

March 10, 1953

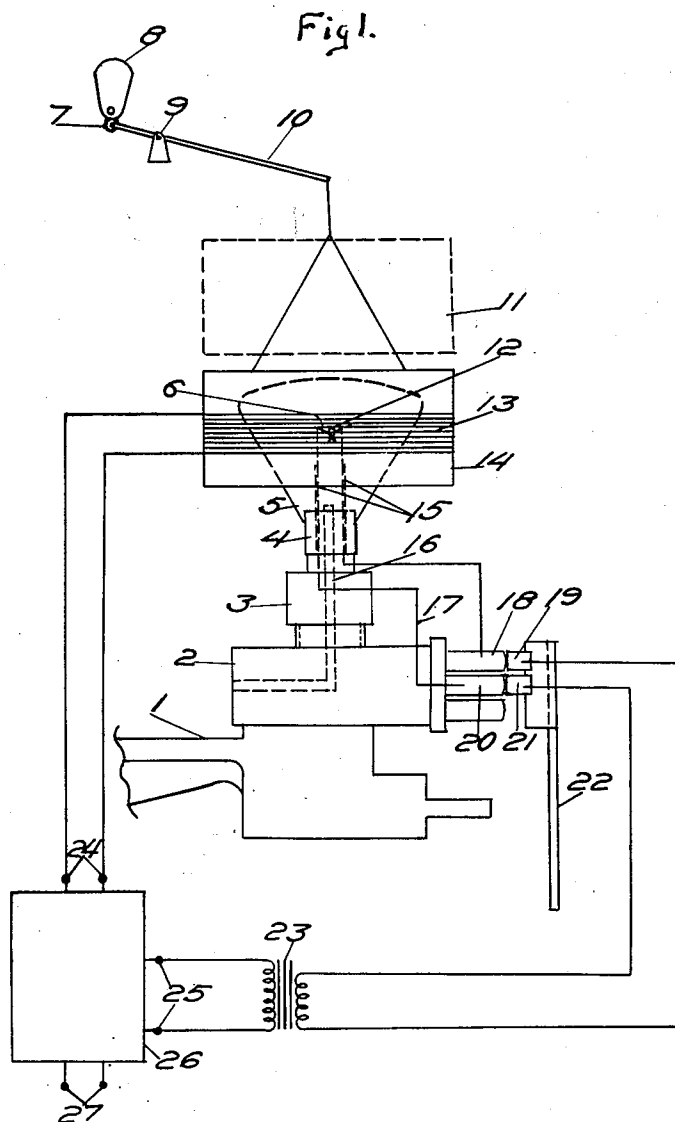
H. F. FALCK

2,630,780

DEVICE FOR DEPOSITING THIN METALLIC LAYERS

Filed Feb. 27, 1948

2 SHEETS—SHEET 1



Inventor:
H. F. Falck
By *G. F. Orendorff*
Att.

