April 14, 1964 T. D. BIRCHALL 3,128,879

CAN-SORTING DEVICE

Filed June 13, 1960 4 Sheets-Sheet 1

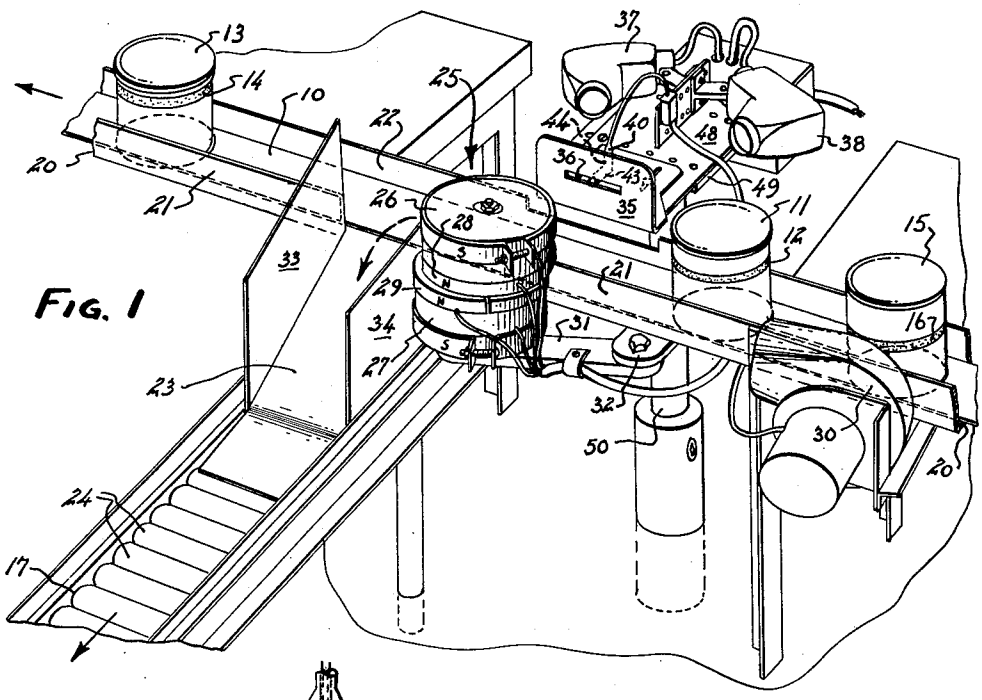


FIG. 1

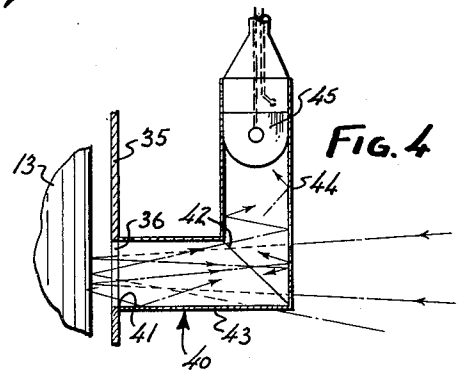


FIG. 4

