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Grenfell et al.

[11] **3,753,513**

[45] **Aug. 21, 1973**

[54] **HANDLING AND SORTING DEVICES**

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[73] Assignee: **Badalex Limited,** Weybridge, England

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[30] **Foreign Application Priority Data**

May 6, 1971 Great Britain..... 13528/71

[52] **U.S. Cl.**..... **221/1,** 221/212, 198/41

[51] **Int. Cl.**..... **B23q 7/04,** B65g 17/46

[58] **Field of Search**..... 209/73; 221/212, 221/183, 184, 295, 1; 198/41

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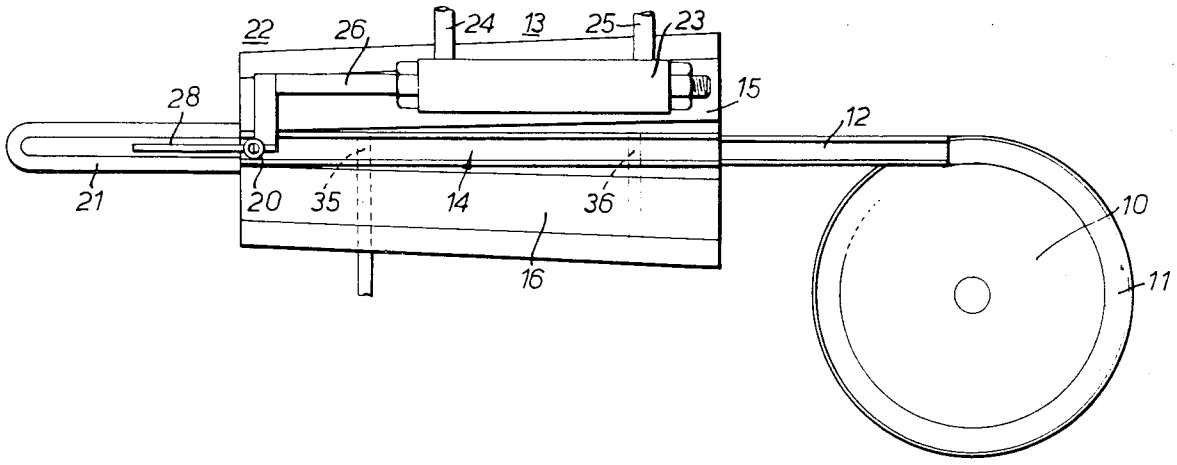
Primary Examiner—Allen N. Knowles

Attorney—Joseph F. Brisebois et al.

[57] **ABSTRACT**

Apparatus and method for handling or sorting articles of magnetic material by magnetomotive means. The articles are fed to a guide across which a magnetic flux is maintained between a pair of pole pieces of a magnetomotive means; the magnetic flux increasing in density along the guide so as to separate and move the articles along the guide in the direction of increasing magnetic flux density.

