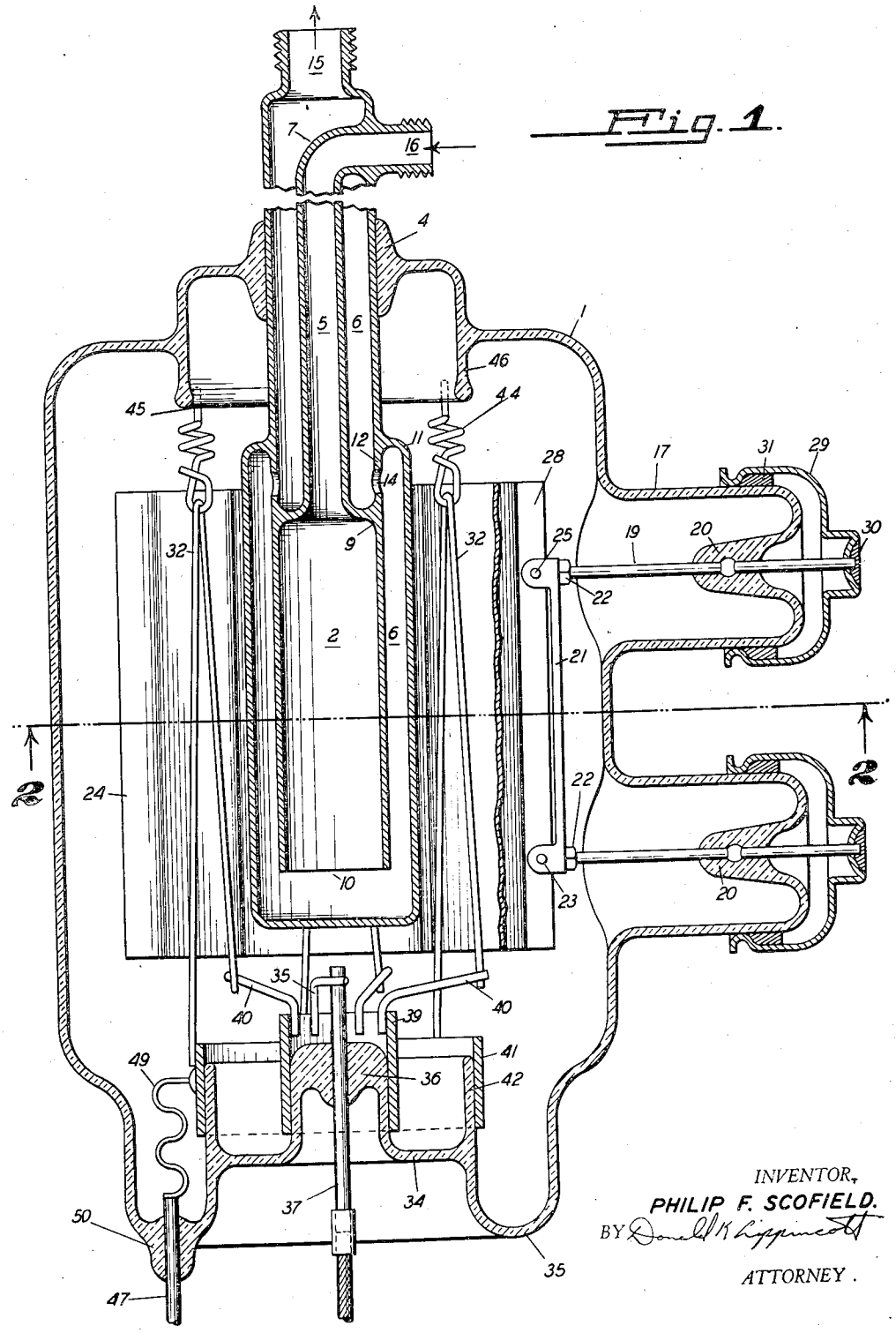
Dec. 11, 1934. P. F. SCOFIELD 1,983,679

ELECTRICAL DISCHARGE TUBE

Filed July 29, 1932 2 Sheets-Sheet 1

Fig. 1.



