United States Patent [19]

Myslinski et al.

[11] **3,863,764**

[45] **Feb. 4, 1975**

[54] **METHODS AND APPARATUS FOR IDENTIFYING NONMAGNETIC ARTICLES**

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[73] Assignee: **Western Electric Co., Inc.**, New York, N.Y.

[22] Filed: **Feb. 28, 1974**

[21] Appl. No.: **446,888**

[52] **U.S. Cl.** ..... **209/111.8**, 29/574, 118/620, 324/34 R

[51] **Int. Cl.** **B07c 5/344**

[58] **Field of Search** ..... 209/73, 81 R, 81 A, 111.8; 29/574; 117/235; 324/34 R; 346/79, 106; 118/620, 401

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Primary Examiner—Robert B. Reeves
Assistant Examiner—Thomas E. Kocovsky
Attorney, Agent, or Firm—R. Y. Peters

[57] **ABSTRACT**

Selected nonmagnetic semiconductor devices in an array of such devices are identified for subsequent processing by coating them with a material containing magnetizable particles. The devices are then tested to select those having the desired electrical characteristics. The selected devices in the array are contacted by the tip of a tubular marking stylus. A magnetic flux is concentrated at the tip and ink flows through stylus so that contact between the tip and article simultaneously magnetically and visibly marks the devices. Magnetic identification permits automatic sorting and removal of the selected devices from the array and the visible marking permits original set up of the array and subsequent verification of the sorting operation.

15 Claims, 12 Drawing Figures

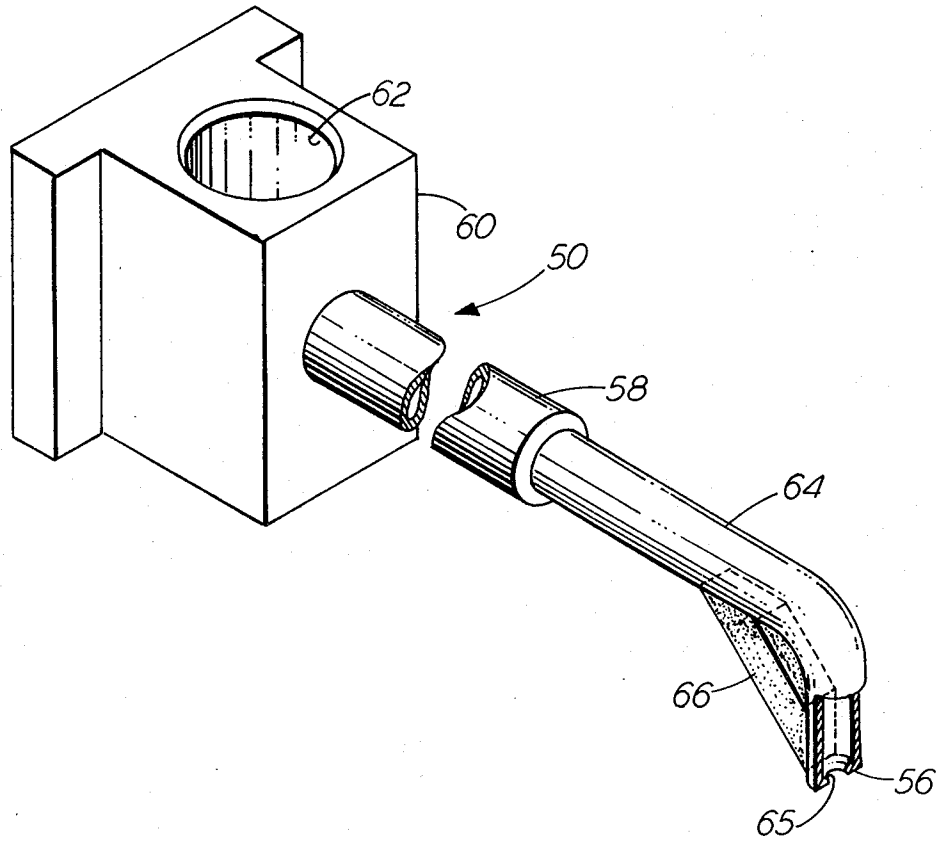


FIG.-1

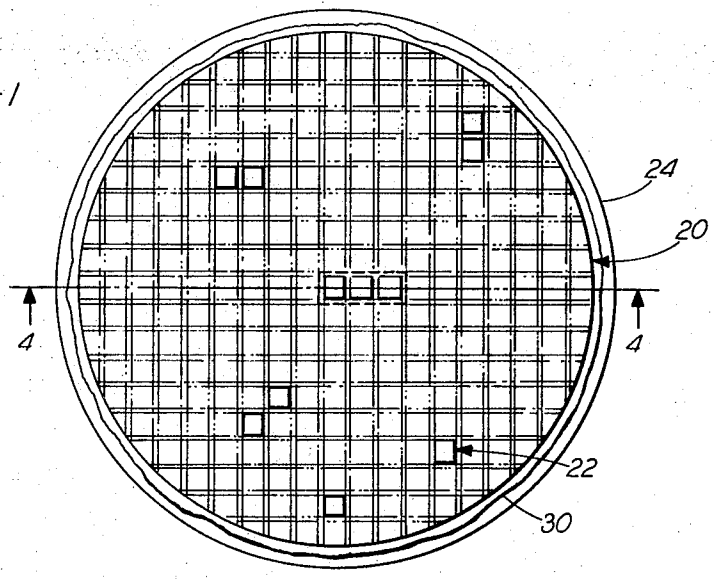
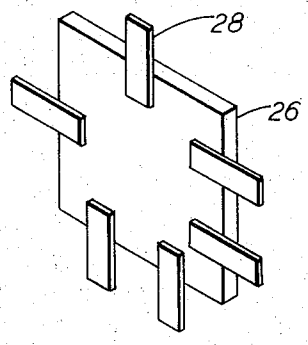


