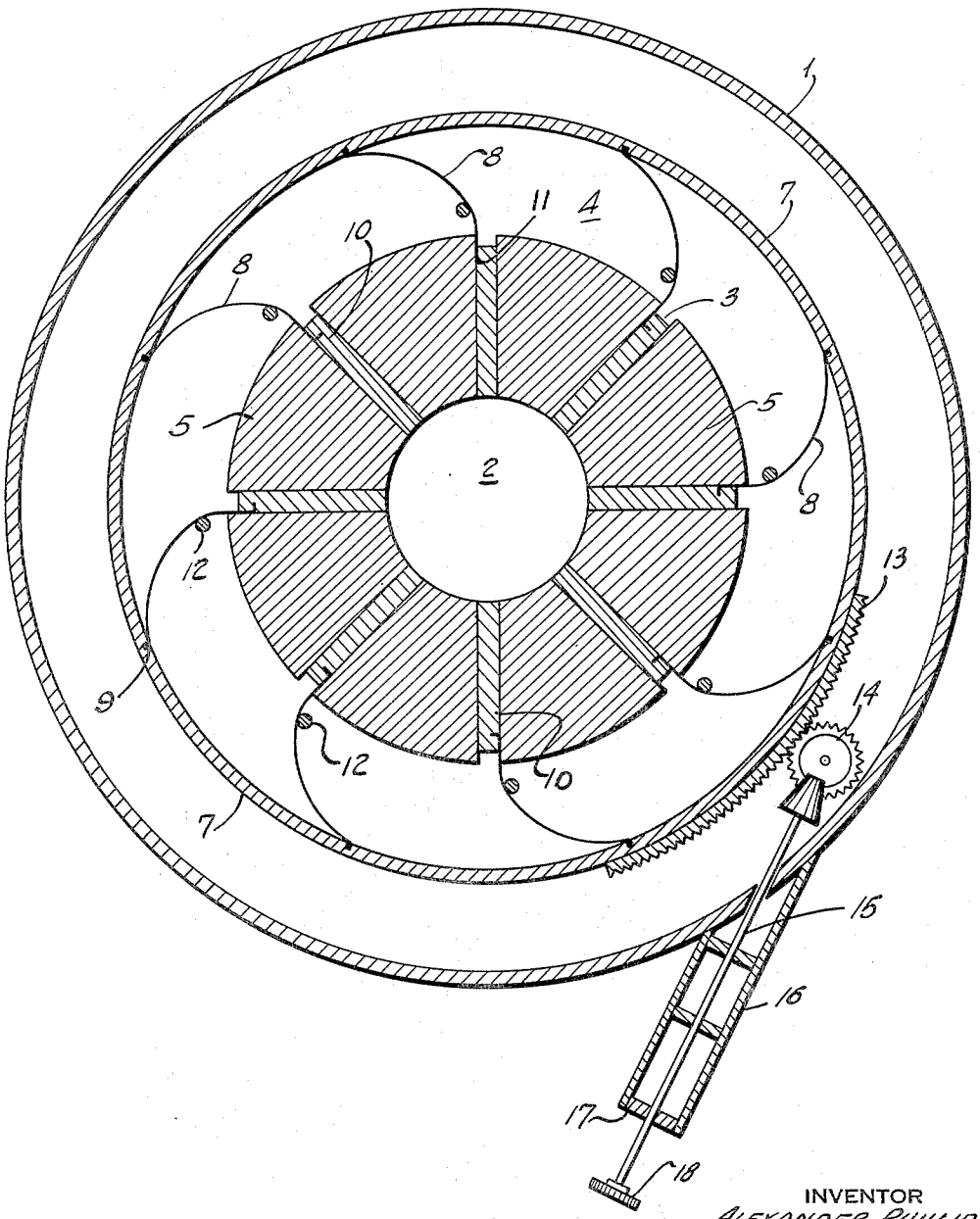
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MAGNETRON TUNER

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Fig. 1.



