United States Patent [19]

Hartline et al.

[11] 3,741,436

[45] June 26, 1973

[54] **HANDLING OF MAGNETICALLY ASYMMETRICAL ARTICLES**

[75] Inventors: **Ernst F. Hartline**, Reading; **Donald M. Large**, Temple, both of Pa.; **Gregory E. Montone**, Alexandria, Va.

[73] Assignee: **Western Electric Company, Incorporated**, New York, N.Y.

[22] Filed: **May 14, 1971**

[21] Appl. No.: **143,511**

[52] U.S. Cl. ..... **221/156**, 198/33 AA, 221/212, 222/197

[51] **Int. Cl.** **B23q 7/12**

[58] **Field of Search** ..... 198/41, 33 AA; 221/156, 212; 222/197

[56] **References Cited**

UNITED STATES PATENTS

3,120,890	2/1964	Waltz	198/33.1
3,147,841	9/1964	Austin	198/33.1
3,164,081	1/1965	Vincze	198/41
3,086,639	4/1963	Donofrio	221/156

OTHER PUBLICATIONS

Western Electric Technical Digest No. 22 by T. L. Maurer, of April, 1971, pages 29 and 30.

Primary Examiner—Richard E. Aegerter
Assistant Examiner—H. S. Lane
Attorney—W. M. Kain, R. Y. Peters et al.

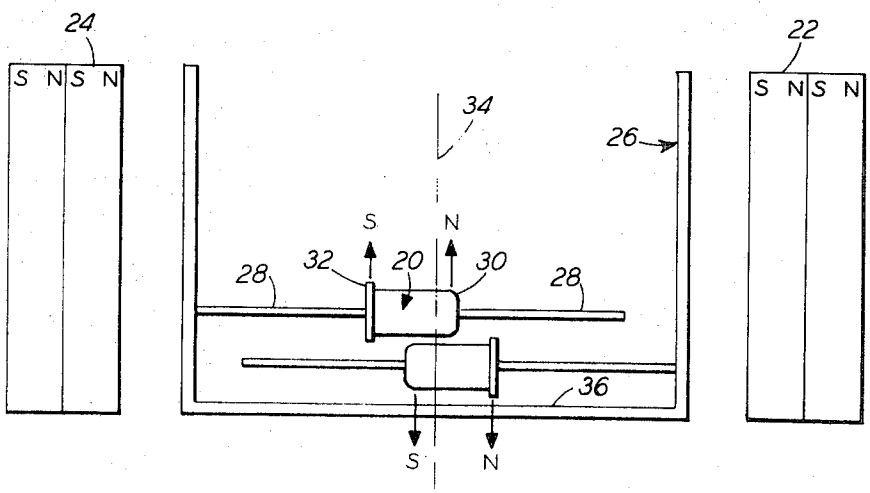
[57] **ABSTRACT**

Articles having axial leads, such as diodes, are handled by initially storing the articles within a magnetic bin and feeding the articles from the bin with a magnetic wheel. The articles are magnetic but they are not "magnetically symmetrical."

The magnetic asymmetry causes a tangling of the articles when they are suspended within the storage bin. A number of techniques are provided to eliminate the tangling: the field strength of the bin is reduced, the field is biased to one side of the bin and the bin walls are placed close together to constrain the articles.

Additional improvements in handling are achieved by operating a magnetic feed wheel with discrete high angular-acceleration steps so that the articles which are not singularly attracted to pickup locations on the wheel are shaken free of the wheel by the stepping action. Thus, uniform feeding of the articles is achieved.

17 Claims, 10 Drawing Figures



PATENTED JUN 26 1973

3,741,436

FIG.-1
(PRIOR ART)

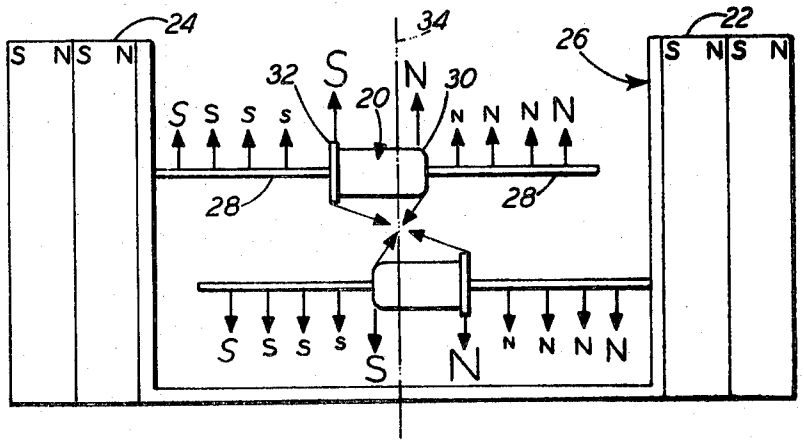


FIG.-2
(PRIOR ART)