FIG.-2



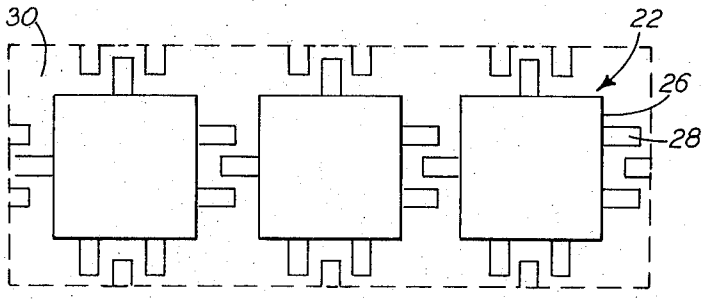


FIG.-3

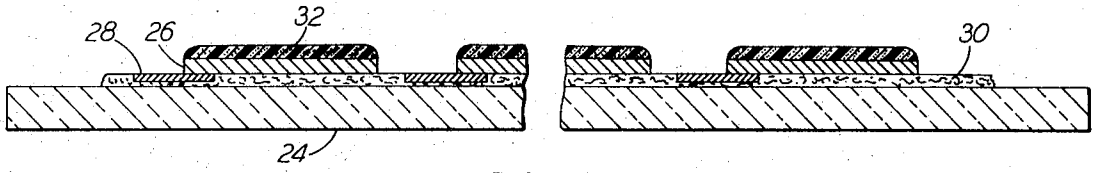


FIG-4

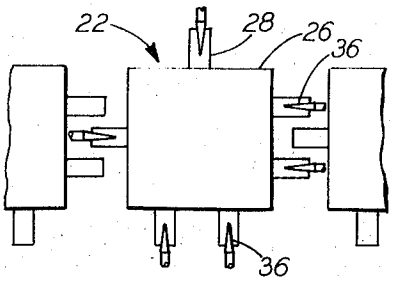


FIG.-5

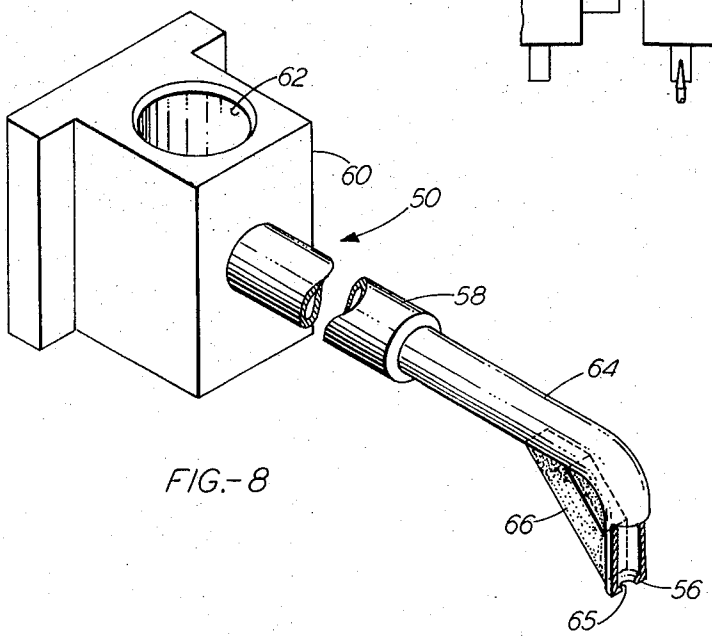


FIG.-8

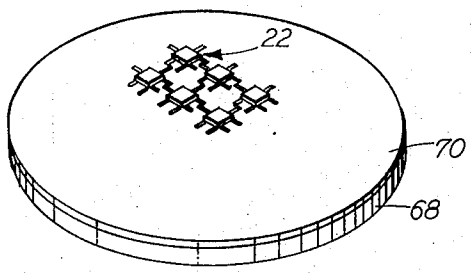


FIG.-9

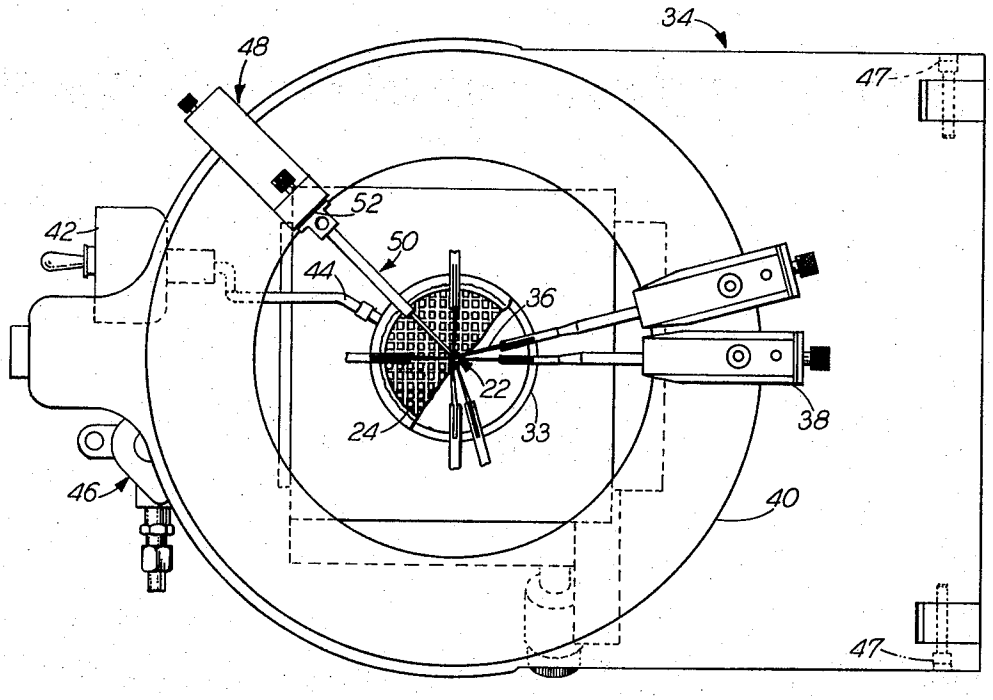

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FIG.- 6

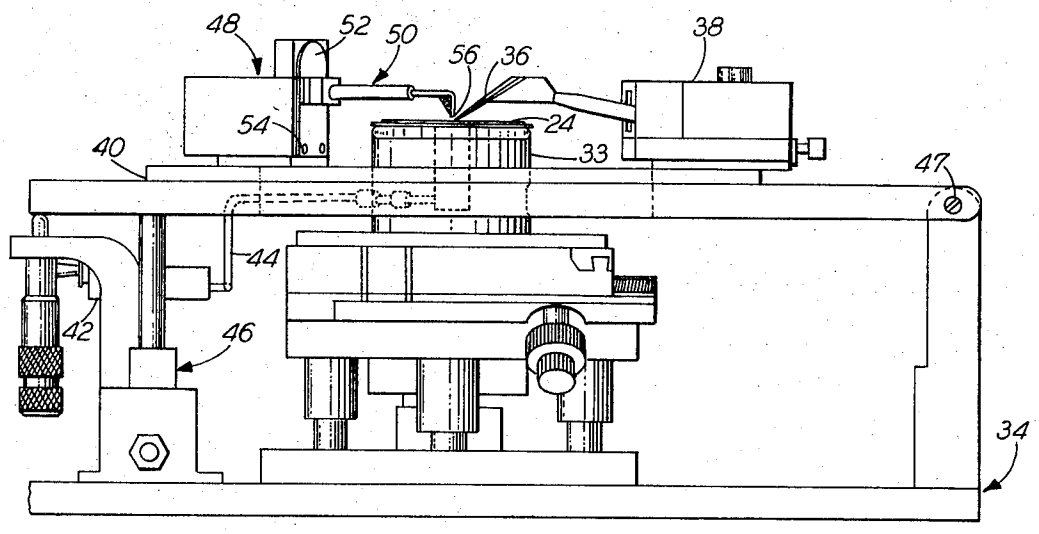

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FIG.- 7

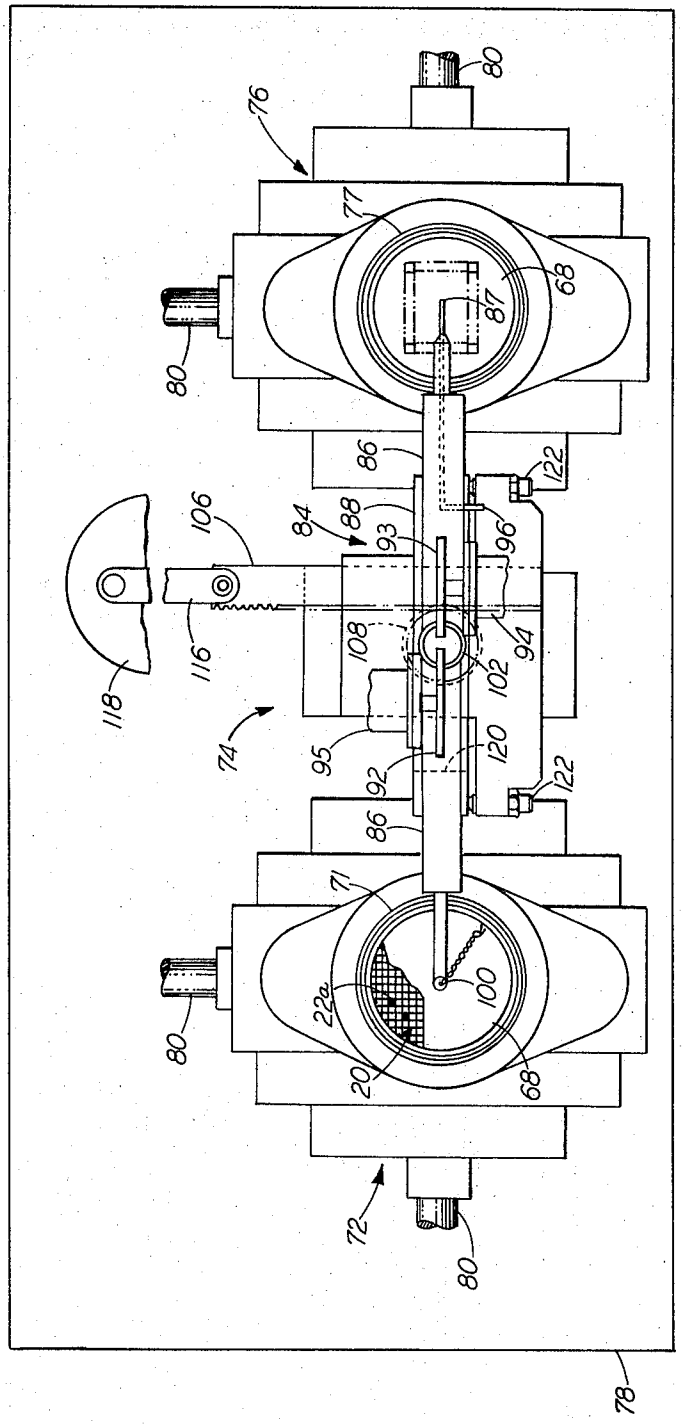