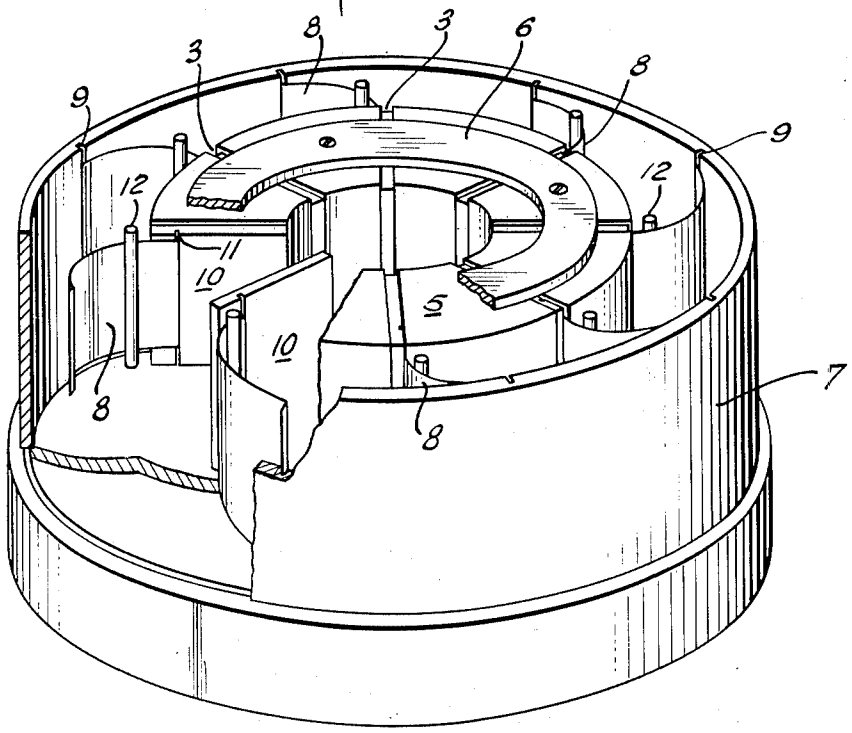
INVENTOR
ALEXANDER PHILLIPS
BY George Sibalkin
Leo J. Muntzberger
ATTORNEY

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MAGNETRON TUNER

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Fig. 2.