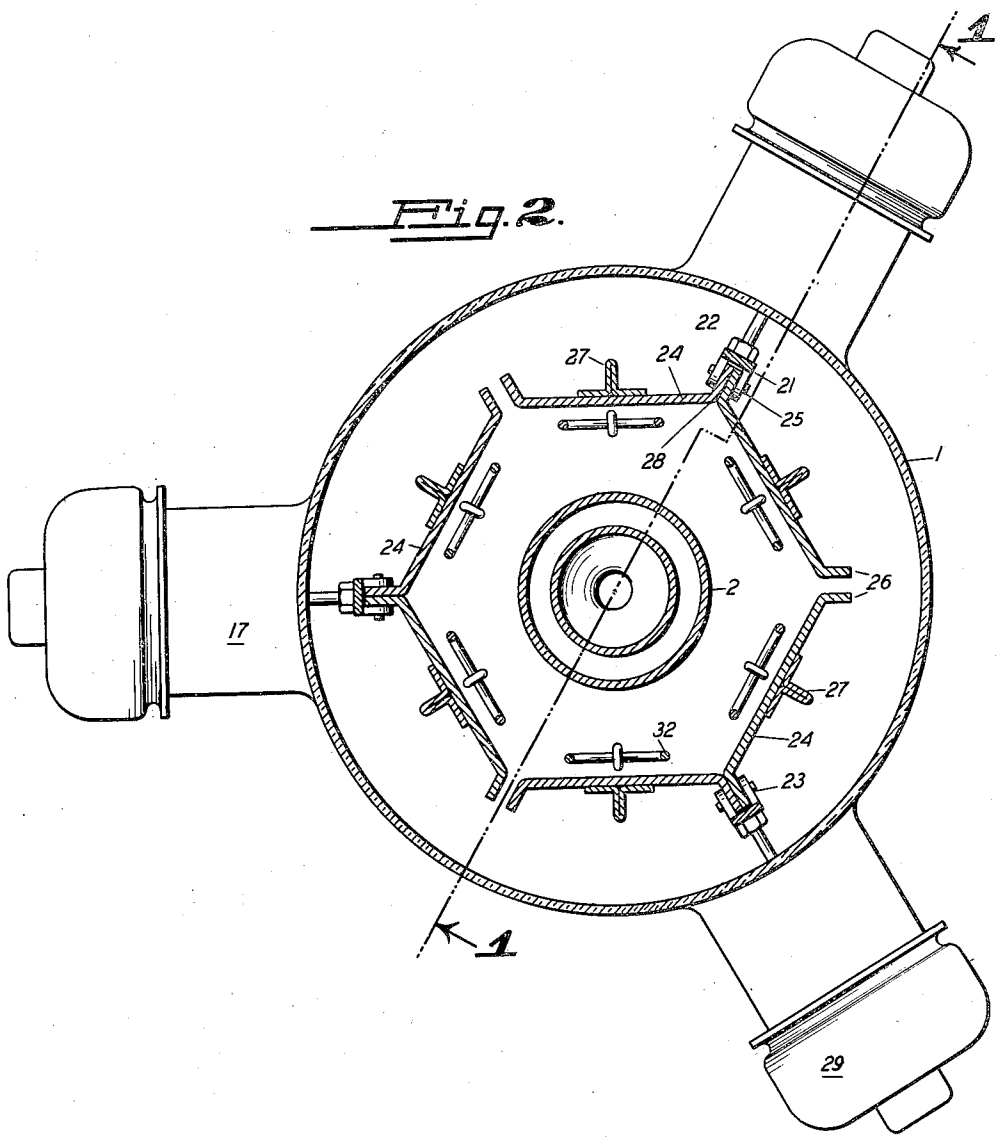
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Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE TUBE

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Application July 29, 1932, Serial No. 625,869

5 Claims. (Cl. 250—27.5)

My invention relates to electrical discharge tubes having an electron-emitting cathode placed between a control electrode and a fluid-cooled anode, and more particularly to discharge tubes of this kind adapted to handle large amounts of power for use, for example, in transmission stations for radio telegraphy or telephony.

