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METHOD AND MEANS FOR ADJUSTING ELECTRON BEAM TREATING POINTS

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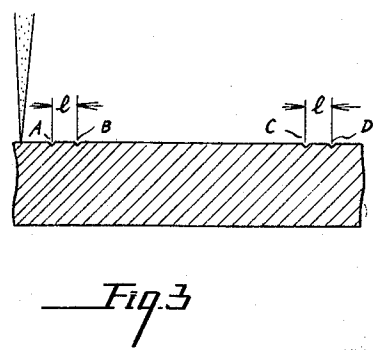
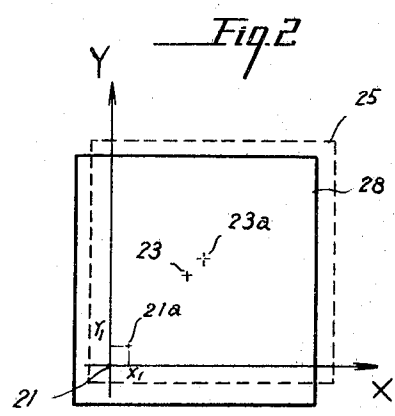
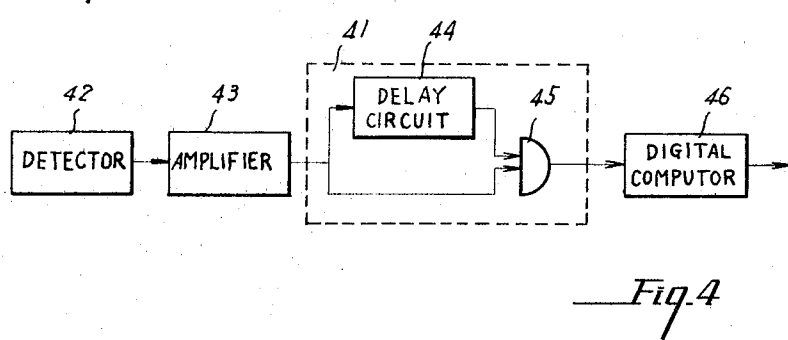
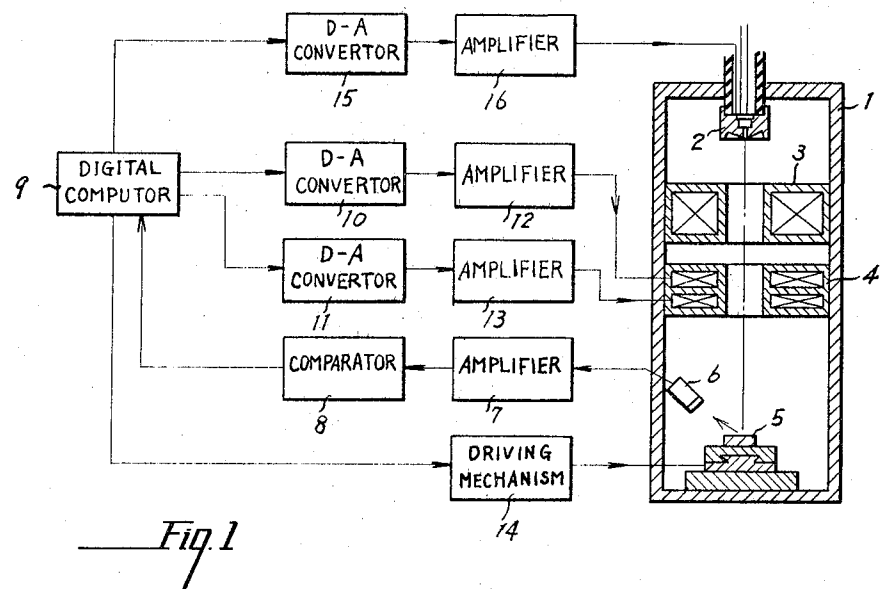


Fig. 2

Fig. 3

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METHOD AND MEANS FOR ADJUSTING ELECTRON BEAM TREATING POINTS

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7 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for accurately focusing an electron beam onto a workpiece treating point by a computer in which the coordinate of the treating point has been stored such that a signal derived from a datum point on the workpiece causes the computer to establish the coordinate of the treating point and to control the deflection of the electron beam or to rotate the workpiece support.

SPECIFICATION

My invention relates to an electron beam apparatus and, more particularly, to a means for automatically coinciding the electron beam with a treating point on a workpiece by providing a datum point on the workpiece.

Generally, a workpiece (for example, an integrated circuit, metal, etc.) is positioned or arranged within the housing of an electron beam apparatus in order to treat, groove, etc., the same where it has already been treated or, in fact, any other place on the workpiece. When this is done, the rearranged position may be different from the original position, causing accurate treatment to be difficult because of the impossibility of accurately aligning the positions.