March 10, 1953

H. F. FALCK

2,630,780

DEVICE FOR DEPOSITING THIN METALLIC LAYERS

Filed Feb. 27, 1948

2 SHEETS--SHEET 2

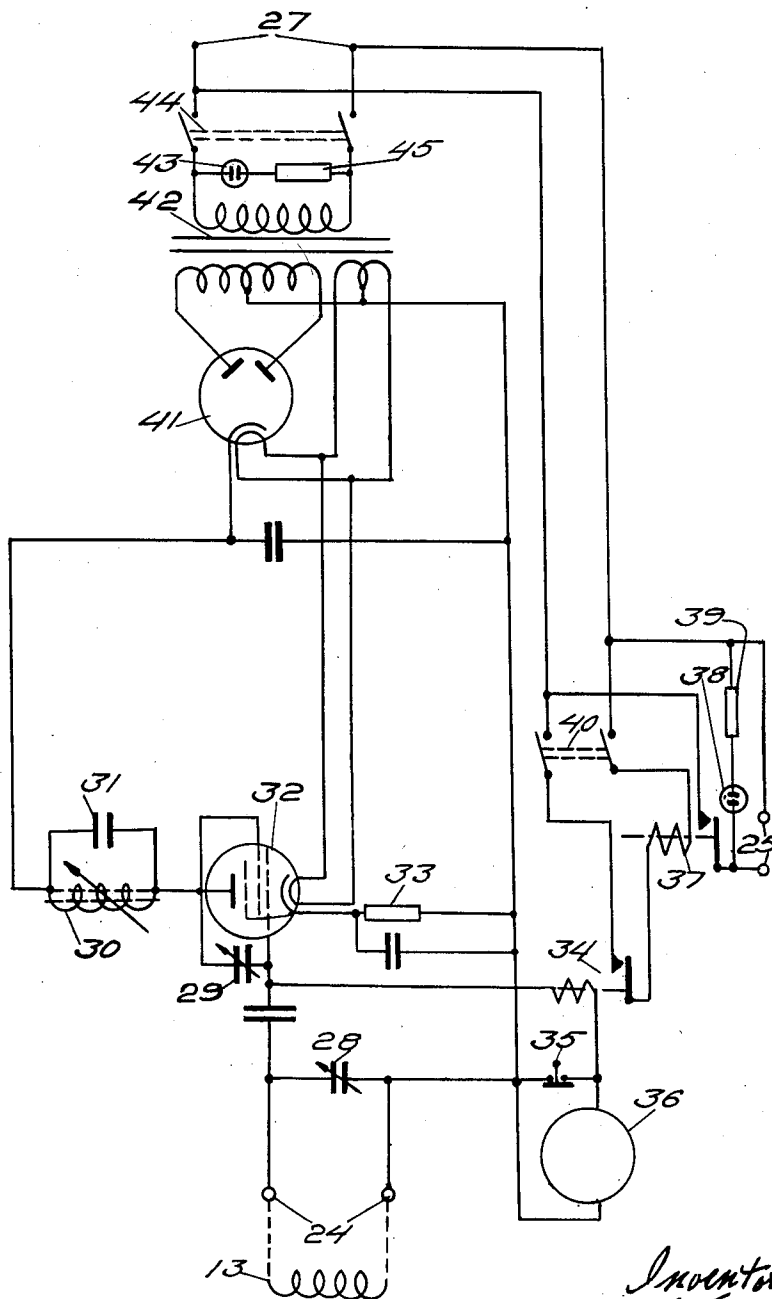


Fig 2.

Inventor:
H. F. Falek
By B. F. O'Handerath
att

UNITED STATES PATENT OFFICE

2,630,780

DEVICE FOR DEPOSITING THIN
METALLIC LAYERS

Håkan Fredrik Falck, Enskede, Sweden

Application February 27, 1948, Serial No. 11,524
In Sweden December 21, 1946Section 1, Public Law 690, August 8, 1946
Patent expires December 21, 1966

3 Claims. (Cl. 118—7)

1

This invention relates to a method for controlling the deposition of a thin metallic layer on an object, and a device for effecting such control and deposition.

From electrical technology it is known to determine the quality or effectiveness of a coil by its Q-value, defined as the relation between the reactance and resistance of the coil:

$$Q = \omega L / R$$

where $\omega = 2\pi f$; L is the series inductance and R is the series resistance. If the coil is an integral part of an oscillator circuit, it is possible to bring about eddy currents by moving a foreign metal body near to the coil. These eddy currents in turn cause a change in the Q-value of the coil. The present invention is based on the fact that such a change in the Q-value of a coil can be utilized for controlling the deposition of a thin metallic layer on the surface of an object. This is done by placing a measuring coil, which is part of a thermionic valve oscillator circuit, near the surface of an object and utilizing the change in the Q-value of the measuring coil caused by deposition of the layer to discontinue application of the layer, as soon as a Q-value, corresponding to a layer of predetermined thickness or extent has been reached. For this control the change in the frequency of the oscillator current or its amplitude can be utilized, i. e. one of the parameters ω or R in the above expression. With the former method great sensitivity can be attained provided that a master oscillator frequency control is used. The other method offers the advantage of being practically independent of the presence of insulating objects, and therefore very great precision can be obtained without special precautions being necessary. Although the invention will be mainly described in connection with the utilizing of amplitude changes for controlling the deposition of the metallic layer, the frequency change method may be utilized for the same purpose.

A device for the deposition of a metallic layer, according to the invention, consists of means for applying the layer to the object and of a member for moving the object towards and away from a position in which the layer is deposited and a measuring coil arranged in the vicinity of the position for deposition of the layer. The measuring coil forms part of a thermionic valve oscillator circuit, which is designed to regulate, by the change of the Q-value of the measuring coil during deposition of the layer, the means which applies the layer, in such a manner that the sur-

2

face of the object is covered with a metallic layer of predetermined thickness or extent.

The device can be used to advantage for automatic mirror-plating in lamp and reflector bulbs.

