Dec. 18, 1956 J. B. BATCHELOR, JR 2,774,645

METHOD FOR REACTIVATING CATHODE RAY TUBES

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Fig. 2

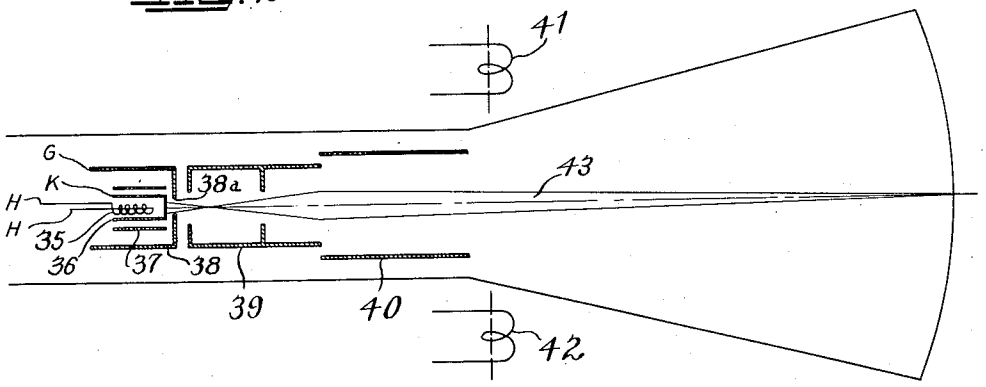


Fig. 1

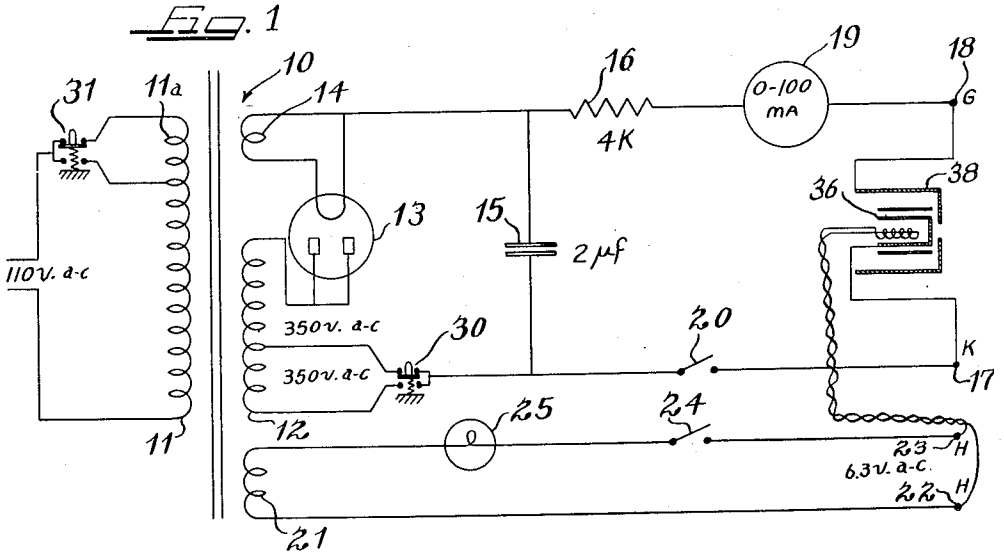
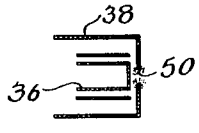


Fig. 3



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METHOD FOR REACTIVATING CATHODE RAY TUBES

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4 Claims. (Cl. 316—2)

The present invention relates to a method for reactivating cathode ray tubes used for television viewing purposes.

It is an object of the present invention to provide a procedure for reactivating cathode ray tubes which is capable of restoring rated cathode emission and performance without endangering the tube elements. It is another object of the invention to provide a procedure for reactivating cathode ray tubes which improves the performance of used tubes, not just temporarily, but over a period of months or years, adding considerably to the useful life of the tube. It is a further object of the invention to provide a procedure for reactivating cathode ray tubes which permits reactivation to be carried on quickly and inexpensively, without removal of the tube from the set, and which permits continued use of the tube in its regular circuits without necessity for any permanent attachments. Finally, it is an object of the invention to provide procedure for reactivating cathode ray tubes which restores operation substantially to the level of a new tube, even where emission has dropped to such a low point as to make the tube unsalvageable by conventional means.