In the conventional method, the treating point is usually adjusted by interposing a beam image of the surface of a workpiece by scanning it with an electron beam. This is generally accomplished by using a screen. However, because of the nature of the screen, it is impossible to obtain an accuracy of more than 10μ ; furthermore, because of beam distribution the interposition of the beam image becomes inaccurate.

My invention overcomes these disadvantages and difficulties by providing a means and a method for speedily and accurately coinciding the electron beam with the treating point.

My invention provides a means for accurately focusing an electron beam onto the treating point of a workpiece by utilizing a computer in which the coordinate of the treating point has been stored. The stored coordinates are programmed by the signal detected from a datum point marked on the workpiece, thereby controlling a deflection lens to cause the electron beam to coincide with the treating point. The computer can, alternatively, control a driving system for a workpiece holder to move the workpiece and effectuate a coincidence of the beam and the treating point.

These and other features and advantages of the present invention will become more apparent from a consideration of the following specification in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic diagram of the invention;

FIG. 2 shows electron beam and treating point coincidence;

FIG. 3 shows a part of a workpiece on which two sets of datum points are marked; and

FIG. 4 is a schematic diagram of a circuit for detecting datum points shown in FIG. 3.

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Referring to FIG. 1, a workpiece 5 is placed within a housing 1 of an electron beam apparatus. An electron gun 2 produces an electron beam which is focused by a focusing lens 3 so as to impinge upon the work piece 5 after deflection by a deflection lens 4. The workpiece is cut, grooved, bored, etc., in the form desired and has a bore, boundary layer, etc., as a datum point for the purpose of coinciding the beam position with a treating point. The datum point is located by scanning the workpiece with the electron beam, the intensity of which is insufficient for treating the workpiece. The signal obtained from the reflection of the beam at the datum point is detected by a detector 6 and fed into comparator 8 after amplification by an amplifier 7. Comparator 8 is adjusted so that a signal is produced and fed into digital computer 9 only when the datum point signal is applied.

In my invention, the computer 9 stores the coordinate of a treating point, and the coordinate of the treating point is compared with the signal of the datum point coordinate; the shift in value between the treating point and the datum point is then accurately converted into a proportional current and applied to the X and Y beam deflection coils so that the position of the workpiece relative to the electron beam can be controlled electrically by deflecting the beam, or alternatively, the shifted value, which is converted into current, may be applied to the workpiece driving mechanism. When locating the datum point, the electron beam is digitally controlled by the digital to analogue (D-A) converters 10 and 11, amplified by amplifiers 12 and 13 and then fed into the X and Y beam deflection lens 4. In the same way, signals for increasing or decreasing the beam intensity are fed from the computer to electron gun 2 via D-A converter 15 and amplifier 16. When computer 9 confirms the fact that the electron beam is coincident with the treating point, the intensity of the electron beam is increased to treat the workpiece in accordance with a signal from the computer.

In FIG. 2, full line 28 shows a theoretical workpiece pattern on which a theoretical datum point 21 is indicated. This datum point is stored in computer 9 and is utilized as the origin of the coordinate. Moreover, a theoretical treating position 23 is previously stored in computer 9 along with the mode of treating. The workpiece is then arranged within the housing of the electron beam apparatus, but it is very difficult to coincide the datum point 21a of the workpiece with theoretical datum point 21 which is the origin of the coordinate. The square indicated by the broken line 25 represents the actual workpiece. As apparent from these two squares, datum point 21a is shifted from origin 21 of the computer, thus making it necessary to locate the position of datum point 21a by scanning the workpiece with the electron beam. Since the beam intensity is insufficient for treating the workpiece, D-A converters 10 and 11 are set to supply an electric current to deflection lens 4 in order to scan the workpiece intermittently in accordance with the command of digital computer 9. When the beam impinges upon datum point 21a, i.e., the point where X_1 and Y_1 intersect, the signal is detected by the detector and fed into comparator 8, where it is compared and fed into computer 9. Computer 9 then confirms the position where the electron beam impinges upon datum point 21a. Consequently, the shifted values of the workpiece are X_1 and Y_1 , thereby translating the coordinate stored in computer 9 in order to coincide the origin with datum point 21a. In this way, the shifted values are converted into a proportional current or voltage and applied to deflection lens 4 or to driving mechanism 14. As a result, the electron beam can be electrically controlled so as to irradiate on the treating point 23a in accordance with the command of the computer. After which, the beam

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intensity is automatically increased in order to treat the workpiece at treating point 23a in accordance with the commanded treating mode.

In order to search the datum point, the scanning area of the workpiece may be divided into several small regions. When no datum point exists in one small region, the workpiece is moved in accordance with the command signal of the computer and the datum point is searched in another small region by scanning with the electron beam.

