United States Patent

Sweitzer

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[54] METHODS FOR SELECTIVELY COATING FERROMAGNETIC ARTICLES

[72] Inventor: **Stanley E. Sweitzer,** Laureldale, Pa.

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

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[52] **U.S. Cl.** **117/38,** 117/93.2, 117/212

[51] **Int. Cl.** **B44d 1/18,** B44d 1/02

[58] **Field of Search** 117/38, 93.2, 212; 335/289, 335/291; 118/301, 213, 504, 505, 406; 18/DIG. 33

[56] **References Cited**

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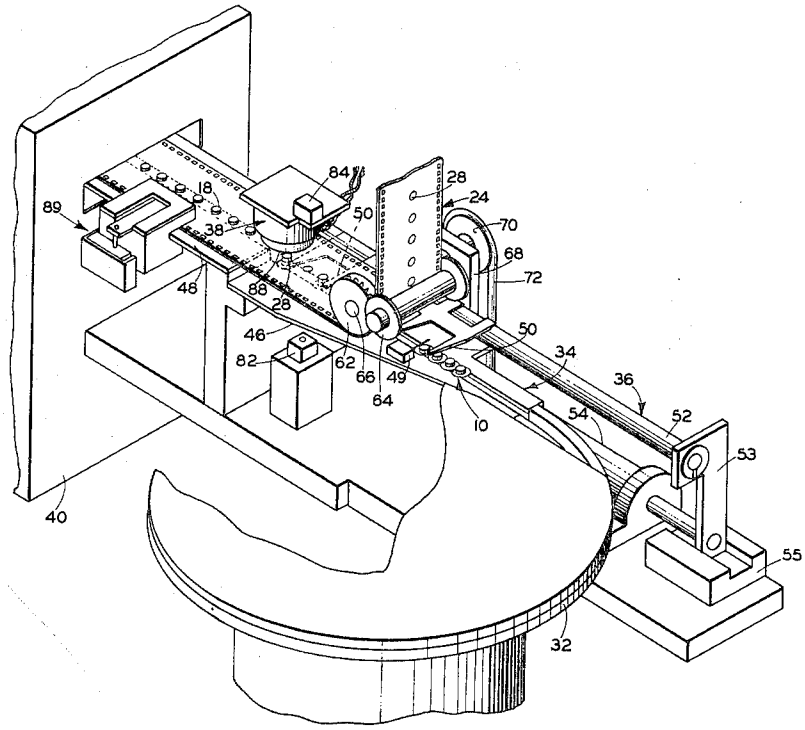
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Primary Examiner—Alfred L. Leavitt
Assistant Examiner—M. F. Esposito
Attorney—W. M. Kain, R. P. Miller and R. Y. Peters

[57] **ABSTRACT**

Ferromagnetic articles to be selectively coated are conveyed through a coating station by a belt which also serves to mask areas of the articles where coating material is not desired. The belt is in the form of an endless tape and coating material is continuously removed from the tape so that each article to be coated is presented with clean tape mask. Automatic apparatus is provided to magnetically lift the articles into engagement with the mask and a support track in coordination with feeding and indexing devices. A step near the end of the track permits the coated articles to drop free of the mask and accumulate in a magazine.