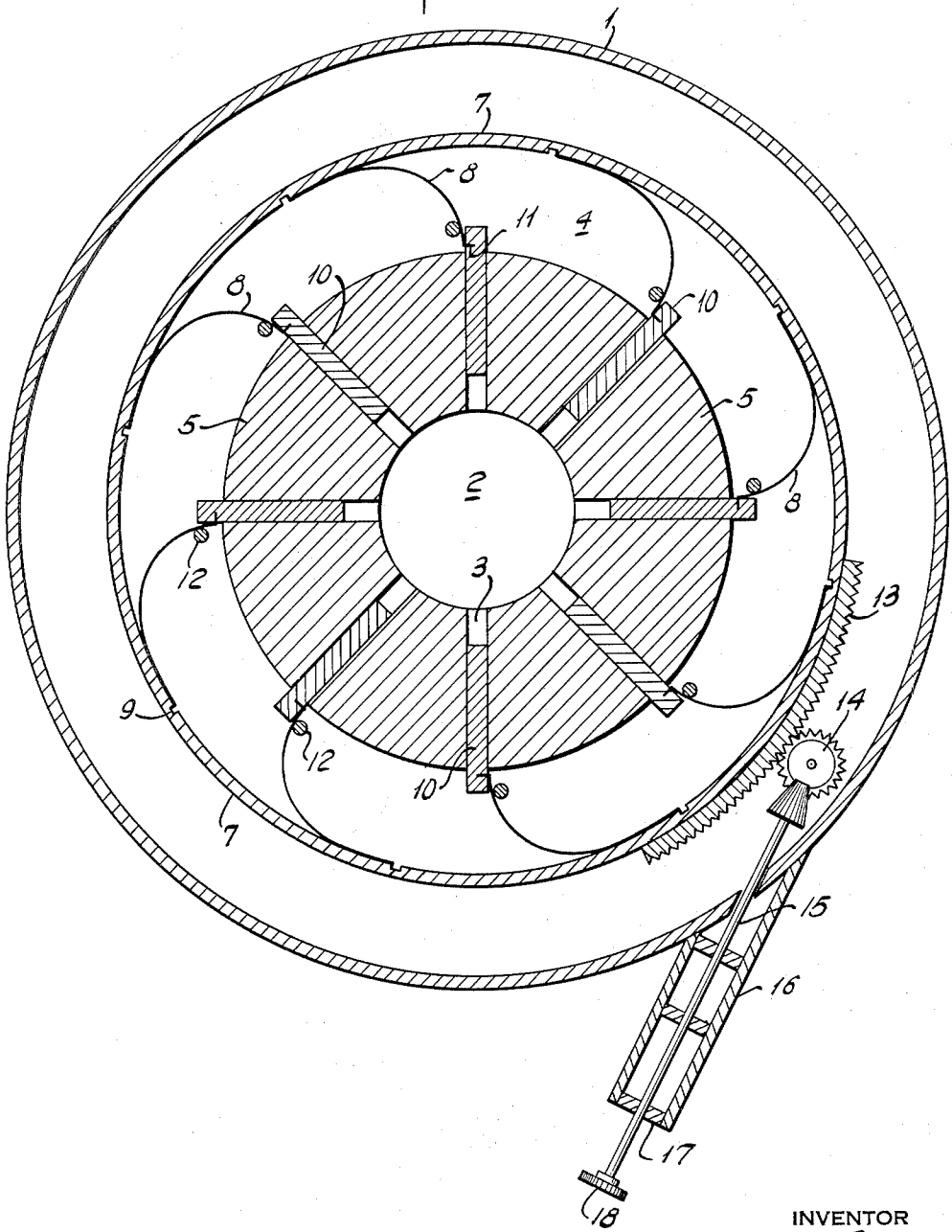
INVENTOR
ALEXANDER PHILLIPS
BY George Sipkin
Lee J. Hunt Berger
ATTORNEY

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Fig. 3.



INVENTOR
ALEXANDER PHILLIPS
BY Lee J. Hunzberger
George Sibkin
ATTORNEYS

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MAGNETRON TUNER

Alexander Phillips, Sudbury, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application February 10, 1955, Serial No. 487,476

8 Claims. (Cl. 315—39.61)

This invention concerns a tuner for multicavity magnetrons and more particularly an improved tunable magnetron.

Although multicavity magnetrons are designed to operate at a predetermined frequency, the operating frequency varies in accordance with the impedance presented to the magnetron by a load and a connecting transmission line from the magnetron to the load. It is therefore desirable to tune multicavity magnetrons in operation. Such tuning is accomplished by variation in the resonating properties of the magnetron.

The principal object of this invention is the provision of an improved tuner for multicavity magnetrons.

An object of this invention is the provision of a magnetron tuner which varies the size and shape of each cavity of a multicavity magnetron.

Another object of this invention is the provision of an improved magnetron having a tuner and being tunable over a broad band of high frequencies.

A further object of this invention is the provision of a tuner which varies the operating frequency of a multicavity magnetron rapidly and efficiently.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood be reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a cross-sectional view of the anode of a multicavity magnetron embodying the improved tuner of the present invention and wherein the slot blocks of the tuner are in one extreme position wherein they close the cavity resonators of the magnetron;

Fig. 2 is a perspective view of the multicavity magnetron anode shown in Fig. 1 with the tuner in the same position as in Fig 1; and

Fig. 3 is a cross sectional view of the anode with the blocks of the tuner retracted to open the cavity resonators.