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68
87
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122
106
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93
96
108
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102
116
118
74
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120
122
86
71
100
22a
20
68
80
72
80
78

FIG-10

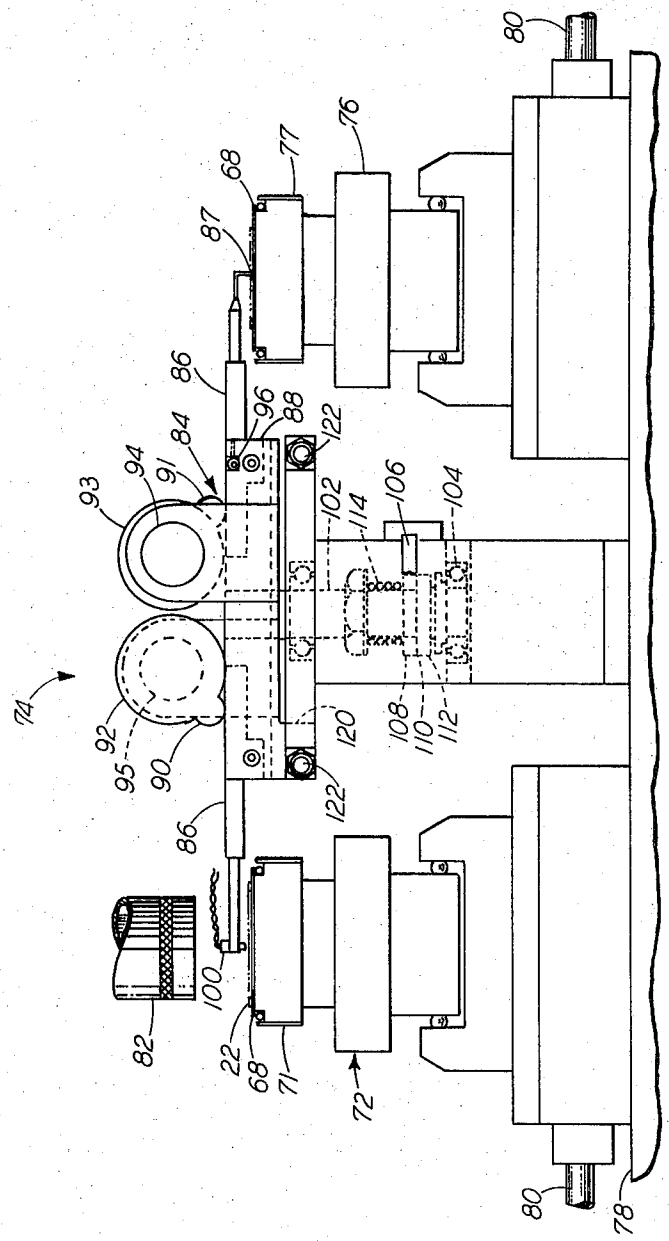

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100
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FIG-11