15 Claims, 6 Drawing Figures



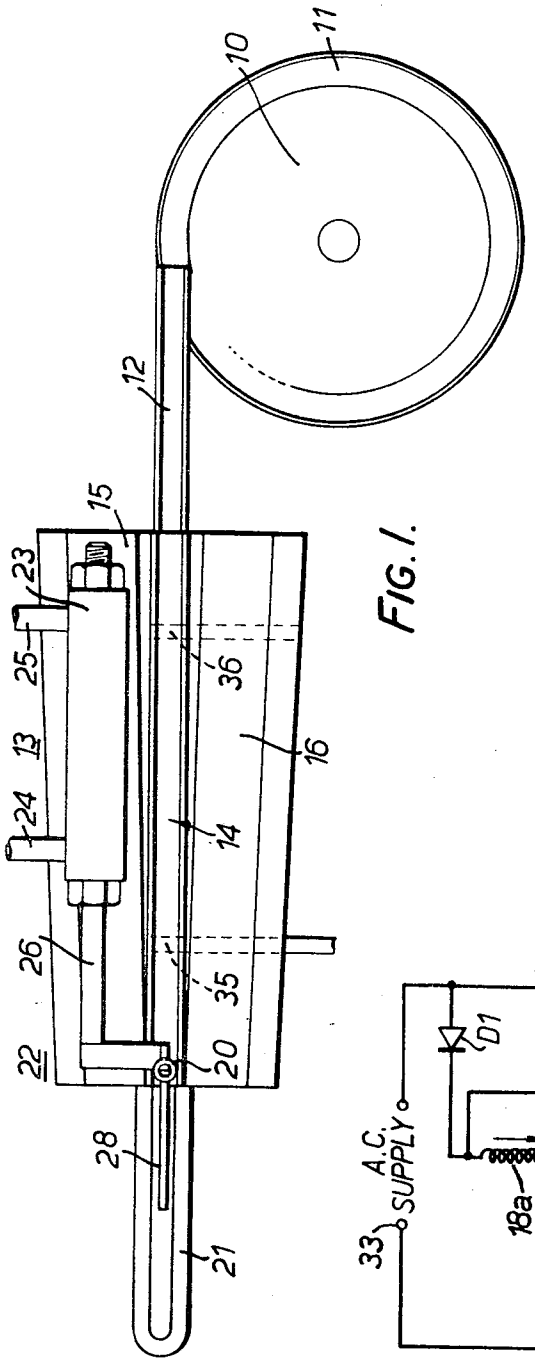

10
11
12
15
23
25
13
24
26
22
28
21
36
16
14
35
20

FIG. 1.

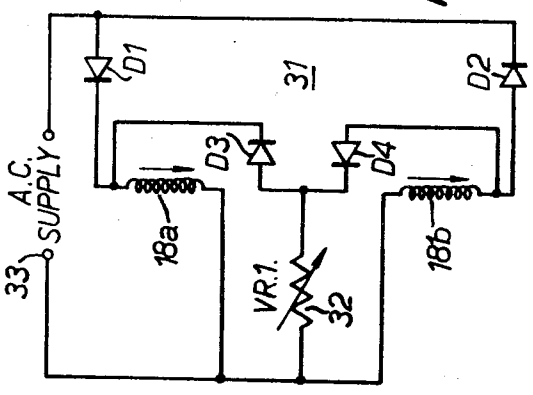

A.C. SUPPLY
33
D1
31
D2
D3
D4
18a
18b
VR1.
32

FIG. 4.

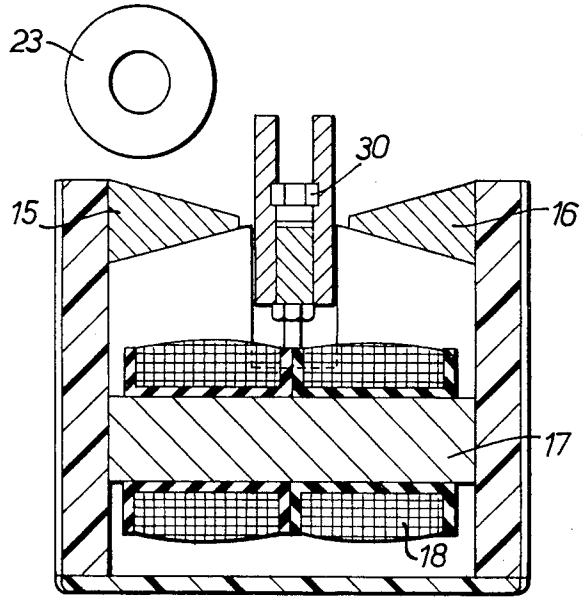


FIG. 2.

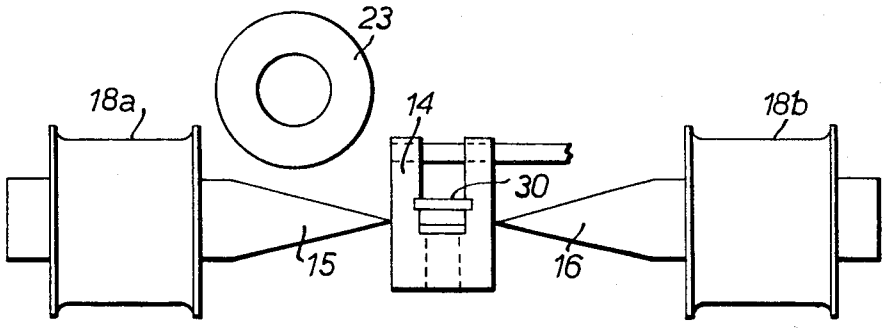


FIG. 3.

