United States Patent [19]

Shurgan

[11] **3,898,503**

[45] **Aug. 5, 1975**

[54] **DUAL CATHODE STRUCTURE**

[75] Inventor: **Joel Shurgan,** Washington Township, N.J.

[73] Assignee: **Duro-Test Corporation,** North Bergen, N.J.

[22] Filed: **Dec. 16, 1970**

[21] Appl. No.: **98,899**

Related U.S. Application Data

[63] Continuation of Ser. No. 791,245, Jan. 15, 1969, abandoned.

[52] **U.S. Cl.** **313/206;** 313/207; 313/244

[51] **Int. Cl.** **H01j 17/06**

[58] **Field of Search** 313/109, 207, 212, 344, 313/346, 206, 273

[56] **References Cited**

UNITED STATES PATENTS

3,079,521	2/1963	Clark	313/109 X
3,369,143	2/1968	Gilmore et al.	313/207 X
3,504,218	3/1970	Emidy et al.	313/109 X

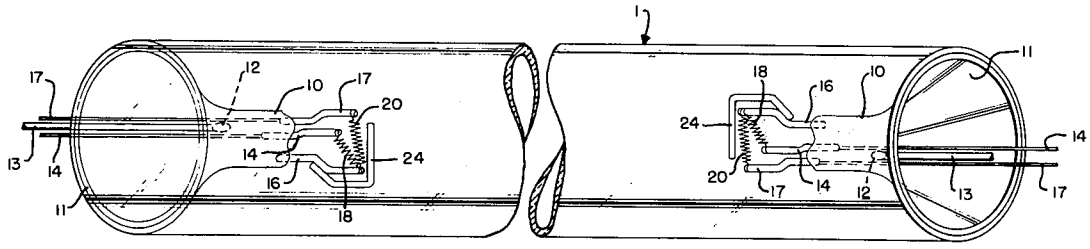
Primary Examiner—Nathan Kaufman

Attorney, Agent, or Firm—Darby & Darby

[57] **ABSTRACT**

A dual cathode structure for a fluorescent lamp comprising a pair of electron emissive cathodes which are connected with a common junction and mounted to have an included angle therebetween. An anode flag is connected to the common junction to collect electrons when the filaments are operating in the anode half cycle. The collected electrons pass through one or both of the cathodes to diffuse the hot spot on the electrode. The lamp operates with reduced wattage with no decrease of light output.