Other objects and advantages will be apparent upon reading the attached detailed description and upon reference to the drawings, in which:

Figure 1 is a schematic diagram of a reactivation device employed to practice the method in accordance with the present invention.

Fig. 2 shows diagrammatically the internal structure of a typical cathode ray tube of the type used for television viewing purposes.

Fig. 3 shows the blocking of the grid aperture which occurs after a long period of use.

Conventional types of tube "rejuvenators" have attempted to increase cathode emission by increasing the current supplied to the heater. This has involved raising the heater voltage to an excessive value, for example twice normal, for short periods of time, or, alternatively, raising the heater voltage "permanently" by a lesser amount by connecting a small auto transformer or the like in the circuit. In either event, the scheme is as ineffective as its use is widespread. The reason for this is that in tubes having indirectly heated cathodes, which includes all cathode ray tubes, the filament is incapable of generating the heat required effectively to renew the emission characteristics of the oxide layer on the cathode. To reduce the risk of burnout a compromise voltage is used which produces, at best, slight temporary improvement.

In accordance with the present procedure, the heater voltage is maintained substantially at the constant rated value and an increase in cathode temperature is produced by applying a high direct voltage between the grid and cathode, making the former positive with respect to the latter, and causing build-up of current flow to a value greatly in excess of the rated cathode current. Progressively increased voltage is applied as necessary to initiate flow of space current and using a lower voltage

once the flow has been started. The flow is cut off when a predetermined current, indicative of normal emission for the particular type of tube being treated and the particular value of the high voltage being applied, has been reached.

The arrangement which I prefer to use for practicing this method is set for in Figure 1. High voltage on the order of 350 volts A.-C. is obtained from a transformer **10** having a primary winding **11** and a secondary winding **12**. Such voltage is rectified by a rectifier tube **13**, which is energized by a filament winding **14**. The rectified voltage is filtered by a capacitor **15** and a series resistor **16** to produce direct voltage on the order of 400 volts at the output **17**, **18**. A milliammeter **19** is provided to measure the output current, controlled by a series switch **20**.

For the purpose of heating the filament of the cathode ray tube, a filament winding **21** is provided which supplies rated filament voltage at terminals **22**, **23** through a filament switch **24**. An "open filament" indicator is provided in this circuit in the form of a series lamp **25**, the voltage at the winding **21** being sufficiently high so as to compensate for the voltage drop which takes place in the lamp **25**. For example, where a lamp is used having a 2.5 volt drop, the winding **21** should have a rated voltage of 8.8 volts A.-C.

Further in accordance with the invention, a double-throw switch **30** is provided which is of the push-button type and which is capable of approximately doubling the output voltage by doubling the amount of secondary winding **12** which is included in the circuit. In the present embodiment the circuit is so arranged that depressing the switch **30** causes the voltage to increase from approximately 400 volts D.-C. to approximately 800 volts D.-C. Provision is made for a still further momentary increase by providing a switch **31** in the primary circuit of the transformer **10** which is capable of cutting out a portion **11***a* of the primary winding **11**, to provide a still further increase in voltage, preferably from 800 volts D.-C. to 1,000 volts D.-C.

Prior to discussing the procedure which is employed in using the circuit of Fig. 1, reference will be made to Fig. 2, which shows a typical cathode ray tube in diagrammatic cross section. Included within the neck of the tube are electrodes for creating an electron beam and for controlling the position and intensity of the beam at the tube face. Such electrodes comprise a heater **35** surrounded by a cathode **36**. The cathode in turn is surrounded by a heat shield **37** and a grid **38**. Arranged opposite the grid **38** is an accelerating electrode **39** followed by a focusing electrode **40**. Deflection coils for deflecting the beam are indicated at **41**, **42**, although the invention is also applicable to tubes of the electrostatic deflection type.

It will be assumed in the following discussion that one skilled in the art is familiar with the construction of a conventional cathode ray tube. It will suffice to say that the cathode is of cup shape, surrounding the heater **35** and coated with a suitable electron-emitting material in the form of an oxide. The grid **38** is not a grid in the usual sense, but is in the shape of a surrounding cup having a small aperture **38***a* axially alined with the end of the cathode **36** and having a diameter which is on the order of $\frac{1}{32}$ of an inch. Because of the small size of the aperture **38***a* it will be apparent that only a limited part of the cathode surface is actually used for useful emission, giving rise to the electron beam **43**. The current in the electron beam under normal operating conditions is quite limited, being less than one milliampere. It is well known to those skilled in the art, and it is readily confirmed by a simple measurement, that the rated, normal current drawn from the cathode of a con-

ventional 21" television picture tube is in the order of 200 microamperes.

