Aug. 20, 1935. I. E. MOUROMTSEFF ET AL 2,011,647

TUBE COOLING DEVICE

Filed July 30, 1932

Fig. 1.

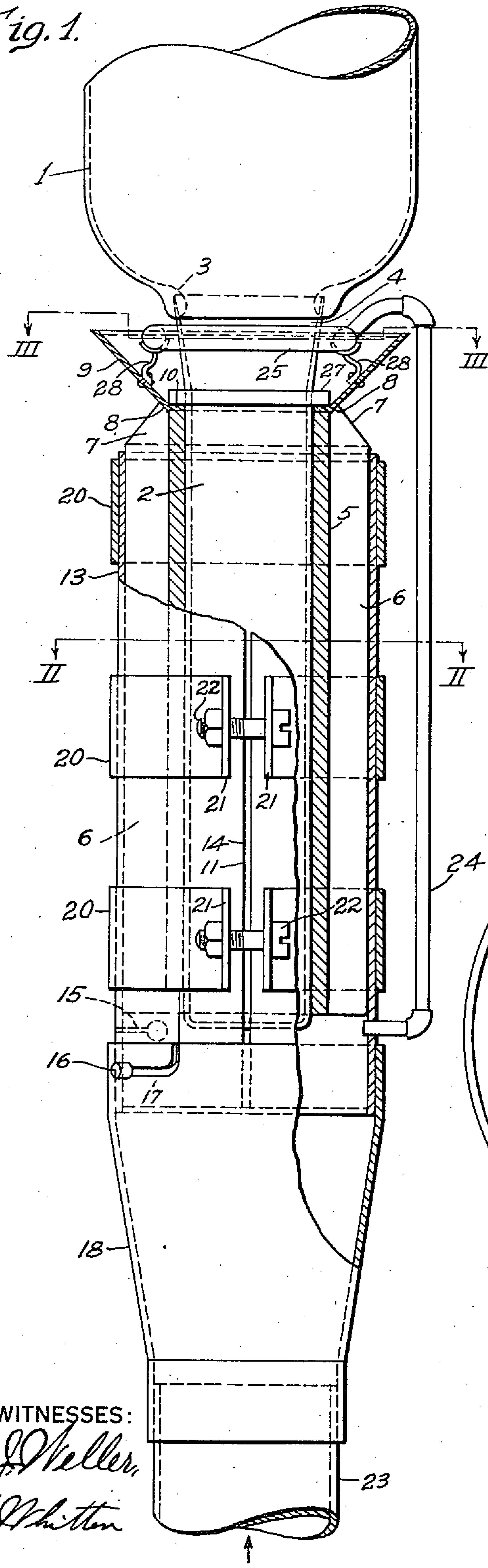


Fig. 2.