10 Claims, 3 Drawing Figures



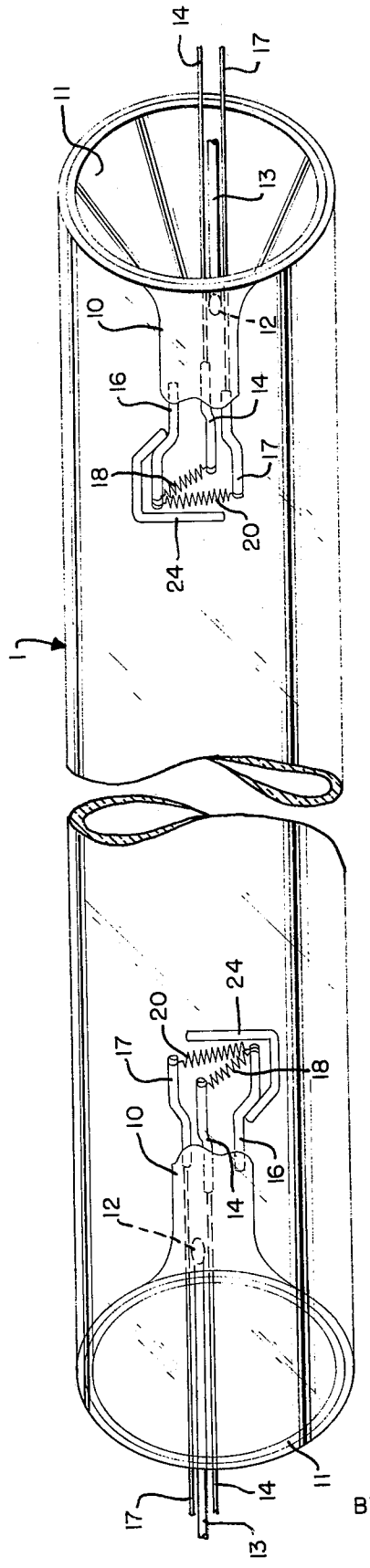


FIG. 1

INVENTOR
JOEL SHURGAN

BY Darby + Darby

ATTORNEYS

FIG. 2

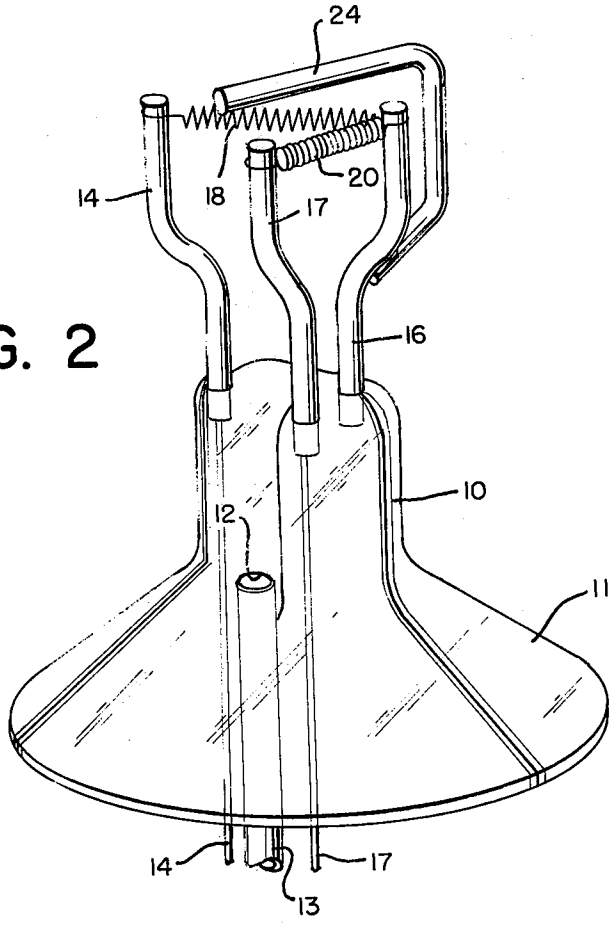
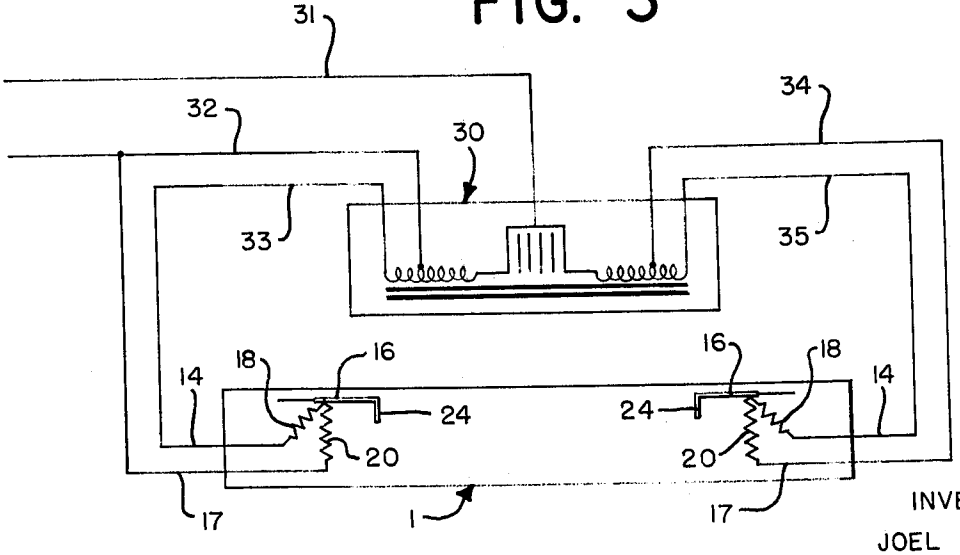


FIG. 3



INVENTOR
JOEL SHURGAN

BY Darby & Darby

ATTORNEYS

DUAL CATHODE STRUCTURE

This application is a continuation of 791,245 filed Jan. 15, 1969, now abandoned.

In the copending application of Thomas Emidy, Walter Simson and Luke Thorington, Ser. No. 536,888, filed Mar. 23, 1966 and entitled "Dual Cathode For Fluorescent Lamps," now abandoned which is assigned to the same assignee as the subject application, a novel dual-cathode structure is disclosed for use with fluorescent lamps of either the pre-heat type, instant-start or rapid-start types. In that application, a pair of similar filament-cathodes of electron emissive material is utilized at each end of the fluorescent lamp. The filament cathodes of each pair are mounted on a stem at a respective end of the lamp with an included angle of less than 180°, and preferably about 45°, between them. One of the filament cathodes of each pair is the main cathode and is connected across a winding of the ballast transformer of the system to receive heating current and arc discharge potential. The main cathode of each pair operates in the normal manner to first strike and then maintain the arc. As the lamp operates a main cathode is stripped of its emissive material. At this time the arc shifts to the other cathode of the pair which operates to maintain the arc. During the time it operates, the auxiliary cathode gives off emissive material which is transferred to the main cathode to enable the main cathode to strike the arc during another starting operation.

