The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to spark gaps, and more particularly to rotary spark gaps.

The primary object of our invention is to generally improve spark gaps, particularly rotary spark gaps of the so-called "cage" type.

It has been proposed to use a spark gap to key the transmitter of a pulse echo system. If a constant frequency pulse is wanted, it is advantageous to use a rotary spark gap so that the frequency of the pulse may be determined by the rotational speed and the number of electrodes on the rotor. A rotary spark gap has other advantages in that there are a considerable number of electrodes, and the electrodes are cooled somewhat by rotation of the rotor, thus prolonging wear. It may be explained that metal is relatively rapidly dissipated or sputtered from the cathode but not from the anode, and inasmuch as there is only one stationary electrode, while there may be four, six, eight or more movable electrodes, it is best to use the movable electrodes as the cathode.

In spite of the foregoing precautions, the useful life of a rotary spark gap is greatly reduced by dissipation of metal from the rotating electrodes, and it is accordingly a further object of our invention to minimize this loss. In accordance with our invention, the electrodes of the rotor are made in the form of round rods, and these rods are rotated about their individual axes at the same time that they are revolved about the axis of the rotor.

A further object of the invention is to avoid the possibility of the electrode rod being so rotated as to present the same surface toward the stationary electrode during each revolution or each few revolutions of the rotor. It is accordingly a more specific object to provide a suitable mechanism to turn the electrode rods very slowly relative to the speed of rotation of the rotor as a whole.

To accomplish the foregoing and other objects which will hereinafter appear, our invention resides in the rotary spark gap element and their relation to the other as are hereinafter more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by a drawing in which:

Figure 1 is a plan view of a rotary spark gap embodying features of our invention;

Figure 2 is a front elevation of the same;

Figure 3 is a transverse section taken in the plane of the line 5—5 of Figure 2;

Figure 4 is a section taken in the plane of the line 4—4 of Figure 2;

Figure 5 is a section drawn to enlarged scale and taken approximately in the plane of the line 5—5 of Figure 2;

Figure 6 is another section drawn to enlarged scale, and taken approximately in the plane of the line 6—6 of Figure 2; and

Figure 7 is a section showing a detail of the belt and pulley drive.

Referring to the drawing, and more particularly to Figure 6, the spark gap comprises a stationary electrode 12, and a plurality of movable electrodes 14 cooperating therewith. The movable electrodes are carried by a disk 16, which is mounted on and rotated by a shaft 18. Referring to Figures 1 and 2, the shaft 18 is driven by an appropriate motor 20. For operation at a fixed pulse frequency, the motor 20 should be a constant speed motor, for example a synchronous motor. In the specific case here illustrated, the electrode rods 14 are carried between spaced disks 16 and 22 fixedly mounted on the shaft 18.

In accordance with the present invention, the electrodes 14 are round rods and are rotatably carried by the disks 16 and 22. Each rod is provided with a wheel 24, and the said wheels all engage a wheel 26 which is disposed coaxially with shaft 18. The wheel 26 may conveniently be carried on the shaft 18, but is rotatable thereon. It will be evident that by causing a slight relative movement between the wheel 26 and the shaft 18, the electrode rods 14 will all be caused to rotate during their revolution about the axis of the rotor. A simple method of doing this is to mount the wheel 26 frictionally on shaft 18 for rotation therewith, and to then apply friction-braking means to the wheel 26 in order to slow it down slightly, relative to the shaft 18.

Although the wheels 24 and 26 may be friction wheels with smooth peripheries, we prefer to make the action more positive by using gear wheels. That is, the wheels 24 are pinions acting as "planet" gears, and mesh with gear 26 acting as a "sun" gear.

We also prefer to make the differential rotation of the gear 26 and the rotor more definite and controllable by using external drive means for the purpose. Specifically, and referring to Figures 1 through 4 of the drawing, the bearings 28 and 30 which carry the main shaft 18 may be enlarged or extended to carry an auxiliary back shaft 32. A pulley 34, fast on shaft 18, is belted by means of a belt 36 to a pulley 38, which is fast on back shaft 32. Another pulley 40 is fast on back shaft 32, and is connected by means of belt 42 to a pulley 44, which is loose on main shaft 18. The belts are preferably round rubber belts received in V-grooved pulleys, as shown in Figure 7. In Figure 5 it will be seen that the sun gear 26 is secured directly to the loose pulley 44, as by means of screws 46.
If all of the pulleys are made equal in diameter, they will all turn in unison at equal speed, and there will be no relative movement of the sun gear and the rotor. The same is true if pulleys 34 and 44 are equal, and if pulleys 30 and 40 are equal. If, however, the diameter of the pulley 30 is altered very slightly relative to the diameter of the pulley 40, the rotative speeds of the sun gear and the rotor will become slightly different. In practice, the change in diameter may be made as little as a few thousandths of an inch. In the present case, the diameter of pulley 30 is increased slightly, and the diameter of pulley 40 is decreased slightly, so that in net effect the speed of the sun gear is reduced slightly compared to the speed of shaft 18. The effect is much the same as though the sun gear and its pulley 44 were held back from full speed rotation by the application of a limited amount of brake pressure, but the speed ratio is predictable and reliable.

It will be understood that other pulley arrangements may be used, and that various changes in diameter may be adopted. Three of the four pulleys have the same diameter, with only one changed, or all may have different diameters. After adopting a slight difference in diameter, the lower or the upper pulleys may then be equally reduced or increased in diameter, if that should prove more convenient in any particular case. In fact, it is not necessary that the external drive be a pulley drive at all, as other mechanisms may equally well be employed, though perhaps somewhat less conveniently.