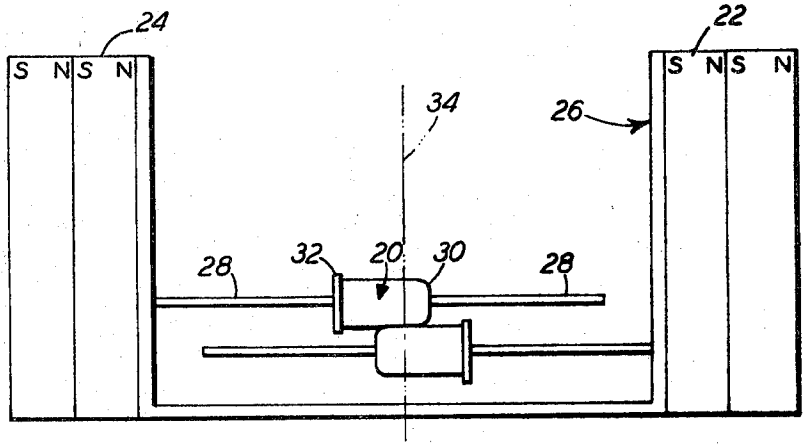
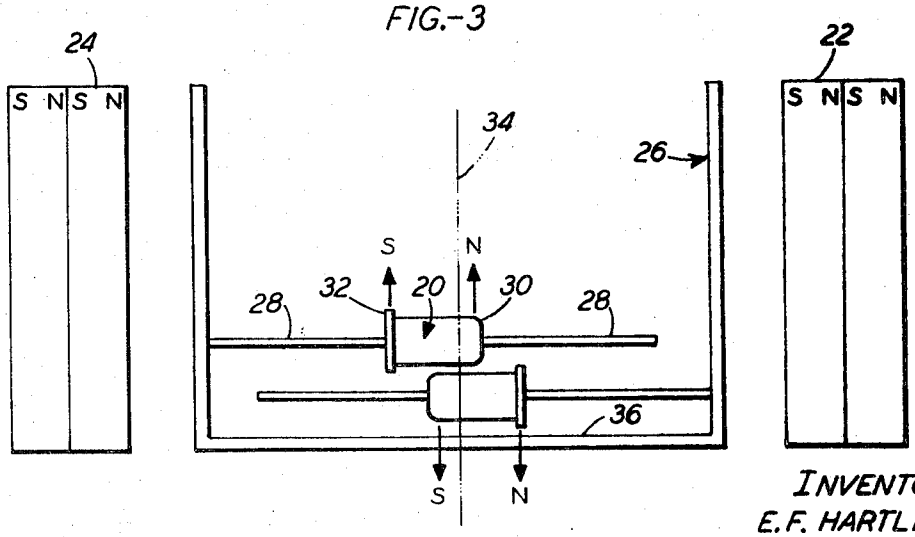


FIG.-3



INVENTORS
E.F. HARTLINE
D.M. LARGE
G.E. MONTONE

BY R.J. Tribulski Jr.
ATTORNEY

FIG.-4
(PRIOR ART)

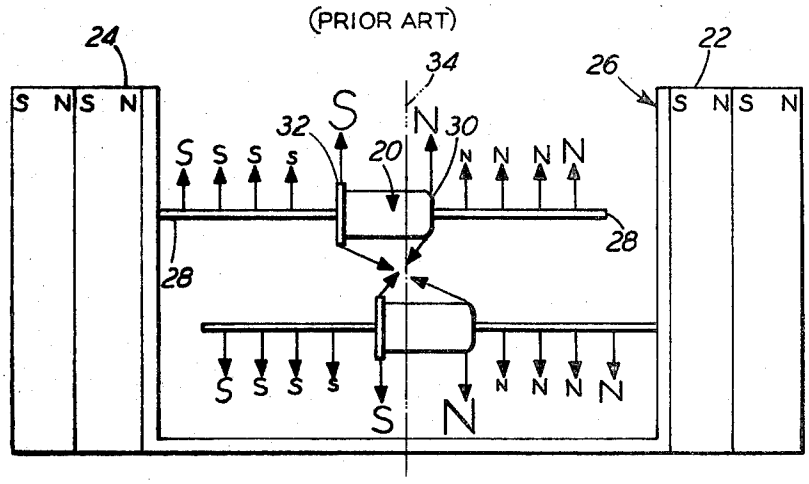


FIG.-5
(PRIOR ART)