The subject invention relates to an improvement in fluorescent lamps of the type having dual cathode structures. In accordance with the invention a pair of electrodes are provided at an end of a fluorescent lamp. The electrodes have one end connected to each other at a common junction with an included angle between the two electrodes of less than 180° and preferably about 45°. The other (outer) ends of the electrode pair are connected to a lamp ballast. An anode flag, or probe, is connected to the junction of the electrodes of a cathode pair. This junction is at the apex of the included angle between the two cathodes. Unlike flags or probes in use in conventional fluorescent lamps, in the lamps of the subject invention any anode current collected by the probe or flag of a cathode pair must pass through one or the other of the cathodes before leaving the lamp. This cathode is heated by the exiting current which tends to equalize the heat of the cathodes during lamp operation. The equalization of the heat in turn diffuses the "hot spot" of the cathode. The heat equalization has been found to increase the operating efficiency of the lamps as well as extend the life of the filament-cathode pair.

It is therefore an object of the invention to provide an improved dual cathode structure for a fluorescent lamp.

A further object is to provide an improved dual cathode structure in which an anode probe or flag is connected to the common junction of a pair of cathodes, the probe acting to collect anode current to equalize the heating of the two cathodes of the pair.

An additional object is to provide a dual cathode structure comprising a pair of electron emissive cathodes mounted with an included angle, of about 90° or less and having an anode flag or probe connected to the common junction of these cathodes which is at the apex of the angle.

Other objects of the present invention will become more apparent upon reference to the following specification and annexed drawings, in which:

FIG. 1 is a view of a lamp using the improved cathode structure of the present invention;

FIG. 2 is a perspective view of the improved cathode structure; and

FIG. 3 is a schematic diagram of a ballast circuit with a lamp using the cathode structure of the present invention.

Referring to FIGS. 1 and 2, the dual cathode structure of the subject invention is shown in a fluorescent lamp 1 of a conventional type having conventional phosphors, fill gas, ionizible material, etc. Since the lamp components other than the cathode are conventional and form no part of the present invention, they will not be described in detail.

The cathode structure of the invention is shown mounted at each end of the lamp and includes the usual stem press 10 with flared stem 11 having a hole 12 which communicates with an exhaust tube 13 through which the fluorescent lamp 1 is exhausted. The stem structure and material are conventional and the structure is mounted to the end of the envelope by any suitable conventional technique, such as glass-to-glass sealing. Mounted in the press 10 are a pair of filament-cathodes 18 and 20 which are also of the conventional construction, i.e. such as of the coiled-coil type. These cathodes are of similar, or identical, construction and are coated with an electron emissive material such as an alkaline earth metal oxide. The cathodes 18 and 20 which are used in the dual structure, preferably utilize a multi-turn overwound design with parameters commonly employed by the industry for pre-heat, rapid-start fluorescent lamps. Filament 18 is held between a pair of electrically conductive support members 14 and 16 mounted in the press 10 while filament 20 is mounted between common support members 16 and another support member 17 also mounted in the press 10.

As shown in FIG. 2, the supporting lead wires 14 and 17 are brought out external of the lamp envelope (not shown) through respective lead wires at the bottom of the flare 11. The filament supports can be, and usually are, extensions of the lead wires. The common support member 16 terminates at the stem press, that is, it is insulated from the other two support members 14 and 17 and their corresponding lead wires. As is conventional, the flare 11 is sealed at the end of the tubular envelope and the envelope is provided with an end cap (not shown) having terminals to which the leads 14 and 17 are connected.

In the preferred embodiment of the invention, the two cathodes 18 and 20 are mounted with an included angle of approximately 40°–45° therebetween. This angle is not critical and it is found that angles up to about 90°, and even somewhat greater, work satisfactorily.

An anode probe 24 is mounted on and is electrically connected to the common support 16 of the cathode pair at the apex of the included angle between the two cathodes. An anode flag (not shown) can be used in place of a probe, if desired. The probe, or flags, are of conventional construction of an electrically conductive material such as nickel clad steel, nickel sheeting or wire. The probe 24, or anode flag, has only this one electrical connection.