The tuner of the present invention is shown installed for operation with an unstrapped, symmetrical magnetron resonator having a slot type cavity resonator anode; this is for the purpose of clarity of illustration. The tuner of the present invention may be utilized with all types of multicavity magnetrons, including strapped or unstrapped magnetrons, having hole and slot or vane type cavity resonator anodes.

The magnetron anode of Figs. 1 and 2 is positioned within a vacuum-tight container cylinder 1. As is well known in the art, a cathode (not shown in the figures) may be positioned, coaxially with the central axis of the unit, in the central area 2 bounded by the anode. The cathode (not shown in the figures) may contain a heating element (not shown in the figures) which may be supplied by suitable electric conductors (not shown in the figures) entering the vacuum area bounded by the container cylinder 1 via suitable seals (not shown in figures), as is well known in the art.

The anode comprises a multicavity resonator having

a plurality of cavity resonators or radial slots 3 opening from a central axis in the area 2 to the annular area 4. The portions of the anode block form anode segments 5 between the radial slots 3; the yoke 6 (shown in Fig. 2) relates the anode segments 5 to each other to form an anode block.

Any of many means well known in the art may be employed to lead off the output oscillations of the magnetron anode and supply them to a utilization circuit.

The tuner of the present invention varies the operating frequency of the magnetron by varying the size of the cavity resonators or radial slots 3. The tuner of the present invention comprises a control cylinder 7 which is coaxial with both the anode central axis and the container cylinder 1; the diameter of the control cylinder is larger than the outer diameter of the anode and smaller than that of the container cylinder 1. The control cylinder 7 is made of non-magnetic material.

A plurality of flexible metal tapes or metal ribbons 8 are fastened at one end, at spaced intervals, to the inside surface of the control cylinder 7. The flexible ribbons 8 are fastened in grooves 9 which are parallel to the central axis of the unit and maintain the flat areas of the ribbons 8 parallel to said axis. At its other end each flexible metal ribbon 8 is fastened to the side of one of a plurality of slot blocks 10. The ribbons 8 are fastened to the slot blocks 10 in grooves 11 which are parallel to the central axis of the unit and maintain the flat areas of the ribbons 8 parallel to said axis.

The slot blocks 10 fit in the slots 3 without binding, to permit radial motion of said slot blocks in said slots. A plurality of guide rods 12 are positioned in the annular area 4 adjacent the slots 3. The ribbons 8 are passed partly around the guide rods 12, which, since their axes are parallel to the central axis of the unit, maintain the flat areas of said ribbons parallel to said axis.

A serrated strip 13 is circumferentially affixed to the outside of the control cylinder 7. The gear arrangement 14 meshes with the serrated strip 13 and a shaft 15. The shaft 15 passes through a hole in the container cylinder 1 into an extended housing 16 which supports said shaft for rotation about its axis and which has a vacuum-tight seal 17. A knurled knob 18 is affixed to the shaft 15 at its outside end.

In operation, the manual turning of the knob 18 turns the shaft 15 about its axis to turn the bevel gear of the gear arrangement 14. The bevel gear of the gear arrangement 14 translates the axial rotation of the shaft 15 to axial rotation of the control cylinder 7. The gear arrangement 14 may be any of the many means well known in the art for translation of motion. In fact, the shaft 15 need not necessarily be tangential to the control cylinder 7, but may be parallel to the axis of said cylinder. In such a case, meshing plane gears of a proper ratio are all that is required to turn the control cylinder 7 from outside the container cylinder 1.

The control cylinder 7 is rotated about its axis due to the meshing of the serrated strip 13 with the gear arrangement 14. The control cylinder 7, rotating about its axis, pulls the ribbons 8, fastened to it, along with it. The guide rods 12 translate the motion of the ribbons 8 into radial forces which are applied to the slot blocks 10 through said ribbons fastened to them.

The radial positions of the slot blocks 10, in the slots 3, are determined by the angular position of the control cylinder 7. The radial positions of the slot blocks 10 determine the sizes of the slots 3, which are the cavity resonators, and thus determine the operating frequency of the magnetron.