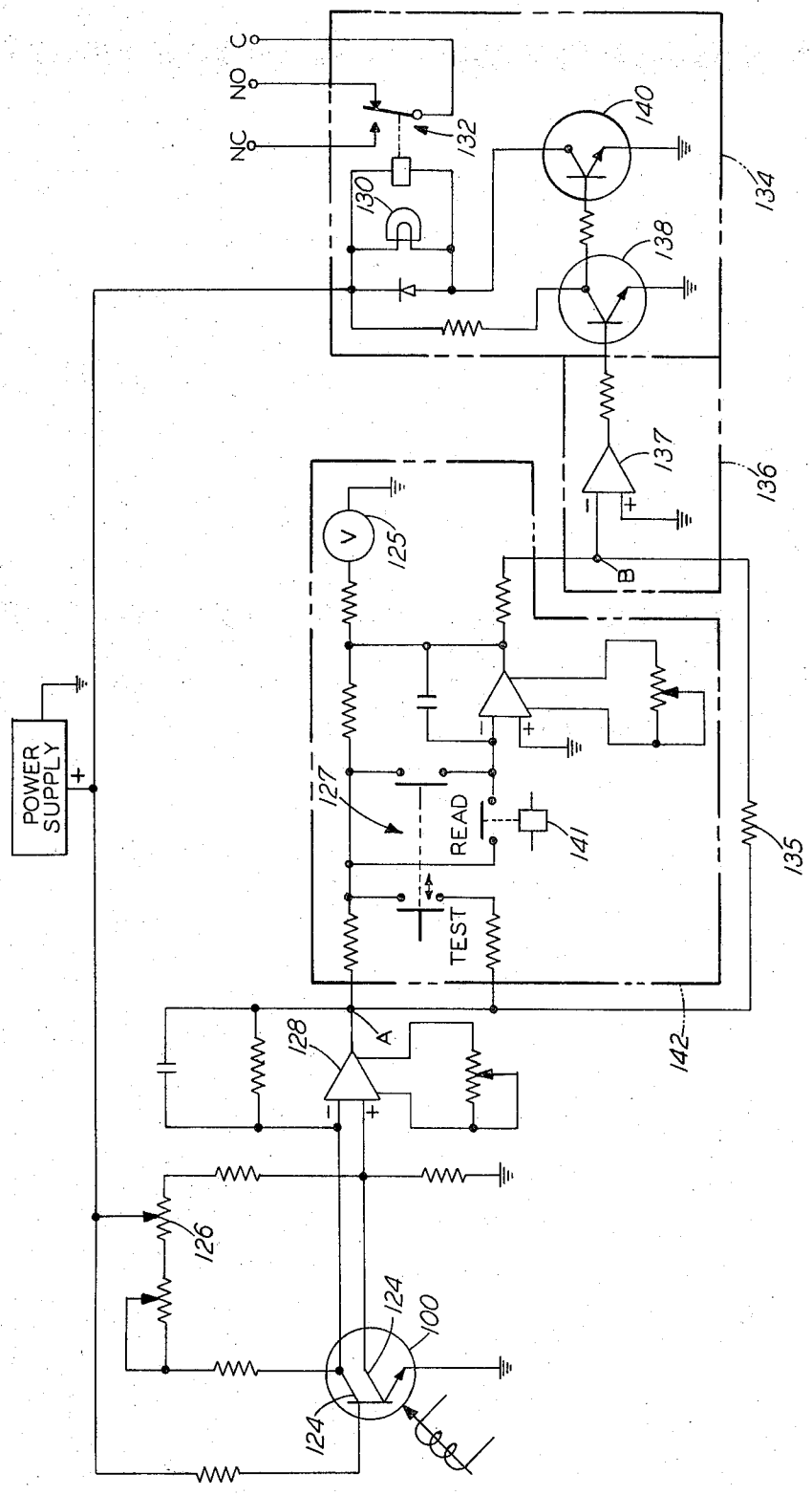

C
NO
NC
132
130
140
138
134
137
136
125
V
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POWER SUPPLY
+
127
READ
TEST
141
135
128
A
142
126
124
100
124

FIG.-12

METHODS AND APPARATUS FOR IDENTIFYING NONMAGNETIC ARTICLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to methods and apparatus for identifying nonmagnetic articles. More particularly, it relates to identifying both magnetically and visibly selected semiconductor devices in an array.

2. Description of the Prior Art

In the manufacture of semiconductor devices, such as diodes, transistors, integrated circuits and the like, the devices are formed, including their beam leads, in and on one side of a wafer or slice of semiconductor material. The slice is subsequently adhered with wax to a ceramic or similar support, its active side containing the leads being against the wax. The slice is divided into an array of individual devices or chips by etching the slice from the exposed side to remove the semiconductor material along grid lines directly above the leads. The width of the grid lines is such that a portion of each lead is exposed and a portion remains covered and attached to the semiconductor material. The beam leads provide the connection from the device elements, e.g., transistor base, emitter or collector to the circuit conductors. The exposed portion of the leads may be contacted to measure the electrical characteristics of the devices. For further information concerning the manufacture of these devices refer to S. S. Hause and R. A. Whitner "Manufacturing Beam-Lead, Sealed-Junction Monolithic Integrated Circuits," *The Western Electric Engineer*, Vol. XI, No. 4 (Dec. 1967) pp. 3–15

It has been found that a certain percentage of the devices will not meet one or more of the requirements for which they are designed. Accordingly, the device leads are contacted by a test probe and the characteristics measured to determine whether or not they fall within design requirements, i.e., specifications. Where characteristics do fall within the specification, such devices are identified for later removal from among the devices in the array. The original orientation of the good devices is maintained while they are removed and positioned to form a new array of all good devices.

Where the devices are not to be positioned in another array of all good devices and, therefore, the orientation need not be maintained, the devices failing specifications (or those passing specifications) may be marked with magnetic ink in accordance with the test results, removed from the support, and the good separated from the bad magnetically. Methods and apparatus for such marking and sorting of devices are disclosed in U.S. Pat. Nos. 3,474,904; 3,507,389; 3,572,400; and 3,623,603 which issued to B. G. Casner et al. Oct. 28, 1969; Apr. 21, 1970; Mar. 23, 1971 and Nov. 30, 1971, respectively, and are assigned to the same assignee as the present application.