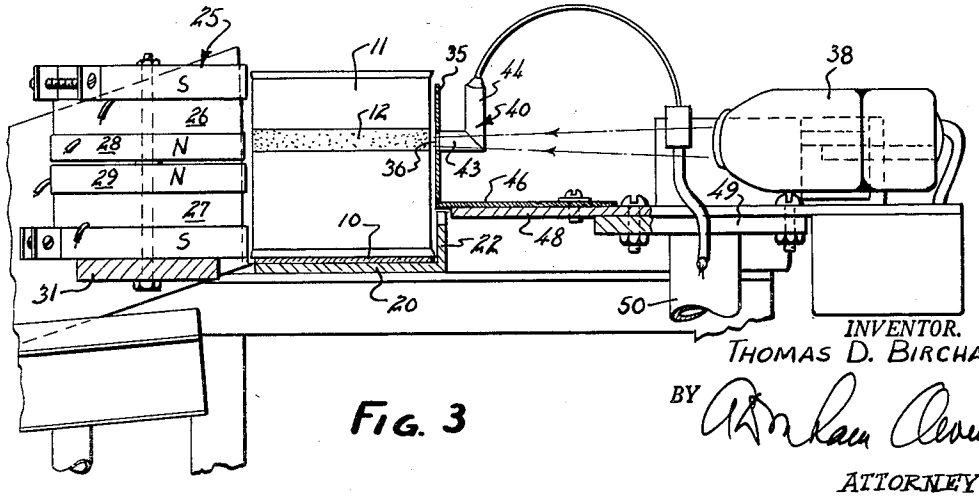


FIG. 3

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CAN-SORTING DEVICE

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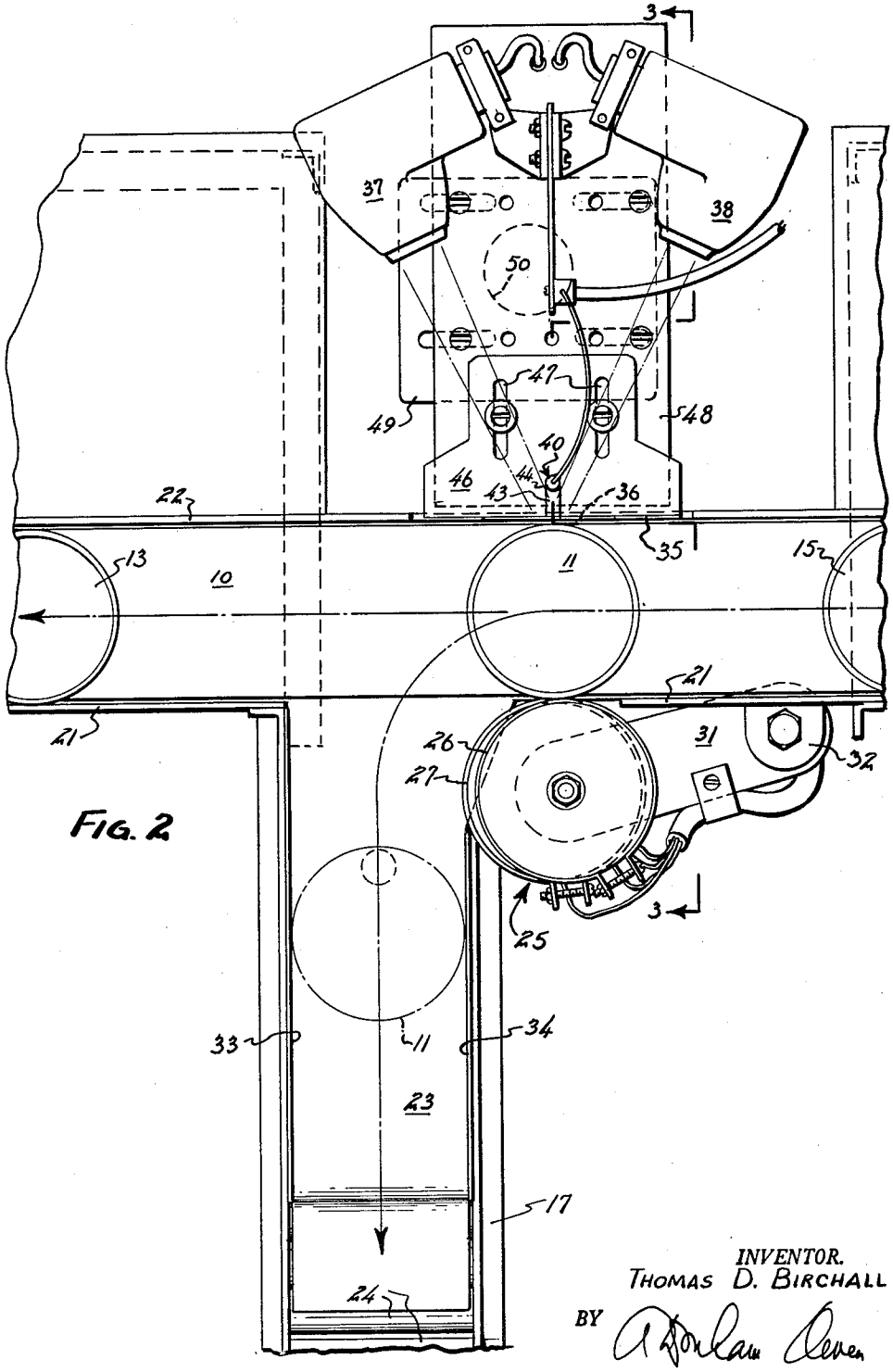


