July 3, 1956 W. E. BIXBY ET AL 2,753,278

METHOD FOR THE PRODUCTION OF A XEROGRAPHIC PLATE

Filed April 14, 1951 2 Sheets-Sheet 1

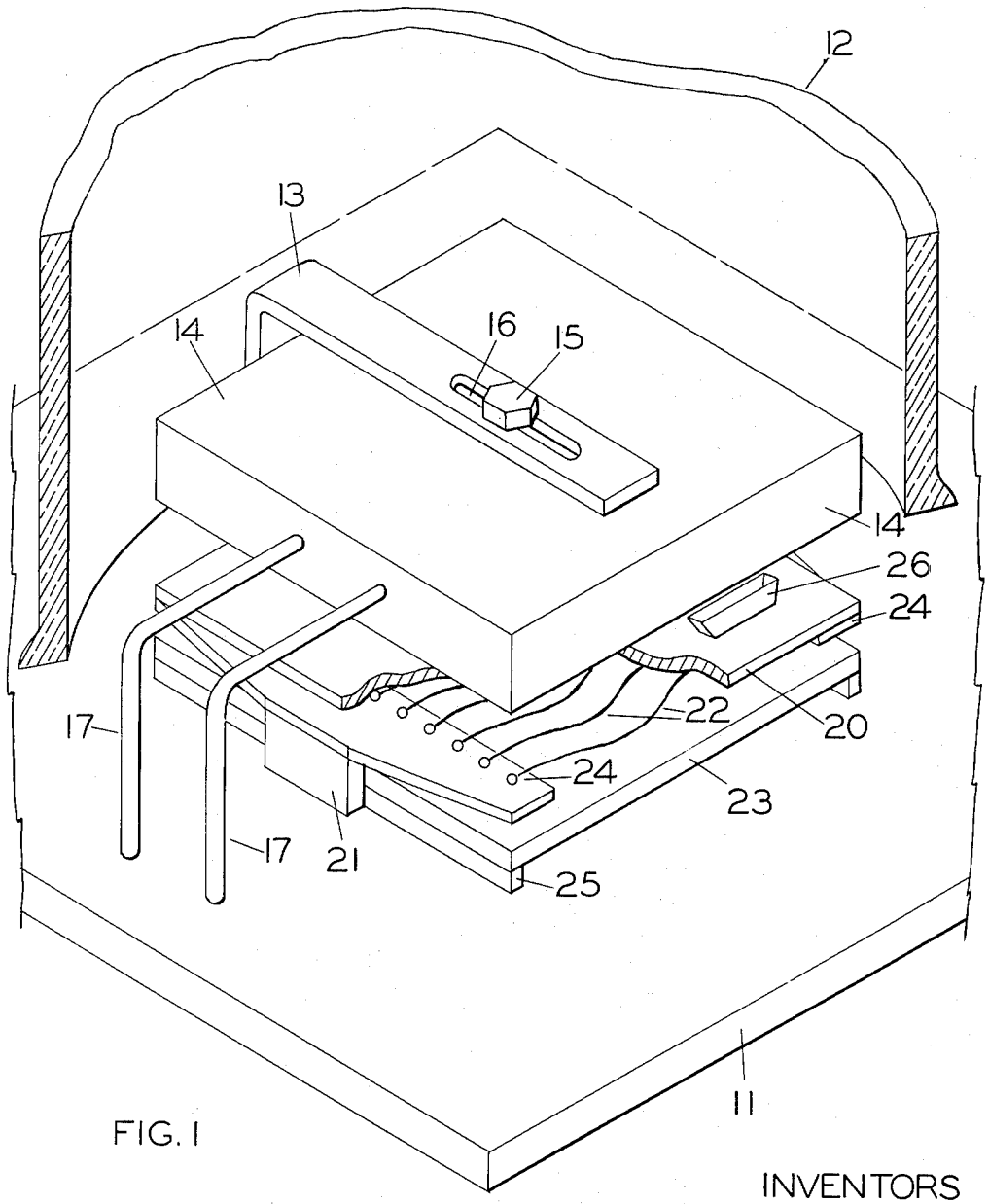


FIG. 1

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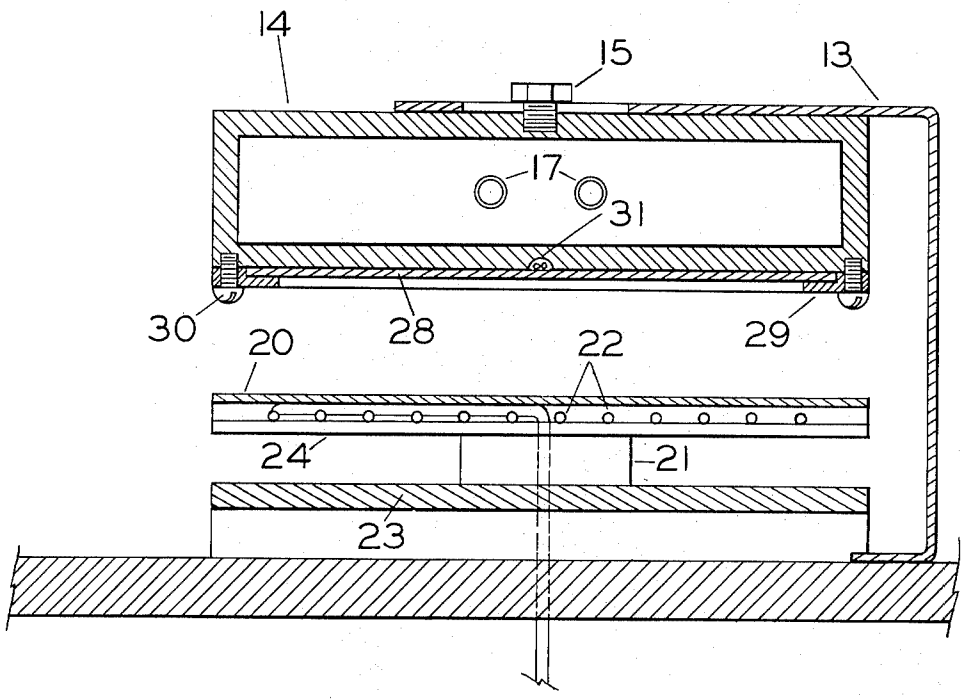


FIG. 2

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METHOD FOR THE PRODUCTION OF A XEROGRAPHIC PLATE

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Application April 14, 1951, Serial No. 221,042

1 Claim. (Cl. 117—200)

This invention relates in general to the process of xerography, and in particular to a method for the preparation of xerographic plates and apparatus for said method.

In Carlson U. S. Patent 2,297,691 there is disclosed a process of electrophotography which has since been developed for commercial use under the name of xerography. According to this process an electrophotographic or xerographic member or plate is provided with an electrostatic charge on its surface and the thus charged plate is exposed to a light image. The xerographic member comprises a photoconductive insulating layer on a conductive backing and when this member is exposed to a light image the illuminated portions of this layer become conductive while the unilluminated portions remain nonconductive. It is apparent, therefore, that exposure of the charged plate to a light image causes selective dissiptation of the surface charge leaving on the plate an electrostatic latent image which can then be developed or transformed into a visible image, for example, by dusting with an electroscopic powder. As this process has been improved and applied to commercial operations there has resulted an increasing need for means and methods for improving the eletcrophotographic speed of xerographic plates and for varying their spectral sensitivity.

It is an object of this invention to provide a new and improved xerographic plate and the provide a method for its preparation.

It is another object of the invention to provide a method for improving and controlling the speed anl spectral sensitivity characteristics of selenium plates prepared by vacuum evaporation of selenium onto a conductive backing.

It is a further object of the invention to provide apparatus for preparing xerographic plates of improved speed and spectral sensitivity.

Additional objects of the invention will be apparent from the following specification and the drawings in which:

Figure 1 is an isometric view of coating and control equipment and apparatus according to one embodiment of the invention; and

Figure 2 is a front elevation in section of an evaporation source as shown in Figure 1.

