

Aug. 9, 1932.

M. MORRISON

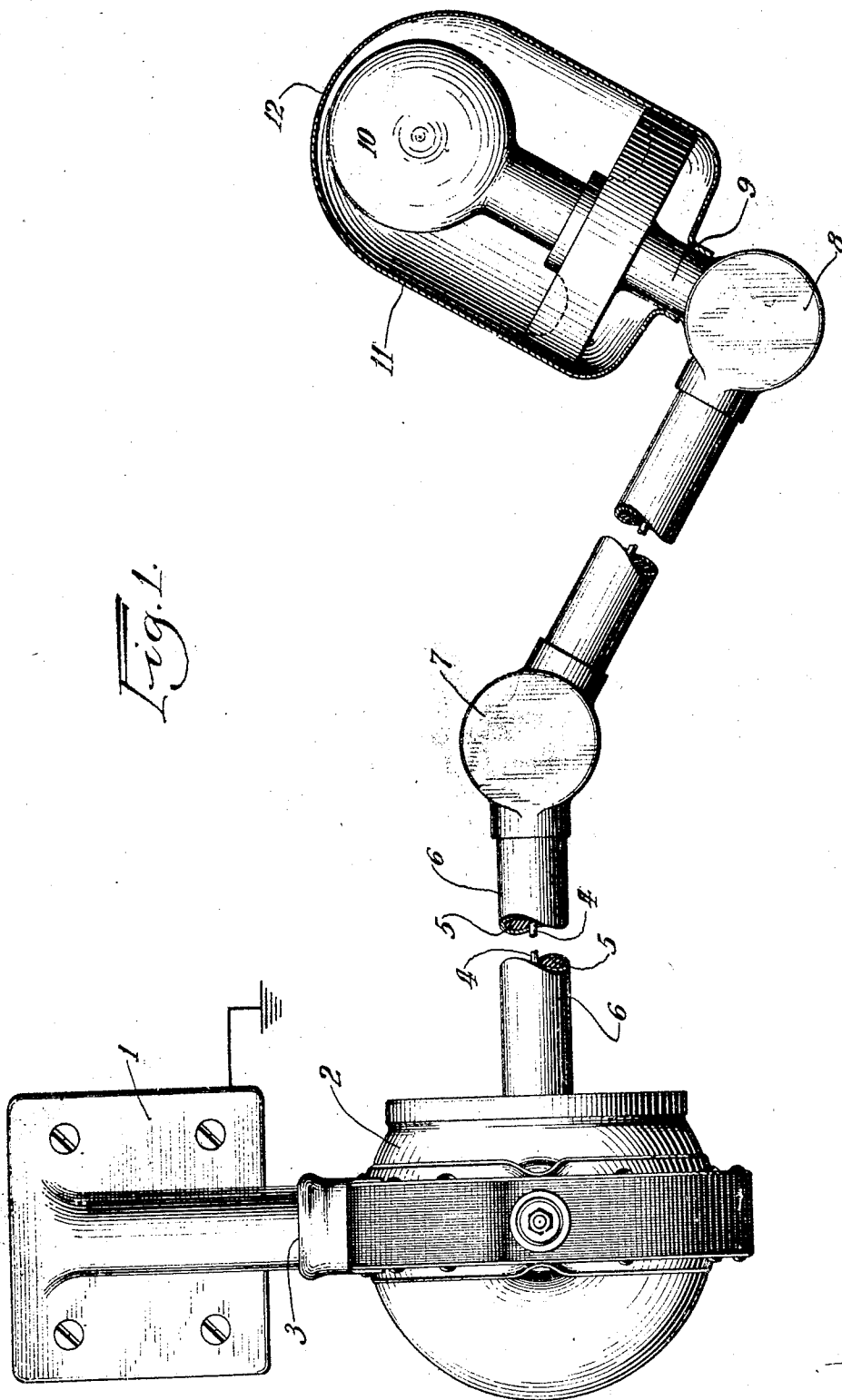
1,870,959

X-RAY APPARATUS

Filed April 13, 1925

4 Sheets-Sheet 1

Fig. 1.