8 Claims, 7 Drawing Figures



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SHEET 1 OF 4

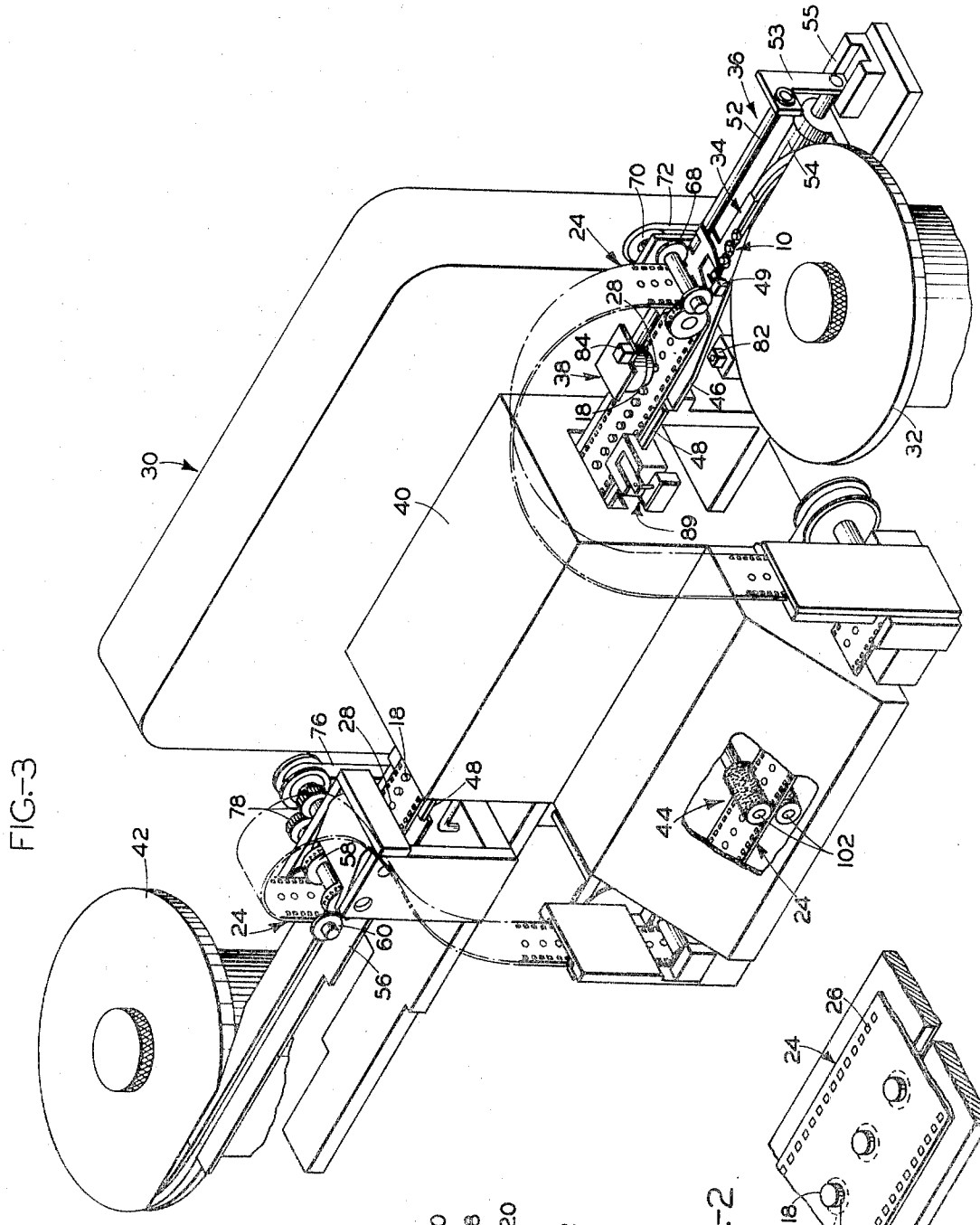


FIG-3

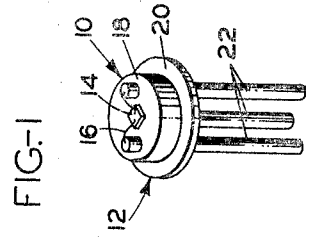


FIG-1

FIG-2

INVENTOR
S.E. SWEITZER
BY R. F. Peters
ATTORNEY

FIG. 4

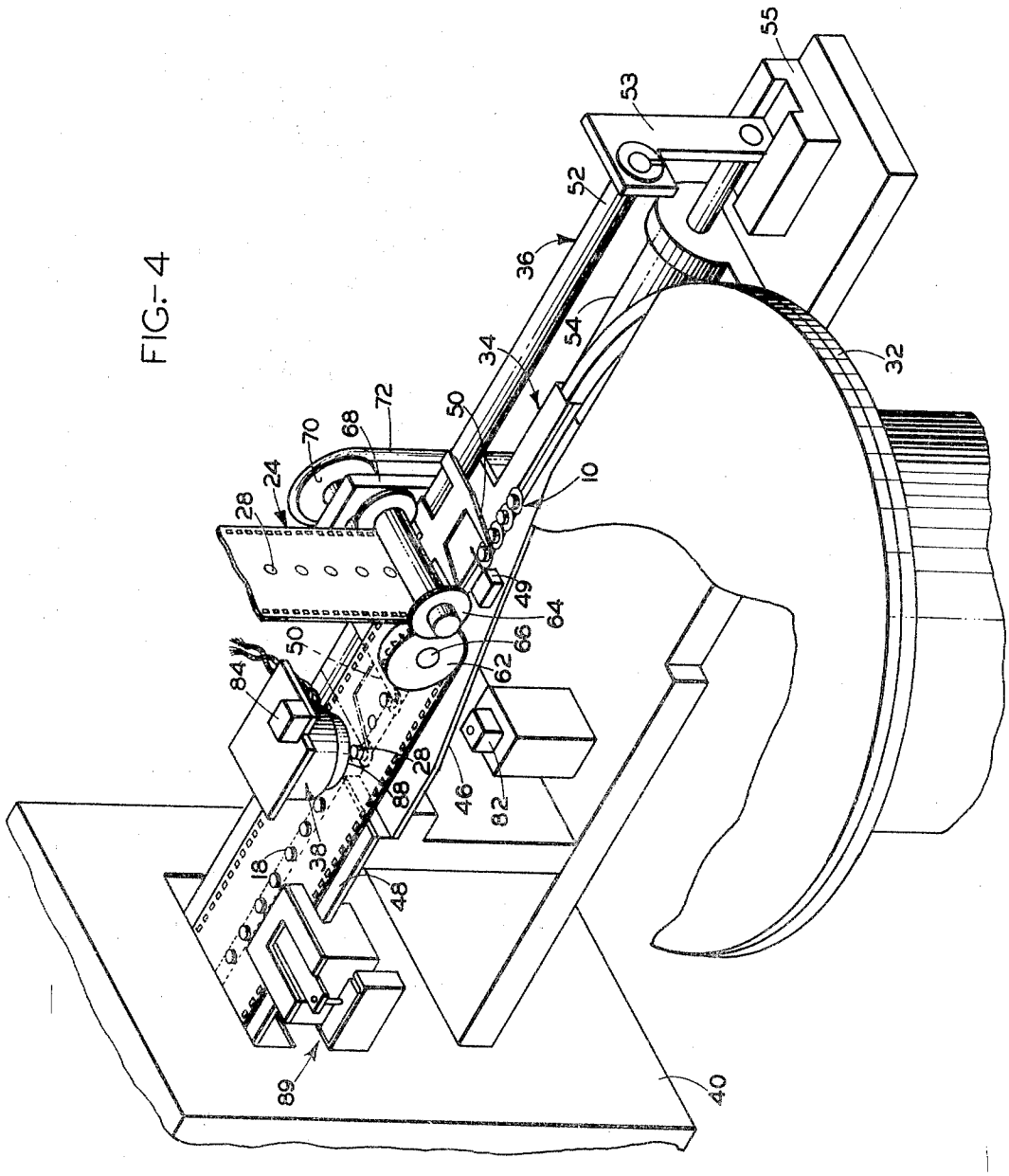

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36
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34
32
50
72
68
70
24
28
10
49
64
66
62
84
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28
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46
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18
38
48
89
40