Referring to FIG. 3, the novel dual cathode is shown operating in a conventional rapid-start ballast circuit. One dual cathode structure is provided at each end of an otherwise conventional fluorescent lamp **1.** In FIG. **3** the ballast autotransformer is designated **30** and has its two input leads **31** and **32** connected to a source of alternating current line voltage. Lead **32,** the common line, and a lead **33** coming out of the ballast autotransformer **30** at one end of the primary winding form a portion of the primary winding which is tapped off to supply low voltage filament current across the two series connected filaments **18** and **20** through leads **14** and **17.** Lead **16,** to the junction of the two filaments, is left unconnected. Two lines **34** and **35** tap off a portion of the secondary winding of the auto-transformer to supply filament voltage across the other pair of series connected cathodes **18** and **20** at the other end of the lamp. Again, the lead **16** to the common junction is left unconnected. The operating voltage is applied to the two cathodes at the opposite ends of the lamp across the primary and secondary of the ballast transformer. A probe, or flag, **24** is shown connected to each common junction of an electrode structure.

In accordance with the subject invention, the probe **24** connected to the common lead **16** of the dual cathode structure at each end of the lamp alternately functions as an anode to "draw" the electrons emitted by the cathode at the other end of the lamp toward it. It should be understood that since the lamp is operated from a source of alternating current voltage that one cathode structure is receiving negative going voltage and emitting electrons while the other cathode structure is receiving voltage whose polarity is more positive than the first. The electrons emitted from the cathode of more negative polarity are drawn to the cathode of more positive polarity at the opposite end of the lamp and are collected by the probe **24.** The electrons collected by a respective probe **24** can travel one of two paths.

Considering that the cathode structure at the left end of the lamp envelope of FIG. **3** is more positive than that at the right end, the first path for the electrons collected by probe **24** is through the filament-cathode **18** and out the lead wire to lead **33** of the ballast. Another path is through the cathode **20** and out the corresponding lead wire **17** to lead **32** of the ballast transformer. A similar dual current path exists for the cathode structure at the right hand end of the lamp when the polarities of the two electrode structures are reversed.

When using the dual cathode structures it has been found that one of the filament-cathode coils of a pair operates at a considerably higher temperature than the other. The use of the anode probe **24** serves to more evenly distribute the temperature since it passes collected electrons through one or both of the cathodes. This produces several advantages which are described in greater detail below.

As is known in the use of rapid start types of fluorescent lamps such as shown in FIG. **3,** during normal operation a spot, called the "hot-spot" is produced on a cathode by the electron stream bombardment. The size of this spot is usually a few turns of the filament and the temperature reached is considerably above 900°C. It has been visually observed that the use of the probes **24** tends to diffuse this constricted "hot spot." This prolongs the life of the cathode since a more diffuse "hot spot" is usually cooler than a more concentrated one and it boils away less of the emissive material.

Lamps using the dual-cathode structure with probe also show a decrease of between one to two watts of input power in a forty watt lamp with the same light output as compared to forty watt lamps using dual cathodes without the anode probes or flags. This decrease is obtained principally by a marked decrease in the voltage drop across the lamp.

The chart set forth below compares dual-cathode lamps of various types made in accordance with the subject invention with lamps using dual cathodes without a probe.

Test No.	Lamp Volts	Lamp Current Amperes	Lamp Watts	Lamp Lumens	Efficacy Lumens per watt	Color
1 - Test	99.9	.423	39.0	2908	74.6	Cool White
1 - Control	102.7	.422	40.2	2946	73.3	Cool White
2 - Test	100.0	.430	39.7	3090	79.6	Cool White
2 - Control	101.9	.428	38.8	3057	76.9	Cool White
3 - Test	110.0	.414	40.2	2354	58.6	Optima
3 - Control	111.8	.412	40.9	2354	57.5	Optima
4 - Test A	98.7	.432	38.3	3018	78.8	Cool White
B	101.2	.430	39.4	3030	76.9	Cool White
C	100.7	.431	39.2	3045	77.7	Cool White
4 - Control D	101.8	.429	39.5	3042	77.0	Cool White

In all cases, for the dual cathodes neither coil is shorted, and for all photometry the lamps were read on a reference ballast in the preheat mode of operation. The "control" lamps for each test were stock lamps made at the same time.

In test No. 1 the central probe was large, shadowing part of the phosphor, which explains the lower lumen reading. In test No. 2 the probe was a thin nickel wire about 0.050 inch in diameter. Test No. 3 is for Optima (a registered trademark of Duro-Test Corporation of North Bergen, New Jersey) type of fluorescent lamp of helicoidal construction. Lamps of this type are characterized by high lamp voltage and low lumen output. Test 4A used filament coils of a length spaced at an angle so their free ends were 3 mm. apart. The probe, 15 mm long was 6 mm ahead of the coils. Test 4B had the same geometry with no probe. Test 4C also had no probe but the end spacing was increased to 1 cm separation.

