

June 18, 1935.

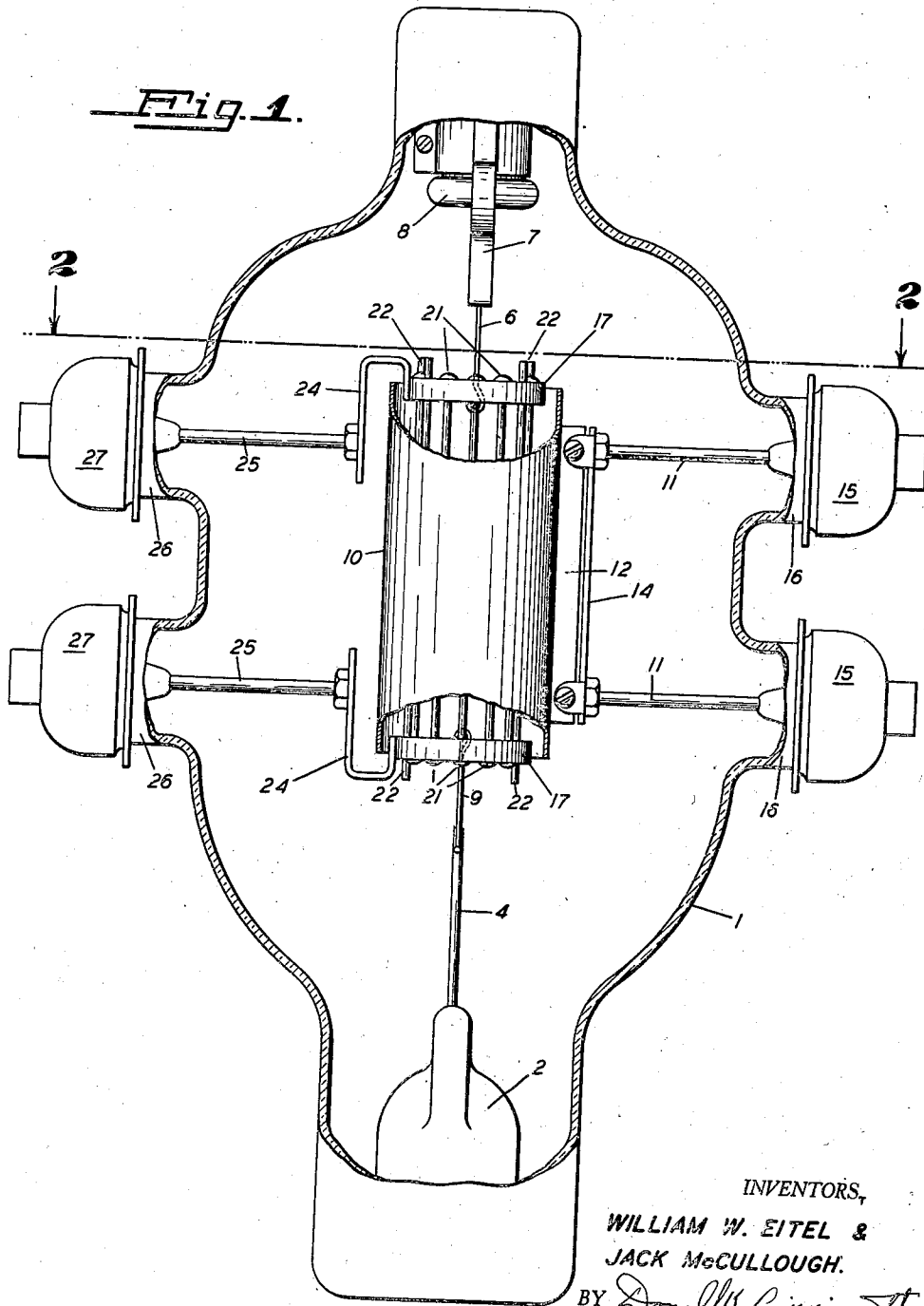
W. W. EITEL ET AL

2,005,257

VACUUM TUBE GRID

Filed April 26, 1933

2 Sheets-Sheet 1



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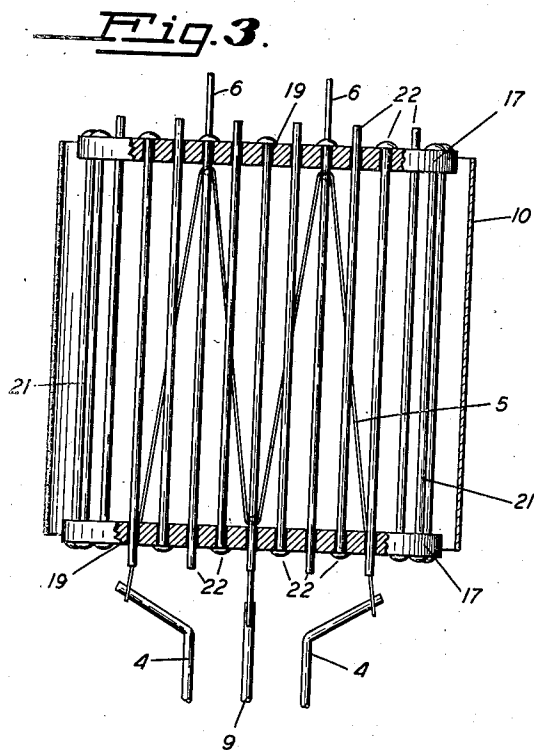
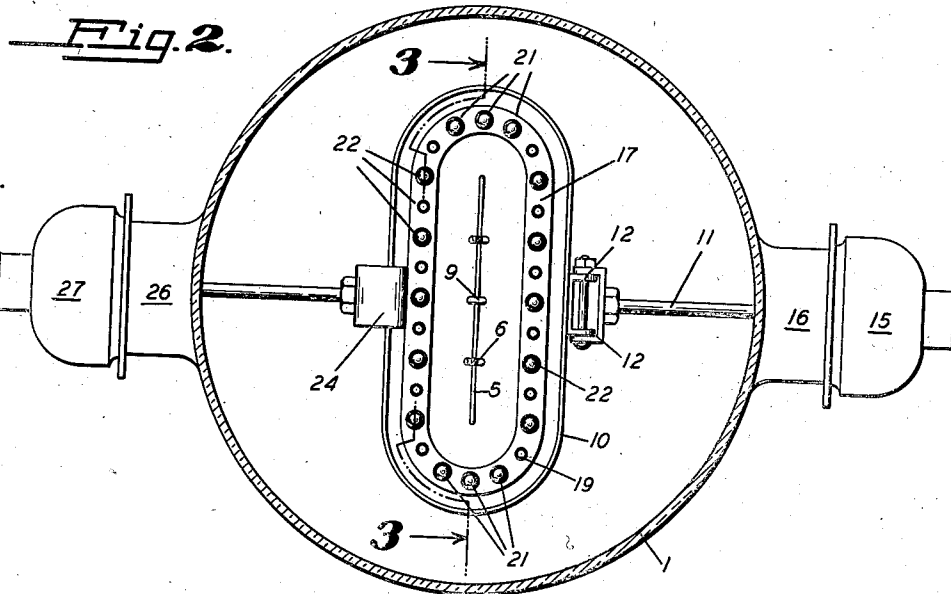
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2,005,257

VACUUM TUBE GRID

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Application April 26, 1933, Serial No. 668,072

2 Claims. (Cl. 250—27.5)

Our invention relates to vacuum tube grids, and more particularly to grids of the heavy duty type to be used in high power radio transmitting tubes or power oscillation generators and amplifiers.

Among the objects of our invention are: To provide a grid suitable for high power vacuum tubes; to provide a grid which will not change its control characteristics under load; to provide a grid in which the individual control elements remain parallel under varying temperatures; to provide a grid having a constant control characteristic particularly adapted to a vacuum tube oscillation generator or amplifier operating at high frequencies; and to provide a simple means and method of preventing physical expansion of grid control elements from changing the control characteristic of a vacuum tube.

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

Referring to the drawings:

Figure 1 is a view in elevation of a vacuum tube embodying our invention, the envelope and the anode being cut away to disclose the elements.

Figure 2 is a sectional view of the tube shown in Figure 1 taken at a plane of section indicated by the line 2—2 in Figure 1.

Figure 3 is a view partly in elevation and partly in section taken along the line 3—3 in Figure 2.