FIG.-5

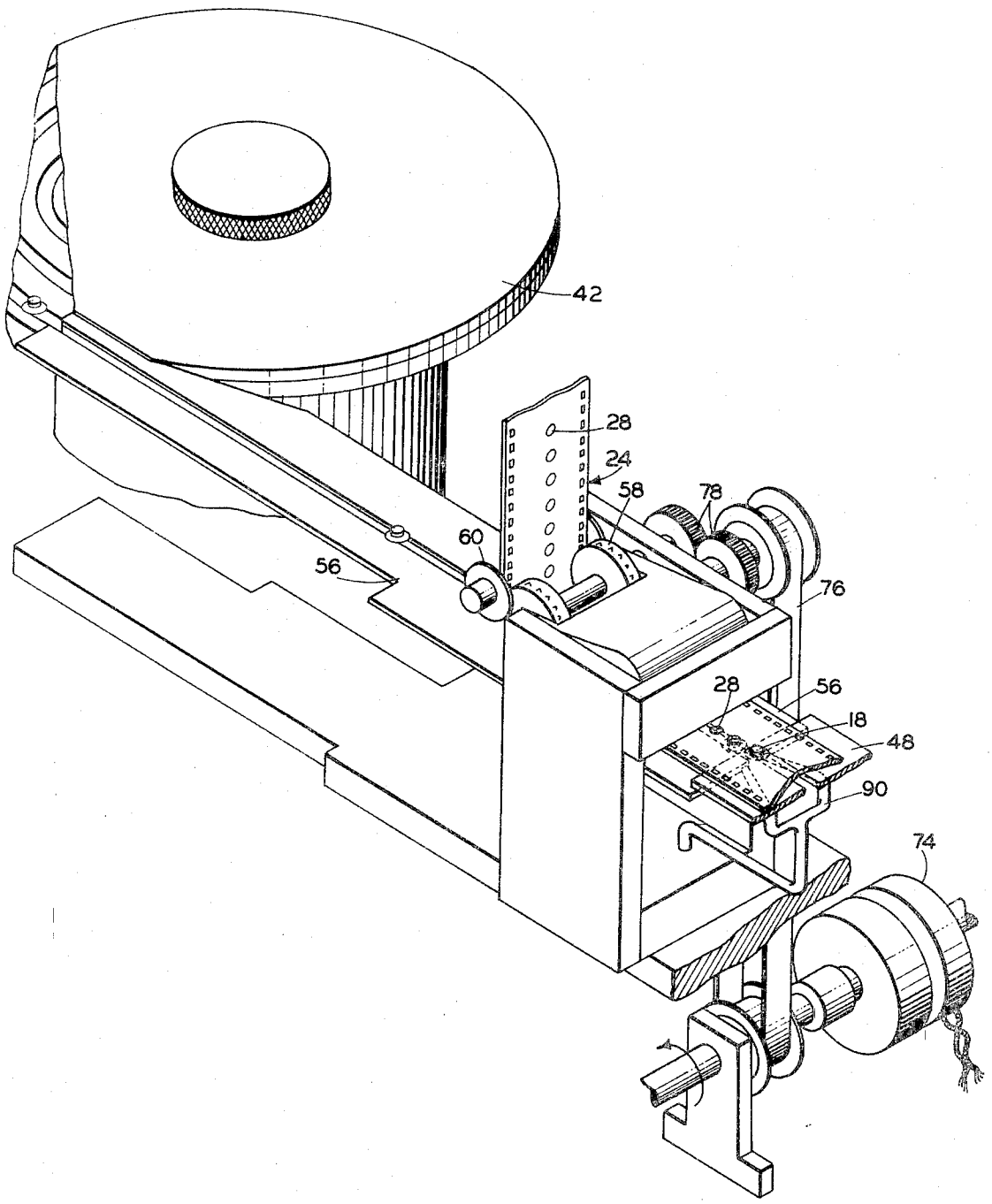


FIG.-6

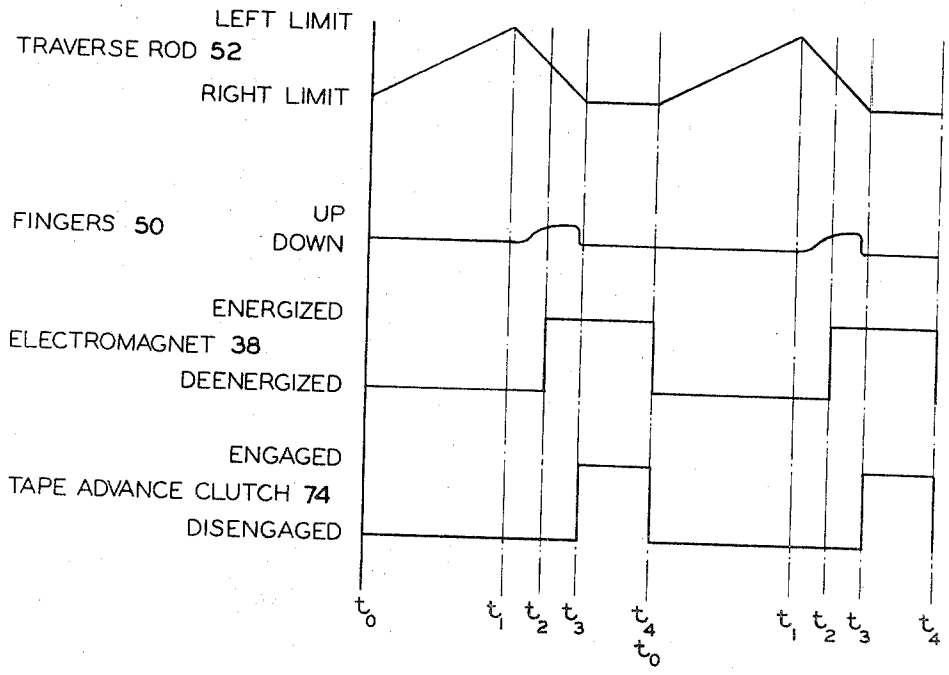
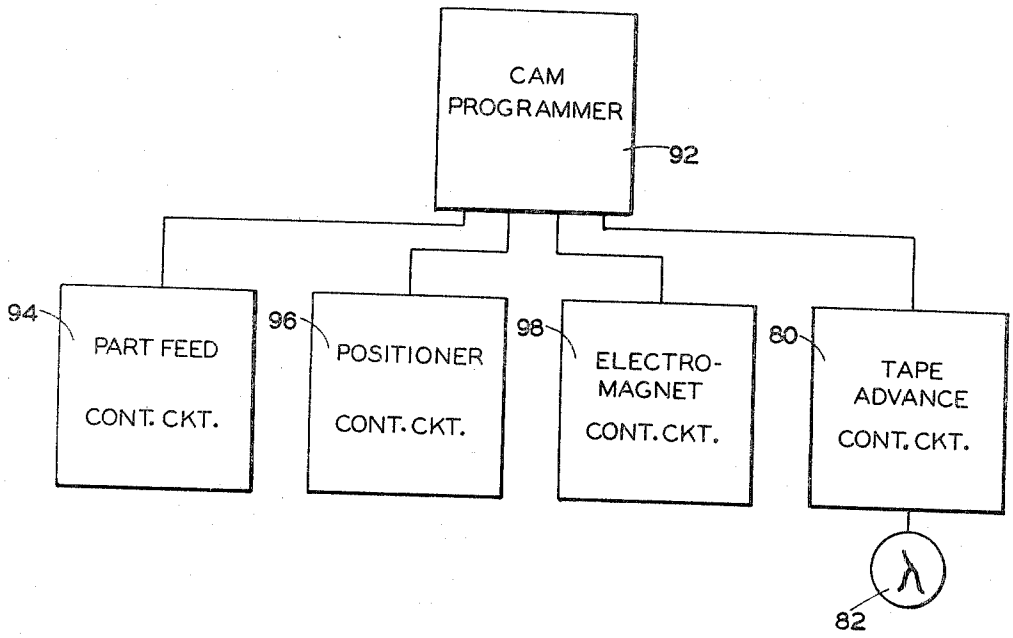

LEFT LIMIT
TRAVERSE ROD 52
RIGHT LIMIT
FINGERS 50
UP
DOWN
ENERGIZED
ELECTROMAGNET 38
DEENERGIZED
ENGAGED
TAPE ADVANCE CLUTCH 74
DISENGAGED
t_0
t_1
t_2
t_3
t_4
t_0
t_1
t_2
t_3
t_4

FIG.-7


CAM PROGRAMMER
92
94
PART FEED CONT. CKT.
96
POSITIONER CONT. CKT.
98
ELECTRO-MAGNET CONT. CKT.
80
TAPE ADVANCE CONT. CKT.
82

METHODS FOR SELECTIVELY COATING FERROMAGNETIC ARTICLES

BACKGROUND OF THE INVENTION

The invention relates to methods for selectively coating ferromagnetic articles and, more particularly, to improved automatic methods for continuous masking and conveying ferromagnetic articles through a coating station wherein the articles have been magnetically engaged with the mask.

