[Second Edition.]

PATENT SPECIFICATION

Application Date: Jan. 27, 1936. No. 2536/36. **469,732**

Complete Specification Left: Oct. 6, 1936.

Complete Specification Accepted: July 27, 1937.

PROVISIONAL SPECIFICATION.

Improvements in or relating to Combinations of Electric Discharge Devices and Materials excited to Luminescence by the Electric Discharge.

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JOHN TURTON RANDALL, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to combinations of electric discharge devices with luminescent materials.

According to the invention in such a combination the luminescent material consists wholly or in part of magnesium tungstate, having an activating impurity which may be lead.

The luminescent magnesium tungstate may be prepared, for example, in the following manner. Pure magnesium tungstate is prepared by heating together equimolecular proportions of pure magnesium oxide and pure tungstic oxide. To the initial mixture there is added 0.1% of lead in the form of nitrate. The material is mixed with pure water to a uniform paste, which is dried for 1 hour at 180° C., ground heated to 850° C. and maintained at this temperature for 1 hour. The material is then ready for use.

When excited by a discharge in low pressure mercury vapour, with which it is in contact, the material luminesces with a bluish-white light, with a higher efficiency and a broader spectrum than that of calcium tungstate. If the material is mixed with cadmium silicate or zinc phosphate and excited as described, the resultant light is nearly white. If it is excited alone by contact with a neon discharge, the combined direct and luminescent radiations can be made nearly white by suitable adjustment of their proportions.

Dated the 27th day of January, 1936.

For the Applicants,
G. S. STURROCK.

COMPLETE SPECIFICATION.

Improvements in or relating to Combinations of Electric Discharge Devices and Materials excited to Luminescence by the Electric Discharge

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JOHN TURTON RANDALL, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to sources of light of the type comprising in combination an electric discharge device and material adapted to be excited to luminescence by the electric discharge through a gaseous filling in the said device. Luminescent material hereinafter will mean material adapted to be so excited.

The object of the invention is to produce such a combination, which gives either a resultant light of a colour substantially different from that of known combinations, with an efficiency large enough to be useful; or a resultant light of a colour substantially the same as that of some known combination with an efficiency greater than that of the said combination. The term "colour" includes all shades of white; two whites of substantially different tints are to be deemed of substantially different colours. The lowest efficiency of any discharge lamp in common use is probably that of the carbon dioxide lamp, namely about 2 lumen/

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watt. The efficiency of the low pressure mercury discharge lamp without luminescent materials is about 5 lumen/watt; but this is often reduced to 3 lumen/watt by coloured glasses. Consequently an efficiency large enough to be useful means one exceeding 2 lumen/watt. The efficiency of the neon discharge without luminescent materials and with a cold cathode usually exceeds 10 lumen/watt; efficiencies as great as, or greater than, these are, of course, highly desirable.

Calcium tungstate is often used as the luminescent material in sources of the type specified. We have found that magnesium tungstate activated so as to emit blue luminescent light is also suitable if associated with suitable discharges, and that it can be activated by lead so as to emit blue luminescent light. Magnesium tungstate, as generally known, is monoclinic, whereas the generally known form of calcium tungstate is tetragonal.

According to the invention, in a source of light of the type specified, the filling of the electric discharge device is one adapted in operation to emit either the low pressure spectrum of mercury or the neon spectrum and the said material is, or contains as a main constituent, magnesium tungstate, having a monoclinic crystalline form, activated so as to emit blue luminescent light.

One method of preparing the magnesium tungstate, described by way of example, is as follows. To a mixture of pure magnesium oxide and pure tungstic oxide, in substantially the proportions $1MgO : 1WO_3$ is added lead nitrate in amount sufficient to give 0.1% lead in the final material. These components are ground into a uniform paste with pure water, dried for one hour at 180°—200° C., reground and heated to 1000° C. for 4 hours. The preparation is preferably removed from the furnace half-way through this heat treatment and reground; if this is not done, black specks may appear in the final product. The material is then ready for use, apart possibly from a slight grinding and sieving to obtain a suitable grain size.

If the filling of the discharge device is one adapted to emit the neon spectrum, for example pure neon, the luminescent material should be in direct contact with the discharge; for the resonance line of neon at 736 Å, which is mainly effective in exciting the luminescence, will not penetrate any solid of appreciable thickness. If the filling is adapted to emit the mercury spectrum, for example the usual mixture of argon and mercury, the luminescent material may either be in direct contact with the discharge or may be separated from it by a solid partition sufficiently transparent to radiation of short wave-length, for example as described in co-pending application No. 12067/36. (Serial No. 70474,298).

The luminescent light from magnesium tungstate, prepared as described, is blue; but its spectrum is broader than that of the light from calcium tungstate and the colour is less saturated. If it is excited by pure neon, the proportion of primary radiation from the discharge to secondary radiation from the tungstate will usually be adjusted, by known means, so as to obtain a light as nearly as possible white in colour at a reasonably high efficiency. A close approximation to white can be obtained with an efficiency as high as 20 lumen/watt.