In general, it can be seen that the use of the central probe will increase lamp efficiency by reducing lamp wattage by more than 1 watt in a 40 watt lamp. In comparison, the usual form of flag or probe will decrease wattage by at most, 0.7 watts in lamps of the same wat-

tage and color type. As in the case for all lamps made with probes, the cathodes must be designed differently than those for lamps with no probe, but because the probe current is used in heating in this invention, the design will be much closer to coils of the type used in probe-less lamps, making filament coil design sometimes simpler.

The dual-cathode structure of the subject invention also can be used with lamps of the rapid-start and instant-start type. Advantages similar to those described above are obtained.

While preferred embodiments of the invention have been described above, it will be understood that these are illustrative only, and the invention is limited solely by the appended claims.

What is claimed is:

1. A fluorescent lamp of the type in which the cathodes receive current from a source of alternating current electrical voltage external to the lamp which supplies both heating current and operating voltage comprising

a sealed envelope having a phosphor coating on the internal wall thereof and having a fill gas and an ionizable medium therein,

a cathode structure means at each end of the envelope comprising an electron emissive cathode means, first and second electrically conductive leads connected to spaced points on said cathode means and extending outside of the envelope to electrically connect the cathode means to the voltage source so that alternating current from the source will flow through the portion of the cathode means electrically connected between said leads to provide heating current to the cathode during the entire time that the lamp is operating and alternately make the structure emit electrons and attract electrons during the negative and positive half cycles of the operating voltage respectively to produce an arc stream discharge,

and electrically conductive probe means for at least one of said cathode structure means having one end electrically connected only to an intermediate point of its respective electron emissive cathode means between said spaced points and the other end positioned within the envelope to extend into the path of the arc stream discharge to collect positive ions when the said one electron emissive cathode is emitting electrons and to collect electrons when said one electron emissive cathode is attracting electrons, said positive ions and said electrons collected by said other end of said probe means being alternately conducted to said one end of said probe means and then to a portion of the electron emissive cathode means of said one cathode structure means, the collected ions causing the heating current flowing through the electron emissive cathode means of said one cathode structure means causing a redistribution of the current to neutralize the ions, and the collected electrons also flowing through a portion of the electron emissive cathode means.

2. A fluorescent lamp as in claim **1** wherein said cathode structure including said probe means has the probe means connected substantially at the mid-point of the electron emissive cathode means.

3. A fluorescent lamp as in claim **2** wherein said envelope is elongated and has a longitudinal axis, means mounting said electron emissive cathode means to be substantially transverse to said longitudinal axis, said probe means also having a substantial portion thereof which is substantially transverse to said longitudinal axis.

4. A fluorescent lamp as in claim **1** wherein said envelope is elongated and has a longitudinal axis, means mounting said electron emissive cathode means to be substantially transverse to said longitudinal axis, said probe means also having a substantial portion thereof which is substantially transverse to said longitudinal axis.

5. The fluorescent lamp of claim **4** wherein said electron emissive cathode means is mounted to have two portions with an included angle of not greater than 90° therebetween and said probe means is located at the apex of said angle.

6. The fluorescent lamp of claim **1** further comprising insulated mounting means for said cathode structure means sealed at each end of said envelope, said insulated mounting means for said cathode structure means having said probe means including a base of insulated material and first, second and third electrically conductive support means affixed to said base, means electrically connecting said electron emissive cathode means between said first and second and said second and third support means to form two portions, said first and second leads being electrically connected to said first and third support means, and means electrically connecting said probe means to said second support means.

7. The fluorescent lamp of claim **6** wherein said conductive probe means is electrically connected to said second electrically conductive support means and includes a portion which is located between the electron emissive cathode means at the respective ends of the envelope.

8. The fluorescent lamp of claim **1** wherein said probe means has the portion thereof for collecting the positive ions and the electrons located between the electron emissive cathode means of the cathode structures at the respective ends of the envelope.

9. A fluorescent lamp as in claim **1** wherein the cathode structure at each end of the envelope includes a conductive probe means.

10. A fluorescent lamp as in claim **9** wherein said envelope is elongated and has a longitudinal axis, means for mounting each said electron emissive cathode means to be generally transverse of said longitudinal axis and said probe means being formed to have a substantial portion thereof to be generally transverse to said longitudinal axis.

* * * * *