In the manufacture of certain articles it is necessary to coat selected portions of the articles while preventing other portions from being coated. For example, in the manufacture of certain types of transistors, it is necessary to apply a protective coating of silicon dioxide to an active transistor element which is mounted on a platform of a flanged header. However, silicon dioxide deposited on the flange of the header would prevent subsequent welding of a closure to the flange. It becomes necessary, therefore, to shield or mask the flange during the coating operation while exposing the top surface containing the active transistor element to the silicon dioxide.

Previously, the articles have been coated in an automatic apparatus using an endless-belt mask having apertures through which raised portions of the articles protrude to be coated. The mask is adjacent to a track which supports the articles as they are pulled by the mask through a coating station. Mechanisms are provided to raise a portion of the belt at one end so that each article may be positioned under an aperture in the mask and the mask lowered over the article to engage it. After the mask is lowered, the raised portion of the articles protrude through the aperture to be coated and the flanged portion remains beneath the belt to be masked. Similarly, a mechanism is provided to lift the belt from each article after it has been coated to disengage and dispose of the article. The method and apparatus are described more fully in copending application, Ser. No. 787,040 filed Dec. 26, 1968, now U.S. Pat. No. 3,587,524, assigned to the assignee of record.

It has been found advantageous to simplify the foregoing apparatus both mechanically and electrically. Such simplification results in reduction of the cost of construction of the apparatus, fewer moving parts with consequent reduced maintenance, and improved operation of the apparatus. In carrying out such simplification, magnetic expedients are incorporated in place of electropneumatic mechanisms.

SUMMARY OF THE INVENTION

It is an object of the invention, therefore, to provide new and improved methods for automatic masking and conveying articles through a coating apparatus.

It is another object of the invention to provide magnetic means for lifting and engaging the articles with the mask.

It is still another object of the invention to simplify the removal of the articles from the mask.

It is another object to simplify the electric and pneumatic control circuits.

The invention accomplishes the foregoing and other objects by providing a two-level track for supporting the articles, having flanged portions to be masked and raised portions to be coated, and an electromagnet to lift the articles from one level to the other and into engagement with an apertured endless-belt mask.

The track consists of a lower level having first and third sections and an upper level second section therebetween which extends through the coating station.

The endless-belt mask extends along and adjacent to the upper level second section and extends beyond each end of the second section so that the belt mask overlaps the lower level first and third sections.

An electromagnet is located above (1) a reference point on the first section and (2) an aperture in the mask which is also aligned with the reference point.

The articles are placed on the first section of the track and individually positioned by indexing them along the track to the reference point. The mask is indexed to align the apertures

with the reference point in timed relationship with the positioning of the articles therewith. The electromagnet is energized in timed relationship with the articles and apertures so that each article in turn is attracted to the mask and the raised portions protrude through the mask apertures. The articles in the mask are pulled from under the magnet onto the second section of the track by the indexing of the mask. Continuous indexing of the mask pulls the articles along the second section of track, thereby conveying them through the coating station to the third section. Since the mask overlaps the third section indexing of the mask pulls the articles from the second section so that they drop out of the mask to the third section of the track. The articles are then disposed of along the third section of the track into an accumulator magazine.

After exiting from the coating station the mask is returned to the starting point through a cleaning station so that the coating on the mask may be removed and a clean portion of the mask presented to each article to be coated.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, advantages and features of the invention will be apparent from the following detailed description of specific examples and embodiments thereof, in which:

FIG. 1 is an isometric view of a transistor subassembly which is to be coated by the apparatus of FIG. 3;

FIG. 2 is a partial isometric view of an endless tape mask and a portion of a support track showing the masking of a plurality of the subassemblies of FIG. 1;

FIG. 3 is an isometric view of an apparatus, utilizing the endless tape mask of FIG. 2, for coating transistor subassemblies in accordance with certain features of the invention;

FIG. 4 is an isometric view of the input end of the apparatus of FIG. 3; and

FIG. 5 is an isometric view of the output end of the apparatus of FIG. 3;

FIG. 6 is a time versus function chart schematically illustrating cooperating between various elements of the invention; and

FIG. 7 is a schematic diagram of an automatic control system for the apparatus of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention will be described in connection with the selective coating of a transistor subassembly; however, it is to be understood that this is only for the purpose of explanation and that the invention is applicable to the selective coating of various other ferromagnetic articles.

Referring to FIG. 1, there is shown a transistor subassembly, designated generally by the numeral 10, which includes a ferromagnetic header designated generally by the numeral 12, an active transistor chip 14 and a plurality of leads 16. The header 12 includes a raised platform 18, a flange 20 and a plurality of terminals 22. The transistor subassembly 10 is to be coated, in the specific example, with silicon dioxide on the entire top of the platform 18 including the transistor chip 14 but not on the surface of the flange 20.

Referring now to FIG. 2, the flange 20 is shielded or masked by a belt or tape mask designated generally by the numeral 24. The tape mask 24 is made with drive perforations 26 which, advantageously, are identical in size and spacing to the perforations in a motion picture film. Consequently, all tooth sprockets used for the control and movement of the tape mask 24 have dimensions to suit motion picture film perforations and spacing. In addition, the tape mask 24 is perforated along its center line with a plurality of evenly spaced masking apertures 28. The masking apertures 28 are large enough to fit over the raised platform 18 of the subassembly 10 but small enough so that the tape mask 24 shields the flanges 20.