According to this invention a selenium xerographic plate of improved properties is prepared by evaporation of substantially pure selenium from an appropriate evaporation source onto the surface of a conductive backing material while maintaining the back material at a controlled and predetermined temperature, whereby electrophotographic speed and spectral sensitivity of the final product may be improved and controlled. In general, within the scope of the invention, increased speed and extended spectral sensitivity are imparted to the final xerographic plate through vacuum evaporation of selenium onto the backing plate at a temperture of at least about 60° C. and generally in the range between 60° and 90° C., with broader spectral sensitivity being particularly

achieved at temperatures about 75° C. and higher. In addition to the sensitvity characteristics imparted to the final plate under the conditions of operation according to this invention, the adhesion of the selenium layer to the conductive backing is improved and controlled by maintaining the backing member temperature during the evaporation below about 90° C. and preferably below about 75° C., whereby there is produced a plate of good electrophotographic speed and spectral sensitivity and likewise a satisfactory adhesion. For a proper and optiumum balance of all characteristics and physical properties a presently preferred temperature is electrical in the range between about 60 and 75° C., preferably at 65° C.

It is observed in general that the speed and spectral sensitivity increase as the evaporation temperature is increased, this temperature being the measured temperature of the backing member during the evaporation, and this increase in sensitivity is most readily apparent in increased sensitivity to red light. It is also observed that the sensitivity characteristics of the member or plate are dependent most largely upon the evaporation temperature during the final stages of evaporation process and, apparently, even after the actual evaporation process is completed, but prior to reversion to room temperature. It is, therefore, a further and specific purpose of the invention to prepare an improved selenium xerographic plate in a two-step process, wherein an initial portion of selenium is vacuum evaporated at one temperature and the subsequent portion at another temperature. Thus, the initial portion of selenium might be deposited at a relatively low temperature, such as, for example, a temperature of about 60°, and a subsequent portion of selenium is evaporated onto the backing member at a higher temperature such as, for example, a temperature between about 75 and 90°.