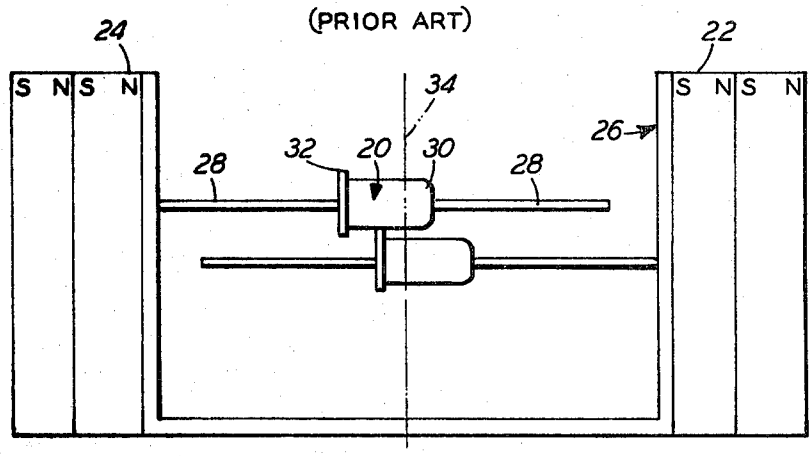


FIG.-6

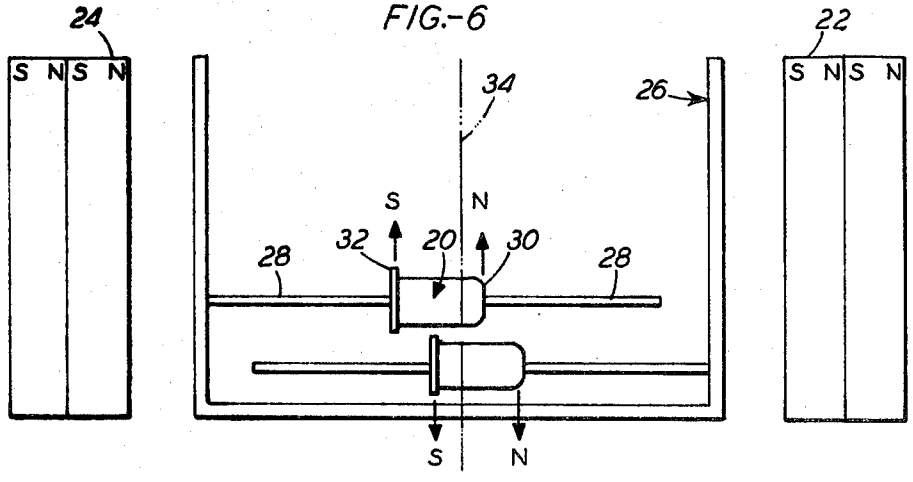


FIG.-7

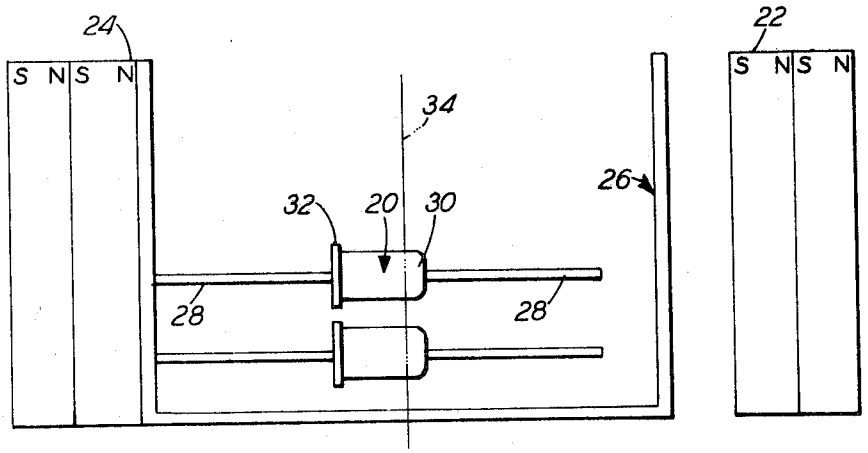

