Aug. 20, 1935. C. J. R. H. VON WEDEL 2,011,922

DISCHARGE TUBE

Filed Feb. 25, 1931

Fig.1.

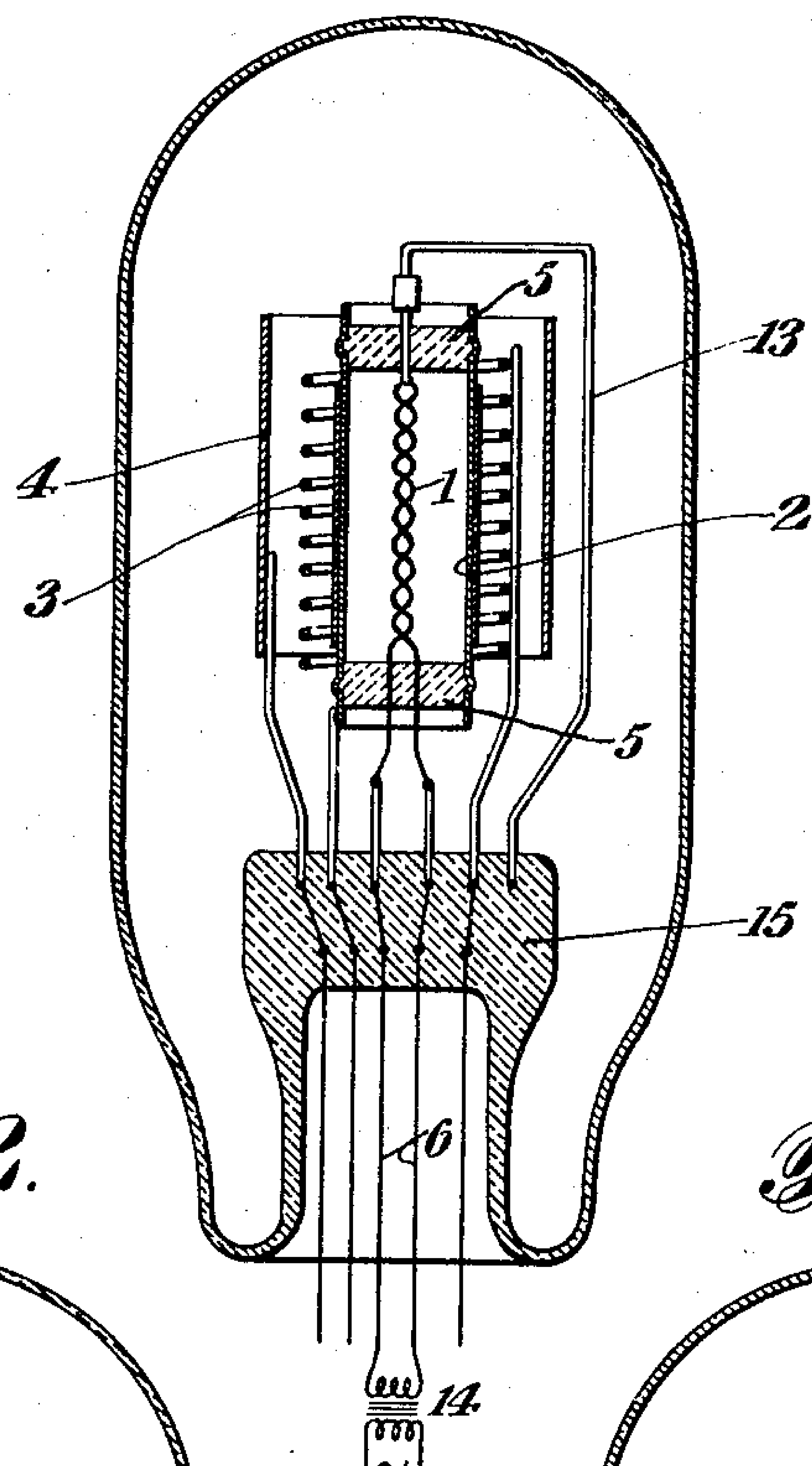


Fig.2.