FIG. 2

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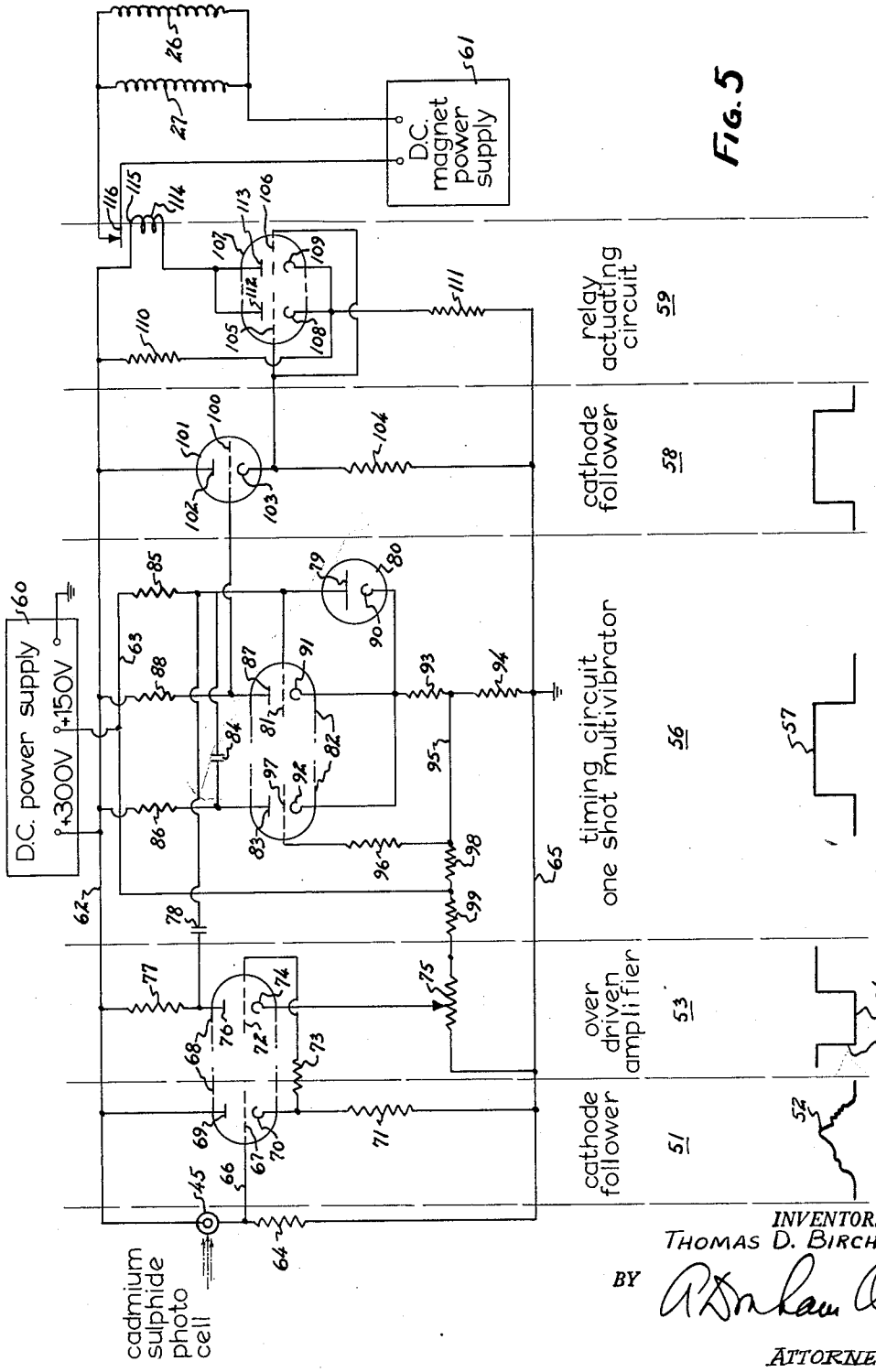


FIG. 5

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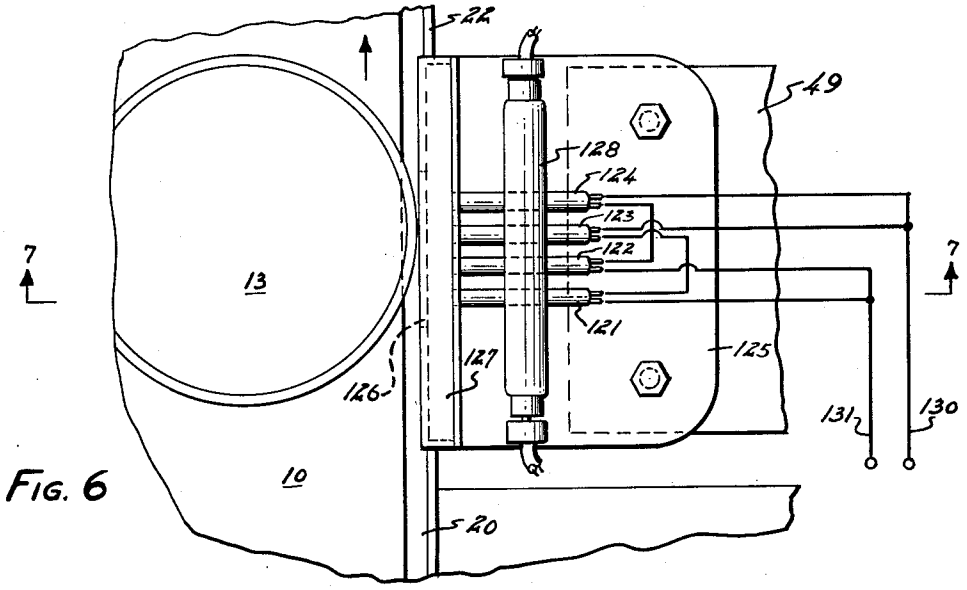


