Rotating anode for an X-ray tube of which at least the target area is made of an alloy which contains from 1 to 5% by weight of rhenium and from 0.1 to 4% by weight of tantalum, the remainder being tungsten.

2 Claims, 1 Drawing Figure
ROTATING X-RAY ANODE HAVING A TARGET AREA MADE OF A TUNGSTEN RHENIUM TANTALUM ALLOY

The invention relates to a rotating anode for an X-ray tube in which at least the target area for the electrons consists of a ternary alloy of tungsten, rhenium and tantalum containing from 1 to 5% of rhenium.

Rotating anodes of this type are described in Netherlands Patent Specification No. 127,039. In this specification it is stated that rotating anodes provided with a target area for the electrons which is made of tungsten containing from 1 to 5% by weight of rhenium are roughened only at greatly increased loads owing to the high ductility of this alloy. However, from the literature it is known that the most effective rhenium content lies at approximately 10% by weight, because with this alloy the so-called dose losses are not appreciably smaller than with alloys containing a higher percentage of rhenium. However, melting phenomena in the path of the focal spot which also may give rise to dose losses are produced only at far higher loads (cf. Sedlatschock and Elsas, "Hohere Belastung von Drehanodenrohren durch Verwendung von legierten Anoden" (Increased loading of rotating anode tubes by the use of alloyed anodes) in Zeitschrift fur angewandte Physik. 15. 2 (1963) pages 175-178, and Netherlands Patent Specification No. 122,291). Hence in practice rotating anodes for X-ray tubes are used which are provided with target areas for the electrons which consist of a tungsten alloy containing about 10% by weight of rhenium. In the Netherlands Patent Specification No. 127,038 it is stated that from 5 to 25% by weight of the tungsten may be replaced by tantalum. In Netherlands Patent Specification No. 122,291, which also relates to rotating anodes for X-ray tubes made of a tungsten alloy containing rhenium, in which however the rhenium content ranges from 5 to 35% by weight, the same statement is made with the addition that the thermal resistance of tungsten rhenium alloys is increased by the addition of tantalum. However, as is known ternary alloys of this nature are not used for the said purpose, probably because of the likelihood that at the proposed percentages of tantalum melting phenomena in the path of the focal spot will occur, as is the case at high rhenium contents. In this connection it should be stated that the melting point of rhenium is about 3180°C and that of tantalum is about 2996°C. Rhenium is a very expensive metal and the content of 10% by weight as used in practice is one of the main causes of the high prices of rotating anodes for X-ray tubes. Reducing the rhenium content to percentages by weight between 1 and 5 in general entails a deterioration of rotating anodes for X-ray tubes made of such alloys. Not only are the dose losses increased at the same number of loads compared with the use of alloys containing 10% by weight of rhenium (see Fig. 9 in the aforementioned paper), but also this deterioration generally sets in at a slightly earlier stage. The high-temperature resistance of alloys containing smaller percentages of rhenium is lower, so that the so-called dishing effect of the rotating anodes also has to be taken into account. The dishing effect causes the angle of the path of the focal spot relative to the rotating anode to be changed. This also gives rise to dose losses.

It is an object of the invention to avoid the said disadvantages and to provide rotating anodes for X-ray tubes the target areas of which for the electrons comprise a ternary alloy of tungsten, rhenium and tantalum containing a percentage by weight of rhenium of between 1 and 5%.

A rotating anode for an X-ray tube which satisfies the requirement according to the invention is characterized in that the target area is made of a ternary tungsten alloy containing from 1 to 5% by weight of rhenium and from 0.1 to 4% by weight of tantalum, the remainder being tungsten.

It has been found that within the percentages stated alloys can be made for making rotating anodes which in respect of the dose losses at equal loads are comparable in quality to rotating anodes the target areas of which consist of a tungsten alloy containing 10% by weight of rhenium, the remainder being tungsten. The surprising effect of small percentages of tantalum was not to be expected on the strength of the literature. Not only are the tantalum percentages mentioned in this connection higher but also it cannot be read at all from the literature that the use of such an alloy for manufacturing the target areas for the electrons in rotating anodes for X-ray tubes enables the rhenium content to be reduced to values of less than 5% by weight without the risk of premature dose losses if the alloy contains small amounts of tantalum. On increasing the tantalum content to more than 4% by weight no further advantages are obtained but on the contrary this may give rise to melting phenomena on loading of the anode.