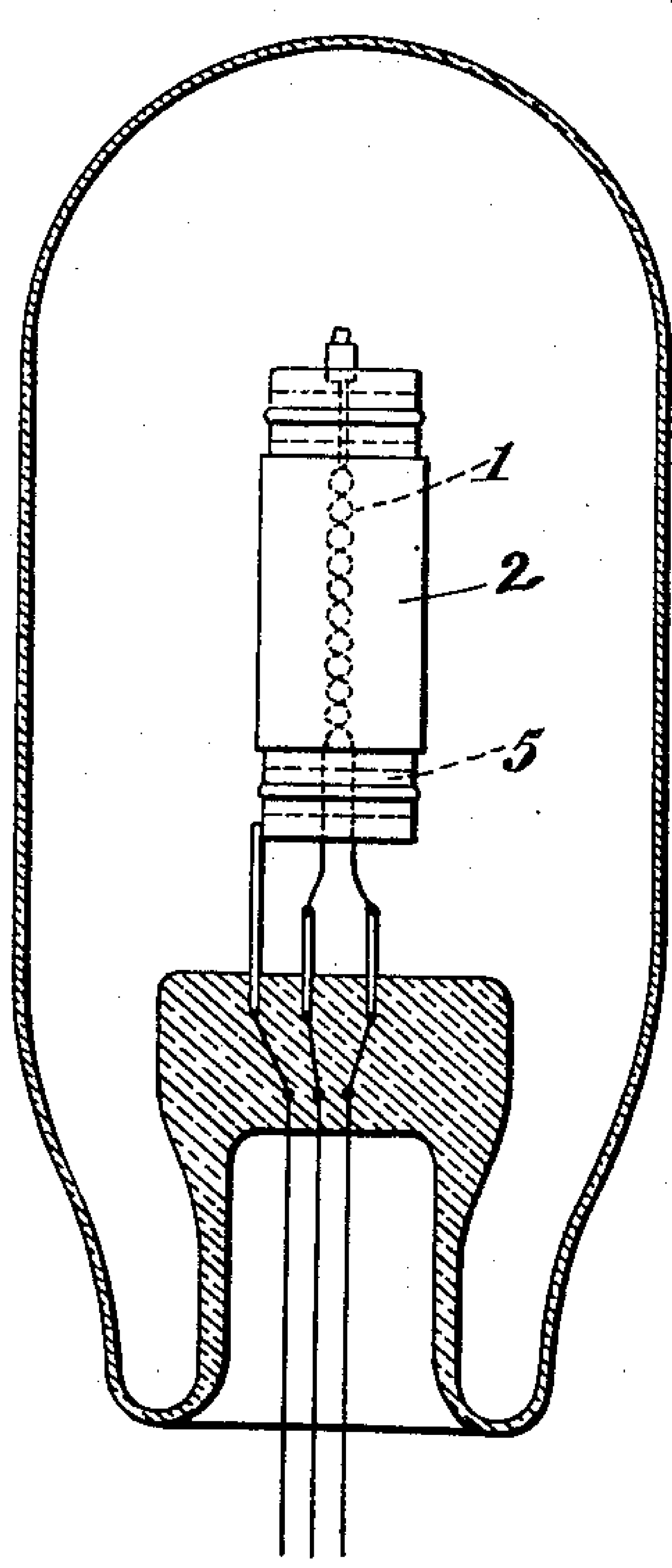
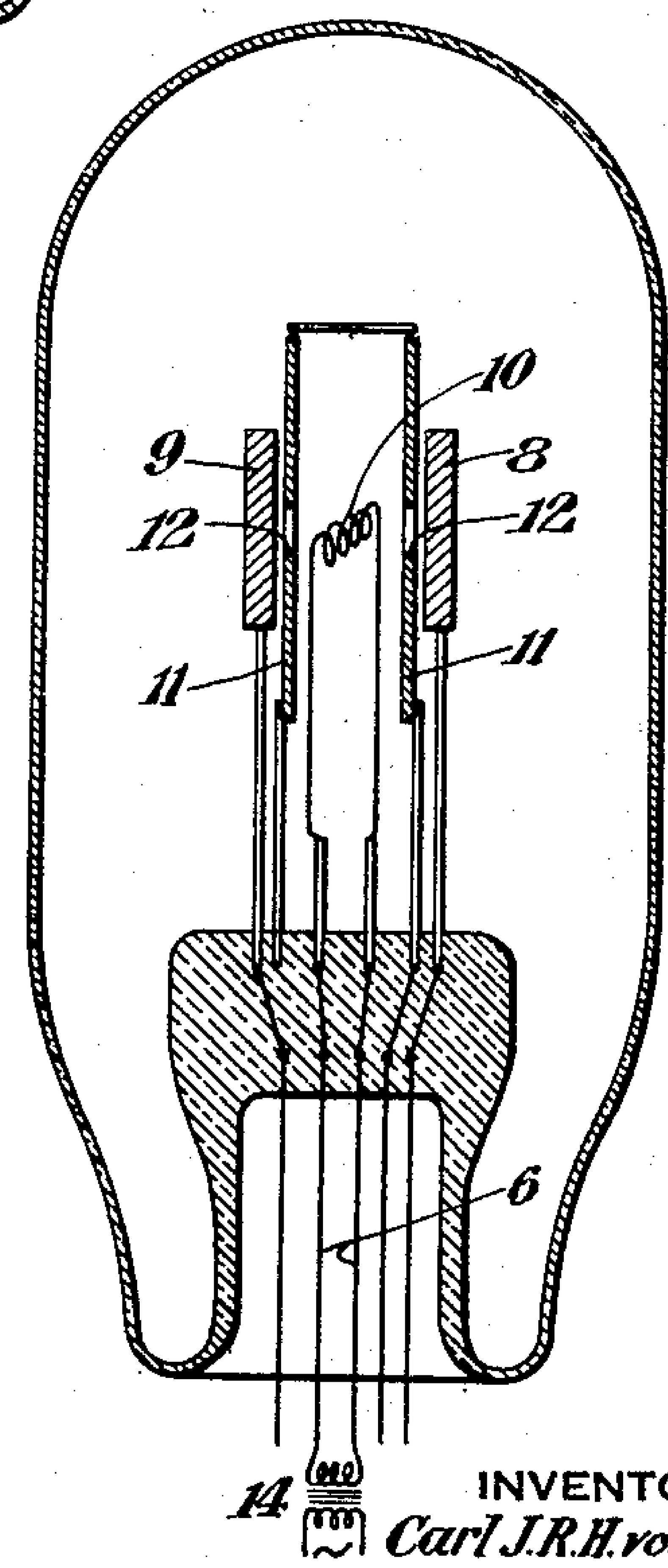