FIG. 6

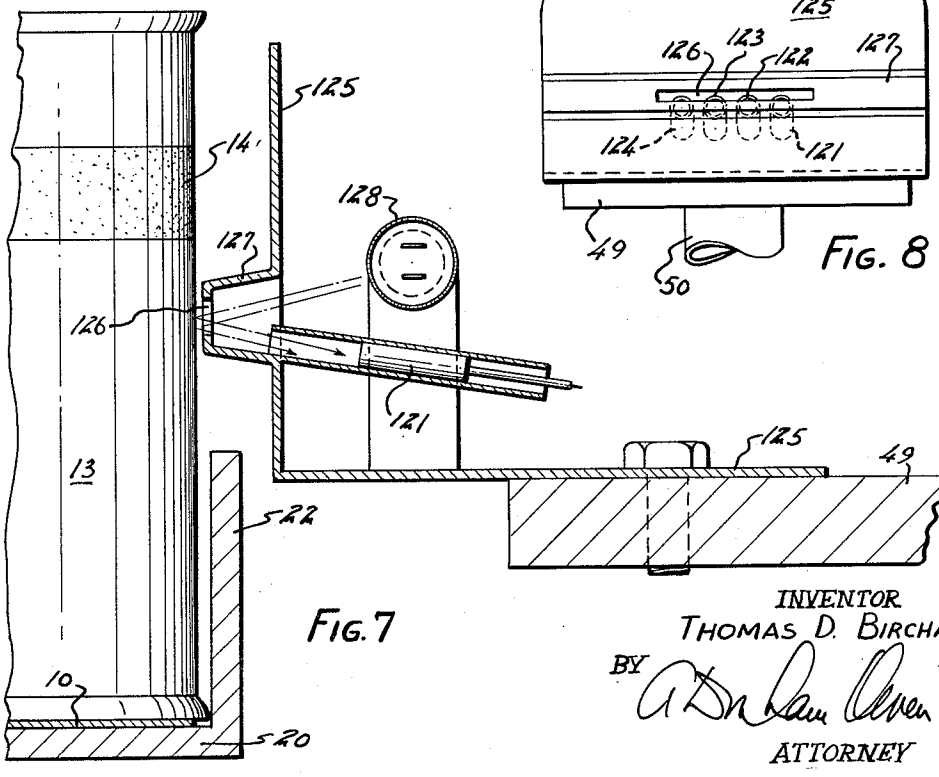


FIG. 7

FIG. 8

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United States Patent Office 3,128,879 Patented Apr. 14, 1964

3,128,879

CAN-SORTING DEVICE

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Filed June 13, 1960, Ser. No. 35,466
10 Claims. (Cl. 209—111.5)

This invention relates to a can-sorting device and particularly to a high-speed can-sorting device employing a magnetic pull-off device and a photoelectric actuator.

A very good can sorter of this general type is described and claimed in my Patent 2,817,438. The present invention, however, can operate at much higher speeds. For example, it has been used to sort cans at the rate of 600 cans per minute—10 per second—for extended periods of time, thereby enabling the canner to mix his grades and varieties in continuous cookers so as to use the cookers to full capacity, and then to sort out the cans accurately as fast as they come out of the cookers.

In order to achieve such high speeds of operation several problems had to be solved. One of these had to do with the energization and de-energization of the magnetic pull-off device. It takes a finite time for an electromagnetic field to collapse, and when operated on either alternating or direct current, this time was too long, for during the de-magnetization a can would already have been deflected from its path by the magnet. This difficult problem I have solved by a novel structure employing two electromagnets, one above the other, wired so that when energized the facing poles are of like polarity. The result has been a much quicker collapse of the field, and unwanted cans have not been unintentionally diverted. Moreover, quicker release of a selected can has been obtained by a horizontal offset of the two magnets.

Also, it was found that the time of actuation and length of actuation tended to vary. At slower speeds these variations could be tolerated, but at high speeds 1/100-second differences are significant. Some trouble was found to be caused by an irregularity in the way the photoelectric cell built up its voltage. These problems have been solved by not relying directly on the wave-pattern of the photoelectric-cell voltage but instead employing a cathode follower to isolate the photoelectric cell voltage pattern and then coupling this voltage to an overdriven amplifier that, in turn, is used to initiate a timing circuit for actuation of the magnet assembly. In other words, the original irregular wave pattern of the photocell is converted into a square wave, and only the initial impulse of this square wave is used to start an automatic impulse timer. Thus, consistent actuation of the magnets is provided, and the initiation and duration of the pulse are freed from significant time variations.

Still other objects and advantages of the invention will appear from the following description of a preferred form of the invention. This device is not, however, intended to be limited to the illustrative details, for in many instances there are equivalent structures that also fall within the spirit of the invention and the scope of the claims.

In the drawings:

FIG. 1 is a view in perspective of a can-sorting device embodying the principles of the invention. The can conveyor line and side track and some other parts have been broken off to conserve space.

FIG. 2 is a top plan view of the device of FIG. 1, shown on an enlarged scale.

FIG. 3 is a view in elevation and in section taken along the line 3—3 in FIG. 2.

