Feb. 2, 1960 L. G. SIMJIAN 2,923,100

ABRADING DEVICE

Filed Oct. 11, 1957

FIG. 1

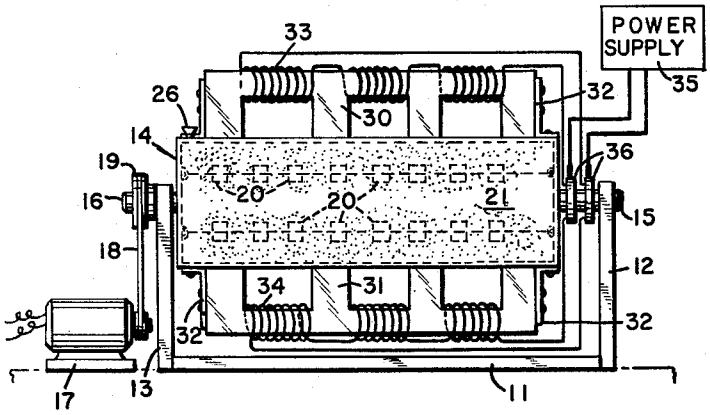


FIG. 2

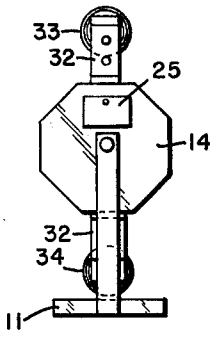


FIG. 3

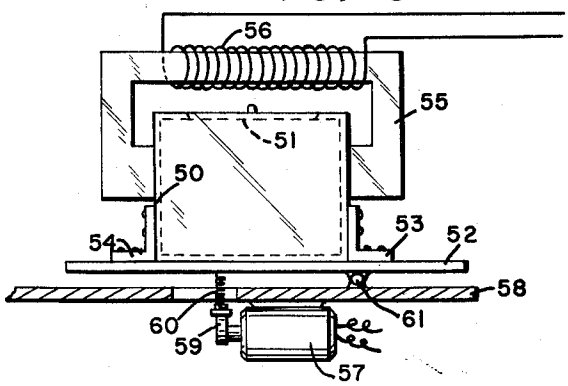


FIG. 4

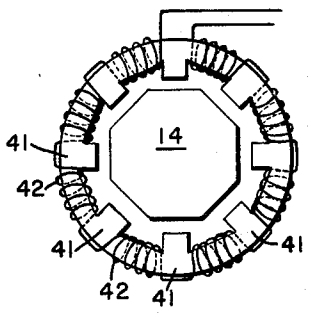


FIG. 5

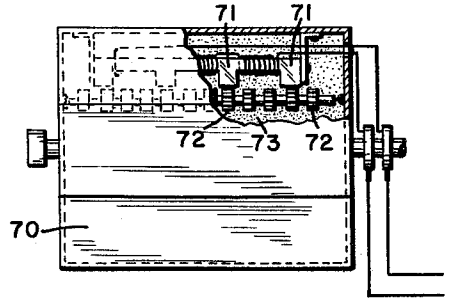


FIG. 7

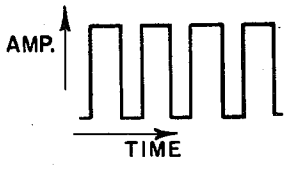
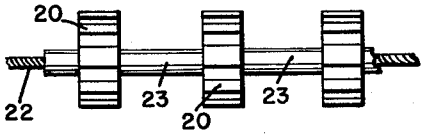


FIG. 6



LUTHER G. SIMJIAN
INVENTOR

BY: Erwin B. Steinberg

AGENT.

United States Patent Office 2,923,100
Patented Feb. 2, 1960

2,923,100

ABRADING DEVICE

Luther G. Simjian, Greenwich, Conn., assignor to Reflectone Electronics, Inc., Stamford, Conn., a corporation of Connecticut

Application October 11, 1957, Serial No. 689,569

12 Claims. (Cl. 51—7)

This invention relates to abrading and polishing of articles by the general method of establishing relative oscillations between the surface of the article to be treated and abrasive particles in contact with such surface. The invention has particular reference to a method which uses a loose abrasive mixture into which articles to be abraded or polished may be immersed and then the mixture is rigidified about the article and relative motion between the article and the rigidified mixture is produced, thus causing abrasive action.

One of the major difficulties in polishing irregular articles lies in the necessity of bringing abrasive materials in contact with the irregular contours. For this reason, many irregular articles must be polished by hand without the use of the usual motor-operated buffing or abrading wheels. The present invention overcomes these difficulties by using a fluent abrasive or polishing mixture which can be rigidified about the article to be polished. The mixture is housed in a receptacle and the object to be polished is immersed into the mixture when the mixture is fluent. Next, the mixture is rigidified about the article and relative motion is introduced between the rigidified mixture and the article to cause abrading of the irregular contour surfaces of the articles.