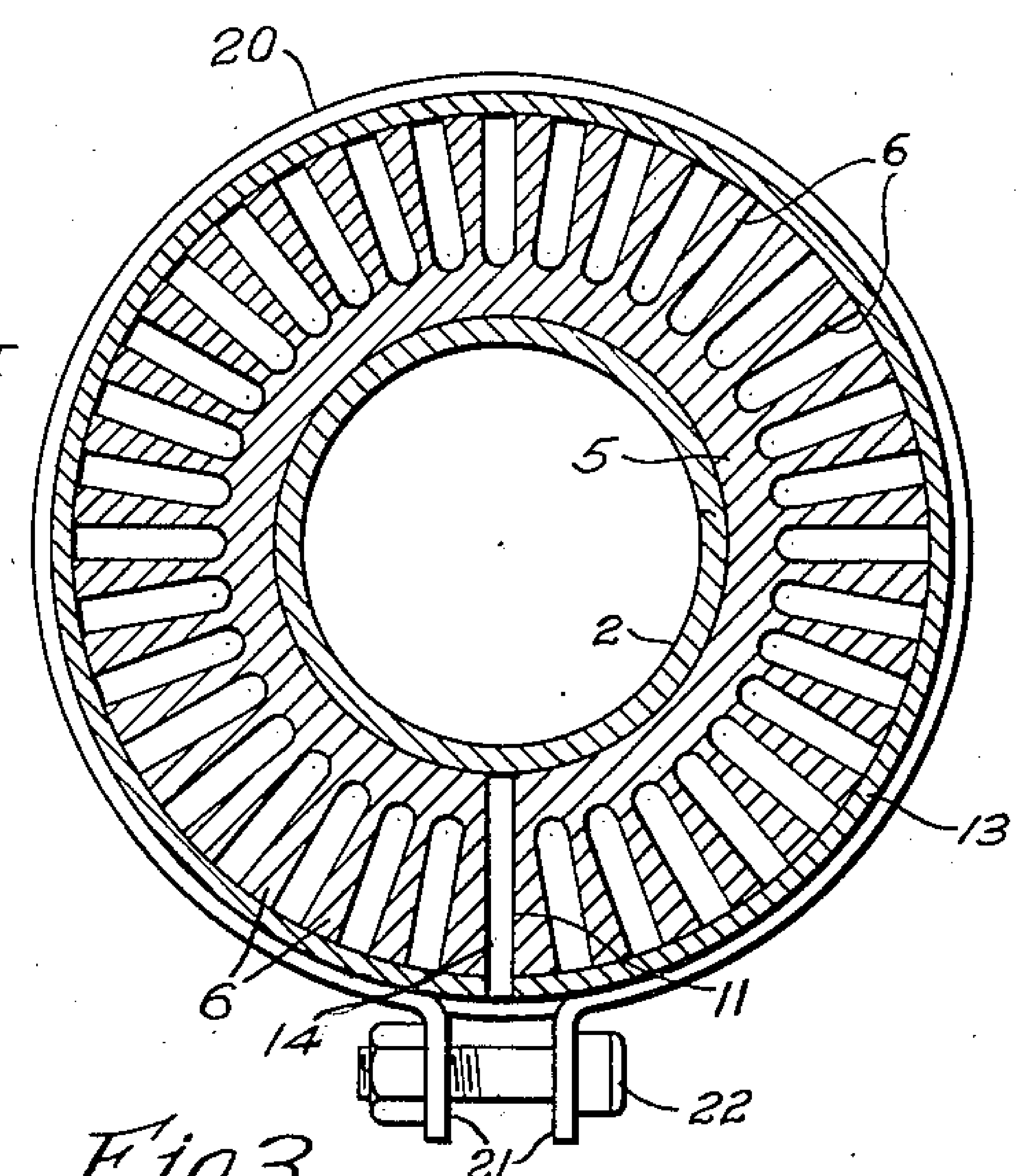
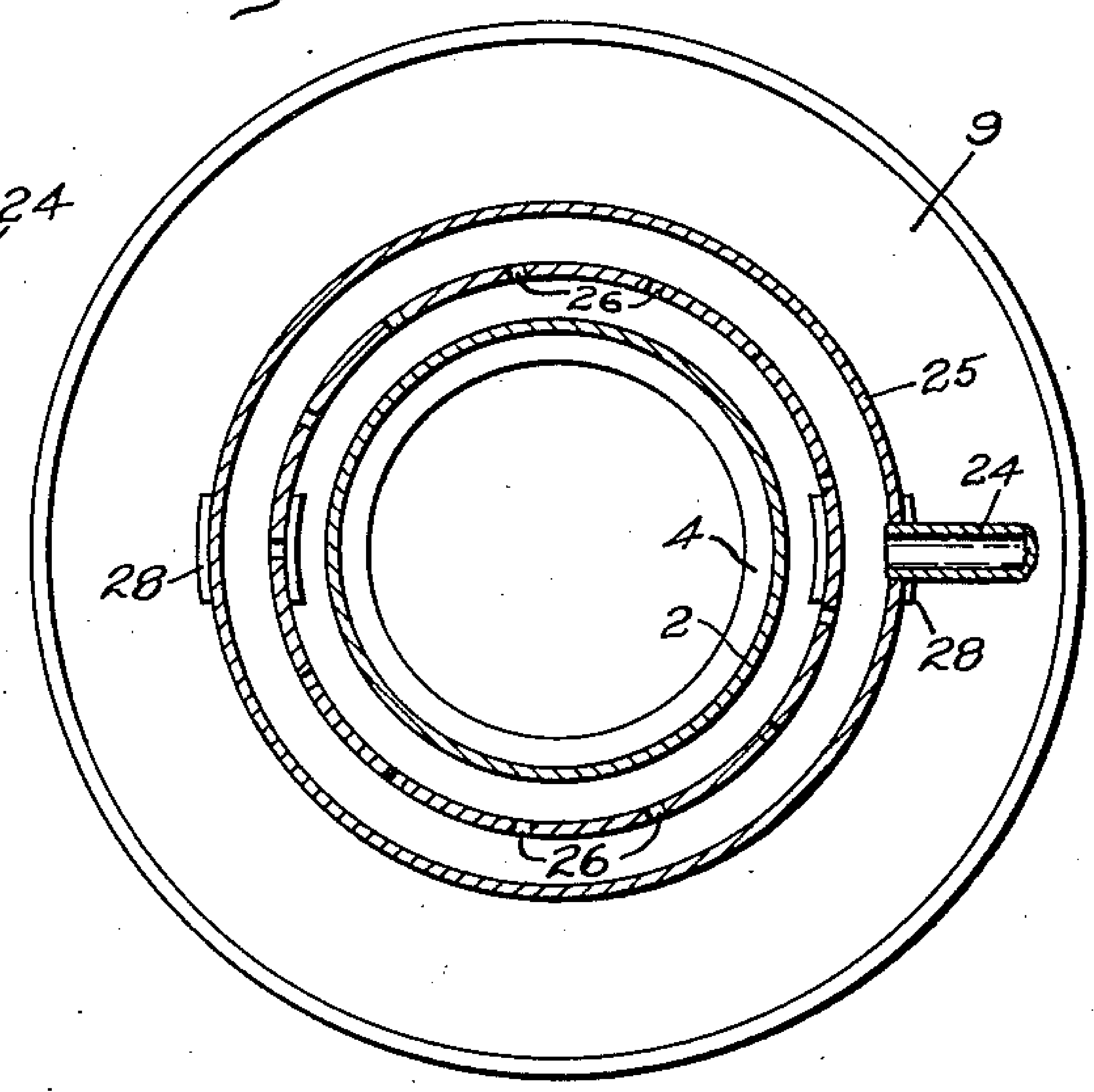