FIG. 4 is an enlarged fragmentary view in side elevation and in section of the photoelectric cell and related parts.

FIG. 5 is an electrical circuit diagram illustrating one circuit that embodies the principles of the present invention, there being many possible variations in the circuit.

FIG. 6 is a top plan view of a modified form of cell arrangement, with the pertinent change in circuitry shown diagrammatically.

FIG. 7 is a view in side elevation and in section taken along the line 7—7 in FIG. 6.

FIG. 8 is a view in front elevation of the modification of FIG. 6.

In this device, cans are photoelectrically selected on the basis of whether a certain portion of the can wall reflects light, as it will if not treated, or whether it has been treated so as not to reflect light into the cell. One way of marking cans to get this effect is to paint or print a dark band around each can, each class of cans having the dark band at a different height. All cans having a dark band at the same height will not reflect light at that height; so a photoelectric device at that height will not be actuated to turn off the magnetic take-off device; hence those cans will be taken off the conveyor as they pass a certain point. All other cans reflect light into the photoelectric device with resultant de-energization of the magnet, so that those cans stay on the conveyor. At each sorting station the can line may be divided into two lines until all the cans have been sorted.

FIGS. 1–3 show a conveyor 10 moving a series of cans in upright position. Some cans 11 are encircled by a dark, non-reflective band 12 about 5/8 of the way up their wall. Other cans 13 have higher bands 14, and still other cans 15 have lower bands 16. This particular station is used to pull the cans 11 off the conveyor 10 and send them down a side track 17, while the other cans 13 and 15 continue on the conveyor 10. There may be still other band heights, and each band height may have a sorting station; thus a later station will separate the cans 13 from the cans 15, and so on.

The conveyor 10 moves in a channel 20 having side walls 21 and 22 that give relatively small clearance to the cans so as to keep them in a straight line. A break in the wall 21 is provided at and before the side track 17, which may simply comprise a sloped gravity slide 23 leading to rollers 24.

A magnet assembly 25 is located in this break in the wall 21 just at the inlet corner between the conveyor 10 and the side track 17. When the magnet assembly 25 is energized, it seizes a can 11 and holds on to it long enough to divert it into the side track, the combination of the centrifugal force on the can resulting from arcuate movement of the can around the periphery of the magnet assembly 25, gravity, and the stripping action of a non-magnetic shield 34 releasing it from the magnetic field. When the magnet assembly 25 is de-energized, it exerts no influence on the cans 13 and 15, and they continue on the conveyor 10 past the side track 17.

The magnet assembly 25 of this invention comprises two direct-current electromagnets 26 and 27, both preferably circular, (though they may be any other convenient geometric shape) and arranged so that the facing adjacent poles 28 and 29 are of like magnetic polarity—both north (as shown in FIG. 3) or both south. As shown best and possibly somewhat exaggeratedly in FIG. 2, the upper magnet 26 is offset upstream relatively to the lower magnet 27, so that both magnets 26 and 27 initially seize the can 11, but only one magnet 27 is still holding the can 11 at the place where it is to be released.

While the magnets 26 and 27 may be mounted for rotation, as in Patent 2,817,438, excellent results have been achieved when they are stationary, due to the differences between the present invention and that of my former patent. So the present invention is not limited

to either stationary or rotatable or rotated magnets. So far as the magnet assembly 25 is concerned the key thing is the use of two magnets 26 and 27 with like poles 28 and 29 facing each other, to give rapid demagnetization.

As shown in FIG. 1, a fan 30 may be provided to keep the magnet assembly 25 cool. To facilitate adjustment of the magnets 26 and 27, both as to their position relative to each other and as to their position relative to the conveyor 10 and side track 17, they are mounted adjustably (as in lengthened slots) on an arm 31, which is pivoted to a bracket 32 for swinging movement out from the track.

As will be explained soon, the magnet assembly 25 is normally energized but is de-energized by the approach of a can not having a band 12 at the proper height. It may be added that the sloping portion 23 may have high side guide plates 33 and 34 to aid in guiding a once-deflected can 11 into the side track 17, even though this can 11 is able to break away from the magnets after seizure due to its momentum or to de-energization of the magnet assembly 25 upon the approach of a can 13 or 15.

On the opposite side of the conveyor 10 from the magnet assembly 25 is a vertical plate 35 with a slit 36, through which, in the form of the invention shown in FIGS. 1–4, two spotlights 37 and 38 send respective beams of light. Adjacent the slit 36 is a photoelectric actuator 40 having its inlet 41 level with and centered with respect to the slit 36. To avoid freak or incidental reflections from cans (as where the ink making the strip 12 covers the can 11 imperfectly) the actuator 40 may comprise an approximately L-shaped tube 42 with an entry portion 43, shown here as horizontal and level with the right-angle portion 44, shown here as vertical, in the upper portion of which the actual photoelectric cell 45 is located, facing down. The L may be inclined either to one side (i.e., the portion 44 only inclined), or back (i.e., the portion 43 inclined also). Thus, the light going through the slit 36 from the spotlights 37 and 38 has to be reflected back from a bright portion of a can wall to actuate the cell 45, for the L-shaped enclosure diffuses the reflected light. One bright gleam is not enough; the average illumination of that portion of the can wall has to be high before it will actuate the cell 45. Another way of getting this result is shown in FIGS. 6–8 and will be described later.