It is a common experience that after a year or two of normal usage the image or "picture" becomes increasingly dim until it becomes necessary to install a replacement, an obviously expensive undertaking. In most cases this deterioration results from loss of cathode emission. In an effort to increase the emission and thereby extend the useful life of the tube, it has been necessary to resort to "rejuvenators" which apply excess heater voltage. This, however, has proved to be an unsatisfactory expedient because of the limited increase of emission which can be obtained in this way and because of the danger of burning out the heater, already weakened by months of use.

In employing the present device the tube is left in the set or carton, the regular socket is removed and the electrodes are connected as shown in Fig. 1, the terminal **18** being connected to the grid, the terminal **17** being connected to the cathode and the heater being supplied with normal heater voltage through the switch **24**. Upon closure of the switch **20** a positive voltage on the order of 400 volts is applied to the grid **38**. Such voltage in the case of a new tube produces a current flow on the order of 60 milliamperes. However, where a tube has been in use for a long period, the current may be only 10 milliamperes, i. e., only 50 times rated value, or even as low as one milliampere, clear indication that the tube has reached the end of its normal useful life, and will no longer produce satisfactory results. Where the current is on the order of 10 milliamperes or more, this is usually sufficient to raise the temperature of both the cathode and grid to a dull red. Upon continued application of voltage, it is found that the current gradually builds up. When the current reaches 60 milliamperes, which, in the average case takes about a minute, the reactivator is turned off and it is found that the tube will, in almost every instance, give service which is satisfactory and substantially the same as that expected from a new tube. Tubes treated in this manner frequently give additional months or years of service and, when the efficiency falls off, the reactivating process may be repeated without damage to the tube elements. It has been found that the device should be turned off when the current reaches 60 milliamperes since reactivation is complete and since continued operation at such high current will, at best, use up rapidly the newly-acquired emission. Furthermore, excessive heat may warp the grid so that it arcs to the cathode, and may even burn open the aperture, lessening its control of electron flow, i. e., picture brightness, during normal operation.

In the case of tubes which have been operated far beyond their normal life, it is found that the space current with 400 volts applied between the electrodes, is less than 10 milliamperes and may even be less than one milliampere. Where the current is in such range the gradual increase up to 60 milliamperes described above will not take place, since the current flow is not sufficiently high to cause any appreciable increase in the temperature of the elements. In short, the reaction cannot get started. In accordance with the present invention the switch **30** is employed for momentarily doubling the applied voltage, to, say, 800 volts. This is generally sufficient to get the reaction started and as soon as the observed current is 10 milliamperes, the push button **30** is released to prevent excessive heat from being generated in the tube elements and to reduce the voltage to approximately 400 volts. Such voltage is generally sufficient to produce a further increase in space current to 60 milliamperes, at which time the voltage is removed and reactivation is complete.

In extreme cases where the initial current flow is less than one milliampere, provision is made for cutting out a portion of the primary winding to produce a proportionate increase in the output voltage of, say, twenty percent. This is accomplished by depressing the push button **31**. Closing the switch **20** and simultaneously pressing both of the push buttons **30**, **31**, is generally sufficient to start the flow, although in some instances it may be helpful to operate the switch **20** intermittently while the push buttons **30**, **31** are both depressed. In any event, both of the push buttons are released as soon as a current as high as 10 milliamperes has been achieved.

My observations have shown that unsatisfactory operation may be caused not only by poor emission, but also by a collection of "dust" in the grid aperture **38***a*. This condition is illustrated in Fig. 3 where the dust is indicated at **50**. I have found that by treating the tube as described above, such dust tends to evaporate and, at the least, to be more readily dislodged. The evaporation is believed due to the high temperature which is achieved by the grid and adjacent cathode during reactivation. Physical dislodgment during the reactivation may be facilitated by tapping on the neck of the tube. Sometimes actual arcs occur which burn the material away.

Frequently cathode ray tubes fail because of short-circuiting which occurs between the grid **38** and the cathode **36**. Such short-circuiting may be due to an excessive collection of dust at the aperture, or may be due to other reasons brought about by the fact that the grid and cathode are separated by only a small space. It is found that by applying the high voltage traetment described above, such short-circuits tend to burn away, and the tube is restored to active life.