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4 Sheets-Sheet 2

Fig. 2.

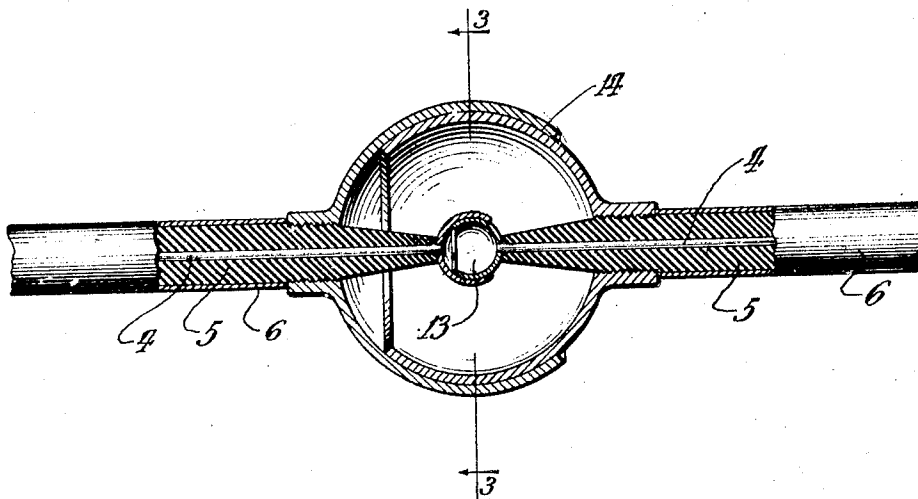
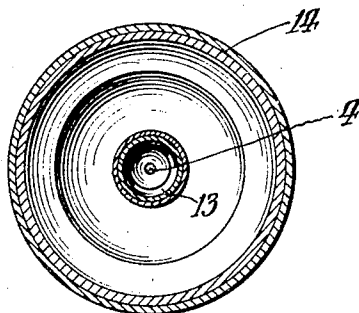


Fig. 3.



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4 Sheets-Sheet 3

Fig. 4.

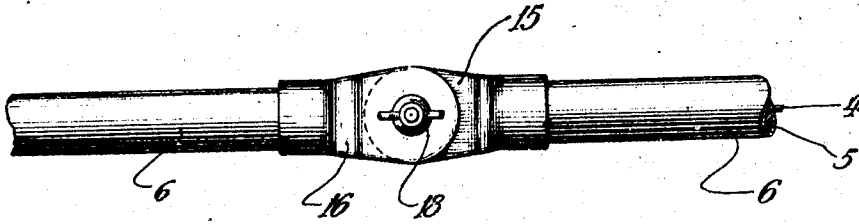
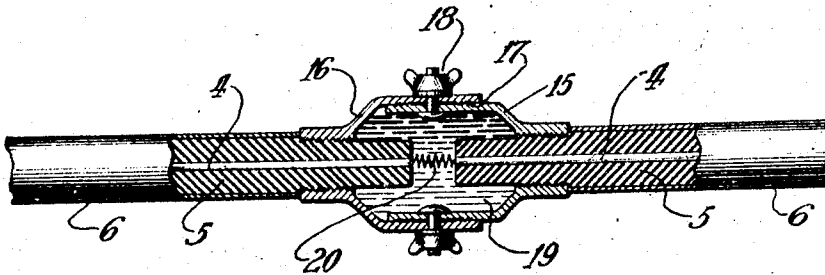


Fig. 5.



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4 Sheets-Sheet 4

Fig. 6.