The mixture employed may comprise small abrasive particles such as Carborundum, boron carbide, silicon carbide, aluminum oxide, diamond powder, etc. or when using a magnetic field for effecting rigidification of the mixture, the mixture may comprise abrasive magnetic particles such as "Alnico," hardened steel particles, barium ferrites, manganese-bismuth particles, or as an alternate the mixture may be a mix of abrasive nonmagnetic particles and of abrasive magnetic particles in suitable proportions. Still further, the abrasive mixture may be mixed with a suitable amount of liquid such as oil, water, or a cleaning fluid such as turpentine, carbon tetrachloride, trichlorethylene, etc. in order to prevent coagulation of the particles and to enhance the finish of the surface to be abraded.

One of the objects of this invention therefore is to provide a polishing arrangement which avoids one or more of the disadvantages and limitations of the prior art arrangements;

Another object of the invention is to polish or abrade objects without resorting to manual manipulation;

Another object of the invention is to abrade the surface of irregular objects for the removal of scale, dirt, paint, or burs;

Another object of the invention is to provide an arrangement which is suitable for treating simultaneously a plurality of articles;

Another and further object of the invention is the provision of an apparatus adapted for polishing articles on a mass production basis.

The invention will be better understood from the following detailed description of several illustrative embodiments, reference being made to the accompanying drawing in which:

Figure 1 is a side elevational view of a typical apparatus embodying one form of the invention;

Figure 2 is an end elevational view of Figure 1;

Figure 3 is a side elevational view, partly in section, of an alternate apparatus embodying one form of the invention;

Figure 4 is an end view of an alternate arrangement which may be used in conjunction with the apparatus of Figure 1;

Figure 5 is a side elevational view, partly in section, of still another arrangement usable in conjunction with the apparatus of Figure 1;

Figure 6 illustrates in detail certain portions contained in Figures 1, 3 and 5, and Figure 7 is a graph illustrating certain current vs. time relationships which may be used in conjunction with the operation of the apparatus per Figures 1, 3, 4 and 5.

Referring now to Figures 1 and 2, numeral **11** identifies a base plate to which are attached two end brackets **12** and **13**. A drum or barrel **14** equipped with shafts **15** and **16** is supported for rotation in brackets **12** and **13** in the usual manner by the use of sleeve or ball bearings (not shown). An electric motor **17** is adapted to rotate the barrel **14** via a belt drive **18** and pulley **19** which is fastened to shaft **16**. The barrel or drum which is depicted as being octagonal in shape but which may be also of hexagonal shape or of any other suitable configuration, contains a plurality of articles to be abraded, such as articles **20** which are surrounded by a suitable abrasive mixture **21**.

A typical method of supporting the articles within the mixture is illustrated in Figure 6 wherein a flexible cable, rope, or wire **22** traverses the length of the barrel and objects **20**, for instance a spur gear, and spacer **23** alternately are placed thereon. It will be observed that by virtue of employing a rope or wire **22**, the articles are not mounted rigidly within the drum but may oscillate and vibrate depending upon the motion imparted to barrel **14**. The spacers **23** serve to space the objects to be abraded from one another in order to avoid damaging the objects by their abrading one another.

The suspending means **22** together with the object to be abraded are placed into the barrel by means of a suitable opening and cover **25** in the drum and after the articles have been placed into the drum, the drum may be filled with the abrasive mixture through a suitable top funnel and opening **26** in the drum in such a manner that the abrasive mixture surrounds the object to be abraded. For the general character and type of the abrasive mixture, reference is made to one of the previous paragraphs.

Disposed on the outside of the drum there is arranged a plurality of electromagnetic pole pieces, numerals **30** and **31** which are held to the drum by means of supporting brackets **32**. The magnetic pole pieces are equipped with magnetic windings **33** and **34** respectively which may be energized from a power supply **35** via suitable electrical conductors and electrical contact brushes together with a set of slip rings **36** fastened to shaft **15**. By virtue of this arrangement, the magnets will rotate in unison with the drum whenever rotation is imparted to the drum via motor **17**.

The operation of the instant device may be visualized as follows:

After the articles to be abraded have been placed into the drum and the drum is filled with the abrasive mixture, which in this instance is a magnetizable abrasive mixture, power supply **35** is energized to establish an electromagnetic field to the mixture confined within the drum. The magnetic field causes the mixture to rigidify and when energizing motor **17** for imparting to the drum bodily displacement in the form of rotation, relative motion be-

tween the rigidified magnetic mixture and the articles suspended therein is obtained. It will be noted that the degree of rigidity imparted to the mixture must be such that the abrasive mixture becomes a united mass which constrains the objects yet does not grip the objects in such a tight manner that the object to be abraded and the mixture would lack relative motion therebetween. This adjustment can be made best by regulating the current flow through the windings **33** and **34** in such a manner that the rigidity of the mixture is maintained somewhat below the maximum rigidity possible. In this manner, vibration of the drum obtained as a result of being rotated is transmitted to the rigidified mixture and also to the suspended articles. Since the articles and the rigidified mixture have a differing mass and as the articles are suspended loosely so as to allow slight motion, relative motion between the mixture and the articles is attained.