It is, of course, to be understood that the preparation of the xerographic plates according to this invention is not independent of time. The time of the operation may be divided roughly into two periods, not necessarily continuous, the one period being the actual time of deposition on a selected area and the other period being the remainder of the time during which the deposited selenium is maintained at an elevated temperature. It is preferred to restrict the actual deposition time to not more than about 12 minutes, and the total time of the operation to not more than 14 to 30 minutes, shorter times being preferred at higher temperatures.

Referring to the figures in detail, there is seen suitable vacuum evaporation mechanism for carrying out the new process. This device comprises a base or block **11** having a hollow shell **12**, such as a bell jar, positioned thereon to form a sealable vacuum chamber. On this base **11** is a mounting support **13**, which receives and holds a temperature control platen **14** by means of bolt **15** operating through slot **16**. The temperature control platen is hollow and is adapted to have a cooling fluid circulated within it and there are, accordingly, fluid supply tubes **17** passing through the base **11** to circulate a temperature control fluid to the temperature control platen.

Positioned on the base **11**, substantially between the platen **14** is a heating means adapted to heat a material for evaporation onto the surface of a plate when mounted on the platen. This heating means comprises a heating plate **20** mounted on support posts **21**, with heating filaments **22** positioned directly below the plate. Below the filaments and also mounted on posts **21** is a reflector **23** adapted to direct a greater portion of the filament heat upwardly toward plate **20**, the reflector optionally having support legs **25** to maintain spacing from base **11**. The filaments are mounted on the under side of plate **20** by means of support terminals **24** which serve the dual pur-

pose of mounting the filaments and joining the heating plate to the support posts. Lead wires passing through posts **21** connect the filaments to an external power source.

For the evaporation coating operation, a conductive backing member **28**, for example, a metallic plate such as an aluminum plate is mounted on the lower face of platen **14** by a masking frame **29** secured to the platen, for example, by screws **30** or other suitable means. A thermocouple **31** is positioned along the lower surface of platen **14** to contact the conductive backing member **28** and to measure the temperature of the member during the coating operation. The selenium for the coating is placed on the heating plate **20**, preferably in evaporating boats **26** of a non-reactive material such as molybdenum. Bell jar **12** is then placed on base **11** and the system evacuated. The selenium in the evaporation boats is then raised to vaporization temperature by heating filaments **21** and a temperature control fluid such as, optionally, water is passed through the temperature control platen. In this manner selenium is evaporated from the boats and passes directly to the face of the xerographic base member while the member is maintained at a temperature determined by the temperature control fluid, and measured by the thermocouple.

It will be apparent that numerous modifications may be made in the apparatus and equipment. For example, modifications may be made in the selenium evaporation source. The desired result is to have the selenium vapor pass in a nearly direct path from the source to the plate, and numerous means may be employed to effect this result. As an illustration of this, the heating mechanism shown in the figures may be kept inactive or may be replaced by a non-heating support for suitable evaporation boats. In such a case, heating for evaporation may be promoted by individual heating filaments for each evaporation boat. Likewise, other heating methods and evaporation sources may be used as will be apparent to those skilled in the art. In addition, under some circumstances where spattering of the selenium may occur, it is desirable to interpose a barrier between the evaporation source and the plate in the same manner the heating source may, if desired, be varied.

It should be noted also that the degree of vacuum and the rate of heating the selenium source may be varied to effect the rate and temperatures of selenium vaporization. In general, however, it has been found that excellent results have been obtained by evaporation at a pressure less than ½ micron of mercury in a substantially direct path from an evaporation source to the plate, with a minimum of deviation from this path. Good results appear through the pressure range from 0.05 to 0.5 micron, but for large quantity production the difficulties of maintaining high vacuum indicate a preferred range from 0.1 to 0.5 micron.

The electrophotographic or xerographic plate produced by this method is characterized by extreme uniformity of coating, the ability to accept a high charge and to retain such a charge in the absence of illumination, and good electrophotographic sensitivity. In particular, a selenium coating is produced in a desired thickness from about 5 to about 100 microns in thickness with a thickness variation less than about one micron. A plate having a 20 micron coating will receive and accept a uniform positive charge of at least 400 volts and will retain at least 80% and generally about 95% of its charge through a period of one minute, and thus will generally retain a usable charge for a period of at least 4 hours. When positively charged and exposed to illumination of one meter candle, it will dissipate at least 10% of its charge per second. The product is a satisfactory xerographic plate for the various applications of the xerographic process.

What is claimed is:

A method of controlling the vacuum deposition of selenium to form a photosensitive, photoconductive insulating selenium layer in a xerographic plate, said method comprising evaporating selenium from an evaporation source onto a conductive backing member during an evaporation period which is not in excess of about 12 minutes, said seleinum being evaporated under a pressure equivalent to between 0.05 and 0.5 micron of mercury, first maintaining the backing member at a temperature between about 60° and about 75° C. until the first portion of the selenium is deposited over the entire backing member and subsequently maintaining the temperature between 75° and about 90° C. for the remainder of the evaporation period until the remainder of the selenium is deposited on the back member, and limiting the total time of holding the selenium in said layer in a temperature range of between about 60° and about 90° C. to a time between 14 and 30 minutes.

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