It will be noted that the wall 35 is part of an L-shaped bracket 46, with slots 47 enabling adjustment closer to and farther from the conveyor 10, relative to a plate 48 that supports the spotlights 37 and 38. The plate 48 is also movable parallel to the conveyor 10 relative to a base plate 49, and the base plate 49 is mounted on a height-adjustable standard 50 for adjusting its vertical positioning. Very accurate adjustment of the position of the photoelectric device 40 and the slit 36 are obtainable in all directions to get very accurate timing with respect to the magnet assembly 25 as well as to relate it to the proper band height, etc.

As shown at the bottom of FIG. 5, the photoelectric cell 45 is connected to a cathode follower 51 that repeats what is likely to be a rather irregular positive-polarity wave pattern 52. An over-driven amplifier 53 transforms this to a negative square wave 54 of the same time duration as the wave pattern 52. The forward edge 55 of this negative square wave 54 is used to actuate a timing circuit 56, which may be a one-shot multivibrator, thereby producing a second square wave 57 of positive polarity, whose duration is independent of the duration of the square wave 54. This positive square wave 57 is transmitted through a cathode follower 58 to a relay-actuating circuit 59 that energizes the magnets 26 and 27. Equivalent circuits may be used, of course.

As an example of one such circuit, the upper portion of FIG. 5 is presented. There is a D.-C. power supply 60 for the circuit and a D.-C. power supply 61 for the magnets 25 and 26. The power supply 60 is connected to a power line 62, preferably at 300 volts, and to a second power line 63, preferably at 150 volts D.-C.

The photoelectric cell 45 is in series with a protective resistor 64 (e.g., 470,000 ohms) across the 300-volt D.-C. power line 62 and a ground line 65. A lead 66 connects the cell 45 to a grid 67 of one-half of an electronic tube 68, which may be a 12AT7, whose plate 69 is connected to the 300-volt D.-C. power line 62. This half of the tube 68 is used as the cathode follower 51; so its cathode 70 is biased by a resistor 71 (e.g., 82,000 ohms) and connected to the grid 72 of the overdriven amplifier 53 by a resistor 73 (e.g., 1 megohm). Thus the photoelectric cell 45 is isolated from the amplifier 53. The amplifier 53, which may be the other half of the 12AT7 tube 68, may have its cathode 74 biased through an adjustable (e.g., 10,000 ohm) potentiometer 75 and its plate 76 connected to the 300-volt D.-C. power line 62 through a plate-load resistor 77 (e.g., 220,000 ohms).

The plate 76 of the overdriven amplifier 53 may be coupled to the timing circuit 56 through a condenser 78 (e.g. 0.01 mf.). The other side of the condenser 78 is connected to the plate 79 of a clamping diode 80 (which may be half of a 6AL5, for example) and to the grid 81 of one-half of an electronic tube 82, such as a 12AX7. Also the condenser 78 is connected through a condenser 84 (e.g., 0.05 mf.) to the plate 83 of the other half of the tube 82. The 150-volt D.-C. line 63 is connected to the plate 79 of the clamping diode through a resistor 85 (e.g., 2 megohms); while the 300-volt D.-C. line 62 is connected to the plate 83 by a resistor 86 (e.g., 270,000 ohms), and to a plate 87 (opposite the grid 81) by a resistor 88 (e.g., 120,000 ohms).

The clamping diode 80 has its cathode 90 connected to both cathodes 91 and 92 of the tube 82, and all three cathodes 90, 91, and 92 are connected across a bias resistor 93 (e.g., 2,200 ohms) and another resistor 94 (e.g., 10,000 ohms) to the ground line 65. Between the resistors 93 and 94 a lead 95 goes through a grid bias resistor 96 (e.g., 1 megohm) to the grid 97 that is between the plate 83 and cathode 92. Both the lead 95 and the resistor 96 are connected through a resistor 98 (e.g., 150,000 ohms) to the 150-volt line 63, which is also connected to the variable resistor 75 through a resistor 99 (e.g., 15,000 ohms), establishing bias reference levels for the overdriven amplifier 53 and the timing circuit 56. Thus the over-driven amplifier 53 sends its signal to and initiates the one-shot multivibrator comprising the timing circuit 56.