An alternate design is shown in Figure 4 wherein the drum **14** is surrounded by a plurality of stationary pole pieces **41** which are equipped with a magnet winding **42**. It will be observed that the magnetic flux again will penetrate the barrel and rigidify the mixture therein. By arranging the pole pieces in proximity to one another and providing a sufficient number of ampere-turns, a substantially constant flux pattern within the mixture can be obtained and the overall effect is the same as the one described in connection with Figure 1.

For best results it will be apparent that the barrel or drum should be made of nonmagnetic material in order that the magnetic flux penetrates through the barrel which acts as the receptacle for the mixture and objects to be abraded. It should be noted that the suspension means **22** and spacing means **23** (Figure 6) may be eliminated if the articles to be abraded are immersed into the mixture, such as an operator placing the objects into the mixture and avoiding articles to be abraded touching one another. As a next step the mixture is rigidified and the articles will be retained very much alike to a mold surrounding a cast object. When imparting vibration to the apparatus, the object will move relative to the surrounding mixture.

Figure 3 shows still another embodiment of the invention using a slightly different apparatus for obtaining the same or similar results. A receptacle **50** having an opening with lid **51** is mounted on a plate **52** by means of brackets **53** and **54**. The receptacle is equipped with a magnetic pole piece **55** and winding **56**. The pole piece may be either attached to the receptacle or may be stationary with respect to the receptacle when motion is imparted to the receptacle. The receptacle may be agitated by an electric motor **57** fastened to a base plate **58** and driving receptacle **50** via an eccentric cam **59** and spring combination **60**. In order that the container **50** vibrate, plates **52** and **58** supporting respectively the receptacle and motor are pivotally mounted with respect to one another at hinge **61**. This arrangement vibrating the receptacle **50** may be considered similar to conventional shakers and vibrators, such as are employed for mixing commercial paints, etc.

Figure 5 shows still another slight variation of the apparatus shown and described in connection with Figure 1. Magnetic pole pieces **71** are disposed at the inside of the drum **70** instead of being supported on the outside of the drum as shown in Figure 1. Articles **72** to be abraded are disposed inside the drum in the same manner as described above and are surrounded by abrasive mixture **73**.

Figure 7 illustrates a modification which may be employed in order to improve the operation of the foregoing apparatus. The graph illustrates variation of the electric current with respect to time which may be applied to the magnetic field. Instead of maintaining the electric current flow constant with respect to time as the receptacle vibrates, the current flow may be cyclically changed with respect to the motion of the article so that as the article is accelerated in the upward or downward direction, the magnetic mixture for a brief period is made less rigid and shortly thereafter more rigid in order to cause impact of the article on the again rigidified mixture. It will be noted that in this event the variations of the electric field must be synchronized with the motion of the container and the object therein.

Although magnetic means are employed for rigidifying the abrasive mixture described in connection with Figures 1, 3 and 5, it shall be clearly understood that other means for rigidifying the mixture may be employed such as changing the configuration of the receptacle shown in my copending application for U.S. Letters Patent, Serial No. 654,283 filed April 22, 1957, now abandoned. The mixture may then be composed of nonmagnetic particles.

It will be apparent to those skilled in the art that most favorable results are achieved when the articles to be abraded are substantially nonmagnetic while employing a magnetizable mixture and an electromagnetic field coupled thereto. Conversely, magnetizable objects may be abraded advantageously in a mixture which is rigidified by other than magnetic means. Furthermore, permanent magnetic means may be substituted for electromagnets without departing from the principle of the invention.

While there have been described certain embodiments of the foregoing invention, it will be apparent to those skilled in the art that various modifications and changes may be made therein without departing from the spirit of the invention which shall be limited only by the scope of the appended claims.

What is claimed is:

1. A method of abrading the contours of an article comprising the steps of inserting the article to be abraded in a receptacle containing an abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours to be abraded; applying to the mixture a magnetic field which rigidifies the mixture and renders it sufficiently rigid to contrain the article yet permitting limited motion of the article relative to the mixture, and bodily displacing the article and mixture by applying motion to the receptacle and the relative motion between the article and mixture causing abrading of the article.

