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"X-RAY DEVICE"

This invention concerns an X-ray device.

According to the present invention, there is provided an X-ray device comprising an X-ray tube; a shutter which is movable between an open position in which X-rays from the X-ray tube may be directed onto material to be tested and a closed position in which the said X-rays are prevented from being so directed; an X-ray detector for detecting fluorescent X-rays; means movable with the shutter for receiving X-rays from the X-ray tube and for directing fluorescent X-rays onto the X-ray detector only when the shutter is closed; and correction means connected to and controlled by said X-ray detector for automatically adjusting the X-ray tube when a change has occurred in the X-rays produced by the X-ray tube.

The means movable with the shutter is preferably a correction standard plate carried by the shutter.

The X-ray tube preferably has a collimator for collimating the X-rays from the X-ray tube.

5 The collimator preferably has a first passage therein which is arranged to receive X-rays from the X-ray tube, and second and third passages therein which can communicate with the first passage, the second passage being arranged to direct X-rays from the said first passage onto the X-ray
10 detector only when the shutter is closed, and the third passage being arranged to direct X-rays from the said first passage onto the material only when the shutter is open.

 The X-ray detector is preferably also responsive to fluorescent X-rays produced by the said material and is arranged
15 to produce signals related thereto, there being indicator or control means responsive to said signals for indicating the value of a property of said material or for exercising a control in dependence on said value.

 The correction means preferably comprises a wave height
20 discriminator and a scaler timer.

 The correction means is preferably controlled by a position sensor which senses the position of the shutter.

 The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

25 Figure 1 is a diagrammatic representation of a known X-ray device,

Figure 2 is a cross-sectional view of an X-ray device according to the present invention,

Figure 3 is a cross-sectional view of the device of Figure 2, the section of Figure 3 being at right angles to that of Figure 2, and

Figure 4 is a block diagram of the X-ray device shown in Figures 2 and 3.

In Figure 1 there is shown a known X-ray device comprising an X-ray tube 1 and an X-ray detector 2 which has openings 3a, 3b for the transmission of X-rays thereto. The X-ray detector 2 is arranged to receive X-rays from the X-ray tube 1 by way of a guide passage 4 which communicates with the opening 3a, and the X-ray detector 2 is also arranged to receive fluorescent X-rays which are reflected from sample material 6 by way of the opening 3b. The X-ray tube 1 is provided with a shutter 5 which is movable between an open position, in which X-rays from the X-ray tube 1 may be directed onto the sample material 6 so that fluorescent X-rays may be reflected from the sample material 6 and onto the X-ray detector 2, and a closed position in which the sample material 6 is prevented from receiving X-rays from the X-ray tube 1. The X-ray detector 2 is connected to a wave height discriminator 7, a scaler timer 8, and an automatic correction means 9 for correcting the X-rays produced by the X-ray tube 1 when the X-ray intensity and/or wave height changes.

In the known construction shown in Figure 1, corrected X-rays (i.e. X-rays whose intensity and/or wave height have been adjusted) are directed from the X-ray tube 1 onto the X-ray detector 2 while the shutter 5 is opened and the sample material 6 is receiving X-rays from the X-ray tube 1. However, there is an overlap between the spectrum of the X-rays from the X-ray tube 1 and the spectrum of the X-rays from the sample material 6 and this makes it difficult to effect an accurate measurement of a property of the sample material 6, e.g. the thickness of a layer thereon.

In Figures 2 to 4 there is therefore shown an X-ray device which overcomes the above-mentioned disadvantage.

As shown in Figures 2 and 3, an X-ray device according to the present invention comprises an X-ray tube 21 and a shutter 29. The shutter 29 is movable between an open position (not shown), in which X-rays from the X-ray tube 21 may be directed onto a sample material 28 to be tested, and a closed position (shown in Figure 2) in which the X-rays from the X-ray tube 21 are prevented from being so directed. The X-ray tube 21 has a collimator 21a for collimating the X-rays from the X-ray tube 21. The collimator 21a has a first guide passage 26 therein which is arranged to receive X-rays from the X-ray tube 21 and to collimate the X-rays because of its large diameter, and second and third guide passages 23, 27 therein which can communicate with the first passage 26. Mounted on the shutter 29 and

carried thereby so as to be movable therewith is a correction standard plate 22 which may be a thin gold plate or may be similar in composition and construction to that of the sample material 28. Thus if the sample material 28 is intended to be provided with a layer of a specific material having a specific thickness, the correction standard plate 22 is similarly provided with such a layer.