Fig.3.



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DISCHARGE TUBE

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Application February 25, 1931, Serial No. 518,068

3 Claims. (Cl. 250—27.5)

This invention relates to discharge tube apparatus, and is applicable to both gas filled and thermionic tubes.

An object of the invention is to provide suitable discharge tubes which will be stable and dependable under operating conditions, and which will be efficient and permit of accurate control of the operation and output of the tubes.

Fig. 1 of the drawing is a sectional view of a thermionic tube embodying the invention,

Fig. 2 is a view of the cathode assembly of the tube of Fig. 1, and

Fig. 3 shows the invention applied to a rectifier tube of the gas filled type.

An electrode construction similar to that shown in Figs. 1 and 2, especially the heater element and its relation to the cathode sleeve, is disclosed and claimed in my copending application, Serial Number 243,042, filed December 28, 1927.

Fig. 1 shows a thermionic tube of the indirect heated type, having a bifilar heating filament 1, heatable cathode sleeve 2, grid 3, and plate 4. The filament or heater is supported by ceramic insulator pieces 5, and has terminals 6 for connection to a source 14 of 60 cycle alternating current for heating the filament. The assembly is rigidly supported by a wire 13 embedded in the glass press 15 of the tube. The energy radiated by the filament heats the cathode sleeve causing the same to become electronically emissive, the sleeve preferably having a coating of an oxide of the alkaline earth metals in order to increase its emissivity. The filament is preferably twisted or helically wound so that the resulting electric field about the filament is in the form of a spiral, in which case the total space charge distribution with respect to the plate field will be much less affected than in the case of the bifilar filament having straight leg portions.

In such a tube any variation or deflection of the electron stream from the cathode, or any change in the normal space charge about the cathode, causes corresponding changes to occur in the plate circuit of the tube. Therefore, while the use of alternating current for heating filaments is desirable for many reasons, it causes serious disturbances in the tube because the varying current sets up varying electromagnetic and electrostatic fields which interfere with the space charge about the cathode and vary the electron stream between the cathode and plate. Where a 60 cycle supply current is used there are created in the tube disturbances of both 60 and 120 cycles, and these frequencies are such that a persistent audible hum is introduced into the tube circuits which seriously interferes with reproduction and impairs the reception of signals.

It is the usual practice in the art to make the cathode sleeves of nickel, or other metal or alloy, the principal considerations of which are that they should have good electrical conductivity or low resistivity to give a unipotential surface and one which will not interfere with the alkaline earth coatings thereon. In the present invention, however, I make the cathode sleeve of an alloy, the principal consideration of which is that it must have a very high magnetic permeability such that it effectively prevents the alternating fields induced by the filament heating current from passing the sleeve, and thereby prevents electromagnetic and electrostatic fields from being set up about the cathode, which otherwise would affect the electron field between the cathode and anode and cause hum in the tube circuits.

I have found that alloys of nickel and iron of from 70 to 85 percent nickel and 15 to 30 percent iron have a sufficiently high magnetic permeability and are suitable for such a sleeve, and will effectively prevent the alternating current hum, an alloy of 80 percent nickel and 20 percent iron being particularly effective in this respect. It has also been found that the addition of a small amount of cobalt to the above alloy may be desirable for certain structural purposes. These alloys are such that their magnetic permeability is many times greater than the materials heretofore used in the cathode sleeves—being much higher even than nickel, cobalt or transformer steel, while their resistivity to current flow is not correspondingly increased.