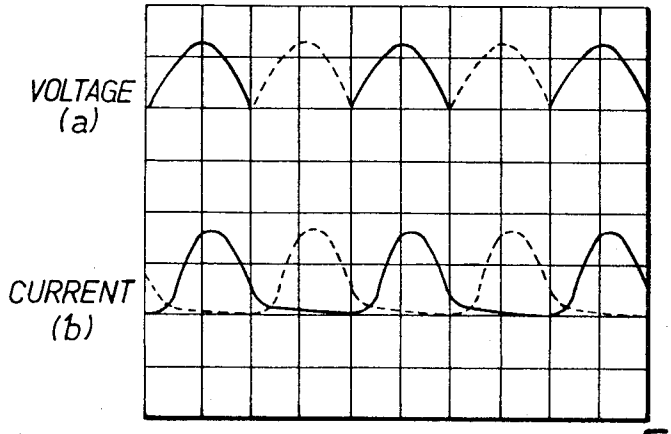

VOLTAGE
(a)
CURRENT
(b)
FLYWHEEL DIODE SERIES R=0

FIG. 5.

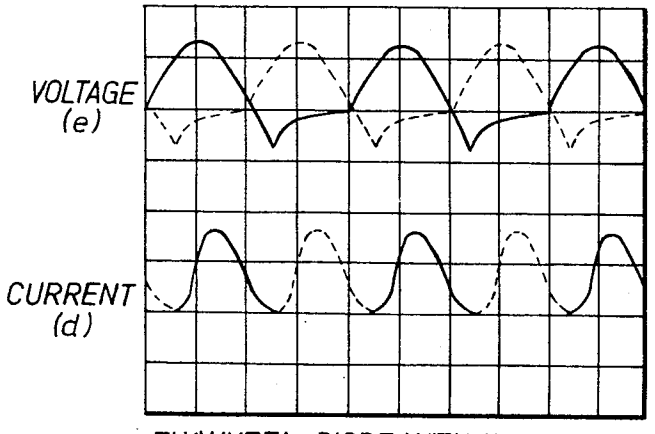

VOLTAGE
(e)
CURRENT
(d)
FLYWHEEL DIODE WITH IK SERIES R

FIG. 6.

HANDLING AND SORTING DEVICES

This invention relates to devices for handling or sorting small articles of magnetic material. The invention can be applied to the handling generally of small magnetisable articles, but it is of particular advantage when used for handling small articles which may or may not be circularly uniform. There is a substantial requirement for feeding singly articles of this kind, from a supply in bulk; it may be desirable to present the articles with a particular orientation. Articles of this kind which are not circularly uniform include locking washers with inwardly or outwardly projecting twisted locking teeth, crinkle spring washers and split spring washers. The sorting of articles of these kinds is difficult because the articles do not closely conform with the ideal shape, and two or more articles may tend to become attached together in such a way that they are not susceptible of separation by normal feed devices. Articles jammed or locked together in this way cause a particular difficulty in automatic feed apparatus, since the interlocked articles may jam in feed guides and chutes intended to pass only single articles, thereby interfering with the proper operation of the apparatus. Should this type of jamming occur in an automatic machine, it is usually necessary to resort to manual supervision and intervention in order to detect and clear the machine.

In one form, the present invention provides an apparatus in which the effect of locking of articles in this way is reduced, so permitting more reliable operation of complex machines.

By way of example, one embodiment of the invention will be described hereinafter, from which features and advantages of the invention will appear, such description being given in conjunction with the accompanying drawings, in which:

FIG. **1** is a diagrammatic plan view of an apparatus for sorting and delivering single articles from a bulk supply;

FIG. **2** is a diagrammatic cross-sectional view of the apparatus of FIG. **1**, taken on the line **2—2** of FIG. **1**;

FIG. **3** is a view similar to FIG. **2** but showing an alternative arrangement of the magnetic parts;

FIG. **4** is a simiplfied circuit of means for energising the magnetic members as used in the arrangement of FIG. **3**; and

FIGS. **5** and **6** are waveform diagrams of voltage and current appearing in the circuit of FIG. **4**, with different values of diode series resistance.

The apparatus shown in FIG. **1** comprises a bowl hopper **10** for washers or the like to be sorted, the hopper receiving a supply in bulk, in which the washers are randomly arranged. The bowl is vibrated in known manner, and has a spiral peripheral path **11** along which washers will travel. The track is so designed that as the washers climb the track they are sorted into single file order. The washers may travel two or three high or maybe together but cannot travel abreast of each other. Deflector means are provided on the track for returning to the bowl any washers which are not in acceptable disposition. The washers leave the track and pass down a chute **12** to a linear feed device indicated generally at **13**. The device **13** presents a linear guide **14** of channel section, and of non-magnetic material. The guide width is somewhat greater than the diameter of the washers being fed. Lying adjacent the sides of the

guide **14** are two magnetic pole members **15** and **16**, forming part of a magnetic circuit arranged in the manner shown in FIG. **2**, with a further magnetic limb **17** over which is wound an energising coil **18**. The pole members **15** and **16** are shaped to provide a highly concentrated horizontal magnetic field, with a maximum concentration of the field at a level slightly above the floor of guide **14**. Further, the pole members, in plan are tapered, in the manner shown in FIG. **1**, so that the magnetic field intensity will increase in the direction towards the delivery end of the guide.