24
S N S N
22
S N S N
34
26
32
20
30
28
28

FIG.-8

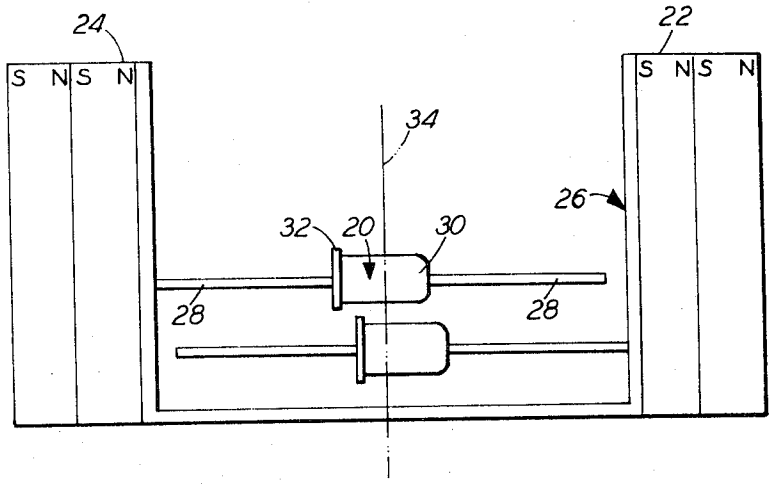
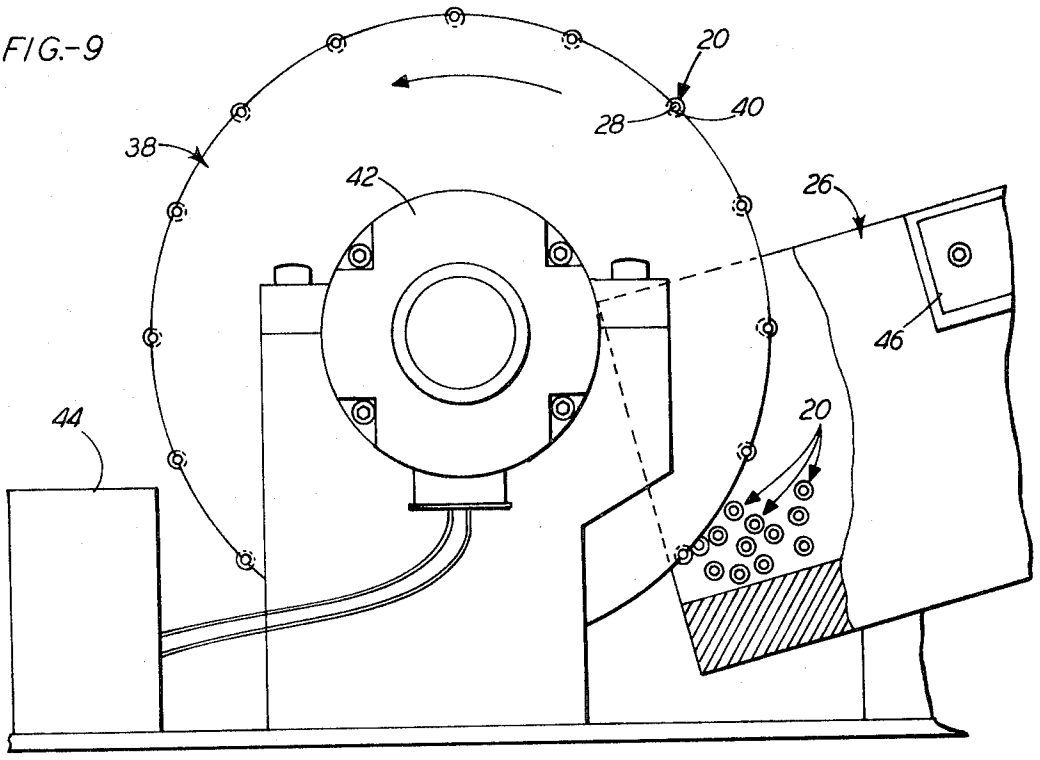