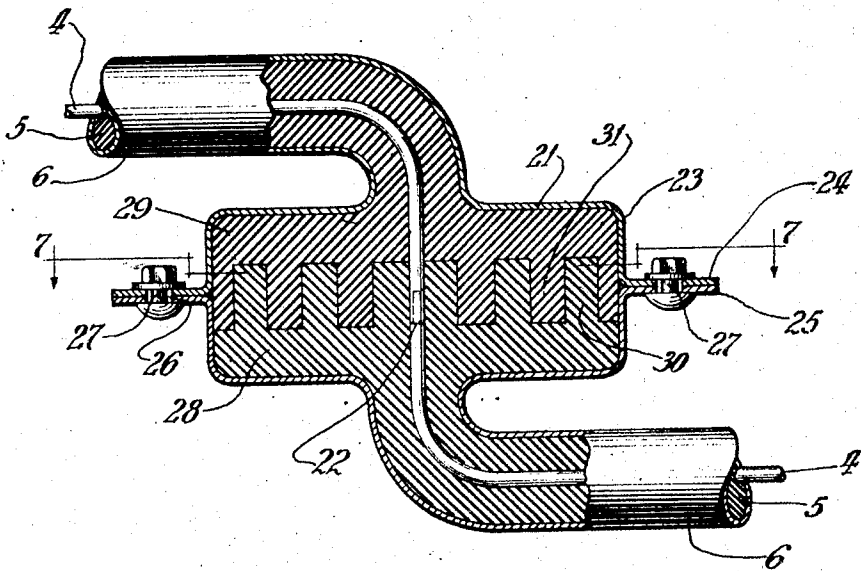
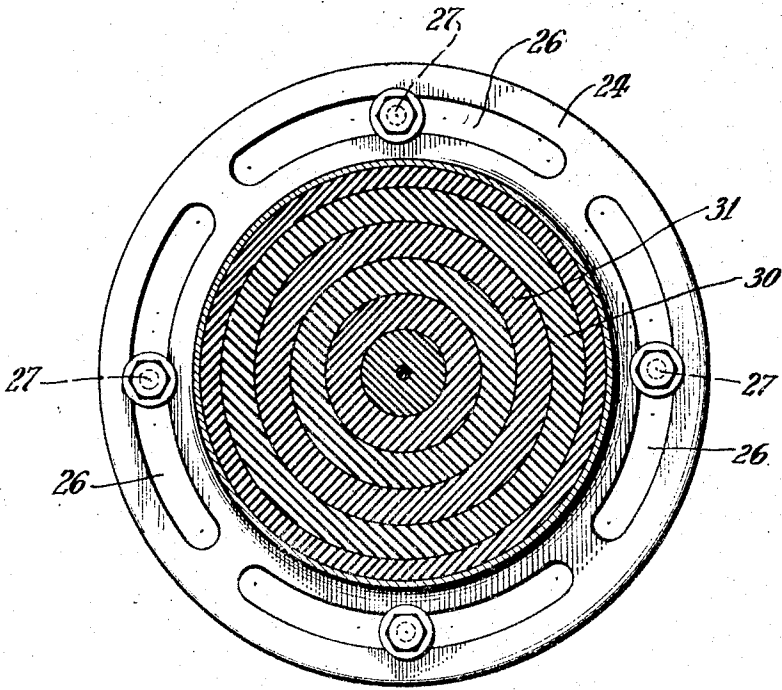


Fig. 7.



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UNITED STATES PATENT OFFICE

MONTFORD MORRISON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
WESTINGHOUSE X-RAY COMPANY, INC., A CORPORATION OF DELAWARE

X-RAY APPARATUS

Application filed April 13, 1925. Serial No. 22,665.

My present invention relates to the use and manipulation of X-ray tubes in practical radiographic, diagnostic and therapeutic use and has as a general object an improved construction which is entirely safe from electrical shock without some of the inherent disadvantages of apparatus in the prior art.

More specifically, my invention relates to a system of electrical conductors and a supporting structure for X-ray tubes. Among the specific objects of my invention are; first, to provide an absolutely shockproof apparatus; second, to provide a structure which permits of the source of high voltage supply current for the tube to be mounted separately from the tube and still retain the shockproof qualities; and third, to provide a structure which may be integrally a system of high voltage conductors and mechanical supporting structure for the tube.

Further and other objects will be in part pointed out and part obvious to those skilled in the art to which my invention appertains, upon digesting the following specification and studying drawings herein referred to.

I attain these objects by the construction disclosed in the accompanying drawings, which illustrate some practical embodiments of my invention.