In a preferred embodiment of the invention the alloy from which the target area for the electrons is made comprises from 2.5 to 3.5% by weight of rhenium and from 0.1 to 2% by weight of tantalum, the remainder being tungsten. These alloys give the best results. In this connection, the term "target area" is used to mean at least the area of impact of the electrons, the so-called focal spot path.

The support for the rotating anode of an X-ray tube preferably is made of a molybdenum alloy having a high thermal resistance, a high recrystallisation temperature and a transition from brittle to ductile at a temperature below room temperature. Examples of suitable alloys are alloys containing small amounts of titanium, zirconium and carbon, such as the alloys known under the trade names TZM and TZC the compositions of which are stated to be from 0.40 to 0.50% by weight of titanium and from 0.06 to 0.12% by weight of zirconium, the remainder being molybdenum, and about 1.25% by weight of tantalum, from 0.5 to 0.25% by weight of zirconium and from 0.15 to 0.30% by weight of carbon, the remainder being molybdenum, respectively.

A rotating anode according to the invention is preferably manufactured by joining a disc made of the ternary tungsten alloy to a disc made mainly of molybdenum by cold deformation by means of a single blow of large energy content between plane die blocks with reduction in thickness and increase in diameter of both discs. From the resulting disc a rotating anode is manufactured in a known manner.

Obviously a support made of carbon or graphite may also be used, the target area being secured to the support, for example, by brazing or by another method known for this purpose.

EXAMPLE I

A rotating anode was manufactured which comprises...
a target area made of a ternary tungsten alloy containing 3% by weight of rhenium and 0.4% by weight of tungsten, the remainder being tungsten, and a support made of a molybdenum alloy containing 0.5% by weight of titanium and 0.08% by weight of zirconium, the remainder being molybdenum. Tests have shown that after an equal number of loads of equal type this rotating anode has smaller dose losses than a rotating anode of equal structure provided with a target area made of a tungsten-rhenium alloy containing 10% by weight of rhenium.

EXAMPLE II

Results similar to those obtained in Example I were obtained when the target area of the anode consisted of a tungsten-rhenium-tantalum alloy containing 3% by weight of rhenium and 1.5% by weight of tantalum, the remainder being tungsten.

The single FIGURE of the accompanying drawing shows curves which show the relationship between dose yield D in rontgen per second, plotted logarithmically along the vertical axis, and the number of loads B, plotted logarithmically along the horizontal axis.

The curve 1 relates to a rotating anode as described in Example I and the curve 2 relates to a rotating anode as described in Example II. The other curves in the FIGURE relate to rotating anodes having target areas which respectively consist in curve 3 of tungsten, in curve 4 of a tungsten-tantalum alloy containing 0.33% by weight of tantalum, the remainder being tungsten, in curve 5 of a tungsten-rhenium alloy containing 5% by weight of rhenium, the remainder being tungsten, in curve 6 of a tungsten-tantalum alloy containing 1.23% by weight of tantalum, the remainder being tungsten, in curve 7 of a tungsten-rhenium alloy containing 10% by weight of rhenium, the remainder being tungsten.

A comparison of these curves clearly shows the advantages of the use of the alloys described for manufacturing the target area of a rotating anode both in respect of the decrease in dose and in respect of the instant in which this decrease sets in, as compared, for example, to tungsten and to tungsten-rhenium alloys.

What is claimed is:

1. A rotating anode for an X-ray tube in which at least the target area for electrons is made of a ternary alloy consisting essentially of about 1 to 5% by weight of rhenium, about 0.1 to 2% by weight of tantalum, and the balance tungsten.

2. A rotating anode as in claim 1, wherein said target area consists essentially of a ternary tungsten alloy which contains about 2.3 to 3.5% by weight of rhenium about 0.1 to 2% by weight of tantalum, and the balance tungsten.

* * * *