2. A method of abrading the contours of an article comprising the steps of inserting the article to be abraded in a receptacle containing a magnetizable abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours to be abraded; applying to the mixture a magnetic field which rigidifies the mixture and renders it sufficiently rigid to constrain the article yet permitting limited motion of the article relative to the rigidified mixture, and bodily displacing the article and mixture by applying motion to the receptacle and the resulting relative motion between the article and mixture causing abrading of the article.

3. A method of abrading the contours of an article comprising the steps of loosely supporting the article to be abraded in a receptacle containing an abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours to be abraded; applying to the mixture a magnetic field which rigidifies the mixture and renders it sufficiently rigid to constrain the article yet permitting limited motion of the article relative to the mixture, and bodily displacing the article and mixture by applying motion to the receptacle and the relative motion between the article and mixture causing abrading of the article.

4. A method of abrading the contours of a plurality of articles comprising the steps of loosely supporting the articles to be abraded in a receptacle containing a magnetizable abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours of the articles to be abraded; applying to the mixture a magnetic field which rigidifies the mixture

and renders it sufficiently rigid to constrain said articles yet permitting limited motion of each article relative to the rigidified mixture, and bodily displacing the articles and mixture by applying motion to the receptacle and the resulting relative motion between each article and the surrounding mixture causing abrading of the articles.

5. A method of abrading the contours of a plurality of articles comprising the steps of loosely supporting the articles to be abraded in a receptacle containing a magnetizable abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours of the articles to be abraded; applying to the mixture a magnetic field which rigidifies the mixture and renders the mixture sufficiently rigid to constrain the articles yet permitting limited motion of the articles relative to the rigidified mixture, and bodily displacing the articles and mixture within the magnetic field by applying motion to the receptacle and the resulting relative motion between each article and the surrounding mixture causing abrading of the articles.

6. A method of abrading the contours of a plurality of articles comprising the steps of inserting the articles to be abraded in spaced relationship in a receptacle containing a magnetizable abrasive mixture when the mixture is substantially fluent whereby the mixture is caused to surround the contours of the articles to be abraded; applying to the mixture a magnetic field which rigidifies the mixture and renders the mixture sufficiently rigid to constrain the articles yet permitting limited motion of the articles relative to the rigidified surrounding mixture, and bodily displacing the plurality of articles and mixture within the magnetic field by applying motion to the receptacle and the resulting relative motion between each article and the rigidified mixture causing abrading of the respective article contours.

7. Apparatus of the character described comprising: a receptacle; a magnetizable abrasive mixture in said receptacle in which an article to be abraded may be immersed; magnetic means disposed to rigidify the mixture about the article yet permitting limited motion of the article relative to the mixture, and means bodily displacing the receptacle and article by imparting motion to the receptacle while the mixture is rigidified.

8. Apparatus of the character described comprising: a receptacle; a magnetizable abrasive mixture in said receptacle in which an article to be abraded may be immersed; electromagnetic means disposed to coact with the mixture to rigidify it about the article yet permitting limited motion of the article relative to the rigidified mixture, and means bodly displacing the receptacle and article by imparting motion to the receptacle while the mixture is rigidified and this motion causing abrading of the article.

9. Apparatus as set forth in claim 8 wherein the electromagnetic means are exterior of the receptacle.

10. Apparatus as set forth in claim 8 wherein the electromagnetic means are disposed at the inside of the receptacle.

11. Apparatus of the character described comprising: a receptacle; a magnetizable abrasive substantially fluent mixture in said receptacle in which an article to be abraded may be immersed; mounting means fastened to the receptacle for loosely supporting the article thereon whereby the article is in contact with the mixture; means disposed to produce a magnetic flux which rigidifies the mixture to render it sufficiently rigid to constrain the article yet permitting limited motion of the article relative to the mixture, and means bodily displacing the article and mixture by applying motion to the receptacle and the relative motion between the article and mixture causing abrading of the article.

12. Apparatus of the character described comprising: a receptacle; a magnetizable abrasive substantially fluent mixture in said receptacle in which a plurality of articles to be abraded may be immersed; mounting means fastened to the receptacle for loosely supporting the articles in spaced relationship whereby the articles are in contact with the mixture; electromagnetic means disposed to produce a magnetic flux which rigidifies the mixture to render it sufficiently rigid to constrain each of said articles yet permitting limited motion of each article relative to the rigidified mixture, and means bodily displacing the plurality of articles and mixture by applying motion to the receptacle and the relative motion between said articles and mixture causing abrading of said articles.

References Cited in the file of this patent

UNITED STATES PATENTS

512,312	Morgan	Jan. 9, 1894
2,480,502	Nieder	Aug. 30, 1949
2,734,316	Dawson	Feb. 14, 1956
2,735,231	Simjian	Feb. 21, 1956
2,787,854	Simpian	Apr. 9, 1957
2,796,702	Bodine	June 25, 1957