Fig. 3.



WITNESSES:

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TUBE COOLING DEVICE

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4 Claims. (Cl. 250—27.5)

This invention concerns a transmitting tube and particularly a cooling device for such a tube.

In vacuum tubes intended for transmission and particularly with powerful transmission tubes, the problem of cooling the anode has ordinarily been met by providing a water jacket but in many situations water cooling is inconvenient. If, for example, the transmitting tube is to be used on an airplane, provision of an ample water supply and a circulating system for it would add inconveniently to the weight to be carried and the space to be occupied.

Also, on board ship, it is often inconvenient to supply fresh water for cooling the tube and sea water, because it deposits a scale, cannot be used.

Heretofore cooling the anode by means of a blast of air has been inefficient because no way was known to bring a sufficient volume of air into intimate contact with the limited surface of the anode.

It is not feasible to make fins or other devices for increasing the effective surface of the anode, integral with it because of the difficulty and expense of machining a copper body of such a shape, of sealing glass thereto and of supporting and heating it during the "out-gasing" treatment.

Moreover, an anode of the usual type may be made by drawing which is much more convenient and inexpensive than machining.

The provision of a supplemental member to provide the increased surface has heretofore been considered impractical because no good thermal junction between the added member and the copper anode could be provided. Also, it has been found in attempts to provide fins by means of a member attached to the tube that the anode became distorted by expanding into the spaces between the fins with a resultant shortened life of the tube.

It is an object of our invention to provide for cooling transmitting tubes by an air blast.

It is a further object of our invention to provide a device for enlarging the effective cooling surface of the anode and afford good thermal connection between such added device and the anode.

It is a further object of our invention to provide a device which will present a large surface to a current of air or other cooling agent which shall be in such intimate contact with the anode that the heat shall be effectively led from the anode to said large surface.

It is a further object of our invention to provide auxiliary cooling means for cooling the anode close to the seal, whereby thermal strains at the seal are prevented.

It is a further object of our invention to provide a cooling device which is capable of being attached to and cooperating with a tube of the standard type usually used with water cooling.

Other objects of our invention and details of the construction will be apparent from the following description and the accompanying drawing in which:

Figure 1 is an elevation, partly in section, showing the vacuum tube and the cooling device.

Fig. 2 is an enlarged sectional view taken along the line II—II of Fig. 1; and,

Fig. 3 is an enlarged sectional view taken along the line III—III of Fig. 1.

The vacuum tube shown in Fig. 1 includes a glass part 1, and a copper part 2 united by a seal 3. The copper portion is mainly cylindrical but may be provided with a flared portion, as shown at 4, at the end which is sealed to the glass.