Such a mirror-plating machine may consist of a table which is rotatable in steps with evenly distributed positions for attaching the lamp bulbs and each position containing a vaporizing or atomizing device or other means for depositing a reflecting metallic layer on the bulbs. The measuring coil is so arranged that it does not follow the table in its rotation, forming part of a thermionic valve oscillator circuit designed to bring about, by change in the Q-value of the coil during the depositing of the layer, termination of the deposition of the layer. The measuring coil may be designed in such a way that it is lifted from the table during rotation of the table and, when the movement of the table is stopped, is moved to a suitable position near the envelope, the mirror-plating of which is to be controlled. For deposition of the layer, volatilization of a metal by a hot cathode may be utilized, the feeder lines of which in the position of application are connectable to a suitable source of supply. The positions for the envelopes around the table may be equipped with evacuating devices to prevent oxidation during deposition of the metallic layer.

The device referred to for applying the metallic layer may be so constructed that the turning mechanism for the support, on which the objects to be treated are positioned, not only takes care of the forward movement of the objects in a step by step manner and effects the beginning of the deposition of the layer; but the measuring coil controls the termination of the deposition. The resting time of the object in the treating position is long enough for the deposition of the layer to be fully completed, before the next movement takes place. It is also possible to construct the thermionic oscillator so that it also controls the movement of the objects by means of the impulse generated in the measuring coil as soon as the desired layer has been obtained.

The measuring coil is connected to one of the grid and anode circuits of the thermionic oscillator, which are tunable. In the circuit containing the measuring coil there is also included a relay, through which the oscillator controls the layer depositing member and, if desired, the driving member for moving the object treated. The thermionic oscillator may also be made adjustable for varying the thickness or extent of

the layer, in which case the grid and anode circuit respectively, connected to the relay, is equipped with a current measuring instrument for controlling the adjustment of the oscillator for the desired thickness or extent of the layer.

The invention is illustrated by way of example in the accompanying drawing in which: Fig. 1 shows an automatic mirror-plating machine in the layer depositing position and Fig. 2 shows the circuit arrangement for an instrument for measuring the metal layer with a relay arrangement connected to it.

On a revolving table 1 of the type used in electric lamp bulb manufacture there is arranged a ring 2, on which a number of evenly distributed positions for attaching the lamp envelopes 5 are arranged around its upper part. The table is revolved step by step in a known manner. Every position is fitted with an exhausting tube 16, which is clamped in a rubber packing, arranged in a clamping sleeve 3, which can be tightened. On the projecting end of the pump tube is attached a rubber sleeve 4, on which the lamp envelope 5 is slipped. In the rubber sleeve there are also inserted two electrodes 15, to which a coiled filament 6 is attached. On the outside of the ring there are two contacts 18 and 20, which in the layer applying position come into contact with a pair of sliding contacts 19 and 21, attached to support 22. On the coiled filament 6, which is connected by wires 17 to the contacts 18 and 20, is hung a loop 12 of suitable mirror forming metal, such as aluminium, which will evaporate when the filament 6 is heated.

The measuring coil consists of a winding 13, attached to a sleeve 14, which is supported by a supporting arm 10 in such a way that the sleeve with the measuring coil can be lowered over the lamp bulb 5 when the latter is moved to layer depositing position. Supporting arm 10 is pivoted about a shaft in a fixed bearing bracket 9, so that a two-armed lever is formed, the free end of which, by means of a roller 7, rests against a cam disc 8. This cam disc is so shaped, and is rotated by suitable transfer of motion from table 1 in such a way, that the measuring coil is not lowered over the lamp bulb 5 until the latter has arrived in position for being plated and is lifted from the same directly before the table is moved forward to the next step. Sleeve 14 is also shown in lifted position by a dotted contour 11.

It is evident that the form and construction of the measuring coil may be varied. For instance it may be moved from the side towards the wall of the lamp envelope and is in that case made as a coil wound on a flat support of, for instance, rectangular shape, the coil together with its support being bent to such shape that a suitable adaption to the wall of the lamp envelope can be obtained.