When the correction standard plate 22 is in the position shown in Figure 2 and is thus in the position in which the shutter 29 is closed, X-rays which are directed onto the correction standard plate 22 will produce fluorescent X-rays which will be directed through the second guide passage 23 and through an opening 25a onto an X-ray detector 24.

The third guide passage 27 is arranged to direct X-rays from the first guide passage 26 onto the sample material 28 only when the shutter 29 is open. That is to say, the first passage 26 and the third passage 27 communicate with each other only when the shutter 29 is open, these passages being out of communication with each other when the shutter 29 is closed. Fluorescent X-rays produced by the sample material 28 are directed onto the X-ray detector 24 by way of an opening 25b therein. The X-ray detector 24 which is thus responsive to the fluorescent X-rays produced by the sample material 28

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produces signals related to these fluorescent X-rays,
and means (not shown) are provided which are responsive to
these signals for indicating the value of a property of the
sample material 28 (e.g. the thickness of a surface layer
5 thereon) or for exercising a control (e.g. the control of
the thickness of said layer) in dependence upon said value.

The X-ray detector 24 is connected to and passes
electrical signals to a wave height discriminator 31. The
output of the wave height discriminator 31 is counted by a
10 scaler timer 32 and is passed to an automatic correction
means 33 which is arranged to correct the X-ray tube 21
automatically when there is a change in the X-rays produced
by the X-ray tube 21, e.g. when there is a change in the
wave height and/or intensity of the X-rays. A position
15 sensor 30 is provided which senses the position of the
shutter 29 and ensures that the correction in the X-rays
produced by the X-ray tube 21 occurs only at a time when
the shutter 29 is closed.

The arrangement may if desired be such that the
20 fluorescent X-rays which are received by the X-ray
detector 24 from the sample material 28 are compared with those
which are received from the correction standard plate 22,
the automatic correction means 33 being required to correct
the X-ray tube 1 only when there is a predetermined difference
25 between the two lots of fluorescent X-rays.

Thus in the case of the embodiment of the present invention shown in Figures 2 to 4, the X-rays from the X-ray tube 21 are directed onto the correction standard plate 22 by way of the guide passage 26 only while the shutter 29 is closed. When, however, the correction standard plate 22 is moved together with the shutter 29 to the open position of the latter, in which it is spaced from the axis of the X-ray tube 21, then since the third guide passage 27 is positioned over the sample material 28 and since the shutter 29 is moved from the position shown in Figure 2, X-rays are directed onto the sample material 28.

Since the position of the shutter 29 is detected by the position sensor 30, the X-ray device illustrated in Figures 2 to 4 is maintained in a correction mode only while the shutter 29 is closed.

~~[Since the corrected X-rays are transmitted to the]
[X-ray detector 24 only during the time that the shutter 29]
[is closed, the corrected X-rays do not affect a measuring]
[operation on the sample material 28]~~

C L A I M S

1. An X-ray device comprising an X-ray tube; a shutter which is movable between an open position in which X-rays from the X-ray tube may be directed onto material to be tested and a closed position in which the said X-rays are prevented from being so directed; an X-ray detector for detecting fluorescent X-rays; means movable with the shutter for receiving X-rays from the X-ray tube and for directing fluorescent X-rays onto the X-ray detector only when the shutter is closed; and correction means connected to and controlled by said X-ray detector for automatically adjusting the X-ray tube when a change has occurred in the X-rays produced by the X-ray tube.

2. An X-ray device as claimed in claim 1 in which the means movable with the shutter is a correction standard plate carried by the shutter.

3. An X-ray device as claimed in claim 1 or 2 in which the X-ray tube has a collimator for collimating the X-rays from the X-ray tube.

4. An X-ray device as claimed in claim 3 in which the collimator has a first passage therein which is arranged to receive X-rays from the X-ray tube, and second and third passages therein which can communicate with the first passage,



the second passage being arranged to direct X-rays from the said first passage onto the X-ray detector only when the shutter is closed, and the third passage being arranged to direct X-rays from the said first passage onto the material only when the shutter is open.

5. An X-ray device as claimed in any preceding claim in which the X-ray detector is also responsive to fluorescent X-rays produced by the said material and is arranged to produce signals related thereto, there being indicator or control means responsive to said signals for indicating the value of a property of said material or for exercising a control in dependence on said value.

6. An X-ray device as claimed in any preceding claim in which the correction means comprises a wave height discriminator and a scaler timer.

7. An X-ray device as claimed in any preceding claim in which the correction means is controlled by a position sensor which senses the position of the shutter.

8. An X-ray device substantially as hereinbefore described with reference to and as shown in Figures 2-4.