In the drawings, Figure 1 is a general view, partly in elevation and partly in section, of one of the complete embodiments of my invention, and Figures 2, 4, and 6 are detailed embodiments which may form a part of Figure 1. Figure 3 is a cross section of Figure 2 taken through the lines 3, Figure 5 is a cross section taken through Figure 4 parallel to the plane of the paper, Figure 7 is a cross section of Figure 6 taken through the line 7.

This invention is related to my Patent 1,466,541, issued August 28, 1923, and to my patent applications Serial Numbers 476,155 filed June 9, 1924; 540,141 filed March 1, 1922; 559,569 filed May 9, 1922; 566,961 filed June 9, 1922; 633,712 filed April 21, 1923; 669,315 filed October 18, 1923, and 674,927 filed November 15, 1923.

In the prior art attempts to construct X-ray tube apparatus which would be entirely shockproof during operation, has al-

ways resulted in structures in which the X-ray tube is mounted integrally with the high voltage transformer or some very closely related arrangement. These structures serve reasonably well where they do not have to be supported or suspended in a space for manipulation around about the human body. Attempts to construct very small transformers and combine them with X-ray tubes integrally and support this combined structure by some framework so that the tube may be manipulated about the patient, has always resulted in a very unsatisfactory structure from a practical standpoint, in that the very smallest dimensions and weight which may be used in the high tension transformer produce a heavy mass which tends to oscillate in pendulum fashion at the end of the supporting structure, causing blurring of details in the X-ray shadowgraphs made, and therefore rendering them in many cases useless so far as interpretation is concerned.

Further in the prior art attempts to separate the tube and the source of exciting high potential has always resolved itself into complicated structure for guiding and trying to hold out of the way the dangerous high voltage conductors which lead the high-voltage current from the source of potential to the tube.

In the device herein described, I combine the supporting structure and the system of high voltage conductors into an integral structure, and not only thereby make a safe and effective means for insulating the high voltage conductors but also attain a simple and strong supporting structure for the tube.

Obviously I may in some cases find the addition of some mechanical framework advantageous or even the combination of my herein disclosed structure with other and existing structures now in use.

In Figure 1, I illustrate a specific structure which is not complete in the most minute details but sufficiently complete to illustrate an embodiment of my invention, when particularly applied to dental X-ray work, and in the figure, 1 is a primary support which may be screwed to the wall or formed as a part of the so-called dental units which are used in

dentists' offices, and which in general contain or have attached thereto practically all of the mechanical apparatus used by the dentist. In this way I obviate the necessity of an especially large or expensive supporting structure which would otherwise be required. 2 is a high voltage transformer which may be a transformer alone or combined with a rectifier. In the illustration I have shown the outline of a transformer already fully described in my patent application 669,315, filed October 18, 1923. The transformer 2 swivels about a vertical axis 3 which gives one degree of freedom to the system as a whole.

15 The low voltage conductors within the transformer and the circuits employed therewith are fully described in the above-mentioned specification and will not be discussed here.

20 The support 1 and the case of the transformer 2, is operated at ground potential as indicated.

The present embodiment illustrates a form of transformer which has one high voltage terminal brought out insulated from the transformer tank, and the other high voltage terminal connected directly to the transformer tank and operated at ground potential. The above-ground-potential high-voltage conductor emerging from the transformer is illustrated by the rod 4 which is surrounded by an insulating bushing 5, which is in turn surrounded by a grounded shield 6. The high voltage conductor 4 is led into and through an insulating joint 7 hereinafter described and thence through one or more elements of conductors, insulated bushings and ground shields such as just described, through and to a second insulating joint 8, which may be similar to joint 7, and thence through an insulated bushing 9 to the X-ray tube 10.

X-ray tube 10, and in general the shield around it, has been described in the last referred to patent application and, therefore, will not be described in detail here. The X-ray tube 10 may be surrounded by a grounded shield 11 which may act not only as a protection against high voltage, but also as a protection against stray X-rays when desired. In some cases the material may be translucent at an area where the X-rays emerge from the shield, such as the location 12, and opaque to the X-rays elsewhere.