In general, these methods separate the magnetically marked devices from the others by passing all of them adjacent to a magnet which attracts the magnetically marked devices to it. However, where device orientation must be maintained, such methods cannot be used.

In other cases, e.g., the canning art, cans are magnetized in bands (which may be of varying magnetic fields) to identify *known* contents for subsequent labeling. But the cans are cylindrical and must be revolved to magnetize the cans around their entire circumference, or if marked in one spot they must be revolved to find the spot, in order to facilitate detection and sorting for labeling. Such a system is not suitable for identifying individual semiconductor devices both because of the disparity in size between cans and semiconductor devices (a semiconductor device may be only 0.020 by 0.020 by 0.002 inches in each dimension), and because semiconductors must remain oriented for testing and positioning in a new array.

Still other art, e.g., magnetic parts sorting, in which parts must be capable of becoming magnetized are carried passed a magnetizing head, magnetized, and then the degree of magnetization measured. The parts are then sorted on the basis of sufficient magnetization. Such methods or apparatus do not provide for magnetically marking selected parts nor maintaining their orientation. Again, the disparity in size between semiconductor devices and the parts found in the magnetic sorting art renders the methods and apparatus thereof unadaptable to the semiconductor devices.

Where the articles are nonmagnetic, they may be made magnetic as disclosed in U.S. Pat. No. 3,692,168 which issued to H. E. Hughes et al. Sept. 19, 1972. However, the magnetic coating disclosed herein is preferred for use with the instant invention.

In contradistinction to the prior art, the instant invention relates to methods and apparatus for identifying semiconductor devices, having unknown characteristics, according to test results while the devices are in close array and in a manner which will not disturb their orientation.

SUMMARY OF THE INVENTION

Accordingly, an object of the invention resides in providing new and improved methods and apparatus for identifying nonmagnetic articles.

With this and other objects in view, the present invention contemplates new and improved methods of identifying nonmagnetic articles which includes coating the articles with a material which will retain a magnetic flux when magnetized and testing the articles individually to determine which articles are to be identified. Then, the individual articles to be identified are contacted with a tip of a marking member, having magnetic flux concentrated at the tip thereof, to magnetize the material and identify the articles in accordance with the test.

The present invention also contemplates new and improved apparatus for identifying nonmagnetic articles having coatings of a material which will retain a magnetic flux when magnetized. The apparatus includes facilitates for testing the articles while in the array to determine the characteristics thereof and also includes provisions for both inducing a magnetic field in the coating and for visibly marking the articles to insure the identification thereof.

The invention contemplates, among other things, coating the inactive surfaces of semiconductor device while the devices are still in array and adhered to a wafer support, with a magnetizable material such as a phenolic base containing iron oxide or the like. The devices are tested to determined which ones have desired electrical characteristics so that they may be identified.

Identification is made by concentrating a magnetic flux at the tip of a magnetizing member, which is small enough to fall within the perimeter of the device, and contacting the iron oxide coating to magnetize it. Further, the magnetizing member is tubular and conducts

a marking fluid to the coating so that the devices are simultaneously magnetically and visibly marked to distinguish the devices having desired characteristics from those which do not.

The wafer support with the devices is removed from the test set and the array transferred undisturbed to a new support from which the devices may be removed with a vacuum pickup. The new support is positioned in a sorting apparatus having a magnetic sensor which detects the magnetic-field of those marked or identified devices those coating has been magnetized. The apparatus automatically removes the identified devices and positions them in a new array which can be instantaneously verified visually for completeness of devices having the desired characteristics. This verification is important where the devices are automatically assembled because a missing device, or an unmarked device transferred erroneously to the array, will produce a defective assembly.

Since the devices have a magnetic coating, they may be arrayed on a magnetic carrier and will remain as placed while being transferred.

BRIEF DESCRIPTION OF DRAWINGS

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

FIG. **1** is a plan view of an interdigitated array of semiconductor devices;

FIG. **2** is an isometric view of one of the devices of the array of FIG. **1**;

FIG. **3** is an enlarged plan view of a portion of FIG. **1** enclosed by dashed lines showing interdigitation;

FIG. **4** is a partial cross section along line **4—4** of FIG. **1** with magnetic material applied to the devices;

FIG. **5** is an enlarged plan view of a semiconductor device with test probes contacting its leads;

FIG. **6** is a plan view of test table and probes arranged to contact a device;

FIG. **7** is a front elevation of the apparatus of FIG. **6** with some of the probes removed;

FIG. **8** is an isometric view of a stylus for marking devices in accordance with the present invention;

FIG. **9** is a isometric view of a silicon resin coated carrier having part of an array of devices thereon;

FIG. **10** is a plan view of sorting apparatus;

FIG. **11** is a front elevation of the apparatus of FIG. **10**; and

FIG. **12** is a schematic electrical diagram of a circuit for sensing identified devices.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1**, an array **20** of interdigitated beam-lead semiconductor devices **22** are contained in a slice of semiconductor material and are shown adhered to a support **24**. The devices **22** are very small, refer to FIG. **2**, the body **26** being about 0.020 of an inch on a side and 0.002 of an inch thick in this example. The beam leads **28** are about 0.004 of an inch wide, 0.008 of an inch long and 0.007 of an inch thick and interdigitated as shown in the enlarged view, FIG. **3**.

To adhere the devices **22** to the support **24**, refer to FIG. **4**, a cement is used, such as wax **30**, which may be of the type sold by the Biwax Corporation under the trade designation B-7050 wax. The wax **30** is filtered to remove all particles over 0.2 of a mil in diameter. The support **24** may be a material such as ceramic, glass or sapphire.

The slice, sometimes called a wafer, of semiconductor material containing all the devices **22** is adhered to the support **24** with the leads **28** against the support. The slice is etched into the array **20** of separate devices **22**, while still on the support **24**, by photolithographic and etching processes well known in the art. These processes expose a portion of the beam leads **28**, as shown in FIG. **3** and **4**, which may be contacted by suitable probes to measure the electrical characteristics of the devices **22** while they are still adhered to the support **24** with the wax **30**.

Coating The Article

The bodies **26** of the devices **22** are coated with a magnetically hard material **32**, i.e., one which will retain a magnetic flux after the magnetizing field is removed. It is desirable that the material **32** not stress the devices **22** mechanically and for this reason an organic material containing iron oxide particles is preferred.