24
S N S N
22
S N S N
34
26
32
20
30
28
28

FIG.-9



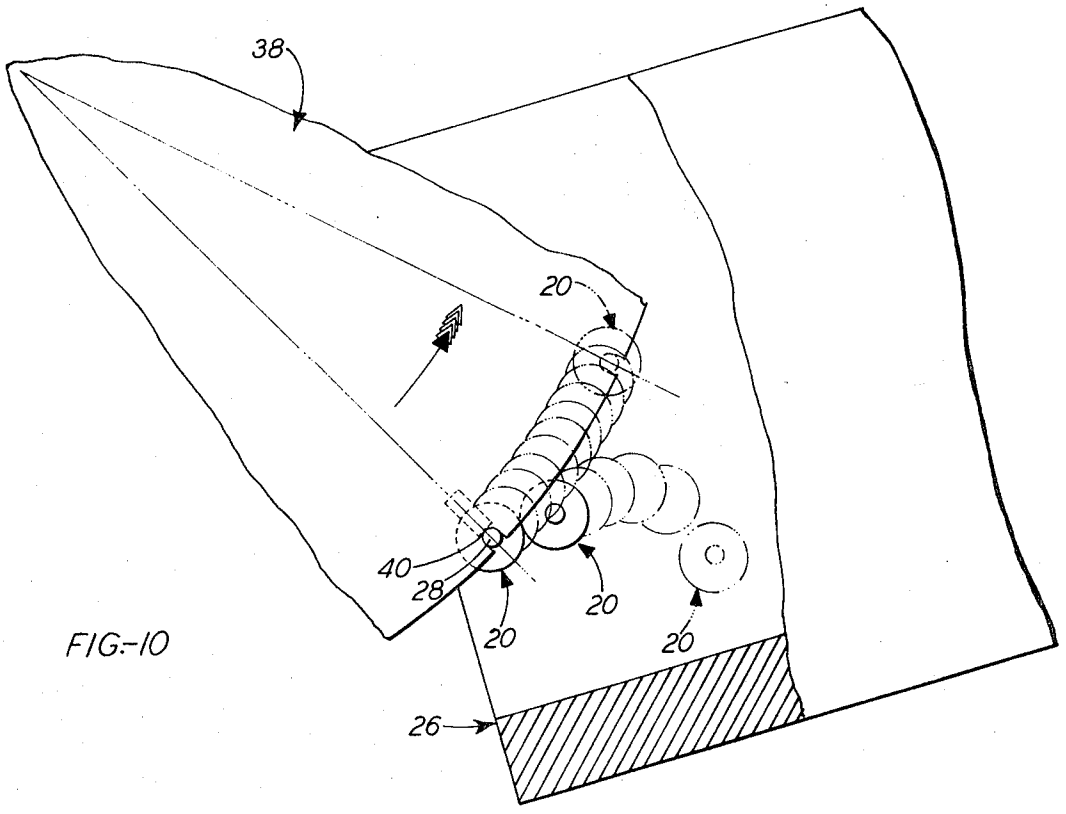


FIG.-10

HANDLING OF MAGNETICALLY ASYMMETRICAL ARTICLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to improved apparatus and methods for handling magnetically asymmetrical articles within a magnetic storage bin. The improvements involve both the suspension of the articles within the bin and feeding of the articles from the bin.

2. Description of the Prior Art

Magnetic articles have been handled with magnetic storage bins and magnetic feed wheels for a considerable time. One example of a very successful handling system is described in U. S. Pat. No. 3,537,580 issued to J. E. Beroset and D. M. Large on Nov. 3, 1970. The system described in this patent is quite useful for handling elongated articles, such as diodes, with axial leads.

As explained in this patent, magnetic storage bins are typically arranged so that one wall of the bin is a south pole of a magnet and the opposite wall is the north pole of the magnet. When an elongated magnetic article is placed within the bin the article aligns itself perpendicularly to each of the walls, and positions itself where the flux density is at a maximum which, in the case of the conventional magnet arrangement shown in the above-referenced patent, is along the center plane of the storage bin. When a plurality of articles is placed within the bun, each of the particles mutually repels surrounding articles. If the articles are uniform in shape along their length or, at least, uniform in their magnetic characteristics along their length, the mutual repulsion between the articles will also be uniform along the entire length of each of the articles. With such magnetically symmetrical articles, the uniform mutual repulsion will result in all of the articles being substantially parallel with one another and uniformly spaced from one another. Thus, a very even distribution of the articles within the bin will occur and the articles can be readily fed from the bin with a magnetic wheel.

Handling of articles that are not so uniformly shaped is not so simple. There are electrical devices, such as diodes, that are provided with magnetic enclosures or "cans" that surround the active semiconductor element. These cans are often provided with a flange at one end. Thus, if one were to view the article as having a center line perpendicular to the axis passing through the device midway along its length, one could consider the device to be magnetically asymmetrical with respect to that imaginary axis. The flange, of course, provides a greater amount of magnetic material on one side of the axis and the relative sharpness of the edges of the flanges provides for concentrations of fields when the articles are magnetized.

FIGS. 1 and 2 show two magnetically asymmetrical articles placed within a conventional magnetic storage bin. On the right side of the bin each of the articles is polarized N and on the left side of the bin each of the articles is polarized S. Along the uniform leads of the articles the polarization is substantially uniform and mutual repulsion occurs. However, the flanges of the articles are polarized more heavily. In other words, a concentration of fields occurs at the flanges. A mutual attraction occurs between the flanges. The attraction resulting from the highly polarized flanges is great enough to overcome the mutual repulsions that are distributed along the leads of the acticles. Thus, the net effect of the mutual attraction is to cause tangling of the articles, as shown in FIG. 2.

A similar phenomenon occurs even when the articles are oriented in the same direction, as shown in FIG. 4. It can be seen that the articles which are displaced to the left side of the bin are polarized slightly differently than the articles displaced to the right side of the bin. In a conventional bin, there is room for the articles to shift laterally far enough to permit the field concentrations associated with the flanges to cause an attractive force that overcomes the repulsive forces associated with the distributed polarizations. The articles become tangled, as shown in FIG. 5.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide improvements to a magnetic handling system for magnetically asymmetrical elongated articles to permit such articles to be suspended between two planar vertically oriented magnetic field-producing members without tangling of the articles.

It is a further object of the invention to provide an efficient system for feeding the magnetically asymmetrical articles from the improved magnetic storage facility.

These objects are achieved by controlling the characteristics of the magnetic field of the storage facility to reduce attractive interaction between the magnetically asymmetrical articles suspended therein.