The slot blocks 10 are moved radially inward, toward the radial center of the anode, when the control cylinder 7 is rotated about its axis in one direction. When the

control cylinder 7 is rotated about its axis in the other direction, the slot blocks 10 are moved radially outward as shown in Fig. 3. The operating frequency of the magnetron is adjustable through the adjustment of the radial position of the slot blocks 10 in the slots 3.

The control cylinder 7 and the slot blocks 10 may be positioned on ball bearings of heat resistant material, such as steel or tungsten carbide. Ball bearings, riding in grooves, reduce friction resistance to motion of the movable parts. The slot blocks 10 and the guide rods 12 are preferably made of heat resistant material.

The metal tapes or ribbons 8 are preferably made of material which maintains its tensile strength and elasticity at high temperatures; such a material may be an alloy well known in the art, for instance, Inconel. The control cylinder 7 is preferably made of non-magnetic material such as copper nickel alloy.

Obviously, there are many means known in the art for rotating a part, such as the control cylinder 7, from outside the container cylinder 1 (shown in Fig. 1) as well as for rotatably supporting the control cylinder and for translating the motion of the control cylinder to radial motion of the slot blocks; any of these means may be utilized with the present invention, without departing from its spirit and scope.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A tuner for a magnetron of the type having an anode member containing a plurality of individual cavity resonators in the form of slots arranged in radial symmetry about a central axis comprising a plurality of slot blocks fitted in said slots, each of said slot blocks being adapted for radial motion in each of said slots, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said anode member, said control cylinder being adapted for rotational motion about said central axis, a groove in a side of each of said slot blocks, a plurality of grooves in spaced relation to the inside surface of said control cylinder, said slot block grooves and said control cylinder grooves being parallel to said central axis, a plurality of metal ribbons, each of said ribbons being gripped at one end in one of said slot block grooves and being gripped at the other end in the closest one of said control cylinder grooves, a plurality of guide rods positioned beyond said anode outer diameter adjacent said slots, said guide rods being parallel to said central axis, each of said guide rods having one of said ribbons partially wound about it, a serrated strip circumferentially affixed to the outside surface of said control cylinder, a vacuum-tight container cylinder positioned coaxially with said central axis and having a diameter greater than that of said control cylinder, a vacuum-tight housing extending from said container cylinder, a shaft rotatably supported in said extending housing having one end inside said container cylinder adjacent said serrated strip and the other end extending outside said housing, gears affixed to the end of said shaft inside said container cylinder adjacent said serrated strip, said gears meshing to translate rotational motion of said shaft about its axis into rotational motion of said control cylinder about said central axis and a knurled knob coaxially affixed to the outside extending end of said shaft.

2. A tuner for a magnetron of the type having an anode member containing a plurality of individual cavity resonators in the form of slots arranged in radial symmetry about a central axis comprising a plurality of slot blocks fitted in said slots, each of said slot blocks being adapted for radial motion in each of said slots, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said anode

member, said control cylinder being adapted for rotational motion about said central axis, a plurality of metal ribbons, means for fastening each of said ribbons at one end to one of said slot blocks and means for fastening each of said ribbons at the other end to the inside surface of said control cylinder in the vicinity of said slot block, a plurality of guide rods positioned beyond said anode outer diameter adjacent said slots, said guide rods being parallel to said central axis, each of said guide rods having one of said ribbons partially wound about it, a serrated strip circumferentially affixed to the outside surface of said control cylinder, a vacuum-tight container cylinder positioned coaxially with said central axis and having a diameter greater than that of said control cylinder, a vacuum-tight housing extending from said container cylinder, a shaft rotatably supported in said extending housing having one end inside said container cylinder adjacent said serrated strip and the other end extending outside said housing, means affixed to the end of said shaft inside said container cylinder and means affixed to the inside of said container cylinder adjacent said serrated strip cooperating with each other and with said serrated strip for translating rotational motion of said shaft about its axis into rotational motion of said control cylinder about said central axis.