The measuring coil 13 is connected to terminal points 24 of the thermionic valve oscillator 26. Part of this is a pentode valve 32, connected as a triode, into the grid circuit of which measuring coil 13 is connected. The oscillator is provided with tunable grid and anode circuits. The degree of regeneration and thus also the oscillation amplitude and the grid current are regulated by the variable condenser 29. A resistance 33 provides automatic bias to the thermionic valve 32 so that the valve is not overloaded when coil 13 is taken away and the oscillations cease. The grid current, which can be varied, controls a low tension relay 34, which in turn controls a high tension relay 37, which controls the heating cur-

rent to the mirror-plating device. The sliding contacts 19 and 21 of the latter are connected to one side of transformer 23, the other side of which is connected to terminal points 25, which are part of the heavy duty relay circuit. The voltage across terminal points 25 is controlled by gas discharge lamp 38, the series impedance of which is indicated by 39.

By regulating the starting current through low tension relay 34 by adjustment of condenser 29 the operator can control the thickness of layer at which the relay 34 is to open. Measurement of this current through relay 34 is effected by pushing in a push-button switch 35 which brings into the circuit a current measuring instrument 36. The measuring instrument 36 can be calibrated with comparatively good precision direct in thickness of layer.

Prior to deposition of a layer the grid and anode circuits are tuned to oscillate satisfactorily (if this has not already been done) and the oscillator adjusted to the desired thickness of layer by adjustment of the condenser 29. Relay 34 is thus closed, and the current passes to the filament through the contacts 18, 20 and 19, 21 respectively. As the layer thickness increases, the Q-value of coil 13 decreases, during which time the grid current drops until relay 34 opens and the layer forming process ceases. A manually operated switch 40 is inserted into the connection to the mains by means of which the current can be interrupted if no envelope has been inserted into the turret station arriving into the depositing position.

Suitable oscillator frequency, which is adjusted by means of variable inductance 30 and condensers 31, and 28 in the anode and grid circuits respectively of the oscillator, is dependent upon the thickness of layer and the material used for the layer, which is to be controlled. For very thin layers and non-magnetic material a comparatively high frequency is required, and for thicker layers and magnetic materials a lower frequency is required.

The oscillator and the layer depositing device are fed from the local supply, to which they are connected by means of terminal points 27 through transformer 42 and switch 44. For indicating connection when the switch is closed a glow discharge lamp 43 and a series impedance 45 are used. The transformer feeds a rectifier 41, providing the thermionic valve oscillator 32 with suitable anode voltage, and is also provided with a heater current winding for generating cathode current in valves 32 and 41.

What I claim is:

1. A device for the deposition of a thin metallic layer on the surface of an object, comprising means for applying the layer to the object, a movable member for moving the object to and from the position in which the layer is deposited, a measuring coil arranged in the vicinity of the position for deposition of the layer, a thermionic valve oscillator having tunable oscillatory grid and anode circuits, said measuring coil being connected in one said circuit, adjustable control means for said grid and anode circuits, electrical relay means controlled by a variation of the grid current, said means for applying the layer being controlled by said relay means, said adjustable control means for said circuits being adapted for tuning of said circuits and thereby regulating, through said relay means, the deposition process for automatically stopping it when the Q-value of the measuring coil is

5

changed by the deposited layer correspondingly to the adjustment of said control means.

2. A device for depositing mirroring surfaces on lamp and reflector envelopes by means of vaporizing of metal, comprising a step-by-step rotatable table, evenly distributed positions provided thereon for attaching the envelopes and each of them containing vaporizing means for depositing a mirroring layer on the envelopes, a measuring coil in a fixed position relative to the table, a thermionic valve oscillator having tunable oscillatory grid and anode circuits, said measuring coil being connected in said grid circuit, adjustable control means for said grid and anode circuits, electrical relay means controlled by a variation of the grid current, said vaporizing means being controlled by said relay means, said adjustable control means for said circuits being adapted for tuning of said circuits and thereby regulating, through said relay means, the deposition process for automatically stopping it when the Q-value of the measuring coil is changed by the deposited layer correspondingly to the adjustment of said control means.

6

3. A device according to claim 2, in which the measuring coil is arranged on a vertically movable lever, said lever and said table being operatively connected for movement of said lever by rotation of said table including cam means for lifting the coil from the table during the rotating of the table and lowering the coil to a suitable position close to the envelope, on which a layer is to be deposited when said table is stopped.

HÅKAN FREDRIK FALCK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,675,120	Marden et al.	June 26, 1928
1,943,619	Mudge et al.	Jan. 16, 1934
2,164,332	Macksoud	July 4, 1939
2,237,328	Birdseye et al.	Apr. 8, 1941
2,338,234	Dimmick	Jan. 4, 1944
2,392,229	Cohen	Jan. 1, 1946