Further improvements to the feeding of the articles are provided by rotating a feed wheel with discrete steps of high angular acceleration to shake free articles which are in contact with the wheel but which are not singularly engaged with one of a number of attractive positions on the wheel.

BRIEF DESCRIPTION OF THE DRAWINGS.

Other objects and features of the present invention will be more readily understood from the following detailed description of specific embodiments thereof, when read in conjunction with the appended drawings in which:

FIG. 1 is an illustration of two magnetically asymmetrical articles located within a conventional magnetic storage bin and is illustrative of a problem associated with the prior art;

FIG. 2 is an illustration of the articles of FIG. 1 after they have become undesirably tangled;

FIG. 3 is an illustration of two magnetically asymmetrical articles suspended within a magnetic storage bin wherein the tangling is reduced by a reduced magnetic field;

FIG. 4 is an illustration of two similarly oriented, magnetically asymmetrical articles within a conventional magnetic storage bin and is illustrative of a problem associated with the prior art;

FIG. 5 is an illustration of the articles of FIG. 4 after they have become undesirably tangled;

FIG. 6 is an illustration of two magnetically asymmetrical articles suspended within a magnetic storage bin wherein the tangling is reduced by a reduced magnetic field;

FIG. 7 is an illustration of the articles of FIG. 6 wherein the tangling is reduced by a biased magnetic field;

FIG. 8 is an illustration of the articles of FIG. 6 wherein the tangling is reduced by physically confining the articles;

FIG. 9 is an elevational view of a magnetic feed wheel operating at one end of a magnetic storage bin and illustrating a double feeding problem that must be overcome during handling of magnetically asymmetrical articles; and

FIG. 10 is an enlargement of a portion of a feed wheel of FIG. 9 illustrating the elimination of the double feeding situation by a stepping action of the wheel.

DETAILED DESCRIPTION

As discussed previously in the description of the prior art, magnetically asymmetrical articles, designated generally by the numeral **20**, are shown in FIGS. **1** and **2** between a north pole **22** and a south pole **24** of a conventional magnetic storage bin, designated generally by the numeral **26**. For purposes of clarity, only two of the articles **20** are shown. However, it should be realized that typical storage bins usually contain hundreds of the articles.

FIGS. **1** and **2** illustrate a prior art problem associated with attempting to suspend such magnetically asymmetrical articles within a conventional magnetic storage bin. Each of the articles **20** is magnetic along its entire length. For example, the article **20** can be considered to have leads **28**, a can portion **30** and a flange **32**. It can be seen that on the right side of the center line **34** of the bin **26**, the articles have a north polarization indicated by N and on the left side of the center line they have a south polarization, indicated by S. Because of the concentrations of the fields at the flanges **32**, articles supported within a conventional bin will tangle, as shown in FIG. **2**.

FIG. **3** illustrates a desirable result derived from an inventive alteration of the magnetic field of the bin **26**. The field to which the articles **20** are exposed is substantially reduced. It can be seen that the lowermost article **20** is virtually lying on the bottom **36** of the bin **26**. The upper one of the articles **20** is virtually lying on the lowermost article. Since the field strength is quite low there is a substantial difference between the state of the articles **20** illustrated in FIG. **3**, and the state of the articles illustrated in FIG. **2**. In FIG. **2** the highly polarized flanges **32** and cans **30** are causing a significant attractive force between the articles **20** and they are held together quite tenaciously. While the phenomenon is not completely understood, it is thought that the reduced field of the bin in FIG. **3** causes the polarity of the flanges **32** and cans **30** to be very greatly reduced. As a result, there is virtually no attraction between the articles **20**. There is simply a uniform repulsive force distributed along the length of both of the articles **20**. The repulsive force is, of course, quite low because of the reduced field strength and, consequently, the articles **20** tend to be spaced quite closely to one another. But, articles **20** can be removed from one another quite readily because there is, in fact, slight repulsive force between the articles.

With the reduced magnetic field, the articles **20** retain their desirable parallel alignment with respect to one another and they can be easily fed out of the bin **26**.

FIGS. **4** and **5** illustrate the prior art problem that existed when the magnetically asymmetrical articles **20** were oriented in the same direction and held within the conventional magnetic storage bin **26**. It can be seen that the conventional bin **26** had an opening that was larger than the length of one of the articles **20**. This large opening, of course, permitted articles of various lengths to be placed in the bin. In other words, the bin is useful for handling articles throughout a substantial range of length tolerances.

As was the case with the unoriented articles illustrated in FIGS. **1** and **2**, the articles **20** of FIGS. **5** become tangled and are, therefore, difficult to remove from the bin **26**. Altering the field to reduce its strength, as was discussed previously with respect to FIG. **3**, helps to eliminate tangling between the oriented articles **20** just as the reduction of field strength eliminates tangling between the unoriented articles. The result of such a reduced field is shown in FIG. **6**.