In vacuum tubes of high power output, used as oscillation generators or amplifiers or for like purposes, it is usually necessary to form the grid control wires of metal having a relatively large section, due to the amount of heat generated in operation. The metals used for such control wires almost always have considerable longitudinal expansion when heated, and we have found that when such wires are assembled parallel to each other, as is the usual custom, and fixed at both ends, that expansion due to the heat of operation will cause a departure from parallelism. This departure causes a change in the control characteristic of the tube, which while producing only a small amount of output variation at the higher wave lengths, will create such an alteration of the tube characteristics

at the low and extreme low frequencies as to render the tube useless for such purposes.

Furthermore, when a tube having fixed, expandable control rods is used, for example, as a modulated oscillator, or as an amplifier of high frequencies, modulated, in particular, with an audio frequency, the power output and consequent heating of the grid elements is constantly changing, and the varying physical displacements of the control rods laterally, away from parallelism, introduce a definite and continuous wave form distortion into the output.

Broadly speaking, our invention comprises forming a grid having a plurality of spaced parallel control elements positioned in the electron stream and free to expand longitudinally. A pair of positioning members are preferably provided to space the ends of the rods, these members being fastened together by support elements preferably similar in size and spacing to the control elements. It is desirable to locate the positioning members and the support elements out of the electron stream in a location of low and relatively steady heat, and to fasten one end of the spaced parallel control elements alternately to each positioning member, allowing the other end to be free as to longitudinal extension, but retaining said end in spaced relation to the other control elements to maintain the elements parallel and free from buckle during expansion.