It will be observed that with three degrees of freedom, a system comprising such a jointed structure may turn into any desired position. Obviously, the transformer 2 need not be integral with the primary support described, but may be located at any convenient place.

Referring to Figures 2 and 3, I shall now describe one set of joints which I may employ at 7 and 8 in Figure 1. The high tension conductor, insulated bushing and grounded shield in this figure are numbered as before.

The high voltage conductor 4 is brought out to a ball and socket joint 13. Concentric with this ball and socket joint 13 is a second ball and socket joint 14 connected to the ground shield 6, and the radius of curvature of the external surface of ball and socket joint 13 is of such a value that when positioned concentrically with the inner surface of the ball and socket 14, together with the difference between the two radii of curvatures, that spark-over does not occur between these two surfaces during use of the tube at operating voltages thereof.

It will be appreciated by those skilled in the art or by reference to the last mentioned patent application, that the internal rod 4 forms a conductor for the high-potential developed at the terminal of the X-ray tube and the ground shield 6 forms the conductor for the other main-terminal of the X-ray tube. Of course, the X-ray tube may have more than two terminals; as a matter of fact, the X-ray tube described in the last mentioned patent application has three terminals but this will not cause confusion among those skilled in the art.

Figure 3 is a cross section of Figure 2, taken through the lines indicated and does not require particular description.

I do not limit myself to gaseous insulation in these joints, such as air, and such as may be used in the embodiment of my invention illustrated in detail in Figures 2 and 3, but also find I can use oil-insulation with considerable success in specific cases.

Rather than fill the joint illustrated in Figures 2 and 3 with oil, I find as a more practical embodiment of my invention a liquid insulating joint, such as that illustrated in Figures 4 and 5. The joint permits of less expensive construction and is more effective in making it liquid-tight. The high voltage conductor, insulating bushing and ground shield bear the same numbers as before, but instead of the concentric ball and socket joints, I utilize a flexible oil container 15 which is shown in the section in Figure 5 having an outer case 16, with a liquid seal at 17 held tight by clamping device 18. The chamber 19 is filled with a liquid insulating medium and the two ends of conductors 4 are bound together by a flexible coupling 20. This form of joint produces quite a satisfactory structure and somewhat smaller in practice than that illustrated in Figures 2 and 3.

The joint illustrated in Figures 4 and 5 obviously may be substituted in position of the joints 7 and 8 in Figure 1.

Since I do not limit myself to the particular kind of joint utilized in my invention, I illustrate a third structure employing solid insulation for the joints 7 and 8, Figure 1. This third embodiment is shown in Figures 6 and 7. The high voltage conductors, insulated bushings and the grounded shield bear

the same numbers as before. In this particular embodiment the high voltage conductor 4 is run entirely through the joint 21, said high voltage conductor being separated at 22, so that it may turn about an axis through the joint without producing mechanical stress in the conductor. The ground shield 6 in this joint is developed into or made electrically a part of a housing 23, which is provided with flanges 24 and 25, as shown in Figures 6 and 7. These flanges are also provided with means for allowing them to turn with reference to each other. Such a structure, for instance, may be one employing slots 26 with bolts 27, to hold the flanges together, thus allowing the tube-housing halves to turn with reference to each other, and each half to take with it such other parts as may be affixed thereto.

The insulation of this joint is provided by using solid material 28 and 29, and by interleaving it or by the use of annular barriers such as 30 and 31, to provide sufficient high voltage insulation between the high voltage conductor 4 and ground shield 6. Two or more of any of the above described joints may be used as a part of the structure illustrated in Figure 1.

As will be appreciated, I have not limited myself to the precise details of structure to be employed in the practical embodiment of my invention, but have disclosed a class of electrical joints; utilizing, first, gaseous; second, liquid; and third, solid insulation, which have been described to be used in conjunction with certain other elements which form a description of my invention, but the scope of which will be better understood from the following claims.