The material **32** may be that sold by the Markem Corporation under the trade designation 7252-H-6A. This is a phenolic base with a fast solvent system to retard vehicle separation. Total solids range from 70 to 85 percent by weight solvents from 15 to 30 percent, the iron oxide particles from 35 to 50 percent, and viscosity from (0.2 to 5) $\times 10^6$ centipoises

The material **32** may be "silk" screened on the bodies **26** using stainless steel mesh-emulsion, stainless steel-nickel or a molybdenum sheet screen. The latter is necessary where the devices **22** are smaller than 30 mils square. For additional mask information refer to R. W. Berry, P. M. Hall, and M. T. Harris *Thin Film Technology*, Princeton, New Jersey: D. VanNostrand Company, Inc., pages 462–466.

A screen having a pattern which exposes the bodies **26** of the devices **22** is aligned and placed in contact with the bodies. Magnetic coating material **32** is then squeegeed through the screen onto the bodies **26** of the devices **22** but not the leads **28**. The screen is then removed and the material **32** cured to provide a magnetically hard coating. Typically, the curing is carried out in two steps: first, at 75°C for one hour before testing to dry the material without disturbing the wax and, second, at 110°C for one hour before sorting.

Testing the Articles

The support **24** containing the coated devices **22** is mounted on the indexing table **33** of a probe tester, designated generally by the numeral **34**. The probe tester **34** may be that disclosed in the article, J. J. Egan, M. E. Kimmel and W. R. Wanesky, "Probe Tester for Beam Lead Devices" *technical digest*, No. 21, Western Electric Co. Inc. (Jan. 1971) pages 9 and 10, or that sold by Electroglas, Inc., Menlo Park, California under the trade designations Model 901, 902 or 910.

Leads **28**, refer to FIG. **5**, are contacted by probes **36** which are connected to a test set (not shown) for measuring the characteristics of the devices **22**. The probes **36**, refer to FIGS. **6** and **7**, are supported by probe heads **38** which may be positioned anywhere around a support ring **40** and adjusted so that the points of the probes **36** just make good electrical contact with the leads **28**. As many probe heads **38** with probes **36**, as are required to provide a contact for each lead **28** in-

volved in the test, are positioned at appropriate places on the ring **40.**

The support **24** is held on the table **33** by a vacuum supplied through a valve **42** and manifold **44** and the rows of devices **22** are aligned with the X and Y directions of movement of the table **33.** The probes **36** are lifted clear of the devices **22** to permit indexing the devices **22** into position beneath the probes by actuating an air cylinder **46** to raise the support ring **40** which pivots about pins **47.** The indexing of the devices **22** and raising of the support ring are controlled by the test set (not shown) and are done automatically when the test has been completed on each device **22.**

Marking Stylus and Identifying the Articles

Further, after the test has been completed but before the devices **22** is indexed, the test set actuates a marking head **48,** such as that sold by Electroglas, Inc., under the trade designation Model **395** Automatic Inker. A marking member or marking stylus **50** is inserted into a spring holding member **52** fastened to the head **48** at the bottom by screws **54.** Upon a signal from the test set, the member **52** is moved outward at the top by a solenoid in the head **48.** This movement rotates the spring member **52** clockwise and, as a result, moves a tip **56** of the stylus **50** downward into contact with a device **22.**

Referring now to FIG. **8,** a tubular member **58** extends from a base **60** of the marking stylus **50.** The base **60** contains a reservoir **62** for *nonmagnetic* marking fluid, such as white, water-soluble ink sold by the Carter Corporation under the trade designation No. 443. The tubular member **58** may be stainless steel tubing, preferably nonmagnetic, and is joined by a transition member **64,** which curves from the horizontal to the vertical. The transition member **64,** may be magnetic stainless steel tubing having an inside diameter or bore of 0.010 of an inch and an outside diameter of 0.020 of an inch. However, an opening **65** at the tip **56** is smaller than the bore of the transition member **64** and may be about 0.007 of an inch in diameter. This constriction prevents excess marking fluid from flowing from the end of the stylus **50** and, thus, controls the flow of marking fluid.

The stylus **50** not only marks with a visible fluid but also induces a magnetic field in the permanently magnetizable material **32** on the devices **22** by virtue of a permanent magnet **66** which bridges the curve of transition member **64.** Although a permanent magnet is preferred for reasons of convenience and small size, a more bulky electromagnet could be wound around the vertical portion of the transition member **64** when space permits, and the same signal which actuates the solenoid in the head **48** could be passed through the electromagnet to magnetize the devices **22.** In either case, permanent or electromagnet, the devices **22** are selected by the test set in accordance with predetermined desired characteristics and the coating of magnetic material **32** of each selected device is simultaneously, visibly and magnetically marked to identify the devices.

The simultaneous dual marking of devices having desired characteristics provides decided advantages. The magnetic marking permits electronic sensing of any marked device in an array. This, in turn, permits the selection and sorting to be done without human guidance and the automatic formation of a new array of devices all of which have the desired characteristics. The visible marking speeds setup and sorting of the array of mixed devices and permits a quick and easy inspection of the new array to make sure it is complete and consists of nothing but desired-characteristic devices.

The setup and sorting of the array of mixed devices are speeded because the edge rows, which may contain no devices having the desired characteristics, may be skipped. That is, the sorting apparatus may be started on the first row containing a device having the desired characteristic. Thus, the apparatus will traverse fewer rows to sort the devices.

If there is no interruption in the pattern of visible marks in the new array, it has been completed satisfactorily and all devices have the desired characteristics. However, if there is an interruption, i.e., one mark missing from the pattern of marks, it is immediately noticeable and it is known that a device is missing or an unmarked device has been inadvertently transferred to the array. In either case the fault may be corrected.

Sensing and Sorting Out the Identified Devices

The support **24** with its array **20** of identified devices **22** is treated in accordance with U.S. Pat. No. 3,690,984 issued to W. R. Wanesky, Sept. 12, 1972, the subject matter of which is incorporated herein by reference. In this regard, the steps which are of interest, refer to FIG. **9,** relate to the transfer of the array **20** of devices **22** (Wanesky's devices 10) from a support **24** (Wanesky's mounting disc 14) to a silicone resin coated carrier **68** (Wanesky's disc 36). These steps transfer the devices **22** in an oriented array to a support from which devices may be removed with a vacuum pickup and without the use of heat or a solvent. This, in turn, permits the devices having desired characteristics to be placed on still another support which will then have an ordered array of nothing but the desired devices. Accordingly, the entire array **20** of devices **22** is transferred to the carrier **68,** which is coated with a pressure-sensitive holding material **70** such as the silicone resin sold by the Dow Corning Corporation under the trade designation "Sylgard 182, " for subsequent removal of those devices **22** which have been identified as having the desired characteristics.