Among the objects of my invention are: To provide an electrical discharge device capable of high power output; to provide a device which has a cathode interposed between the control electrode and a fluid-cooled anode; to provide a thermionic tube having a fluid-cooled anode positioned on its central axis; to provide a fluid-cooled anode sealed through an envelope, which will not crack the seal during operation; and to provide a high frequency oscillator and amplifier in which the cathode acts as a grounded shield between anode and control electrode.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of my invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawings:

Figure 1 is a sectional view of a tube embodying my invention, the plane of projection being indicated by the line 1—1 of Figure 2.

Figure 2 is a transverse sectional view of the tube, the plane of section being indicated by the line 2—2 of Figure 1.

In general terms my invention comprises a thermionic tube having an envelope in which is sealed a fluid-cooled anode. This anode is supported by one end of the envelope, and is mounted coaxially with the envelope of the device. A control electrode substantially cylindrical in shape and positioned within the envelope, concentrically surrounds the central anode. An electron-emitting cathode is interposed between the anode and control electrode.

A specific embodiment of my invention is shown in the drawings. Mounted coaxially with a suitable envelope 1 is a cylindrical, tubular anode 2, joined to the envelope by a seal 4. The envelope may be of quartz, boro-silicate glass or other refractory material, and the metal-to-glass seal through the envelope is made by any of the usual methods. The metal employed for the anode should be of a material readily sealed into the envelope, tungsten, for example, being satisfactory when the boro-silicate glasses are used.

The anode 2, usually circular in section, is assembled so that two concentric channels are formed therein. An inner channel 5 and an outer channel 6 are separated by the insertion of an inlet tube 7, which extends almost to the inner end of the anode and is welded to the anode at the point of insertion. Shortly after the inlet tube passes the region of the seal, it is expanded to form an inlet shoulder 9, and is left with an open end 10 to allow contained fluid to pass freely into the outer channel 6.

The main body of the anode has an anode shoulder 11 which increases the diameter of the anode, and provides ample fluid space in the outer channel. In order to firmly support the inlet tube, a partition 12 extends from the base of the anode shoulder 11 to the bend of the inlet shoulder 9.

Holes 14 are provided in partition 12 to permit circulation through the anode. An exhaust port 15 is formed on the exterior end of the anode and is threaded to permit easy attachment to a drain, or a return pipe to a circulating supply. Likewise inlet port 16 on the exterior end of the inlet tube 7 is provided with threads to facilitate coupling to the circulating fluid system.

While the drawings show the inlet tube entering the anode at right angles, other ways of porting the anode will be apparent to those skilled in the art.

After the anode has been sealed in place, electrode arms 17, of the same material as the envelope, are fused to the side walls of the envelope. These arms have electrode supports 19 mounted in their distal ends, and held in place by the support seal 20. The electrode arms are in pairs, and the combination of three of such pairs form the supporting structure of the complete control electrode. Yoke 21, spanning and connecting each pair of supports is screwed to the supports and is permanently joined and fixed in place by the small lock nuts 22. Holes 23 are provided in each end of the yoke whereby the individual control segment 24 may be attached by means of pins 25.

Each of these angular segments is made from imperforate sheet metal, preferably tantalum, and extends the full length of the anode, stiffened at the outer edges by flanges 26. To further provide against buckling, reinforcing ribs 27 are applied to the major plane surface. Each segment may be assembled from two sections with center flanges 28 gripped by the yoke 21, or the entire segment may be formed from a single sheet with a fold for the center flange 28 where the yoke is applied. The pins 25 pass through the

yoke and the center flange and tie the control segment to the support structure.

A single control segment is supported in the same manner by each of the three pairs of electrode arms, and the control segments are assembled concentrically around the anode to form the complete polygonal control electrode.

It is desirable to space the control segments slightly apart inside the envelope, so that various unitary or partial use may be made of the segments in exterior circuits, thus allowing the tube to be used in a number of different ways.

It will also be obvious that the anode 2 may be polygonal in shape to cooperate with the planar control surfaces, or that the control segments may be circular in shape, without departing from the spirit of my invention.