Coating of the subassemblies 10 is accomplished by permitting silicon dioxide to condense on the surfaces of the subassemblies when the subassemblies are placed into an atmosphere containing gaseous silicon dioxide. The tape mask

24 prevents condensation of silicon dioxide on the flanges 20 but, of course, the tape mask 24 itself becomes coated with silicon dioxide.

The mask 24 is operated as an endless belt or tape arrangement and, in order to continually have a properly conditioned mask available for the articles, successive portions of the mask are cleaned after each exposure to the coating operation. Although silicon dioxide is soluble in hydroflouric acid, it is preferably to use a dry cleaning technique so that the maintenance of acid baths and rinses is not required. It is, therefore, desirable to keep the configuration of the mask 24 as simple as possible so that the mask can be readily cleaned by dry techniques such as brushing.

Since the mask 24 must also be able to withstand repeated cycling, it is important in this particular use of the invention that the tape have good wear characteristics. Also, it is essential that the mask 24 be nonmagnetic so that it will not form a magnetic path or shunt or become magnetized. A preferred material for the mask 24 in this case is a nonmagnetic grade of stainless steel but other materials such as hard brass, phosphor bronze or plastic may be used.

Referring now to FIG. 3, there is shown a coating apparatus designated generally by the numeral 30, for automatically masking and coating the subassemblies 10. The machine 30 includes: a vibratory feeding and storage magazine 32, built in accordance with U.S. Pat. No. 3,194,392, issued to R. W. Manderbach on Aug. 13, 1965 and mounted on vibrating unit; a three-section support track designated generally by the numeral 34; a positioner designated generally by the numeral 36 and built in accordance with U.S. Pat. No. 3,435,943, issued to A. F. Johnson on Apr. 1, 1969; the endless tape mask 24; an electromagnet designated generally by the numeral 38; a coating station 40; an accumulator magazine 42 similar to magazine 32 and also mounted on a vibrating unit; and a cleaning station designated generally by the numeral 44.

Referring now to FIG. 4, the subassemblies 10, to be coated, are fed onto a lower level first section 46 of the support track 34 from the vibrating magazine 32 to a spring stop 49. The first section 46 of the support track 34 must be nonmagnetic and preferably is made from nonmagnetic-type stainless steel. From the spring stop 49 the subassemblies 10 are moved in increments, i.e., indexed, to a point adjacent a second section 48 of the track 34 by means of the positioner 36 disclosed in the above-cited U.S. Pat. No. 3,435,943 issued to A. F. Johnson. Preferably, the subassemblies 10 are moved in four steps by the Johnson apparatus to minimize the length of stroke of the piston within an air cylinder 54, there being one finger 50 for each step desired. However, from one step to as many as desired may be used. The fingers 50 of the positioner 36 are fixed to a traverse rod 52 and are moved back and forth along the first section 46 of the track 34 by the piston within the air cylinder 54 acting on the rod 52 through a link 53 which permits rotation of the rod during translation. A guide block 55 guides the link 53 and maintains it in the vertical position. During the stroke toward the second section 48 of the track 34, the fingers 50 are adjacent the first section 46 of the track, thus moving the subassemblies 10 to the left. On the return stroke, the rod 52 is rotated clockwise, by a cam and follower mechanism (not shown), around its own axis sufficiently to lift the fingers 50 to pass over the subassemblies 10 as the traverse rod 52 returns. At the end of the return stroke, the cam mechanism rotates the fingers 50 back again to lower them in place adjacent the first section 46 of the track 34 and behind the next subassemblies to be moved. On the forward indexing stroke, i.e., advancing to the left, one subassembly 10 is pushed along the first section 46 past the spring stop 49 by the right-hand finger 50 to a point at the limit of the forward stroke where the subassembly can be engaged by the next finger 50 on the next stroke. At the same time an earlier subassembly 10 is positioned by the left-hand finger 50, at the limit of the forward stroke, on the first section 46 of the track 34 at a point, hereinafter termed the reference points, below the electromagnet 38.

The endless-tape mask 24 lies adjacent the second section 48 throughout the length of the section and the coating station 40 and rests on the flanges 20 of the subassemblies 10 (FIG. 2) when the subassemblies are on the second section. In addition, the belt mask 24 extends beyond the second section 48, at each end to overlap both the first section 46 at the input end of the coating machine 30 and a third section 56 of the track 34 (FIG. 5) at the output end of the apparatus. The second section 48, like the first section 46, is nonmagnetic and is preferably made of stainless steel. The second section 48, and consequently the mask 24 which lies adjacent to it and extends over the first section 46, is elevated above, or stepped up from, the first section just enough to permit the tape to clear the raised finger 50. The third section 56 is at approximately the same level as the first section 46, and is stepped down from the second section 48.

The tape mask 24 is held against a drive sprocket 58 (FIG. 5) by an idler roller 60 and against a sprocket 62, which is driven by the mask 24, by an idler roller 64 (FIG. 4). The driven sprocket 62 is mounted on one end of a sprocket shaft sprocket shaft 66 for rotation in a support 68. A grooved friction pulley 70 is mounted on the opposite end of the sprocket shaft 66 and a friction belt 72, fixed at one end, is wrapped half way around the pulley 70. The belt 72 is tensioned at the other end by means of a spring (not shown to apply a friction drag which retards rotation of the driven sprocket 62. The drag on the driven sprocket 62 maintains the mask 24 taut between the drive and the driven sprockets 58 and 62, respectively. The friction belt 72 is preferably made of leather but other suitable materials may be used.