The coated carrier **68** with the array **20** is placed on a table **71** of an input positioning fixture **72,** refer to FIGS. **10** and **11,** of a sorting apparatus designated generally by the numeral **74.** The input positioning fixture **72** and an output positioning fixture **76,** having a table **77,** are mounted on a base **78.** The X-Y movement of these fixtures is provided by means of stepping motors (not shown) which drive the shafts **80** of the fixtures. The positioning fixtures **72** and **76** are commercial items, such as may be obtained from Automation Gages, Inc., and are under control of the apparatus **74.** A microscope **82,** only the objective of which is shown in FIG. **11,** permits the operator to view the devices **22** for aligning the array **20** with the X-Y movement of the fixture **72,** setting the starting point and checking the operation of the apparatus **74.**

A transfer mechanism **84** is located between the positioning fixtures **72** and **74.** Two identical arms **86,** one having a pickup tip **87** and the other a magnetic field detector **100** at the extremity, are pivoted in a yoke **88** of the transfer mechanism **84.** The arms **86** are raised or lowered by lobes **90** and **91** on cams **92** and **93,** respectively. The cam **93** is rotated by a pickup motor **94** and the cam **92** is rotated by a detector motor **95.** The motors **94** and **95** are stepping motors supported by the

yoke **88.** The motors rotate by stepping in small increments and may be stopped at any point desired in their rotation. A flexible vacuum connection (not shown) is made to a tube **96** which leads to the vacuum tip **87.**

The detector **100** may be of the type sold by Western Magnetics, Inc., of Glendale, California under the trade designation Magnistor, or it may be a tape recorder pickup. However, the Magnistor is preferred because no relative motion is required between the pickup and magnetic field. The field can be detected while the device **22** is stationary. The tip of the detector **100** is positioned about 0.002 of an inch above the surface of the coating of magnetic material **32** on the devices **22** for detection but is lifted about 0.015 of an inch during index.

The yoke **88** is fixed to a vertical shaft **102** which is mounted in bearings **104.** The shaft **102** is rotated 180° clockwise or counterclockwise by means of a rack **106** and pinion **108.** Friction material **110** is fixed to a friction disc **112** which, in turn, is fastened to the shaft **102.** The pinion **108** is urged against the friction disc **112** by a spring **114.** The rack **106** is connected, by a link **116,** to a crank disc **118** which is rotated 180° for each revolution of a single revolutionary clutch and motor (not shown). Thus, the rack **106** is driven forward by one revolution of the clutch and pulled back by the next revolution.

The stroke of the rack **106** is slightly greater than that which is needed to rotate the pinion **108** through 180°. An ear **120** is provided on the yoke **88** while stop screws **122** are provided on the transfer mechanism **84.** The stop screws **122** and the ear **120** permit stopping the yoke **88** at precisely the same point each time at the end of 180° of rotation, while the friction drive permits a slight amount of overtravel of the rack **106** to insure that at least 180° of rotation of the pinion **108** and yoke **88** will occur.

In operation, the coated carrier **68** (FIGS. **10** and **11**) with the array **20** of devices **22** is placed on the table **71,** rotated and aligned using the microscope **82,** and moved in the X-Y directions to set the starting point such that indexing will carry the first row (having a marked device such as **22***a*) of devices **22** beneath the detector **100.** Another coated carrier **68,** or uncoated, magnetized equivalent thereof, is placed on the table **77** and also adjusted to a suitable starting point. The array **20** on the table **71** is then indexed automatically along the X-axis so that each device **22** in the first row is brought beneath the detector **100.**

When a magnetic field is sensed by the detector **100,** because the coating material **32** of the device **22***a* is magnetized, the detector generates a signal. This signal actuates the motors **94** and **95** to raise the arms **86,** and causes a motor (not shown) to rotate the yoke 180° clockwise to position the vacuum pickup tip **87** over the magnetized device **22.** Next, in order to pickup the device **22***a* and transfer it to the coated carrier **68** on the table **77,** the motor **94** is rotated once to lower and raise the tip **87.** A vacuum is applied when the tip **87** is in its lowermost position. This vacuum is maintained until the yoke **88** is revolved 180° counterclockwise and the motor **94** revolved once again to lower and raise the tip **87** while it is over the table **77.** The vacuum is removed when the tip **87** is in its lowermost position; thus, depositing the device **22***a* on the carrier **68** on table **77.**

The positioning fixture **72** indexes the next device **22** on the table **71** into position and the detector **100** is lowered to within 0.002 of an inch of the device by the motor **95** and corresponding cam **92.** Also, the positioning fixture **76** indexes the table **77** so that the carrier **68** thereon is indexed one position in preparation for receiving the next device **22.** If the next device **22** is magnetized, the sequence previously described is repeated. If not magnetized, the fixture **72** indexes again until a magnetized device **22** is encountered. Thus, the input table **71** is indexed continuously along the rows of the array while the output table **77** is indexed only to receive a device **22** which has been picked up. A row is transversed in the X direction in this manner and at the end of the row the fixture **72** shifts in the Y direction to the next row. This continues until all marked devices **22** are transferred to the carrier **68** on the table **77.** Then, another carrier **68** of tested and marked devices **22** is placed on the table **71** and the process repeated. The result is a new array of devices **22** all of which have been selected by test to have the same characteristics.

Since the output table 77 is moved independently of the input table **71,** table 77 may be moved the same increment as that of the original array **20,** or what is often the case, much larger increment to expand the array.

Referring now to FIG. **12,** there is shown a schematic electrical circuit diagram for detecting the devices **22** which have been magnetized. The detector **100** is a Magnistor which is essentially a transistor having two collectors **124.** Originarily the current is divided equally between them. However, when the unit is subjected to a magnetic field, the current is diverted as it leaves the emitter so that more current is directed to one collector than the other. The detector **100** is adjusted when no magnetic field is present for equal current in each collector **124** by eans of a potentiometer **126,** a meter **125,** and a switch **127** set in the "read" position. When the currents are equal, the output of a probe amplifier **128** at a point A is zero volts. As a result, a lamp **130** and relay **132** in an output driver circuit **134** are unenergized.