For protection, and for electrical contact purposes, each arm is equipped with a connection cap 29. The electrode supports are soldered or otherwise fastened to the cap by weld 30 and the caps are maintained in place by cement 31.

Interposed between the anode and the control electrodes is a cathode, in this instance composed of a plurality of V-shaped filaments 32. These filaments are preferably of refractory material capable of emitting copious quantities of electrons when heated, such as tungsten. The end of the envelope opposite the insertion of the anode is used to support the filaments, and a stepped reentrant stem 34 is fused to the envelope at 35.

This stem is provided with a central circular seal 36 around the cathode lead 37. A metal stem sleeve 39 is fused or otherwise fastened around stem 34 and connected to the cathode lead by link 35. Filament supports 40 radiate from this stem sleeve and one arm of the filament-V is welded thereto. The other arm is welded to a concentric metal skirt sleeve 41 which is fastened to a skirt 42 extended from the reentrant stem 34.

The apices of the filaments are resiliently supported by filament springs 44 fused at insertion 45 into an envelope ring 46 which surrounds the anode seal. The insertion of these springs follows a method well known in the incandescent lamp industry.

The V-shaped filaments are adjusted to a position that is preferably closer to the control electrode than to the anode and the proper tension is placed on the filament by adjustment of the filament springs.

The skirt sleeve 41 is flexibly connected to cathode lead 47 by the extensible link 49. This lead is brought through the envelope by a lead seal 50.

It will be seen that all of the filament-V's are in parallel connection, and in tubes of high power the cathode leads are made large in diameter to prevent temperature rises cracking the lead seals.

In operation, the cathodes are heated and the tube connected in a suitable circuit, and fluid, preferably water, on account of its cheapness and availability, is circulated through the anode as indicated by the arrows. By spacing the inlet tube away from the anode wall in the neighborhood of the seal, cold water from the main supply does not come in contact with the seal. This greatly reduces strain at the seal and promotes long operating life.

While the amplification constant of the tube is relatively low, due to the position of the control electrode, the internal resistance is also low due to the unobstructed electron path, and large amounts of power are efficiently handled. At high frequencies, used as an oscillator or amplifier, the filamentary cathode acts as a grounded screen or shield between anode and control electrode, and high conversion efficiencies are obtained. The operating characteristics are comparable to those of the standard grid type tube having a shield between grid and plate, known in the art as a screen grid tube, without the complexities involved in such multi-element structure.

Tubes handling 5 kilowatts of power are small in size and economical to operate, especially when employing the higher frequencies.

I claim:

1. An electrical discharge device having an envelope, a central fluid-cooled anode mounted coaxially with said envelope, a plurality of electrically separated sections of a control electrode polygonally arranged around said anode, and an electron-emitting cathode interposed between said sections of a control electrode and said anode.

2. An electrical discharge tube having an envelope, a hollow anode sealed through one end of said envelope, concentric channels formed integrally with said anode within said anode for directing the flow of a circulated fluid, a plurality of planar control electrodes polygonally arranged around said anode, and a plurality of filamentary conductors capable of emitting electrons when heated interposed between said anode and said control electrodes.

3. An electrical discharge device, an envelope, a stem fused to one end of said envelope, a central fluid-cooled anode sealed through said stem and mounted coaxially with said envelope, a stepped reentrant stem in the opposite end of said envelope, a cathode circumjacent said anode supported at its lower end by said reentrant stem and a plurality of planar control electrodes arranged around said anode, each of said control electrodes being supported within the envelope by the side walls thereof.

4. An electrical discharge device having an envelope, a central fluid-cooled anode mounted coaxially with said envelope, a plurality of separate control electrode sections arranged around said anode, each of said sections being separately supported within the envelope by the side walls thereof, and an electron-emitting cathode interposed between each of said sections and said anode.

5. An electrical discharge device having an envelope, a central fluid-cooled anode mounted coaxially with said envelope, a plurality of separate control electrode sections arranged around said anode, said sections being spaced apart and adapted to be separately connected to an external electrical circuit, and an electron-emitting cathode interposed between each of said sections and said anode.

PHILIP F. SCOFIELD.