Referring to Figure 4, it will be seen that the loose pulley 44 is, in the present case, mounted on main shaft 18 by means of an anti-friction ball bearing 48. This refinement is dispensable, though desirable when using an elastic belt such as those here employed.

Ball bearings are also preferably used for the back shaft 22 at posts 28 and 30, and for the main shaft 18 at post 50. Another ball bearing may be used for the main shaft 18 in either the post 28 or the post 30, or, if desired, large clearance holes may be provided in these posts and the motor 20 then used as a bearing for the opposite end of the main shaft. In the one case, the coupling between the motor shaft and the main shaft 18 may be a flexible coupling, and in the other case should be a rigid coupling.

The shafts 18 and 22, and the pulleys 34, 38, 40 and 44 may be made of a suitable insulation material such as Bakelite. The bearings 28, 30 and 50 and the base 52 on which they are mounted may also be made of Bakelite or like synthetic resin. The disks 16 and 23 of the rotor, as well as the collars 84 at one end of the electrodes 14, may be made of brass or other highly conductive metal. In fact, the sun and planet gears may also be made of brass because the relative rotative speed is slight and the tooth pressure is light. The electrode rods 14 are preferably made of tungsten, molybdenum, or other metal having similar high temperature characteristics. The stationary electrode 12 is similarly made of high temperature metal and may be mounted on a brass plate or slide 86. This is connected at the upper end of an insulation pedestal 88, and its position is preferably made adjustable, as by means of a screw 60 received in a slot 82 in holder 86, thus making it possible to adjust the interelectrode spacing.

External connection to the stationary electrode may be made in any desired manner, as by means of a soldering lug (not shown) received on the screw 80. External connection to the rotor may be obtained by means of a soldering lug (not shown) secured at a screw 84, which is an end of which is formed into a box-like holder 88 for a carbon block 70. Block 70 acts as a brush bearing against the projecting end of a metal rod 80 (Figure 6) running axially through the right-hand end portion (as viewed in Figures 1 and 2) of insulation shaft 18. The rounded projecting end of said rod is shown in Figures 1 and 2 just inside the block 70.

The rotor disks 10 and 22 are permanently secured to a metal spool-like hub 74 (Figure 6) having end flanges 76. A screw or pin or like metal connector 78 is driven through the hub 74 into the aforesaid center rod 80, thereby establishing the desired electrical connection between the rotor and the carbon block or brush 70.

It is believed that the operation of our improved rotary spark gap, as well as the advantages thereof, will be apparent from the foregoing detailed description thereof. The rotor has numerous electrodes, and is therefore preferably used as the cathode or consumed element of the spark gap. The life of each revolving electrode, and consequently of the entire structure, is greatly prolonged by slowly rotating the electrode relative to the rotor as the latter spins. In this way the entire peripheral surface of the cylindrical electrode is used, instead of only a thin strip of surface at one side of the cylinder. There is some slow wear of the stationary electrode, but after long use this may be replaced. In fact, the mounting of the revolving tungsten rods is such that these two may be replaced when the collars and gears preferably being secured at the ends of the rods by releasable set screws.

It will be apparent that while we have shown and described our invention in a preferred form, many changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, as sought to be defined in the following claims.

We claim:

1. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including a disk and a plurality of electrode rods spaced about the periphery of the disk, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, a motor to drive the rotor, and additional means to rotate the rods as they revolve with the rotor.

2. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including circular end disks with a plurality of round electrode rods extending in axial direction and spaced about the periphery of the disks, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, a motor to drive the rotor, and additional means to rotate the rods as they revolve about the axis of the rotor.

3. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including circular end disks with a plurality of round electrode rods extending in axial direction and spaced about the periphery of the disk, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, and means to rotate the rods as they revolve about the axis of the rotor, said means operating in response to rotation of the rotor and being so arranged as to rotate the
5 rods only a very small fraction of a revolution for each revolution of the rotor.
4. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including circular end disks with a plurality of round electrode rods extending in axial direction and spaced about the periphery of the disks, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, and means to rotate the rods as they revolve about the axis of the rotor, said means including a plurality of wheels secured to the ends of the rotor, said wheels engaging said center wheel, whereby the electrode rods are very slightly rotated as they are rapidly revolved with the rotor.
8. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including end disks with a plurality of round electrode rods extending in axial direction and spaced about the periphery of the disks, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, a motor, a main shaft connecting the motor and the rotor, and additional means to rotate the rods as they revolve about the axis of the rotor, said means comprising a back shaft parallel to the main shaft, fast and loose pulleys on the main shaft, there being a very slight difference in diameter between at least two of the pulleys, in order to produce a slight differential movement of the loose pulley relative to the main shaft, a center wheel secured to the loose pulley, and wheels on each electrode rod, said latter wheels engaging said center wheel, whereby the electrode rods are very slightly rotated as they are rapidly revolved with the rotor.
9. A rotary spark gap comprising a stationary electrode, a rotor, said rotor including circular end disks with a plurality of round electrode rods extending in axial direction and spaced about the periphery of the disks, the sides of said rods acting as movable electrodes for cooperation with the stationary electrode, a motor, a main shaft connecting the motor and the rotor, and additional means to rotate the rods as they revolve about the axis of the rotor, said means comprising a back shaft parallel to the main shaft, fast and loose pulleys on the main shaft, two fast pulleys on the back shaft respectively belted to said fast and loose pulleys on the main shaft, there being a very slight difference in diameter between at least two of the pulleys, in order to produce a slight differential movement of the loose pulley relative to the main shaft, a sun gear secured to the loose pulley, and a planet gear on each electrode rod, said planet gears meshing with said sun gear, whereby the electrode rods are very slightly rotated as they are rapidly revolved with the rotor.

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