An additional field alteration is useful in the case of oriented articles. This alteration is illustrated in FIG. **7**. The field of the bin **26** in FIG. **7** is biased so that the left side of the bin is more influential on the articles **20** than the right side. The biasing causes all of the articles **20** to migrate to the left side of the bin **26**. Because of this migration, all of the flanges **32** are displaced to the one side of the bin **26**. Thus, there is no longer an attractive phenomenon between the flanges **32** since all of the flanges have similar polarization. All of the devices **20** in the biased field are exposed to the same degree and direction of magnetization along their entire lengths, and an equal distribution of repulsive force occurs. The articles **20** in this case do not tangle; they retain the desirable parallel alignment and are readily removed from the bin.

FIG. **8** illustrates another alteration which is useful to preclude tangling of oriented ones of the articles **20**. The opening in the bin **26** is reduced to virtually preclude lateral shifting of the articles **20** within the bin. In this way, all of the flanges **32** are retained on one side of bin **26** and the attractive phonomenon that developed in the prior art is eliminated. While the distribution of the field along the lengths of the articles **20** is not exactly uniform, as in the case of the biased field of FIG. **7**, the distribution is similar enough so that attractive forces between the articles are eliminated. Of course, the reduction in openings of the bin **26** precludes the use of the bin for articles having a wide range of overall lengths. The utility of the bin arrangement of FIG. **8** is limited to articles having uniform lengths.

When handling oriented articles, the combined effects of biasing the field as shown in FIG. **7**, and reducing the bin opening as shown in FIG. **8** can be advantageous when the articles **20** are introduced into the bin **26** with a reduced opening. There is very little opportunity for the articles **20** to become tangled prior to the time that they become attracted to the more highly polarized side of the bin. Thus, a combined biased field and reduced-opening in the bin **26** provides a lower probability for tangling between the articles **20**.

FEEDING SYSTEM

When a conventional feed wheel, designated generally by the numeral **38**, is utilized to feed the articles **20** from the bin **26**, as shown in FIG. **9**, there often occurs a doubling phenomenon. This doubling phenomenon occurs when one of the articles **20** is engaged with one of a plurality of magnetically attractive positions **40** on the periphery of the wheel **38** and another one of the

articles 20 becomes weakly engaged between the attracted article and the surface of the wheel 38. With a slow rotation of the wheel 38, the captive or "doubled" article would be carried out of the bin 26 on the surface of the wheel.

If the wheel 38 is being used to feed a testing operation or an operation where one-at-a-time feeding is desired, the doubling would, of course, be highly undesirable. The doubling phenomenon is particularly acute when feeding magnetically asymmetrical articles out of a bin having a reduced magnetic field. The articles 20 tend to be very closely spaced to one another because of the light repulsive forces developed by the low magnetic field. Additionally, their peculiar shape, that is, the existence of the flanges 32, tends to result in a substantial number of the articles 20 being doubled on the surface of the wheel 38.

Elimination of the doubling phenomenon is achieved by an inventive driving of the wheel 38 with discrete high acceleration, rotational steps. The wheel 38 is driven by a stepping motor 42 which is controlled by a control unit 44. In a typical example of a feeding system, the wheel 38 having a diameter of 6-⅜ inches is driven with bursts of steps by the motor 42 which, in this case is a SLO-SYN type SS 250—P1 available from the Superior Electric Company, Bristol, Connecticut. Each of the articles 20 has a weight of approximately 0.3 gms. The motor is driven so that each pulse rotates the wheel 38 1.8°. Each burst of pulses comprises 10 pulses having a 4 to 5 millisecond duration. A 50 millisecond pause between bursts is used to perform a testing operation, not shown. After the 50 millisecond pause, another burst of 10 pulses indexes the wheel 18° so that a subsequent one of the articles 20 is brought to the test position. This combination of angular accelerations results in a highly successful one-at-a-time feeding of the articles from the bin 26.

It is important to realize that while the acceleration should be rapid in order to eliminate "doubling," the acceleration should be controlled so that it is not too rapid. Too high an acceleration will result in shaking off the articles from the attractive positions 40 of the wheel 38.

FIG. 10 shows the wheel 38 being stepped through one burst of ten pulses. One of the articles 20 is retained within the attractive position 40. Another one of the articles which is initially held as a "double" is thrown off by the stepping motion of the wheel 38.

Additional improvements to the feeding system are provided by inclining the bin 26 approximately 10° to 15° from a horizontal position to cause the articles 20 to move toward the wheel 38 under the influence of gravity. Also the bin is vibrated with a conventional vibrator 46 to further assist the movement of the articles 20 toward the wheel 38.

Through this inventive stepping motion and altered field arrangement, magnetic articles having very exaggerated shapes can be handled expeditiously with magnetic handling systems.