Referring now to FIG. 5, the drive sprocket 58, and consequently the tape mask 24, is driven by means of an electric motor (not shown) through an electromagnetic clutch 74, a timing belt 76 and a pair of drive gears 78. The clutch 74 is actuated to drive the sprocket 58 and tape mask 24 by means of a tape advance control circuit 80 (FIG. 7) and is halted by a photoelectric detector 82 which interrupts the control circuit 80. Such interruption occurs when the edge of an aperture 28 first exposes the photoelectric detector 82 to light projected through the aperture from the source 84. An aperture 28 at that time (refer to FIG. 4 again) is directly above the subassembly 10 at the reference point on the first section 46 of the track 34.

The electromagnet 38 is also centered above the reference point and both the subassembly 10 and the aperture 28 so that the subassembly, aperture and magnet are vertically aligned. The pole face 88 of the electromagnet 38 is adjacent the tape mask 24 but just far enough above the mask to clear the top of the platform 18 of the subassembly 10 which protrudes through the tape mask 24. Since the headers 12 are ferromagnetic, when the electromagnet 38 is energized, the subassemblies 10 will be attracted by the magnet and thus lifted into engagement with the tape mask 24. Preferably, the electromagnet 38 is energized with alternating current so that the subassemblies 10 vibrate as they are lifted into contact with the tape mask 24. This vibration aids the entry of the raised platform 18 into the aperture 28 in the masking tape.

When the subassemblies 10 are in engagement with the mask 24, they are at the height of the second section 48 of the track 34. Movement of the tape mask 24 pulls the subassemblies from beneath the electromagnet 38 onto the second section 48 of the track 34 which then supports the subassemblies 10. A conventional lever operated microswitch 89 is provided to detect the absence of the subassemblies 10 from the mask 24, when the magazine 32 becomes empty.

Further movement of the mask 24 urges the subassemblies 10 along the second section 48 through the coating station 40 to the third section 56 of the track 34. The mask 24 continues beyond the second section 48 to a point over the third section 56 so that the subassemblies 10 drop from engagement with the mask 24 to the third section 56 at the lower level of the track 34. An air jet 90 between the track levels blows the subassemblies 10 to an accumulator magazine 42 where they are vibrated into the magazine.

Operation

The operation of the apparatus can be understood best by a description of one complete cycle of the apparatus 30 and reference to FIGS. 3, 6, and 7 alternately. Assume the apparatus 30 is operating and that the cam programmer 92, which will complete one revolution and stop, has just activated both the feed control circuit 94 and the positioner control circuit 96. Thus, the subassemblies 10 are being fed by vibration from the magazine 32 to the stop 49. Also, the feed control circuit will remain actuated for a portion of the machine cycle sufficient to assure that at least one subassembly 10 is against the stop 49 when needed.

At time t_0, which occurs at the activation of the feed control circuit 94 and the positioner control circuit 96, the fingers 50 are down and engage the subassemblies 10. The right-hand finger 50 engages the subassembly 10 which is against the stop 49 and the traverse rod 52 is at the right-hand limit of its stroke. The traverse rod 52 advances to the left under the control of the positioner circuit 96.

At time t_1, the rod 52 reaches the left-hand limit of its travel, reverses under the influence of the control circuit 96 and retracts. Thus, the left-hand finger 50 has positioned one subassembly 10 at the reference point beneath an aperture 28 in the mask 24 and the electromagnet 38, while the right-hand finger 50 has pulled one subassembly 10 past the spring stop 49 and into position to be engaged by another finger 50 on the next stroke of the traverse rod 52. In addition, as the traverse rod 52 retracts, a cam mechanism (not shown) of the positioner 36 rotates the traverse rod 52 clockwise, thus lifting the fingers 50 sufficiently to clear the subassembly 10 but not enough to strike the mask 24.

At time t_2 the electromagnet 38 is energized by the cam programmer 92 through the electromagnet control circuit 98. The magnetic field of the electromagnet 38 attracts and lifts the subassembly 10, which was placed below the electromagnet at time t_1 by the positioner 36, into the aperture 28 and engagement with the mask 24. The traverse rod 52 continues to retract and shortly before the rod is fully retracted the cam mechanism of the positioner 36 rotates the rod counterclockwise so that the fingers are down and ready to engage the subassemblies 10 on the next cycle.

At time t_3, the traverse rod 52 reaches the right-hand limit of its travel. The positioner control circuit 96 then inactivates the positioner 36 until the control circuit 96 again receives a signal from the programmer 92 to advance the traverse rod. Also at this time the programmer 92 activates the tape advance control circuit 80 which engages the clutch 74 to advance the tape mask 24. Since the electromagnet 38 is still energized, the subassemblies 10 are maintained in engagement with the mask as it advances. The mask 24 continues to advance until the photoelectric circuit 82 "sees" light from the source 84 through an aperture 28 in the mask 24.