If a series of washers or similar small magnetic articles are fed into the guide **14**, a well determined disposition of the washers results. Firstly, each washer will be supported, somewhat in the manner shown in FIG. **2**, so as to be horizontal and spaced from the floor of the guide. Secondly, since the washers become magnetised in a direction transverse to the length of guide **14**, the washers will repel each other magnetically and will therefore take up a spaced distribution along the length of the guide. Again, to the extent that each washer is non-circularly symmetrical, each washer will take up the position which presents the minimum magnetic reluctance to the lines of magnetic force extending across the width of the guide. Further, each magnetised washer will tend to move along the guide in the direction from the position of lesser to greater magnetic intensity, and its movement in that direction will be limited by the magnetic repulsion of any washer which may be positioned ahead of it along the length of the guide. Consequently, with a given magnetic configuration and field strength the washers will assume a regular defined positioning in the guide. If then a washer should be removed from the forward end of the guide, the remaining washers will move along the guide, to re-establish the original pattern of distribution.

A washer at the leading end of the guide, as at **20**, is removed and fed to a delivery guide **21** by means of an escapement mechanism **22**. The details of this mechanism depend to some extent upon the shape of the washer or other article being fed, but may include an actuating cylinder **23** which in this case is conveniently pneumatically operated with feed lines **24** and **25**, the ram **26** of the cylinder moving a finger **28**, which engages a washer at **20**, and moves it forwardly into the guide **21**. From the guide **21** the washers are fed singly, by an appropriate means, to further handling apparatus.

As a result of the configuration of the magnetic field, it will also occur that if two or more washers are fed to the guide **14** disposed one over the other, the washers when magnetised will also repel each other, and will be separated into the desired sequence of single washers.

In the form of construction shown in FIG. **2**, the guide **14** has a covering member **30**, so as to provide a substantially closed guideway for the magnetically suspended washers. This confines the movement of the washers under the action of the magnetic field.

Other magnetic arrangements can be used, and one alternative is shown in FIG. **3**. In this arrangement the pole pieces **15** and **16** are provided in FIGS. **1** and **2** with respective coils **18*a*** and **18*b***, but the magnetic circuits of the pole pieces are not in this case completed through a common magnetic member.

Depending to some extent on the shape of the articles being fed, the magnetic field produced between the pole pieces **15** and **16** may be static, for example one

produced by means of a uniform direct current passed through coils **18**, or by means of a permanent magnet, but a varying magnetic field can also be used with some advantage. In some circumstances, for example, it may be advantageous to use a field produced by means of an alternating current, or by means of a pulsating current such as that produced by rectified alternating current. Combinations of unidirectional and pulsating currents can also be used, and an arrangement for producing a variable combination of such currents is shown in FIG. **4**.

In this arrangement, magnet coils **18***a* and **18***b* are provided. The coils are wound in the same sense so that if simultaneously energised the resultant flux would be in the same direction, as indicated by the arrows. The input of a rectifier bridge **31**, composed of diodes D1 to D4, is connected in series with a variable control resistor **32** across the terminals **33** of an alternating current supply. Coil **18***a* is connected between the junction of rectifiers D1 and D3 and a terminal of the supply; coil **18***b* is connected between the junction of diodes D2 and D4 and the same terminal of the supply. By manipulation of the variable resistor **32**, it is possible to vary the proportion of the direct and alternating current which is fed to the magnet energising coils **18***a* and **18***b*. This is due to the fact that the coils **18***a* and **18***b* are energised alternately through diodes D1 and D2, which are connected in opposite senses. When the resistance of resistor **32** is zero, diodes D3 and D4 act as fly wheel diodes and with the applied voltage waveform (a) as shown in FIG. **5**, give a current wave-form as at (b). Increasing the resistance of resistor **32** changes the voltage and current wave-forms to those shown at (c) and (d) in FIG. **5**. The reason for the wave-forms obtained is due to various factors, but the back e.m.f. of the coils causes the current flow in diodes D3 and D4. The effect of increasing the series resistance in the fly wheel diode circuit is to increase the time constant of the decay of the magnetic field in the coil.