Although certain embodiments of the invention have been shown in the drawings and described in the specification, it is to be understood that the invention is not limited thereto, is capable of modification and can be arranged without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for magnetically handling a plurality of magnetically asymmetrical articles comprising:
confronting sidewalls for laterally confining said articles when placed between said sidewalls; and
means for establishing between and transverse to said sidewalls a magnetic field of substantially constant predetermined intensity,
said field intensity being of a strength in relation to said articles so as to maintain said articles just suspended between said sidewalls thereby overcoming the tendency to adhere to each other.

2. The apparatus of claim 1 which further comprises:
a pickup wheel having a plurality of attractive positions spaced about the periphery thereof, the wheel being positioned at one end of the sidewalls with a portion of the periphery engageable with the suspended articles; and
means for rotating the wheel in discrete steps of high angular acceleration to shake free any articles in excess of one that are engaged with one of the attractive positions of the wheel, whereby a controlled feeding of single articles is achieved.

3. The apparatus of claim 2, wherein the sidewalls are inclined toward the pickup wheel and further comprising vibrating means to facilitate movement of the articles toward the wheel.

4. Apparatus according to claim 1, wherein said means for establishing said magnetic field is constituted of two magnetic elements, one at each sidewall, one of which is stronger than the other.

5. Apparatus according to claim 1, wherein said sidewalls are spaced apart by a distance not substantially greater than the length of said articles, so as to substantially preclude shifts of said articles laterally between said sidewalls.

6. A method of handling magnetically asymmetrical articles comprising:
placing said articles between confronting sidewalls for laterally confining said articles; and
establishing between and transverse to said sidewalls a magnetic field of substantially constant intensity and of a strength relative to said articles so as to maintain said articles just suspended between said sidewalls thereby overcoming the tendency to adhere to each other.

7. The method of claim 6 which further comprises the further step of:
rotating a pickup wheel which has a plurality of attractive positions spaced about the periphery thereof, and which is positioned at said one pair of ends of said sidewalls with a portion of the periphery engageable with the suspended articles, in discrete steps of high angular acceleration to shake free articles which are in contact with the wheel but are not singularly engaged with one of the attractive positions, whereby a controlled feeding of single articles is achieved.

8. The method of claim 7 which comprises the step of vibrating the sidewalls to facilitate the movement of the articles to the wheel.

9. The method of claim 6 further comprising the step of removing said articles from between the ends of said sidewalls by magnetically attracting at least one of said articles at a time.

10. The method of claim 9, wherein the magnetic removing is effected with intermittent acceleration transverse to the direction of the magnetic attraction and in-

tense enough so that the inertia of the attracted articles other than the first overcomes the attraction.

11. The method of claim 9, wherein the articles other than the first fall back between the sidewalls in response to the overcoming of the attraction by their inertia.

12. Apparatus for magnetically handling a plurality of magnetically asymmetrical articles comprising:

confronting sidewalls for laterally confining said articles when placed between said sidewalls;

means for establishing between and transverse to said sidewalls a magnetic field of predetermined intensity, said field intensity being proportioned in relation to said articles so as to maintain said articles suspended between said sidewalls without the tendency to adhere to each other;

a pickup wheel having a plurality of attractive positions spaced about the periphery thereof, the wheel being positioned at one end of the sidewalls with a portion of the periphery engageable with the suspended articles; and

means for rotating the wheel in discrete steps of high angular acceleration to shake free any articles in excess of one that are engaged with one of the attractive positions of the wheel, whereby a controlled feeding of single articles is achieved, said means for rotating the wheel comprising a stepping motor and a control unit for rotating the motor in bursts of pulses, each burst having from 2 to 20 pulses and each pulse having a duration of 2 to 8 milliseconds.

13. The apparatus of claim 12 wherein each pulse rotates the wheel at least one degree.

14. The apparatus of claim 13 wherein the wheel has a diameter of from 4 to 10 inches.

15. The apparatus of claim 14 wherein each article has a weight of from 0.2 to 0.4 grams.

16. A method of handling magnetically asymmetrical articles comprising:

placing said articles between confronting sidewalls for laterally confining said articles;

establishing between and transverse to said sidewalls a magnetic field of intensity proportioned relative to said articles so as to maintain said articles suspended between said sidewalls without the tendency to adhere to each other;

rotating a pickup wheel which has a plurality of attractive positions spaced about the periphery thereof, and which is positioned at said one pair of ends of said sidewalls with a portion of the periphery engageable with the suspended articles, in discrete steps of high angular acceleration to shake free articles which are in contact with the wheel but are not singularly engaged with one of the attractive positions, whereby a controlled feeding of single articles is achieved, the wheel being rotated in bursts of pulses, each burst having from 2 to 30 pulses and each pulse having a duration of 2 to 8 milliseconds.

17. The method of claim 16 wherein each pulse rotates the wheel at least 1 degree.

* * * * *