When a workpiece is to be treated more than once, it may be possible to mark the datum point at the beginning of the treatment or after the first treatment has finished, allowing the information to be stored without establishing a theoretical datum point.

It is also desirable to use two or more datum points when the workpiece is displaced rotationwise rather than just a single point. In this case, the rotation angle is calculated by digital computer 9 in the same way as when only one datum point is used, after which the compensating current or voltage is applied to the deflection lens.

Referring to FIG. 3, two sets of datum points are utilized, the points in each set being separated by distance l . It is preferable to make the datum points in the shape of a longitudinal groove, and, moreover, by providing two sets of datum points, the error of the specification of the datum point in accordance with the information of the groove, hollow, etc. can be decreased. In order to detect the signals arising from this type of datum point, a comparator circuit 41 as shown in FIG. 4 is used. By scanning the workpiece of FIG. 3 with the electron beam, the signal of datum point A is detected by detector 42 and amplified by amplifier 43. The amplified signal is then split and fed into a delay circuit 44 and an AND circuit 45. The delay circuit is arranged so that the signal is delayed by l/v sec., where l is the distance between the datum points A and B and v is the scanning speed of the electron beam. When the electron beam scans datum point B, the signal is detected by detector 42 and fed into comparator 41 via amplifier 43. The signal of datum point B is also split and fed into the delay circuit 44 and AND circuit 45. At this time, the signal of datum point A (delayed by l/v sec.) is fed into AND circuit 45, thus operating the AND circuit 45 and producing an output signal. The computer 46 stores the position of datum point B in accordance with the output signal from AND circuit 45. When the position of datum point B is coincident with the original position preset in computer 46, the computer produces a command for treating the workpiece so that the appropriate amount of current is applied to the electron gun to increase the beam intensity. On the position preset on the coordinate of the computer, the shifted value is calculated and the compensating current or voltage is applied to the deflection lens.

As aforementioned, when the workpiece is arranged rotationwise, datum points C and D are effectively used to calculate the rotation angle.

While I have shown and described preferred embodiments of my invention, it may otherwise be embodied within the scope of the appended claims.

I claim:

1. An electron beam apparatus for treating a workpiece having at least one datum point comprising:

(A) an electron beam source having at least a first and a second intensity, said first intensity being insufficient to treat the workpiece and said second intensity being sufficient to treat the workpiece;

(B) means for focusing said electron beam;

(C) means for deflecting said electron beam;

(D) means for detecting electrons reflected from the datum point when irradiated by said beam; and,

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(E) a computer means connected to said deflection means, said electron beam source and said detection means and having stored therein a datum point and coordinates of a treating point relative to that datum point, said computer means programmed to control the electron beam source and said deflection means to scan the workpiece at said first intensity to cause a signal from the datum point on the workpiece when irradiated which signal is transmitted to the computer means by said detecting means, said computer means comparing the coordinate of the detected signal and the stored datum point and transmitting a signal to said deflection means to coincide the beam with the treating point.

2. Apparatus as set forth in claim 1 wherein said detection means includes a comparator circuit for transmitting only the signal from the datum point of the workpiece to the computer.

3. Apparatus as set forth in claim 1 wherein said detecting means includes a delay circuit and an AND circuit and wherein said workpiece has at least two datum points whereby a signal from one of said datum points is detected and split and fed to said circuit, said delay circuit delaying the signal for a period equal to the time necessary for the beam to cause a signal from the other datum point to be detected.

4. A method of irradiating a workpiece at a treating point with an angularly adjustable, variable intensity electron beam comprising:

(A) establishing a datum point and a treating point on a coordinated pattern that is substantially identical to said workpiece;

(B) storing the coordinates of said points in a computer;

(C) placing a datum point on said workpiece;

(D) scanning said workpiece with an electron beam of intensity insufficient to treat said workpiece and sufficient to cause a signal in the form of electrons reflected from the datum point when irradiated;

(E) detecting said signal from said datum point;

(F) feeding said signal to a computer to calculate the coordinates of said datum point on the workpiece and to compare said coordinates with said coordinates stored in the computer to establish a command signal proportional to the coordinates of the treating point on said workpiece; and

(G) feeding said command signal to the electron beam to irradiate said workpiece at its treating point.

5. A method as set forth in claim 4 including supplying said command signal to means for angularly adjusting said beam to coincide with the workpiece treating point.

6. A method as set forth in claim 4 wherein at least two datum points on a pattern are established and stored in a computer and wherein at least two datum points are placed on said workpiece.

7. The method of claim 6 wherein a signal detected from one of said datum points is delayed for the period of time required to scan said other point and said detected signals are fed to the computer together to establish the coordinates of the treating point on the workpiece.

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