When the detector **100** is brought within the magnetic field of a magnetized device **22,** the difference in currents through the collector circuits generates a voltage which is amplified to about 30 millivolts at point A by the amplifier **128.** This voltage is applied through a resistor **135** to point B which is at the input of a trip circuit **136** whose amplifier **137** is adjusted to conduct at a certain voltage level such as +15 millivolts or greater. This causes transistors **138** and **140** to conduct and the current through the collector circuit of transistor **140** to energize the lamp **130** and relay **132.**

In order to eliminate the effect of drift, a "sample and hold" circuit **142** is included. The output voltage of the circuit **142** is equal to its input voltage but opposite in sign. A relay **141** is energized to place the circuit **142** in the "sample" mode during index from one position to another. The relay **141** is left unenergized to place the circuit **142** in the "hold" mode, while in position above one of the devices **22.** For example, if the output of the probe amplifier **128** at point A during index is +10 millivolts, the input to circuit **142** is +10 millivolts just prior to detecting a device **22.** With the switch **127** in the "test" position and the relay **141** energized, i.e., in the sample position, the output of the circuit **142** at point B is −10 millivolts. The relay **141** is then de-

energized so that the −10 millivolts is held. When the detector **100** is positioned above a magnetized device **22,** the voltage applied to point B by the amplifier **128** through the resistor **135,** may be +30 millivolts. Accordingly, the net voltage at point B available for tripping the circuit amplifier **137** will be the difference between the output of the probe amplifier **128** at A and the −10 millivolt output of the sample and hold circuit **141,** i.e., +20 millivolts. In this way the voltage due to any drift, up to the time immediately prior to detection, plus the magnetic field voltage is applied to point B where the negative of any voltage due to drift is also applied. Consequently, the trip circuit **136** "sees" the +20 millivolt difference which is the voltage due to the affect on detector **100** of the magnetic field of the magnetized device **22.**

While there has been described and illustrated herein practical embodiments of the present invention, it is to be understood that various modifications and refinements which may depart from the disclosed embodiment may be adopted without departing from the spirit and scope of the present invention.

What is claimed is:

1. A method of identifying nonmagnetic articles which comprises the steps of:

coating the article with a material which is capable of retaining a magnetic flux when magnetized;

testing the articles individually to determine which articles are to be identified;

and contacting the individual articles to be identified in accordance with the testing, with a tip of a marking member having a magnetic flux concentrated at the tip thereof to magnetize the material and identify the articles.

2. The method of claim **1** wherein only one article is tested to determine whether it should be identified.

3. The method of claim **1** wherein a portion of the marking member is tubular and marking fluid flows through the tubular portion so that the step of contacting both visibly and magnetically identifies the articles.

4. The method of claim **3,** wherein the visible and magnetic identification are accomplished simultaneously.

5. A method of identifying magnetizable article which comprises the steps of;

testing the articles to determine whether they have a certain characteristic;

concentrating a magnetic flux at the tip of a marking member;

flowing a marking fluid through the member; and

placing the tip of the marking member adjacent the article to simultaneously deposit fluid on and magnetize the article having the characteristic determined in accordance with the testing, to both visibly and magnetically identify the article.

6. A method of identifying semiconductor devices in an array which comprises the steps of:

coating all the devices in the array with a material which will retain a magnetic flux when magnetized;

testing the devices in the array;

concentrating the flux of a permanent magnet at the tip of a marking member;

flowing a marking ink through the marking member; and

contacting certain devices in the array, in accordance with the testing, with the tip of the member to deposit marking fluid and simultaneously magnetize the coating material so that the selected devices are visibly and magnetically identified and identification is insured.

7. A method of identifying and sorting articles from an array of the articles which comprises the steps of:

coating all the articles with a material which will retain a magnetic flux;

testing the articles individually to determine which articles are to be identified;

concentrating a magnetic flux at the tip of a marking member;

contacting the individual articles to be identified, as determined by the test, with the tip of the marking member to induce a magnetic field in the material and identify the articles;

sensing the magnetic field induced in the magnetic material of the identified articles; and

sorting the identified articles from the array in accordance with the magnetic field.

8. The method of claim **7** wherein the articles are beam-lead semiconductor devices in an interdigitated array.

9. The method of claim **8** wherein a portion of the marking member is tubular and marking fluid flows through the member to both visibly and magnetically identify the semiconductor devices to insure identification.

10. The method of claim **9** wherein a magnetically sensitive transistor is used to sense the induced magnetic field.

11. Apparatus for identifying nonmagnetic article having a magnetizable coating in an array such devices, which comprises:

means for testing the articles while in an array to determine the characteristics thereof; and

means for both inducing a magnetic field in the magnetizable coating and visibly marking the articles to insure the identification of said articles.

12. The apparatus of claim **11** wherein the articles are beam-lead semiconductor devices and the means for simultaneously inducing a magnetic field in the magnetizable coating material and visibly marking the device, comprises:

a reservoir for marking fluid;

a tubular portion extending from the reservoir, said portion being ferromagnetic and having a fluid dispensing tip smaller than the article to be identified; and

magnet means adjacent the tubular portion at the tip for magnetizing the article whereby the article is simultaneously visibly and magnetically identified to insure identification.

13. A marking stylus, for identifying semiconductor devices coated with a magnetizable material, which comprises:

a reservoir for marking fluid;

means for conducting marking fluid from the reservoir and magnetic flux to the devices to be identified; and

a magnet means for providing magnetic flux to the conducting means whereby the devices may be both visibly and magnetically marked upon contact with the conducting means to insure identification.

14. A marking stylus according to claim **13,** wherein the means for conducting marking fluid and magnetic flux, comprises:

a tubular member joined at one end to the reservoir and extending horizontally therefrom to an exit end; and

a ferromagnetic tubular transition member, smaller in area at the tip than the devices to be identified, which curves from a horizontal plane at the exit end of the tubular member to a vertical plane, and the bore of which is constricted at the tip of form an opening smaller than the bore to control the flow of marking fluid.

15. A marking stylus according to claim **14,** wherein the magnet means is a permanent magnet which bridges the curve of the transition member and provides magnetic flux concentrated at the tip of said member.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,863,764 Dated February 4, 1975

Inventor(s) S. A. Myslinski-E. J. Pritchard-H. A. Tooker

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 32, after "3-15" insert a period (.);
line 35, "are" should be --were--.

Column 2, line 38, "includes" should be --include--;
line 44, after "having" insert --a--;
line 57, "device" should be --devices--.

Column 3, line 11, "those" should be --whose--.

Column 6, line 61, "74" should be --76--.

Column 8, line 31, "Originarily" should be --Ordinarily--;
line 37, "eans" should be --means--.

Claim 5, line 1, "article" should be --articles--.

Claim 11, line 1, "article" should be --articles--.

Claim 14 (Col. 11) line 8, "of" (second occurrence) should be --to--.

Signed and sealed this 6th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
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