The cooling device comprises a body 5 of aluminum, the central portion of which is a hollow cylinder having an internal diameter adapted to fit around the copper cylinder 2. Projecting radially from the hollow cylinder are a plurality of fins 6. These fins extend longitudinally of the cylinder throughout substantially the whole length thereof although at the upper end they are beveled, as indicated at 7. The inner part of the extreme top of the fins is beveled in the opposite direction, as shown at 8, to provide a conical seat against which the lower margin of the conical surface of a shield 9 rests. The lower edge of this shield is turned inward to form a flange 10 which rests against the upper end surface of the central cylindrical portion 5 of the aluminum sleeve.

A slit 11 extends radially through the central portion 5 of the sleeve and merges with the space between two fins. The whole of the aluminum body is thus split throughout its radial thickness and the split extends the entire length of the sleeve.

If desired, several such slits may be made, thus dividing the aluminum body into two or more sector-like parts. A housing 13 surrounds the aluminum sleeve and extends to the lower edge of the bevel portion 7 of the fins. This housing is slit throughout its length, as indicated at 14. At the other end, the housing extends beyond the bottom surface of the aluminum sleeve affording a margin which is provided with projecting studs 16 to cooperate with bayonet slots 17 upon a funnel 18. Slots 15, similar to the bayonet slots, in the margin of the housing provide yieldable tongues on which the studs 16 are located. The funnel and the housing are thus fastened together making a flexible joint.

A plurality of bands 20 surround the housing and are each provided with out-turned ends 21 through which bolts 22 extend for tightening the bands.

The funnel 18 is connected to a pipe 23 which extends to any source of air under pressure, indicated by the arrow at the end of the pipe. For best flow of air the angle between the surface of the funnel 18 and its axis should be between 5 degrees and 14 degrees.

A branch pipe 24 conducts air around the housing to a circular pipe 25 which surrounds the anode 2 a short distance below the seal 3, being supported from shield 9 by brackets 28. The surface of the pipe 25 which is toward the copper is perforated, as indicated at 26 in Fig. 3 to direct air against the anode 2 a short distance below the seal 3.

The flange 10 at the lower edge of the shield 9 cooperates with a flange 27 on the anode to secure the shield in place. The flange 27 is found on standard tubes intended for use with a water jacket and no redesign of the tube is required to adapt it to cooling by air by means of this jacket.

In the operation of the device, the split aluminum sleeve 5 is placed around the anode. The housing 13 is then placed over the sleeve and the clamping rings 20 are placed over the housing. The bolts 22 are then tightened and draw the rings and sleeve into close contact with each other and with the anode 2. Because the housing and sleeve are split they yield readily to the clamping action of the rings 20.

This yielding is by a flexure of the housing and sleeve in a plane at right angles to the axis, but the reinforcing action of the fins 6, which are integral with the central portion 5, the cylindrical form of the central part of the sleeve and the stiffness of the housing 13 because of its curvature, render the assembly very rigid against any tendency to bend in any plane through the axis. If, therefore, one ring 20 is tightened more than the others, the result is not a local excessive pressure of the sleeve 5 against the anode tube but this excess of pressure is distributed lengthwise of the sleeve throughout considerable area.

It frequently happens that the heat-treatment of the tube leaves the thin-walled anode distorted. If such distortion results in irregular contact between the anode and the jacket, the copper is likely to become perforated where the contact is poor, thus shortening the life of the tube. Compression of the aluminum sleeve, by the clamping rings tends to force it against the anode and the anode into true cylindrical form. This results in an improved characteristic of the tube. It also ensures more uniform contact between jacket and tube, thus tending to increase the life of the tube.

In cases where the anode is so badly misshaped that a single split in the aluminum sleeve is insufficient to permit it to accommodate itself to the anode, a sleeve split into several sector-like parts may be employed. It may even be possible, in some cases to force such an anode into substantially complete contact with the sleeve, thereby making the cooling of such a tube by air practicable and also prolonging the life of what would otherwise be a very short-lived tube. Even in the absence of any serious distortion, jackets made in several sections are convenient with anodes of large diameter, partly because of the smaller expense of manufacture.

When the sleeve has been assembled on the anode as described, the funnel is connected to the lower end of the sleeve and the pipes 24 and 25 are put in place. The pipe 23 from the funnel is connected to a fan case or to an air intake operated by the movement of the airplane or to any other source of supply of air or of other cooling gas under pressure.