If the excitation is by mercury, the said proportion will generally be adjusted so that the efficiency is a maximum; the colour will be nearly the same as that of the secondary radiation. If magnesium tungstate is used alone, the light will be bluish-white; the efficiency may be at least 30 lumen/watt; the corresponding value for calcium tungstate under similar conditions is not more than 20 lumen/watt. If magnesium tungstate is mixed in suitable proportions with a material giving red light luminescence, a nearly white light may be obtained; if luminescent cadmium silicate of known kind is this material, the efficiency of the nearly white light may be as high as 25 lumen/watt; if luminescent zinc phosphate of known kind is used, the efficiency will be probably somewhat lower. When efficiency of the combined source is the main consideration, the method of increasing efficiency may be used which is described in Patent Specification No. 460,890.

We are aware that Patent Specification No. 184,485 refers to the use of zinc and magnesium tungstates, prepared according to well-known methods, for producing radioscopic screens We believe that other references could be found to the excitation of these materials by agencies other than X-rays. But, so far as we are aware, no previous proposal has been made to use these materials in sources of light of the type specified.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A source of light of the type specified wherein the filling of the electric discharge device is one adapted in operation to emit either the low pressure spectrum of mercury or the neon spectrum, and the

watt. The efficiency of the low pressure mercury discharge lamp without luminescent materials is about 5 lumen/watt; but this is often reduced to 3 lumen/watt by coloured glasses. Consequently an efficiency large enough to be useful means one exceeding 2 lumen/watt. The efficiency of the neon discharge without luminescent materials and with a cold cathode usually exceeds 10 lumen/watt; efficiencies as great as, or greater than, these are, of course, highly desirable.

Calcium tungstate is often used as the luminescent material in sources of the type specified. We have found that magnesium tungstate activated so as to emit blue luminescent light is also suitable if associated with suitable discharges, and that it can be activated by lead so as to emit blue luminescent light. Magnesium tungstate, as generally known, is monoclinic, whereas the generally known form of calcium tungstate is tetragonal.

According to the invention, in a source of light of the type specified, the filling of the electric discharge device is one adapted in operation to emit either the low pressure spectrum of mercury or the neon spectrum and the said material is, or contains as a main constituent, magnesium tungstate, having a monoclinic crystalline form, activated so as to emit blue luminescent light.

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If the filling of the discharge device is one adapted to emit the neon spectrum, for example pure neon, the luminescent material should be in direct contact with the discharge; for the resonance line of neon at 736 Å, which is mainly effective in exciting the luminescence, will not penetrate any solid of appreciable thickness. If the filling is adapted to emit the mercury spectrum, for example the usual mixture of argon and mercury, the luminescent material may either be in direct contact with the discharge or may be separated from it by a solid partition sufficiently transparent to radiation of short wave-length, for example as described in co-pending application No. 12067/36.

The luminescent light from magnesium tungstate, prepared as described, is blue; but its spectrum is broader than that of the light from calcium tungstate and the colour is less saturated. If it is excited by pure neon, the proportion of primary radiation from the discharge to secondary radiation from the tungstate will usually be adjusted, by known means, so as to obtain a light as nearly as possible white in colour at a reasonably high efficiency. A close approximation to white can be obtained with an efficiency as high as 20 lumen/watt.

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We are aware that Patent Specification No. 184,485 refers to the use of zinc and magnesium tungstates, prepared according to well-known methods, for producing radioscopic screens We believe that other references could be found to the excitation of these materials by agencies other than X-rays. But, so far as we are aware, no previous proposal has been made to use these materials in sources of light of the type specified.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A source of light of the type specified wherein the filling of the electric discharge device is one adapted in operation to emit either the low pressure spectrum of mercury or the neon spectrum, and the

said luminescent material is, or contains as a main constituent, magnesium tungstate, having a monoclinic form, activated so as to emit blue luminescent light.

2. A source of light according to Claim 1 wherein the said magnesium tungstate is activated as aforesaid by lead.

3. A source of light according to Claim 1 wherein the said magnesium tungstate activated as aforesaid is prepared substantially as hereinbefore described by way of example.

4. A source according to Claim 1 or 2 in which the filling is adapted to emit in operation the low pressure mercury spectrum and the luminous efficiency of the source is not less than 25 lumen/watt.

5. A source according to Claim 1 or 2 in which the filling is adapted to emit the low pressure spectrum of mercury and the said material consists of magnesium tungstate activated as aforesaid mixed with luminescent cadmium silicate or zinc phosphate, so that the combined light of the source is nearly white.

6. A source according to Claim 1 or 2 in which the filling is pure neon, and the proportions of the primary and secondary radiations are so adjusted that the colour of the combined light approaches as nearly as possible to white, subject to the efficiency not being less than 15 lumen/watt.

Dated the 5th day of October, 1936.
For the Applicants,
G. S. STURROCK.

Abingdon: Printed for His Majesty's Stationery Office, by Burgess & Son.
[Wt. 8012B.—50/11/1937.]

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