Action of the timing circuit one-shot multivibrator and the clamping diode can be described as follows: In steady state condition the right-hand half of the tube 82 is conducting heavily, since its grid 81 is returned to the plus 150 volt D.C. power line through the resistor 85. This produces a voltage drop across the common cathode resistor 93 sufficient to hold the left-hand half of the tube 82 beyond cut-off, since its grid 97 is returned through the resistor 96 to the more negative potential end of the resistor 93. When the negative pulse 54 is received from the over-driven amplifier 53, it is impressed on the grid 81 of the tube 82, since the clamping diode 80 will not conduct when a negative polarity signal is impressed on its plate 79. The leading edge of the negative pulse 54 reduces the amount of conduction between the cathode 91 and the plate 87 and thus reduces the voltage drop across the common cathode resistor 93, which permits the left-hand half of the tube 82 to begin conducting. This conduction between the cathode 92 and the plate 83 produces a voltage drop across the resistor 86, which drives the plate 83 in a less positive direction. This less positive (negative-going) condition is transmitted by the coupling capacitor 84 to the grid 81 of the right-hand half of the tube 82, driving it still more negative. This action multiples until, in a very few micro-seconds, the right-hand half of the tube 82 is cut-off, and the left half is conducting heavily. This condition persists until the

charge across the coupling capacitor **84** (which was produced by the less positive change in potential at the plate **83**) bleeds off through the resistor **85** to the point where the right-hand half of the tube **82** will once again begin to conduct. When conduction begins again between the cathode **91** and the plate **87**, an increased voltage drop appears across the common cathode resistor **93**, thus increasing the bias in the direction of cut-off of the left-hand half of the tube **82**. This reduces the conduction between the cathode **92** and the plate **83**, and reduces the voltage drop across the plate resistor **86**. The voltage at the plate **83** is now going in a more positive direction and this is transmitted by the coupling capacitor **84** to the grid **81** of the tube **82**. This further increases conduction of the right-hand half of the tube **82**, the action multiplying in a very few micro-seconds until the original steady state condition exists where the right-hand half of the tube **82** is conducting heavily and the left-hand half is cut-off. During the steady state condition there is a large voltage drop across the plate resistor **88** due to heavy conduction between the cathode **91** and the plate **87** of the tube **82**. The voltage at the plate **87** rises to approximately the potential of the 300-volt D.-C. power line **62** for the duration of the time that the right-hand half of the tube **82** is at or beyond cut-off. The output of the timing circuit one-shot multivibrator at the plate **87** is a positive direction square wave, the duration of which is determined by the length of time the right-hand half of the tube **82** is kept at or beyond cut-off. This time is in turn determined by the RC time constant of the capacitor **84** and the resistor **85**, and is independent of the duration of the actuating negative square wave **54**.

The clamping diode **80** is for the purpose of removing positive-going transients that may exist on the trailing edge of the negative square wave **54**, which might tend to reduce the accuracy of the timing circuit **56**. The clamping diode **80** will conduct when a positive direction transient appears at its plate **79**, thus removing its possible interference at the grid **81** of the tube **82**. The normal one-shot multivibrator action in the timing circuit is operated below the level where the clamping diode **80** can conduct; thus its action does not affect the timing circuit except to remove undesirable positive going transients from the actuating negative square wave **54**.

The plate **87** is connected to the grid **100** of a cathode follower **58**, comprising a tube **101** whose plate **102** is connected to the 300-volt D.-C. power line **62** and whose cathode **103** is connected to ground through a resistor **104** (e.g., 68,000 ohms).

The cathode **103** is also connected to the relay-actuating circuit **59**, to both grids **105** and **106** of a dual triode tube **107** or the like. The cathodes **108** and **109** of this tube **107** are connected together, to the 300-volt D.-C. power line **62** through a resistor **110** (e.g., 68,000 ohms), and to ground through a resistor **111** (e.g., 4,500 ohms).

The plates **112** and **113** of the tube **107** are likewise connected together and through the coil **114** of a relay **115** to the 300-volt D.-C. power line **62**. The relay **115** is normally closed, to energize the D.-C. magnet power supply **61** and the magnets **26** and **27**. However, when the photoelectric cell **45** is energized, the coil **114** opens a relay switch **116** to de-energize the magnets **26** and **27** for a timed interval. The relay **115** then again closes (as by springs) and the magnets **26** and **27** are re-energized.

Operation

Cans **11**, each with a non-reflective marking band **12** at the height of the light slit **36** and cans **13** and **15** with their bands **14** and **16** at different heights, are moved along the conveyor **10**. The lights **37** and **38** are sending beams of light through the slit **36**, but there is nothing around to reflect back much light, any part being dulled that would do so. As a result, the magnets **26** and **27** are energized. They remain energized when a can **11** comes along, for its band **12** does not reflect sufficient light to energize the photoelectric cell **45**. Hence, the magnets **26** and **27** pull the can **11** off the conveyor. Being offset, the magnet **26** releases the can **11** first and once it is started on its way down the side track **17**, it is freed from the pull of the magnet **27** by a combination of centrifugal force, gravity, and the stripping action of the non-magnetic shield **34**.