At time t_4, the circuit 82 "sees" light from the source 84. Between t_3 and this time the cam programmer 92 completes its one revolution and stops. At t_4 the photoelectric circuit 82 interrupts the tape advance circuit 80 which disengages the tape advance clutch 74. This stops the mask 24 with an aperture 28 directly beneath the electromagnet 38 and above the reference point. In addition, the subassembly 10 which was beneath the magnet has now been pulled onto the second section 48 of the track 34. Also, at time t_4 the photoelectric circuit 82 signals the electromagnet control circuit 98 to deenergize the electromagnet 38 and signals the cam programmer 92 to start another cycle. The cycle now begins again with the cam programmer 92 activating the feed and positioner control circuits 94 and 96, respectively, which results in another subassembly 10 being placed at the reference point.

Continuous cycling causes the tape mask 24 to urge the subassemblies 10 through the coating station 40 so that the raised portions become coated while the flanged portions below the tape remain masked and uncoated.

The subassemblies 10 are pulled along the second section 48 of the track 34 to the third section 56. Since the second section 48 is at a level higher than the third section 56 and the mask 24 extends beyond the second section 48, the transistor subassemblies 10 drop from the apertures 28 in the mask 24 to the third section 56 of the track 34. An air jet 90 directed along the third section 56 propels the subassemblies to the accumulator magazine 42 mounted on a vibrator for vibrating the subassemblies 10 into the magazine.

Within the coating station 40, the subassemblies 10 are exposed to the silicon dioxide in gaseous form and, because the subassemblies 10 and the mask 24 are at substantially ambient temperatures, silicon dioxide condenses on the exposed surface of the subassemblies 10 and the mask 24. Since the mask 24, as well as the subassemblies 10, become coated with silicon dioxide, it is desirable to remove the coating from the mask to prevent coating buildup and eventual ineffectiveness of the mask. The silicon dioxide is removed by passing the mask 24 between rotating brushes 102 which brush away the silicon dioxide coating within the cleaning station 44. Thus, clean tape mask 24 is returned from the cleaning station 44 to the starting point in good condition for masking subassemblies 10 again.

The previous described control circuits are conventional except insofar as they are combined with each other into an inventive system. They can readily be constructed by those skilled in the art of assembly of such circuits and, therefore, the circuits are not described in detail.

What is claimed is:

1. A method for masking a ferromagnetic article having a flanged portion to be masked and a raised portion to be coated and conveying the article through a coating station, which comprises the steps of:

positioning the article beneath magnetic means and adjacent a mask aligned with respect to said magnetic means, the mask having an aperture through which the raised portion of the article may protrude to be coated;

attracting the article into engagement with the mask by actuating said magnetic means so that the raised portion protrudes through the aperture and the flange portion is masked;

maintaining the article in engagement with the mask to move the article by means of the mask; and

advancing the mask to move the article through the coating station to coat the raised portion of the article.

2. The method, as recited in claim 1, which includes the further step of removing the coated article from the mask.

3. The method, as recited in claim 2, wherein the mask is a flexible, endless, stainless steel belt and the magnetic means is an alternating current magnet.

4. The method, as recited in claim 3, which includes the further step of cleaning the mask by returning the mask to the starting point through a brushing station to remove the accumulated coating.

5. A method for masking ferromagnetic articles having raised portions to be coated and flanged portions to be masked, the articles being moved along a track through a coating station, the track having first and third lower sections and a second upper section therebetween, the second section extending through the coating station, which comprises the steps of:

placing the articles on the first section of the track;

indexing the articles along the first section to a reference point;

advancing a belt mask in successive steps, the belt having spaced apertures therein through which the raised portion of the articles to be coated may protrude, one aperture being aligned above the reference point after each advancement of the mask;

energizing an electromagnet to lift each article in turn from the first section of the track into engagement with an aperture in the mask, the electromagnet being positioned directly above the mask and the reference point, the advancement of the mask moving the articles from beneath the electromagnet onto and along the second section of the track through the coating station; and

dropping the coated articles from the mask to the third section of the track for disposal.

6. The method, as recited in claim 5, wherein:

the mask is an endless, flexible tape;

the tape and first and second sections of the track are non-magnetic stainless steel; and

the electromagnet is of the alternating current type.

7. The method, as recited in claim 6, which includes the further step of:

cleaning the endless-belt mask by returning the mask to the starting point through a brushing means.

8. A method for masking ferromagnetic articles having raised portions to be coated and flanged portions to be masked, the articles being moved along a track having first and third sections at one level and a second section therebetween at a higher level, the second section extending through a coating station, which comprises the steps of:

placing the articles on the first section;

indexing the articles one at a time along said first section to a reference point;

advancing a stainless steel endless-belt mask in successive steps, the belt having spaced apertures therein through which the raised portion of the articles to be coated may protrude, the apertures being sequentially aligned vertically with the reference point after each step;

energizing an alternating current electromagnet, which is aligned with the reference point and positioned above and adjacent the mask, to lift the individual articles from said first section of the track into the apertures of the mask as the apertures are aligned with the reference point, and to vibrate the articles to assist the raised portions in entering and protruding through the apertures, the successive mask advancing steps moving the lifted articles onto and along said second section of the track through the coating station;

dropping the coated articles from said second section and the mask to said third section of the track;

propelling the coated articles along said third section to a magazine for accumulation; and

cleaning the endless-belt mask by returning the mask to the starting point through a brushing means.

* * * * *