Air, therefore, enters the funnel 18 from said source and passes up through the channels in the aluminum sleeve. These channels are each formed by the space between two adjacent fins and between the central cylindrical portion 5 and the housing 13. Intimate contact between the moving air and a large surface of the aluminum sleeve is thus provided.

Heat from the anode flows into the central cylindrical portion of the sleeve 5 and into the several fins by conduction. From the fins and the exterior surface of the central portion, the heat is delivered to the air which, being in motion, carries it away and is, therefore, hot when it emerges at the beveled part 7 of the fins. The shield 9 is provided in order to prevent this hot air from contacting with the glass part of the tube or with the seal where the copper and glass meet. This air as it emerges from the channels is deflected by the shield 9 and passes into the surrounding atmosphere without coming against the glass 1 or the seal 3.

Additional air from the same source passes through the pipe 24 into the pipe 25 and emerges through the perforations 26, impinging against the copper a short distance below the seal 3. Thus, air which has not been heated is caused to impinge directly against the copper a short distance from the seal. If the cooling action of the air in the channels were insufficient to prevent heat flowing by conduction upward in the walls of the anode 2 reaching the seal, the effect of the air directly impinging upon the copper near the seal will prevent sufficient heating of the copper at the seal to cause damage.

The cooling material may very well be some other gas, such as hydrogen, instead of air, in which case the emerging gas instead of being literated into the atmosphere will ordinarily be returned to the pump or other source of pressure through some device presenting sufficient radiation surface to insure complete cooling of the circulating gas.

The cooling device may be supported by brackets attached to any of the clamping rings 20 and the clamping rings may be loosely secured to the cooling device in any desirable fashion to prevent inconvenient separation of the parts when the clamping bolts 22 are loosened.

While aluminum has been mentioned as the preferred material for the cylindrical sleeve 5 any suitable material of good thermal conductivity may be used. Brass is particularly serviceable. Also it is possible to increase the thermal conductivity of the joint between the anode and the jacket by suitable plating. For example the anode, the jacket or both may be plated with gold or with nickel.

It will be observed that the cooling device is neither bulky nor heavy and is, therefore, well adapted for cooling a tube in an airplane or in other situations where weight and bulk are important considerations.

Many modifications of details will readily occur to those skilled in the art and come within the spirit of this invention, which is limited only by the prior art and indicated in the accompanying claims.

We claim as our invention:

1. In combination, a vacuum tube including a cylindrical anode, a cylindrical split metal sleeve surrounding said anode, fins projecting from said sleeve, extending longitudinally thereof and integral therewith, a housing surrounding said sleeve contacting the outer edges of said fins and cooperating with them to provide a plurality of channels extending longitudinally of said sleeve, said housing being split, and a plurality of clamping means each surrounding said housing at separated points thereof, whereby the housing may be radially compressed to cause intimate contact between the sleeve and the anode.

2. In combination, a vacuum tube including a cylindrical copper part, a cylindrical split aluminum sleeve surrounding said copper part, fins projecting from said sleeve, extending longitudinally thereof and integral therewith, a housing surrounding said sleeve contacting the outer edges of said fins and cooperating with them to provide a plurality of channels extending longitudinally of said sleeve, said housing being split, a plurality of clamping means each surrounding said housing located at separated points thereof, whereby the housing may be radially compressed to cause intimate contact between the sleeve and the copper part.

3. In combination, a vacuum tube including a glass part, a cylindrical copper part and a seal therebetween, a cylindrical split aluminum sleeve surrounding said copper part, fins projecting from said sleeve, extending longitudinally thereof and integral therewith, a housing surrounding said sleeve contacting the outer edge of said fins and cooperating with them to provide a plurality of channels extending longitudinally of said sleeve, said housing being split, a plurality of clamping means each surrounding said housing located at separated points thereof, whereby the housing may be radially compressed to cause intimate contact between the sleeve and the copper part, and means for directing a separate current of aeriform cooling material against the copper part near said seal.

4. In combination, a vacuum tube, the wall of which includes a cylindrical copper portion, a cooling device external to said tube surrounding and extending along said copper portion, said cooling device having structure yieldable in any plane normal to the axis of said cylindrical portion and rigid in any longitudinal plane, means for applying clamping pressure at points distributed along the length of said cooling device to bring it into good thermal contact with the copper by yielding in said normal planes, the rigidity of said device in longitudinal planes tending to constrain the copper into a true cylindrical form.

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