Referring to the drawings, which illustrate a preferred embodiment of our invention as applied to a high power vacuum tube oscillation generator and amplifier, a vitreous envelope 1 is provided at one end with a reentrant stem 2 through which are sealed cathode leads 4. An M-type filamentary cathode 5 is mounted on these leads, the two upper bights of the cathode being supported by spring hooks 6 carried by a spring frame 7 mounted on a dummy stem 8 which is sealed in the opposite end of the envelope. The lower bight of the filament is positioned by a cathode hook 9 sealed into the stem.

An anode 10 surrounds the cathode, and is supported by a pair of anode struts 11 sealed into the side of the envelope, and connected to flanges 12 on the anode by means of a yoke 14. The anode struts pass through the envelope wall and are connected to anode caps 15 mounted on anode projections 16. These caps serve as the exterior contacts for connection to the anode current supply.

Interposed between the anode and the cathode, is a composite grid structure comprising a pair of spacing members 17 having a series of equally

spaced apertures 19 therein, through which the various grid elements may pass to form a cylindrical grid cage. These elements, particularly in tubes of high power, are preferably stiff rods rather than flexible wires, and are customarily made from a refractory metal such as tantalum, tungsten or molybdenum.

As the legs of the M filament are all in the same plane, the shape of the anode and grid is preferably that of a flattened cylinder so that the flat faces of the anode and grid are exposed to the electron stream. Few electrons are drawn to the rounded lateral surfaces of the anode and the grid wires between these surfaces and the cathode are not effective in the control of the electrons, the main heating of the anode and grid taking place on the flat faces. This action is well known in the art and can be visually demonstrated in tubes having elements of this shape by overloading the tube until the anode glows at a red heat. The glowing will appear on the anode faces parallel to the plane of the filament.

We prefer therefore to solidly connect and separate the two spacing members 17 by welding the ends of certain of the grid elements to both of the members to form a supporting framework for the remainder. These grid support elements 21 are placed substantially in the plane of the filament, out of the electron stream and in the type of tube shown, in the rounded corners on each side of the grid structure.

We then weld the ends of the remainder of the grid elements, hereafter called grid control elements 22, alternately to the spacing members in staggered relation so that only one end of each rod is welded, the opposite end passing freely through the opposed aperture in the other spacing member.

There is thus formed a complete cylindrical grid cage made up of the parallel control elements, the spacing members, and the support elements. This cage is placed in the tube between the anode and cathode so that the freely expandable control elements are the only ones in the electron stream and subject to extensive variations of heat.

The entire grid structure may be supported in any well known manner, but we prefer to weld an elbow 24 to the top and bottom spacing members and connect the outer ends of these elbows to grid struts 25 sealed through the envelope in lateral envelope projections 26 opposite the anode projections 15, and then provide these projections with grid connection caps 27 connected to the grid struts.

In operation the tube is energized, and the support elements 21 will thereupon expand slightly due to heat from the filament and general operating temperatures. If these support elements should depart from parallelism slightly no harm will be done as they have no substantial control over the electrons. As one end of all the control elements is free in an aperture of one of the spacing members, this original expansion will not disturb their relationship to each other. During further operation, power peaks, and heavy loads may be imposed on the

tube, but the control elements are free to expand through the apertures of the spacing members and do so, thus preventing buckling. Any buckle would open a wider gap between two of the elements, and reduce the effective control of the grid as a whole.

It is, of course, not necessary that the control elements be alternately welded to the spacing members. They may all be welded to one member, and extend through the apertures in the other. The alternate construction is preferable, however, in that it makes for ease of assembly, and there is more room for welding. Furthermore, the welding operation virtually closes the apertures and a support member having alternate apertures closed by welding is stronger than one in which all the apertures remain open.

While we have shown the grid as constructed of vertical parallel grid elements, it may be desirable to place the spacing members 17 on the sides of the cathode with the control elements extending horizontally. In this case, the support elements 21 of the grid may be separated for the cathode leads 4 and the spring hooks 6, placing the support members above and below the electron stream. The operation is the same although the horizontal positioning is not preferred in tubes of extreme high power due to the tendency of the control elements to sag under the influence of gravity, when heated above a red heat.

In the structure here shown and described the support elements 21 which connect the two spacing members 17 are identical with the control elements 22 both in dimensions and spacing. It is obvious however that as they are removed from the direct electron stream, that a single larger rod may be substituted, or like connection, without violating the spirit of our invention.

We claim:

1. A vacuum tube grid comprising a pair of conductive support members having a series of apertures therein, conductive means for spacing said support members, and a plurality of parallel grid wires extending between said support members through said apertures, said wires being solidly fastened in alternate apertures of one of said support members and free to expand through the remaining apertures, said support members providing the sole electrical connection between said wires.

2. In combination a vacuum tube comprising an envelope, a cathode lying in a plane, a plurality of vertical wires surrounding said cathode and arranged to form a grid of substantially rectangular cross section, upper and lower conductive supports for said wires said supports having a series of apertures therein, the vertical wires located at the narrow edges of said grid being solidly fastened to both of said supports and the wires located in the broad surfaces of said grid parallel to the plane of said cathode being solidly fastened at one end to one of said supports only, the other end being free to expand through an aperture in the other support.

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