3. A tuner for a magnetron of the type having an anode member containing a plurality of individual cavity resonators in the form of slots arranged in radial symmetry about a central axis comprising a plurality of slot blocks fitted in said slots, each of said slot blocks being adapted for radial motion in each of said slots, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said anode member, said control cylinder being adapted for rotational motion about said central axis, means for translating rotational motion of said control cylinder about said central axis into radial motion of said slot blocks in said slots, said translating means comprising metal ribbons fastening each of said slot blocks to the inside surface of said control cylinder, means for maintaining said ribbons parallel to said central axis, a vacuum-tight container cylinder positioned coaxially with said central axis and having a diameter greater than that of said control cylinder, a shaft rotatably supported in a vacuum-tight seal in said container cylinder having one end inside said container cylinder adjacent the outer surface of said control cylinder and the other end extending outside said container cylinder, means for translating rotational motion of said shaft about its axis into rotational motion of said control cylinder about said central axis, said latter translating means being supported by said control cylinder and by said shaft and being located within said container cylinder.

4. A tuner for a magnetron of the type having an anode member containing a plurality of individual cavity resonators in the form of slots arranged in radial symmetry about a central axis comprising a plurality of slot blocks fitted in said slots, each of said slot blocks being adapted for radial motion in each of said slots, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said anode member, said control cylinder being adapted for rotational motion about said central axis, means for translating rotational motion of said control cylinder about said central axis into radial motion of said slot blocks in said slots, said translating means comprising metal ribbons fastening each of said slot blocks to the inside surface of said control cylinder.

5. A tuner for a magnetron of the type having an anode member containing a plurality of individual cavity resonators in the form of slots arranged in radial symmetry about a central axis comprising a plurality of slot blocks fitted in said slots, each of said slot blocks being adapted for radial motion in each of said slots, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said anode mem-

ber, said control cylinder being adapted for rotational motion about said central axis, means for translating rotational motion of said control cylinder about said central axis into radial motion of said slot blocks in said slots, said translating means comprising a plurality of ribbons having high tensile strength and elasticity fastening each of said slot blocks to the inside surface of said control cylinder.

6. A resonator of the type having a member containing a plurality of individual cavity resonators arranged in radial symmetry about a central axis comprising a plurality of blocks fitted in said cavity resonator, each of said blocks being adapted for radial motion in each of said cavity resonators, a control cylinder positioned coaxially with said central axis having a diameter greater than the outer diameter of said member, said control cylinder being adapted for rotational motion about said central axis, and means for varying the radial positions of said blocks in said cavity resonators in accordance with the angular position of said control cylinder, said means comprising a plurality of metal ribbons fastening each of said blocks to the inside surface of said control cylinder.

7. A resonator of the type having a member containing a plurality of individual cavity resonators arranged in radial symmetry about a central axis comprising a plurality of blocks fitted in said cavity resonators, each of said blocks being adapted for radial motion in each of said cavity resonators, a control cylinder positioned coaxially with said central axis having a diameter greater

than the outer diameter of said member, said control cylinder being adapted for rotational motion about said central axis, and means for varying the radial positions of said blocks in said cavity resonators in accordance with the angular position of said control cylinder, said means comprising a plurality of ribbons having high tensile strength and elasticity, each of said ribbons fastening one of said blocks to the inside surface of said control cylinder.

8. A tunable resonator comprising a member containing a plurality of individual cavity resonators arranged radially about a central axis, a block fitted in each of said cavity resonators and adapted for radial motion therein, a control cylinder positioned coaxially with said central axis and being adapted for arcuate adjustment about said central axis, adjustable means coupled to said control cylinder for arcuately adjusting said control cylinder about said central axis, and means for translating arcuate adjustment of said control cylinder about said central axis into radial adjustment of said blocks in said cavity resonators, said means including a plurality of ribbons having high push and pull strength and flexibility fastening each of said blocks to said control cylinder.

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