What I claim is:

1. A jointed conductor for X-ray tube circuits comprising two internal conductor members fixed to an internal ball and socket joint, each said internal conductor member surrounded by an external conductor member and insulated therefrom, the two said external conductor members being fixed to an external hollow ball and socket joint concentric with the aforesaid ball and socket joint and spaced therefrom.

2. A jointed conductor for X-ray tube circuits comprising two internal conductor members fixed to a common internal flexible joint having a rounded contour, each said internal conductor member being surrounded by an external conductor member and insulated therefrom, the two said external conductor members being fixed to a common external hollow flexible joint having a rounded internal surface and concentric with the aforesaid internal flexible joint, said internal and external flexible joints having a substantial air-gap therebetween, whereby the formation of corona between the opposed surfaces of the said internal and external

joint is substantially prevented at operating voltages thereof.

3. In an X-ray device, an X-ray tube and a primary support, said tube and said support being connected by a jointed conductor comprising two internal conductor members fixed to a common internal flexible joint, each said internal conductor member surrounded by an external conductor member and insulated therefrom, the two said external conductor members being fixed to a common external hollow flexible joint concentric with the aforesaid internal joint, the said internal and external flexible joints having a substantial air-gap therebetween.

4. In an X-ray device, the combination of an X-ray tube and a holder therefor, means for supporting said holder comprising a tubular section, a swivel joint connecting said section to said holder, an electric conductor internally concentric with said tubular section and insulated therefrom, a swivel joint for said electric conductor disposed internally of said first mentioned swivel joint and spaced therefrom to provide a substantial air-gap therebetween.

5. In an X-ray device the combination of an X-ray tube and a holder therefor, a support for said holder comprising a plurality of grounded tubular sections, swivel joints connecting adjacent sections to each other, an electric conductor internally concentric with each of said tubular sections and insulated therefrom, a plurality of swivel joints connecting the electric conductor of one section to the electrical conductor of the adjacent section, said last mentioned swivel joints being disposed internally of said first mentioned swivel joints and spaced therefrom to provide a substantial air-gap therebetween.

6. In an X-ray device, the combination of an X-ray tube and a holder therefor, a support for said holder comprising an outer grounded conductor, a ball and socket joint connecting said outer conductor to said holder and to said tube, an inner conductor concentric with said outer conductor and insulated therefrom, a ball and socket joint connecting said inner conductor to said tube disposed axially of said outer ball and socket joint and provided with a substantial air-gap between each of said ball and socket joints.

7. In an X-ray device, the combination of an X-ray tube and a holder therefor, a support for said holder comprising an outer conductor, a swivel joint connecting said outer conductor to said holder and to said tube, an inner conductor concentric with said outer conductor and insulated therefrom, a swivel joint connecting said inner conductor to said tube disposed internally of said first mentioned swivel joint and proportionally spaced therefrom, relative to the voltages at

which the tube is designed to operate, that the formation of corona therebetween is substantially prevented.

5 8. In a shock proof X-ray unit the combination with an X-ray tube and a holder therefor of a support for said holder comprising a plurality of grounded metallic sections pivotally connected to each other, a high tension source of energy for said X-ray tube
10 remotely disposed therefrom, a plurality of conductors concentrically disposed internally of said metallic sections and insulated therefrom, said conductors being pivotally connected to each other, said pivotal connections
15 being co-axially disposed relative to the pivoted connections of said metallic sections, said metallic sections and said conductors being arranged to transmit energy from said source to said X-ray tube and the respective
20 pivoted connections of said sections and said conductors being sufficiently insulated from each other to prevent formation of corona during operation of said X-ray tube.

9. In a shock proof X-ray unit the combination of an X-ray tube and a metallic holder therefor, means for supporting said holder comprising a plurality of grounded metallic sections pivotally connected together, a conductor internally concentric with each of said
30 sections, the conductor of each of said sections being pivotally connected to the conductor of the adjacent section and said last mentioned pivotal connections being co-axially disposed with respect to the pivotal
35 connections of said sections and insulated from said sections.

In testimony whereof, I hereunto affix my signature this 8th day of April, 1925.

MONTFORD MORRISON.

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