When a can **13** or **15** comes along, its wall reflects light into the slit **36** and energizes the photoelectric cell **45**. The positive current pulse **52** from the cell **45** is transformed instantaneously into a negative square wave **54** by the overdriven amplifier **53**, and the forward edge **55** of the square wave **54** energizes the timing circuit **56**, causing instant de-energization of the magnets **26** and **27** by the relay **115** for a time sufficient to let the can **13** or **15** pass by without magnet deflection. Then the relay **115** closes, and the magnets **26** and **27** are re-energized. (In place of the relay **115** a large thyratron tube or transistor switch may be used.) The like-polarity opposing poles **28** and **29** cause the de-energization to take place very quickly without prolonged magnetic effects due to reluctance, slowness in collapse of field, or inertial re-activation, or whatever. Moreover, the magnets **26** and **27** are as quickly re-activated.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and description herein are purely illustrative of the principles and are not intended to be limiting. For example, a single light source may be used instead of two lamps **37** and **38**. The relay **115** may act oppositely, i. e., be normally open for some applications. A single magnet **26** or **27** may be used for some applications, and for others twin magnets may be used without wave shaping or other shapes of waves may be used.

A more significant embodiment is shown in FIGS. 6–8. Here, a plurality of photocells **121**, **122**, **123**, and **124** are used back of a plate **125** with a slit **126**, provided in a projection **127**. A fluorescent tube **128** is used as the light source. The photoelectric cells **121** and **123** are wired together in series, and the cells **122** and **124** are in series with each other. The cell group **121** and **123** is wired in parallel with the group of cells **122** and **124**, and wired into the circuit with leads **130**, **131** taking the place of the cell **45** of FIG. 5. This arrangement gives excellent results, counteracting chance reflection from cans and giving improved accuracy.

What is claimed is:

1. In a can separating device the combination of a conveyor along which said cans are propelled, a pair of magnetizable members adjacent said conveyor located one above the other with the poles closest to each other of like polarity; means to energize said members when it is desired to pull a can off said conveyor, whereby a can adjacent said members will be pulled against them and pulled off said conveyor; and a side conveyor into which said cans are discharged from said members.

2. The device of claim 1 wherein said members are offset slightly along said conveyor, so that only one of them is in contact with said can at said side conveyor.

3. The device of claim 1 wherein said magnets are round, so as to pull a can around a quadrant thereof when taking it off said line.

4. The device of claim 2 wherein said members are horizontally displaced a short distance relative to each other along a line parallel to said conveyor.

5. A can sorting device for sorting from a conveyor line cans having a dark band at a predetermined height around their outer periphery from cans not so marked by using electromagnetic means beside the can conveyor to pull a can off said conveyor when magnetized; said device being characterized by photoelectric cell means which controls the magnetization and demagnetization of the

electromagnetic means according to whether a predetermined quantity of light is or is not directed at said photoelectric cell means, a wave shaping circuit for converting photoelectric energy from said cell means into a definite wave pattern, and timing means utilizing one pulse portion of said definite wave pattern for energizing said electromagnetic means for a predetermined and definite time independent of the time of actuation of said photoelectric cell means, said photoelectric cell means being combined with light diffusing means for causing reaction of said cell means to the general intensity of reflection of said can at band height rather than to spot reflection.

6. The device of claim 5 wherein said photoelectric cell means comprises a single cell housed in an L-shaped tubing having a horizontal portion open facing the can line and a vertical portion in which is said cell.

7. The device of claim 5 wherein said cell means comprises a plurality of cells arranged successively close to each other side by side in a lengthwise line beside said conveyor.

8. The device of claim 7 wherein there are four said cells with the first and third said cells in series, the second and fourth cells in series, and the two series groups in parallel with each other.

9. A can sorting device for sorting from a conveyor line cans having a dark band at a predetermined height around their outer periphery from cans not so marked by using electromagnetic means beside the can conveyor to pull a can off said conveyor when magnetized; said device being

characterized by photoelectric cell means which controls the magnetization and demagnetization of the electromagnetic means according to whether a predetermined quantity of light is or is not directed at said photoelectric cell means, a wave shaping circuit for converting photoelectric energy from said cell means into a definite wave pattern, and timing means utilizing one pulse portion of said definite wave pattern for energizing said electromagnetic means for a predetermined and definite time independent of the time of actuation of said photoelectric cell means, said wave-shaping circuit producing a square wave and said timing means utilizing the forward impulse thereof as said pulse portion.

10. The device of claim 1 wherein said means to magnetize said members comprises photoelectric cell means responsive to light reflected back from the cans on the conveyor, means for shaping the energy waves produced by said cell means to a predetermined uniform shape, and means actuated by said means for shaping for energizing said members for a timed interval.

References Cited in the file of this patent

UNITED STATES PATENTS

2,446,628	Brown	Aug. 10, 1948
2,817,438	Birchall	Dec. 24, 1957
2,892,951	Linderman	June 30, 1959
2,999,591	Crump	Sept. 12, 1961
3,005,548	Flanders	Oct. 24, 1961