The resistivity of the alloy is important in that the electromagnetic forces are largely transformed into eddy currents set up in the sleeve. That resistivity is a factor is shown by the formula for the current density as determined by the solution of Maxwell's differential equations of an electromagnetic field. In a massive conductor the eddy currents set up are a function of

$$\sqrt{\frac{f.u}{o}}$$

where f is the frequency of the wave, u the permeability and o the resistivity. However, even though the material may have twice as much resistivity, if it has fifty times more permeability, the effect is that the electromagnetic forces emanating from the heater are five times more effectively neutralized or barred from the space charge in the tube, and the fact that the electromagnetic forces may introduce more heat in the sleeve due to increased resistivity is beneficial rather than detrimental, since it tends to maintain the necessary temperature of the sleeve. The low resistivity or high conductivity of the material has heretofore been considered the most important factor, whereas it is possible to increase the resistivity provided there is a much greater increase in the magnetic permeability, and still obtain a much better effect.

As shown in Figs. 1 and 2 of the drawing, the sleeve may be used as a core for the emissive coating of the cathode, but in other cases it may be desirable to provide a plating of nickel on the surface of the sleeve, which plating is preferably very dense and smoothly polished and thereafter oxidized and again reduced to obtain high emissivity. Tubes made in accordance with this invention, and used as cascade amplifiers for audio frequencies, will permit an amplification of the signals up to many thousand times without an objectionable amount of hum being introduced by the heater field which formerly limited their employment for high amplification.

The invention may be advantageously employed in other kinds of tubes, such as gas filled discharge tubes operating from alternating current, and where it is necessary that fields created by electrodes having varying current impressed thereon will be restricted to certain areas in order to prevent interference with the main discharge of the tube.

Fig. 3 shows a gas filled discharge tube adapted for full wave rectification, having anodes 8 and 9 with a common filament 10 cooperating therewith, the electrodes being separated by barriers 11 which are preferably placed adjacent the anodes within the mean free path of the gas which fills the tube so as to prevent interaction between the plates and their barriers. The barriers have openings as indicated at 12 through which the main discharge passes. The tube is preferably filled with an inert gas, such as argon, but any suitable gas may be employed, and it has been found that the addition of mercury vapor to the argon is advantageous under certain conditions.

The barriers in such a tube shield the action of the field of one plate from the other plate field, and each of the plate fields should only extend effectively towards the cathode. In this construction if the barriers are made of an alloy in accordance with the invention, the high permeability provides a more effective isolation of the respective fields, and enables the mass of the barriers to be considerably reduced which means more shock proof construction of the tube. Such barriers also have less gas content and are more readily degassed. Also, the large thin surfaces of such barriers may be more easily heated during the manufacturing process for purposes of degassing, because they will heat up earlier under eddy current treatment on account of their high permeability, and have the advantage of not corroding as easily as iron and have no large amounts of nitrogen occluded such as carbon, which is particularly difficult to degas. Furthermore, the alloys will not interact with the oxide coated cathodes, even if they disintegrate to a certain extent under ionic bombardment, so as to render the oxides less emissive. They can be employed effectively in large mercury arc rectifiers, instead of the usual iron barriers around the anodes, because they will withstand mercury vapor.

In case it is desirable to prevent electromagnetic waves set up outside the tube from affecting the discharge path within the tube, the foregoing alloys of high permeability may be helically wound in the form of ribbons or wires around the discharge chamber and will provide an effective barrier with a minimum amount of material.

What I claim is:—

1. A gaseous rectifier tube comprising an electron emissive cathode adapted to be heated by alternating current, a plurality of anodes in said tube, and shields therein interposed between said electrodes, each at a distance within the mean free path of the gas from its respective anode composed of an alloy having a permeability several times higher than that of soft iron, for preventing the electromagnetic field about said cathode, due to the heating current, from interfering with the normal electron field between each shield and its respective anode and between said anodes.

2. A discharge tube comprising an electron emissive cathode adapted to be heated by alternating current, a cooperating anode, and a barrier surrounding said cathode and having a portion disposed between the cathode and anode, said barrier being composed of an alloy having several times higher magnetic permeability than soft iron for neutralizing the resulting field of the cathode in the space between the barrier and anode.

3. A discharge tube comprising an electron emissive cathode adapted to be heated by alternating current, a cooperating anode, and a nickel-iron alloy barrier disposed between said cathode and anode, said barrier having a ratio of magnetic permeability to electrical resistivity several times that of soft iron and adapted to restrict the magnetic field of the cathode to the space between said cathode and barrier.

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