Thus in wave form (a), no reverse voltage is shown since the fly wheel diode clamps the voltage close to zero, slightly positive due to the voltage drop across the diode. Waveform (c) on the other hand shows that the reverse voltage is allowed to increase due to the effect of the series resistance. The reason for the narrower current pulses is less readily apparent, but may be caused by distortion of the current wave-form due to hysteresis of the magnetic circuit and, in particular, the remanent magnetism in the iron at the end of each pulse. The magnetic flux wave-forms are not shown but there is a continuous component due to remanence within the iron. It should be noted that, whereas in the wave-form (b) the currents in the two coils overlap in time, this does not occur in current wave-form (d). Thus the effect of increasing resistor 32 is to reduce the mean value of the field and to increase the AC component in it. This causes additional vibration of the component being fed which tends to oscillate more strongly between the retaining walls between the coils, and is therefore free to progress forwards into the strengthening magnetic field produced by the longitudinal tapering of the pole pieces.

For the most efficient operation of the magnetic linear feed device shown in FIGS. **1** and **2**, it is desirable to arrange that the rate of supply of washers or the like to the guide should be controlled so that the number of articles in the guide at any one time should lie between an upper and a lower limit.

We claim:

1. Apparatus for handling or sorting articles of magnetic material, comprising in combination a guide for said articles, a magnetomotive means for generating a magnetic flux across a pair of pole pieces located adjacent the sides of said guide, and feed means for presenting said articles to one end of said guide, said magnetic flux increasing in density along said guide from said one end whereby articles fed to said one end will move along said guide in the direction of increasing magnetic flux density.

2. Apparatus according to claim **1** wherein said pole pieces are shaped to provide a highly concentrated magnetic field with a maximum concentration slightly above said guide.

3. Apparatus according to claim **2** wherein said pole pieces are tapered inwardly from said one end to the other end of the guide for generation of said increasing magnetic flux.

4. Apparatus according to claim **1** wherein said guide is of channel section and of non-magnetic material.

5. Apparatus according to claim **4** wherein said guide has a covering member to provide a substantially closed guide way for said articles.

6. Apparatus according to claim **4** wherein the guide width is greater than the maximum diameter of the articles to be fed so that the articles can take up positions which represent the minimum magnetic reluctance to the lines of force extending across the guide.

7. Apparatus according to claim **1** wherein said pole pieces are connected by a magnetic limb over which is wound an energising coil.

8. Apparatus according to claim **1** including a mechanism for removing articles from the guide on arrival at said other end thereof.

9. Apparatus according to claim **8** wherein said mechanism comprises a pneumatic cylinder having a rod reciprocable along the guide, and a finger adjacent the other end of the guide and movable by said rod to engage and remove said articles.

10. Apparatus according to claim **1** wherein each pole piece is provided with a respective coil energised by a combination of unidirectional and pulsating currents.

11. Apparatus according to claim **10** wherein said coils are wound in the same sense and are connected to a rectifier bridge having oppositely connected diodes for alternate energisation of said coils, the proportion of direct and alternating current fed to the coils being controllable by means of a variable resistor connected in series with said rectifier bridge across an alternating current supply.

12. A method for handling or sorting articles of magnetic material comprising the steps of randomly feeding said articles to one end of a guide; and generating, by means of a magnetomotive system having a pair of pole pieces located adjacent the sides of said guide, a magnetic flux; said magnetic flux increasing in density along said guide from said one end thereof, whereby said articles move along said guide in the direction of increasing magnetic flux density.

13. A method according to claim **12** wherein said magnetic flux is generated to provide a highly concentrated magnetic field with a maximum concentration slightly above said guide.

14. A method according to claim **12** wherein said articles are removed in turn on arrival at the other ends of said guide.

15. A method according to claim **12** wherein coils of said pole pieces are energised by a combination of undirectional and pulsating currents.

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Disclaimer

3,753,513.—*Julian Pascoe Grenfell*, Weybridge, and *John Brown Buchanan*, Mytchett, England. HANDLING AND SORTING DEVICES. Patent dated Aug. 21, 1973. Disclaimer filed May 28, 1975, by the assignee, *Badalex Limited*.

Hereby enters this disclaimer to claims 1–9, inclusive, 12, 13 and 14 of said patent.

[*Official Gazette July 22, 1975.*]