Because of the fact that the filament voltage is operated at the rated value during reactivation, it is found that the percentage of failures from opening of the filament is extremely low, less than one percent. With regard to the effect on the grid and cathode, they tend to reach approximately the same temperature when high voltage is applied, since they are of comparable size. Furthermore, they are of rugged construction so that heating to red heat or slightly above does not produce any observable damage.

In practicing my invention in its preferred form, assuming that reactivation is being applied to cathode ray tubes of the conventional type, flow of current between cathode and grid is cut off when it reaches approximately 60 milliamperes, as indicated by the meter. The flow of 60 milliamperes may be verified experimentally, as follows: Applying about 400 volts between the cathode and grid of a tube in new condition is found to produce a flow of current which rises very quickly to 60 milliamperes, and which rises only gradually after this value is reached. This indicates that the value of 60 milliamperes may be taken as characteristic of a tube which is in new condition. It further indicates that once the current ceases its rapid rise, it has reached the characteristic value for that particular type of tube and the magnitude of the applied voltage. Therefore, during the reactivation process on a weak tube, the current flow may be observed on any suitable indicating means, and when the current ceases to rise rapidly (once the build-up of current has begun), the voltage may be removed with assurance that the current has reached the characteristic value. Furthermore, it is found that tubes which have been subjected to current on the order of 60 milliamperes give consistently good results, while tubes which are subjected to maximum currents widely departing from 60 milliamperes show inferior results. Regardless of the type of cathode ray tube, the maximum current to which the grid and cathode should be subjected, in accordance with the present invention, is that value which is characteristic of a new tube of the same type when subjected to the same direct voltage.

What I claim is:

1. The method of rejuvenating a used television cathode ray tube having an indirectly heated cathode with a heater and a single-aperture cup-shaped grid, said method comprising the steps of energizing the heater with substantially normal voltage, applying a direct voltage between the cathode and the grid making the latter so highly

positive with respect to the former as to cause build-up of current flow between the cathode and the grid which is greatly in excess of the rated, normal cathode current, and removing said voltage at the time the current reaches a reference value for the magnitude of the applied voltage which is characteristic of a new tube of the type under treatment, said reference current having a value of substantially 60 milliamperes thereby to (*a*) reactivate the cathode material and (*b*) remove any foreign matter present in the aperture of the grid.

2. The method of rejuvenating a television cathode ray tube having a cathode coated with electron-emissive material together with a cathode heater and a single-aperture cup-shaped grid adjacent the cathode, said method comprising the steps of supplying substantially normal voltage to the heater, applying a direct voltage between the cathode and the grid to make the latter so highly positive with respect to the former as to cause build-up of current flow between the cathode and the grid which is many times greater than the normal cathode current and at least as high as 60 milliamperes, and removing said high voltage when the current reaches a value of substantially 60 milliamperes, whereby (*a*) the emissive material is reactivated but without subsequent deactivation and (*b*) any foreign matter in the grid aperture is cleared away.

3. The method of rejuvenating a used television cathode ray tube having an indirectly heated cathode with a heater and a single-aperture cup-shaped grid, said method comprising the steps of energizing the heater with substantially normal voltage, applying a positive direct voltage to the grid relative to the cathode, such voltage being sufficiently high and being applied for a total period of

time which is sufficiently long as to establish a build-up of current flow from cathode to grid which is greatly in excess of rated cathode current, and cutting off the current flow at substantially 60 milliamperes, so that obstructions in the grid aperture are removed and so that emission approaching the normal emission characteristic of a new tube is restored.

4. The method of rejuvenating a used television cathode ray tube having an indirectly heated cathode with a heater and a single-aperture cup-shaped grid, said method comprising the steps of supplying substantially normal voltage to the heater, applying a first positive voltage to the grid relative to the cathode which is capable of producing in a new tube of the type under treatment a current flow of about 60 milliamperes, determining any lack of substantial increase in emission by the cathode as a result of said first voltage, momentarily applying a second voltage substantially higher than the first to cause current flow up to about 10 milliamperes, and then reapplying said first voltage for a total period of time which is sufficiently long so that the current builds up to a maximum value of substantially 60 milliamperes, so that emission approaching the normal emission characteristic of a new tube is restored.

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