate, and methyl cellulose. Other thermoplastic materials which can be used and which are soluble in commercially available alcohols or esters are vinyl butyral and vinyl acetate.

There is no critical factor regarding proportion between the matrix and ceramic; we have found that the upper limit of ceramic is indicated only by the ability of the matrix to hold the pellet together during use and prevent its fracturing, and the lower limit of the ceramic is dictated by the desired abrasion rate and reduction in peening or pounding of the edges of the article.

In general, the ceramic content is dictated by the abrading effect desired; viz, the greater the content of ceramic, the more abradant effect achieved by the pellet. Also, the ceramic abradant has the effect of reducing the wear rate of the article until the ceramic content becomes so high that there is insufficient binder to hold the pellet together during use. It is quite obvious to one skilled in the art as to how the optimum ratio of ceramic to binder may be determined from the particular application.

Our experience does not indicate any criticality in the proportion of ceramic to binder other than that previously mentioned, and even this factor is influenced by the tumbling speed of the barrel and the matrix metal. From this we conclude that each tumble finishing operation has an empirically determined optimum ratio of ceramic to matrix bond, tumbling speed, and proportion of weight between abrasion media and article to be finished. These factors are well known to those skilled in the art, and do not need further amplification here.

From a consideration of the invention, it will be apparent that various modifications can be made without departing from the underlying scope of the invention. For example, the shape of the pellet forms no material part of the present invention and can be varied as desired to minimize the possibilities of lodging the pellet within the article. Also, various combinations of matrix ingredients may be made. While there has been disclosed the copper, aluminum, lead or iron sintered matrices, it will be apparent that alloys of these metals are equally suitable. Also, it will be understood that the invention is not limited to specific proportions of ceramic abradant to matrix, but the proportion can be varied according to design preference. Further, the solution used for reducing the pellet size, following the tumble finishing operation, can be the same as that used for anodizing or immunizing, or a separate solution may be used.

It will be understood that numerous variations of the invention may be made without departing from the underlying principles of the invention. It is intended that such revisions and variations will be included in the scope of the following claims.

We claim:

1. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined material or materials, the steps of: selecting a liquid bath treatment which will readily dissolve some materials but which does not appreciably dissolve the articles to be finished, selecting a substance which will be dissolved by said liquid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of said selected substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said liquid bath treatment to dissolve away the substance in the surface of said pellets to reduce their size and thereby facilitate their removal from said articles.

2. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined metallic material or materials, the steps of: selecting a liquid bath treatment which will readily dissolve some metals but which does not appreciably dissolve the articles to be finished, selecting a metallic substance which will be dissolved by said liquid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of said selected metallic substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said liquid bath treatment to dissolve away the metallic substance in the surfaces of said pellets to reduce their size and thereby facilitate their removal from said articles.

3. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined metallic material or materials, the steps of: selecting a liquid bath treatment having an active agent therein of the group consisting of relatively strong acids and bases which will readily dissolve some metals but which does not appreciably dissolve the articles to be finished, selecting a metallic substance which will be dissolved by said liquid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed through a coherent matrix of said selected metallic substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said liquid bath treatment to dissolve away the metallic substance in the surfaces of said pellets to reduce their size and thereby facilitate their removal from said articles.

4. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined metallic material or materials, the steps of: selecting a liquid anodizing bath treatment which will cause some metals to be readily dissolved but which does not appreciably dissolve the articles to be finished, selecting a metallic substance which will be dissolved by said liquid anodizing bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of said selected metallic substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said liquid anodizing bath treatment to dissolve away the metallic substance in the surfaces of said pellets to reduce their size and thereby facilitate their removal from said articles.

5. In a process for surface finishing generally foraminous articles of manufacture which are made from aluminum and/or its alloys, the steps of: selecting a nitric acid bath treatment, selecting a metallic substance which will be dissolved by said nitric acid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of a metallic substance selected from the group consisting of copper, and iron and their alloys, tumbling said articles with said pellets, and then subjecting the articles in which pellets become lodged during the tumbling operation to said nitric acid bath treatment to dissolve away the metallic substance in the surfaces of said pellets to reduce their size and thereby facilitate their removal from said articles.

6. In a process for surface finishing generally foraminous articles of manufacture which are made from magnesium and/or its alloys, the steps of: selecting a hydrofluoric acid bath treatment, selecting a metallic substance which will be dissolved by said hydrofluoric acid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said acid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of a metallic substance selected from the group consisting of aluminum and its alloys, tumbling said articles with said pellets, and then subjecting the articles in which

pellets become lodged during the tumbling operation to said hydrofluoric acid bath treatment to dissolve away the metallic substance in the surfaces of said pellets to reduce their size and thereby facilitate their removal from said articles.

7. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined material or materials, the steps of: selecting a liquid bath treatment which will readily dissolve some plastic materials but which does not appreciably dissolve the articles to be finished, selecting a plastic substance which will be dissolved by said liquid bath treatment, selecting abrasive granules which will not be appreciably dissolved by said liquid bath treatment, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of said selected plastic substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said liquid bath treatment to dissolve away the substance in the surface of said pellets to reduce their size and thereby facilitate their removal from said articles.

8. In a process for surface finishing generally foraminous articles of manufacture which are made from a predetermined material or materials, the steps of: selecting an organic solvent which will readily dissolve some plastic materials but which does not appreciably dissolve the articles to be finished, selecting a plastic substance which will be dissolved by said organic solvent, selecting abrasive granules which will not be appreciably dissolved by said organic solvent, forming tumble finishing pellets wherein said abrasive granules are dispersed throughout a coherent matrix of said selected plastic substance, tumbling said articles with said pellets, and thereafter subjecting the articles in which pellets become lodged during the tumbling operation to said organic solvent to dissolve away the substance in the surface of said pellets to reduce their size and thereby facilitate their removal from said articles.

No references cited.

UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 2,947,124 August 2, 1960

Gerald C. Madigan et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 35, for "180° F." read -- 1800° F. --.

Signed and sealed this 23rd day of May 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents