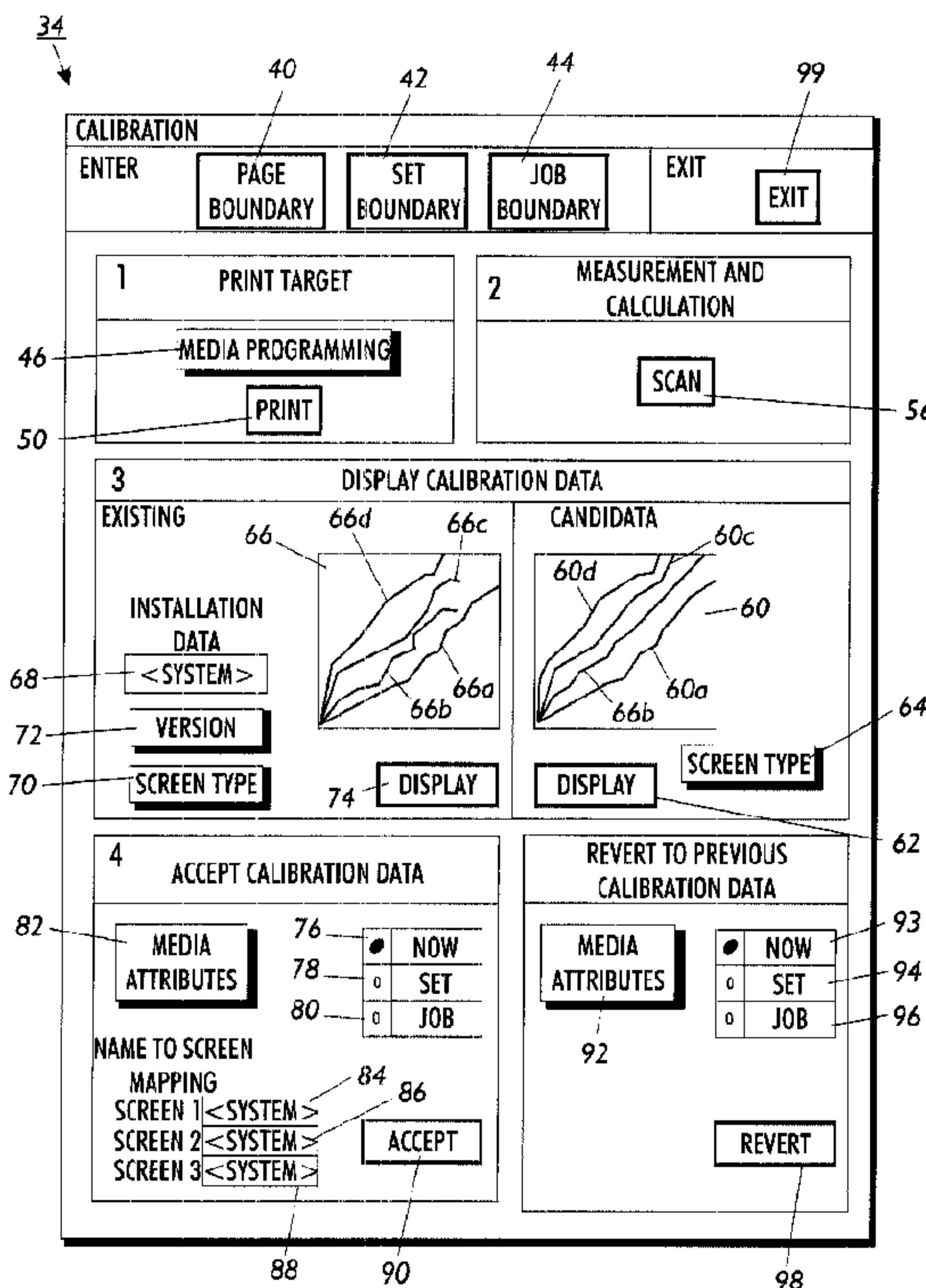




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 (54) Title: INCREASED TEMPORAL FLEXIBILITY WHEN PERFORMING/APPLYING/REVERTING CALIBRATION FOR A PRINTER OUTPUT DEVICE



(57) **Abrégé/Abstract:**

A system for compensating for a calibration drift in an image output device includes a user input means for specifying an output medium. An image output device controller converts original image data to final image data used by the image output device. The image output device produces a calibration image, as a function of an output medium, for a plurality of halftone screens capable of being produced by the image output device. A processor communicates with the controller. The processor calculates a plurality of candidate tone reproduction curve sets for the specified output medium. Each of the sets corresponds to one of the plurality of halftone screens. The candidate tone reproduction curve sets are accepted for compensating for a calibration drift in the image output device.

**XER 2 0335**  
**D/A0443**

**INCREASED TEMPORAL FLEXIBILITY WHEN  
PERFORMING/APPLYING/REVERTING  
CALIBRATION FOR A PRINTER OUTPUT DEVICE**

**Abstract of the Disclosure**

A system for compensating for a calibration drift in an image output device includes a user input means for specifying an output medium. An image output device controller converts original image data to final image data used by the image output device. The image output device produces a calibration image, as a function of an output medium, for a plurality of halftone screens capable of being produced by the image output device. A processor communicates with the controller. The processor calculates a plurality of candidate tone reproduction curve sets for the specified output medium. Each of the sets corresponds to one of the plurality of halftone screens. The candidate tone reproduction curve sets are accepted for compensating for a calibration drift in the image output device.

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**Background of the Invention**

The present invention relates to calibrating an electronic printer output device. It finds particular application in conjunction with calibrating an electronic printer output device using a tone reproduction curve ("TRC") and will be described with particular reference thereto. It will be appreciated, however, that the invention is also amenable to other like applications.

An electronic printer output device ("printing device"), also referred to as an image output terminal ("IOT"), is generally capable of producing color and standard black-and-white tones to produce images. The printing device accepts color level specifications (typically for each of four (4) colors including cyan, magenta, yellow, and black ("CMYK")) as input and produces corresponding color areas on a printed page. This production of the corresponding color areas is often performed by a screening operation (also referred to as a halftoning operation) wherein a fine pattern of color dots is printed. The dots appear as varying color tones in accordance with the number of color dots used when viewed from a distance. The allowed color level specifications for each of the CMYK color spaces generally vary over some finite range such as 0 to 1 or 0 to 255. The colors at the extremes (i.e., 0 and 1 or 0 and 255) are white and saturated CMYK colors, and numbers between the extremes yield intermediate color tones. However, while the color level specifications may vary linearly, a linear change in color levels typically does not result. Instead, there may be

a particular threshold before lighter toned colors become visible. Similarly, darker toned colors may prematurely appear saturated.

A printing device is designed to operate under certain conditions. More specifically, a printing device is calibrated to operate at an ideal set-point, for producing relatively consistent output when used within an environment having specific desired operating parameters such as, for example, a specific humidity, temperature, and dust count, etc. If any of the operating parameters deviates from the desired operating parameter, the printing device may drift away from the ideal set-point. To some extent the drift can be corrected with controlled feedback mechanisms within the printing device itself, but typically requires further corrective action to maintain color consistency in the printed output. This invention relates to this corrective action.

One way to compensate for the drift within the printing device includes modifying data within a printing device output device controller ("controller"). The controller converts image data (e.g., PostScript® data or PDF data) into raster data, which is transmitted to the printing device where it is printed. More specifically, a calibration (or correction) TRC modifies the raster data before it is sent to the printing device. The resulting image produced by the printing device using the corrected raster data is printed correctly (i.e., as if the printing device had not drifted from the ideal set-point and the data was not corrected by the TRC). Both linear and nonlinear drifts within a printing device may be compensated by using calibration TRCs.

In order to accurately produce a desired color level, the correspondence between the color level specification of the printing device and the actual color level produced by the printing device must be known. The TRC provides an illustration of the corresponding relationship.

In order to determine the TRC, a sample set of color level specifications are printed and the color levels actually produced by the printing device are measured by a device such as a colorimeter or spectrophotometer. The measured points are then used as raw data to calculate a set of curves. The set of curves produced are referred to

as the calibration TRCs, or simply as TRCs. Various methods exist for creating TRCs. One such method is set forth in U.S. Patent No. 5,696,889, which is hereby incorporated by reference.

5 Although TRCs can be created and applied to correct for drifts in a printing device output, there is currently no method or system that permits a user to specify a boundary (e.g., page, set, or job) after which a calibration process begins for a specified output medium. Furthermore, there is no method or system that permits the user to then specify a boundary (e.g., page, set, or job) after which TRCs that were calculated during the calibration process will be applied to future outputs of the  
10 printing device.

The present invention provides a new and improved apparatus and method which overcomes the above-referenced problems and others.

### **Summary of the Invention**

15 A method for calibrating a printer output device identifies an output medium. A calibration image is produced on the output medium. The calibration image represents a plurality of available halftone screens. Colors on the calibration image are measured. A plurality of candidate tone reproduction curve sets are calculated for the identified output medium. Each of the sets corresponds to one of the available halftone screens. The sets of the tone reproduction curves are accepted for  
20 calibrating the printer output device to compensate for drifts from an optimum set-point.

In accordance with one aspect of the present invention, a calibration boundary is identified. An output process of the image output terminal is suspended after the identified calibration boundary.

25 In accordance with another aspect of the present invention, the calibration image on the medium is input into an image processor.

In accordance with a more limited aspect of the present invention, versions of existing sets of tone reproduction curves, which were previously stored in the image processor, are browsed.

5 In accordance with an even more limited aspect of the present invention, one of the existing sets of tone reproduction curves is compared with one of the candidate sets of the tone reproduction curves.

In accordance with another aspect of the present invention, an acceptance boundary, after which the accepted tone reproduction curve will be used for calibrating the printer output device, is specified.

10 In accordance with another aspect of the present invention, an alternative output medium, which is to be associated with the accepted set of tone reproduction curves, is selected.

In accordance with another aspect of the present invention, a reversion is made to a previous version of existing sets of tone reproduction curves for any  
15 identified output medium.

One advantage of the present invention is that it provides a method and system for applying various sets of TRCs that are dependent on output mediums and/or halftoning screens.

20 Another advantage of the present invention is that it provides a method and system for calculating various sets of TRCs after a user specified page, set, and/or job boundary.

Another advantage of the present invention is that it provides a method and system for applying the various sets of TRCs after a user specified page, set, and/or job boundary.

25 Still further advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

### **Brief Description of the Drawings**

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as  
5 limiting the invention.

FIGURE 1 illustrates a system according to the present invention;

FIGURE 2 illustrates a flowchart according to the present invention;

and

FIGURE 3 illustrates a computer display screen according to the  
10 present invention.

### **Detailed Description of the Preferred Embodiments**

With reference to FIGURE 1, a system **10** for compensating for a calibration drift includes an electronic printer output device ("printing device") **12**, also referred to as an image output terminal ("IOT"), and a printer output device  
15 controller ("controller") **14** (image data generator). In the preferred embodiment, the printing device is a color printer. However, it is also contemplated that the printing device be a black-and-white printer or a color and black-and-white facsimile machine.

The controller **14** converts original image data (e.g., PostScript® or PDF format), which is received by the controller **14**, to final image data (e.g., raster  
20 data). The final image data is transmitted from the controller **14** to the printing device **12**, which renders the image data on an output medium **20**. In the preferred embodiment, the output medium is some type of paper (e.g., glossy or semi-glossy). However, other types of output media (e.g., plastic transparency) are also contemplated.

25 By operating various input devices (e.g., a keyboard **22** and/or a mouse **24**) and a viewing monitor **26**, which communicate with the controller **14**, a user **30** is capable of correcting a calibration drift (or a drift from an optimum set-point), which is associated with the printing device **12**, by processing the final image data that is

transmitted to the printing device **12**. In other words, if the calibrated settings of the printing device **12** drift over time, the final image data that is transmitted to the printing device **12** may be modified to bring the output produced by the printing device **12** back to the desired quality.

5           FIGURE 2 shows a flowchart **32** of a method for calibrating the printing device **12** to compensate for calibration drifts. FIGURE 3 illustrates a preferred display screen **34** that may be viewed by the user during the calibration process outlined in FIGURE 2.

10           With reference to FIGURES 1-3, a method for compensating for a calibration drift within the printing device **12** starts at a step **200**. A determination is made in a step **202** if the user **30** merely desires to revert back to a previously stored set of TRCs. If the user **30** does wish to revert to a previous set of TRCs, control passes to a step **250**. The reversion process will be described in more detail below. Otherwise, if the user **30** does not wish to revert to a previous set of TRCs, control  
15 passes to a step **204**.

          A calibration boundary is specified by the user **30** in the step **204**. More specifically, using the keyboard **22** or mouse **24**, the user **30** selects one of three (3) "buttons" **40**, **42**, **44** displayed on the monitor **26**. In this way, the user **30** delays the calibration process from beginning until after the specified calibration boundary is  
20 reached.

          An output "job" includes one or more "sets," while each "set" includes one or more groups of "pages." Therefore, a user may, for example, desire to print five (5) sets of groups, each of which includes three (3) pages. Clicking on the Page Boundary button **40** delays the beginning of the calibration process until after the  
25 current page is completely printed; clicking on the Set Boundary button **42** delays the beginning of the calibration process until after the current set (e.g., group of three (3) pages) is completely printed; clicking on the Job Boundary button **44** delays the beginning of the calibration process until after the current job (e.g., all five (5) sets) is completely printed.

There are several reasons why it is desirable to specify a calibration boundary for delaying the start of the calibration process. For example, although an output quality has begun to deteriorate, it may be desirable to keep all pages within each set to a consistent level of quality, which would be achieved by clicking the Set Boundary button **42**. Alternatively, if it is desirable to maintain a consistent level of quality within a job, the user would click the Job Boundary button **44**. Furthermore, because the process described below requires a calibration image (target image) to be produced, the Page Boundary button **40** alerts the system to finish printing the current page so that a complete calibration page (target page), which includes the calibration image, may be produced.

Once the calibration boundary is reached, the controller **14** suspends an output process of the printing device **12** in a step **206**. Then, in a step **208**, the user **30** specifies the type of medium (e.g., glossy paper, matted paper, clear transparency, etc.) on which the calibration image (target image) is to be produced by selecting a Media Programming button **46**. The target image is produced, in a step **212**, on the specified medium using the printing device **12** by selecting a Print button **50**. Preferably, the target image represents all the halftone screens supported by the printing device **12**. The target image is input into an image processor **52** in a step **214**, preferably using a color measurement device **54**, such as a colorimeter or spectrophotometer, by selecting a Scan button **56**. More specifically, colors on the target image are measured in the step **214**. Then, data representing the measured colors is transmitted from the scanning device **54** to the processor **52**, which is preferably included within the controller **14**. Then, the processor **52** calculates candidate sets of tone reproduction curves. The number of sets so produced is preferably the same as the number of halftone screens supported by the printing device **12**. It is to be understood that the candidate sets of TRCs are stored in the processor **52**. In this manner, the candidate sets of TRCs may be recalled at a future time as existing TRCs, the benefits of which will become apparent from the discussion outlined below.

Each of the candidate sets of TRCs represents one of the halftone screens supported by the printing device **12**. Furthermore, each of the sets preferably includes four (4) lines **60a**, **60b**, **60c**, **60d**; each of the lines **60a**, **60b**, **60c**, **60d** corresponds to one of the colors in the CMYK color space.

5           In a step **216**, the user **30** displays one of the sets of TRCs. More specifically, the user **30** selects one of the screen types using a Screen Type button **64** before selecting a Display button **62**. Once the Display button **62** is selected, an image of the candidate set of TRCs **60** for the selected screen type is displayed.

10           Then, in steps **220**, **222**, **224**, the user **30** browses through previously stored versions of TRCs (i.e., existing TRCs) for the specified medium type, which are stored in the controller **14** and classified according to halftone screens. As discussed above, the candidate sets of TRCs that were calculated by the processor **52** will be available as existing TRCs in future calibration processes.

15           In the step **220**, the user **30** displays one of the existing TRC sets **66**. More specifically, the user **30** chooses a halftone screen type by selecting a Screen Type button **70**. Then, the user **30** chooses one of the existing versions for the selected screen type by selecting the Version button **72**. The existing TRC set **66** for the selected halftone screen type and version is displayed when the user **30** selects the Display button **74**. System information (e.g., the date the currently displayed existing  
20           set of TRCs was installed) is displayed in a window **68**.

          In the step **222**, the user **30** compares the currently displayed candidate TRC set **60** with the currently displayed existing TRC set **66**. For example, the user **30** may be familiar with the output that will be produced using the currently displayed existing TRC set **66**. Furthermore, a sophisticated user may be able to determine  
25           whether the candidate TRC set **60** will produce acceptable output on the printing device **12** by comparing the lines **60a**, **60b**, **60c** **60d** with the lines **66a**, **66b**, **66c** **66d** in the existing curve **66**.

          In a step **223**, the user **30** chooses whether to compare the lines **60a**, **60b**, **60c** **60d** with the lines **66a**, **66b** **66c** **66d** for another halftone screen type. If the

comparison is desired, control returns to the step **216** where the lines are selected by halftone screen type (using the Screen Type button **64**) and displayed by selecting the Display button **62**, or to the step **220** where the lines are selected by halftone screen type (using the Screen Type button **70**) and displayed by selecting the Display button **74**. Otherwise, if the user **30** no longer wishes to compare the lines **60a, 60b, 60c 60d** with the lines **66a, 66b 66c 66d** for another halftone screen type, control passes to the step **224**.

In the step **224**, the user **30** determines whether to accept the currently displayed candidate TRC set **60**. If the user **30** does not decide to accept the candidate TRC set **60**, control passes to a step **234** for stopping the calibration process (if the user **30** determines not to accept the candidate TRC sets). Alternatively, if the user **30** determines to accept the currently displayed candidate TRC set **60**, control passes to a step **226**.

In the step **226**, the user **30** sets an acceptance boundary after which the new (accepted) TRC set **60** (i.e., the currently displayed candidate TRC set) will be used by the processor **52** for generating future final image data. More specifically, the user **30** selects one of the Now, Set, or Job buttons **76, 78, 80** to indicate that the new TRC set **60** will be used beginning with the next output page, set, or job, respectively. Then, in a step **230**, the user **30** also sets the media type (by selecting a Media Attributes button **82**) with which the new set of tone reproduction curves will be used. A default medium type, which is the medium type selected in the step **208**, is initially displayed.

Once the type of medium that will be used with the currently displayed candidate TRC set **60** is selected, system information regarding the halftone screen types associated with the currently displayed candidate TRC set **60** is shown in windows **84, 86, 88**. More specifically, the processor **52** preferably assigns identifying names to each of the halftone screens supported by the printing device **12**. The identifying names are then displayed in the windows **84, 86, 88**.

Then, the new tone reproduction curve set is accepted by selecting the Accept button **90** in a step **232**.

If the user **30** wishes to produce a new tone reproduction curve set for another type of medium, the above described steps are carried out again by selecting said type of medium in **46** in the step **208**. In this manner, the new TRC set accurately reflects the dependence on the medium type. However, rather than carrying out the above process again for another medium type, a less sophisticated user may wish to associate the current candidate TRC set **60** with another type of medium. If the user **30** wishes to do this in a step **233**, control returns again to step **230** where an alternative medium is set by **82**. This process continues until the user **30** wishes to associate no more medium types with the current candidate TRC set **60** in which case control passes to the step **234**.

The calibration stops in the step **234**. Then, the user **30** exits the calibration screen **34** by selecting an Exit button **99**.

After the new TRC set has been accepted and new output has been produced by the printing device **12** as a function of the new TRC set, the user **30** may determine the quality of the new output is inferior. In this case, the user **30** may want to revert back to the most recently stored set of tone reproduction curves. Therefore, the user **30** starts the calibration process again in the step **200**. Then, in the step **202**, the user **30** indicates that reversion is desirable. Therefore, control passes to a step **250**.

In the step **250**, the user **30** sets a reversion boundary by selecting one of a Now, Set, or Job button **93**, **94**, **96**, respectively. The selected reversion boundary indicates when the processor **52** will revert to the most recent set of TRCs; until the selected reversion boundary is reached, the currently selected set of TRCs **60** will continue to be used by the processor **52** for producing the final image data.

Then, in a step **252**, the user **30** identifies the associated media attributes (e.g., the type of medium) of the TRC set to be deleted. More specifically, because different types of media may have been associated with the candidate TRC set

(e.g., in the step **230**), the user **30** identifies the medium type of the TRC set to be deleted.

Then, in a step **254**, the user **30** reverts to the most recent existing TRC set stored in the processor **52** by selecting a Revert Button **98**. Control then passes to  
5 the step **234**.

The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as  
10 they come within the scope of the appended claims or the equivalents thereof.

Having thus described the preferred embodiment, the invention is now claimed to be:

1. A method for calibrating a printer output device, comprising:
  - identifying an output medium;
  - producing a calibration image on the output medium, the calibration image representing a plurality of available halftone screens;
  - 5 measuring colors on the calibration image;
  - calculating a plurality of candidate tone reproduction curve sets for the identified output medium, each of the sets corresponding to one of the available halftone screens; and
  - accepting the sets of the tone reproduction curves for calibrating the
  - 10 printer output device to compensate for drifts from an optimum set-point.
  
2. The method for calibrating a printer output device as set forth in claim 1, further comprising:
  - identifying a calibration boundary; and
  - suspending an output process of the image output terminal after the
  - 5 identified calibration boundary.
  
3. The method for calibrating a printer output device as set forth in claim 1, further comprising:
  - inputting the calibration image on the medium into an image processor.
  
4. The method for calibrating a printer output device as set forth in claim 3, further including:
  - browsing versions of existing sets of tone reproduction curves which were previously stored in the image processor.

5. The method for calibrating a printer output device as set forth in claim 4, further including:

comparing one of the existing sets of tone reproduction curves with one of the candidate sets of the tone reproduction curves.

6. The method for calibrating a printer output device as set forth in claim 1, further including:

specifying an acceptance boundary after which the accepted tone reproduction curve will be used for calibrating the printer output device.

7. The method for calibrating a printer output device as set forth in claim 1, further including:

selecting an alternative output medium to be associated with the accepted set of tone reproduction curves.

8. The method for calibrating a printer output device as set forth in claim 1, further including:

reverting to a previous version of existing sets of tone reproduction curves for any identified output medium.

9. A system for compensating for a calibration drift in an image output device, comprising:

a user input means for specifying an output medium;

an image output device controller for converting original image data to final image data used by the image output device, the image output device producing a calibration image, as a function of an output medium, for a plurality of halftone screens capable of being produced by the image output device;

a processor communicating with the controller, the processor calculating a plurality of candidate tone reproduction curve sets for the specified

10 output medium, each of the sets corresponding to one of the plurality of halftone screens; and

means for accepting the candidate tone reproduction curve sets for compensating for a calibration drift in the image output device.

10. The system for compensating for a calibration drift in an image output device as set forth in claim 9, further including:

5 an image input device for converting the calibration image into calibration data, which is transmitted to the processor for calculating the plurality of candidate tone reproduction curve sets.

11. The system for compensating for a calibration drift in an image output device as set forth in claim 10, further including:

5 means for displaying different candidate tone reproduction curve sets and visually comparing the displayed candidate set of tone reproduction curves with an existing set of tone reproduction curves.

12. The system for compensating for a calibration drift in an image output device as set forth in claim 10, wherein an output process of the image output device is suspended after a calibration boundary, which is set by a user, is reached, the calibration image being produced after the output process is suspended.

13. The system for compensating for a calibration drift in an image output device as set forth in claim 10, further including:

means for deleting the accepted set of tone reproduction curves and reverting to an existing set of tone reproduction curves.

14. The system for compensating for a calibration drift in an image output device as set forth in claim 9, wherein the accepted set of tone reproduction

curves is used by the controller for converting original image data to final image data after an acceptance boundary is reached, the acceptance boundary being specified by a user.

5 15. A method for compensating for a calibration drift in an image output device, comprising:  
specifying a calibration boundary;  
rendering a target output image on the image output device after the  
5 calibration boundary is reached, a plurality of halftone screens capable of being produced by the image output device being represented on the target output image;  
measuring colors included on the target output image;  
calculating a set of candidate tone reproduction curves for each of the  
halftone screens;  
10 accepting one of the candidate tone reproduction curve sets; and  
processing future image data, which is used to produce images on the output device, with the accepted candidate set of tone reproduction curves.

16. The method for compensating for a calibration drift in an image output device as set forth in claim 15, wherein the accepting step includes:  
selecting the candidate tone reproduction curve set.

17. The method for compensating for a calibration drift in an image output device as set forth in claim 15, further including:  
specifying an acceptance boundary, the step of processing being performed after the acceptance boundary is reached.

18. The method for compensating for a calibration drift in an image output device as set forth in claim 15, further including:  
viewing existing sets of tone reproduction curves; and

5 comparing an existing set of tone reproduction curves with a candidate set of tone reproduction curves.

19. The method for compensating for a calibration drift in an image output device as set forth in claim 18, further including:

storing the candidate sets of tone reproduction curves for use in the future as the existing sets of tone reproduction curves.

20. The method for compensating for a calibration drift in an image output device as set forth in claim 15, further including:

reverting to a previously stored set of tone reproduction curves.

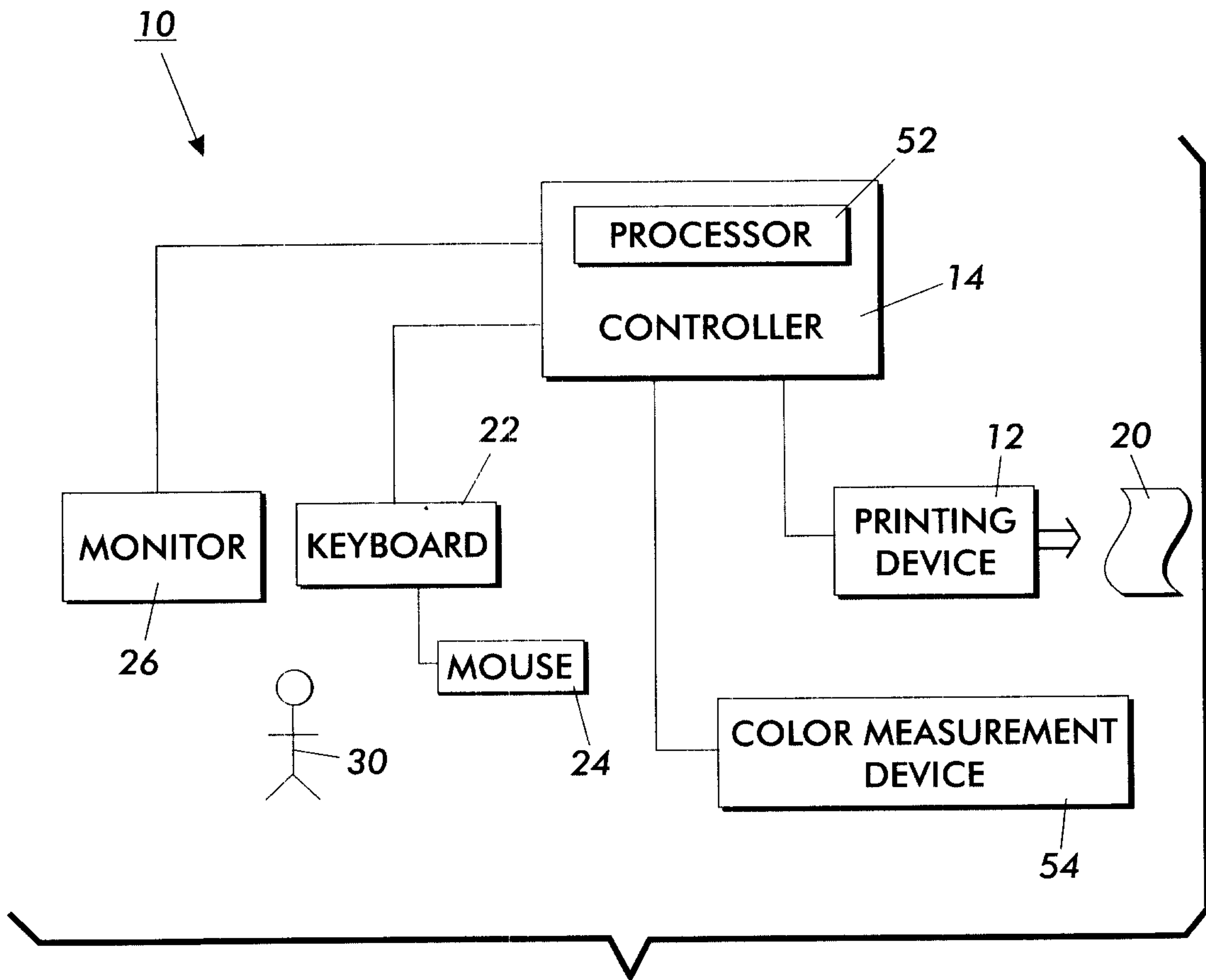


FIG. 1

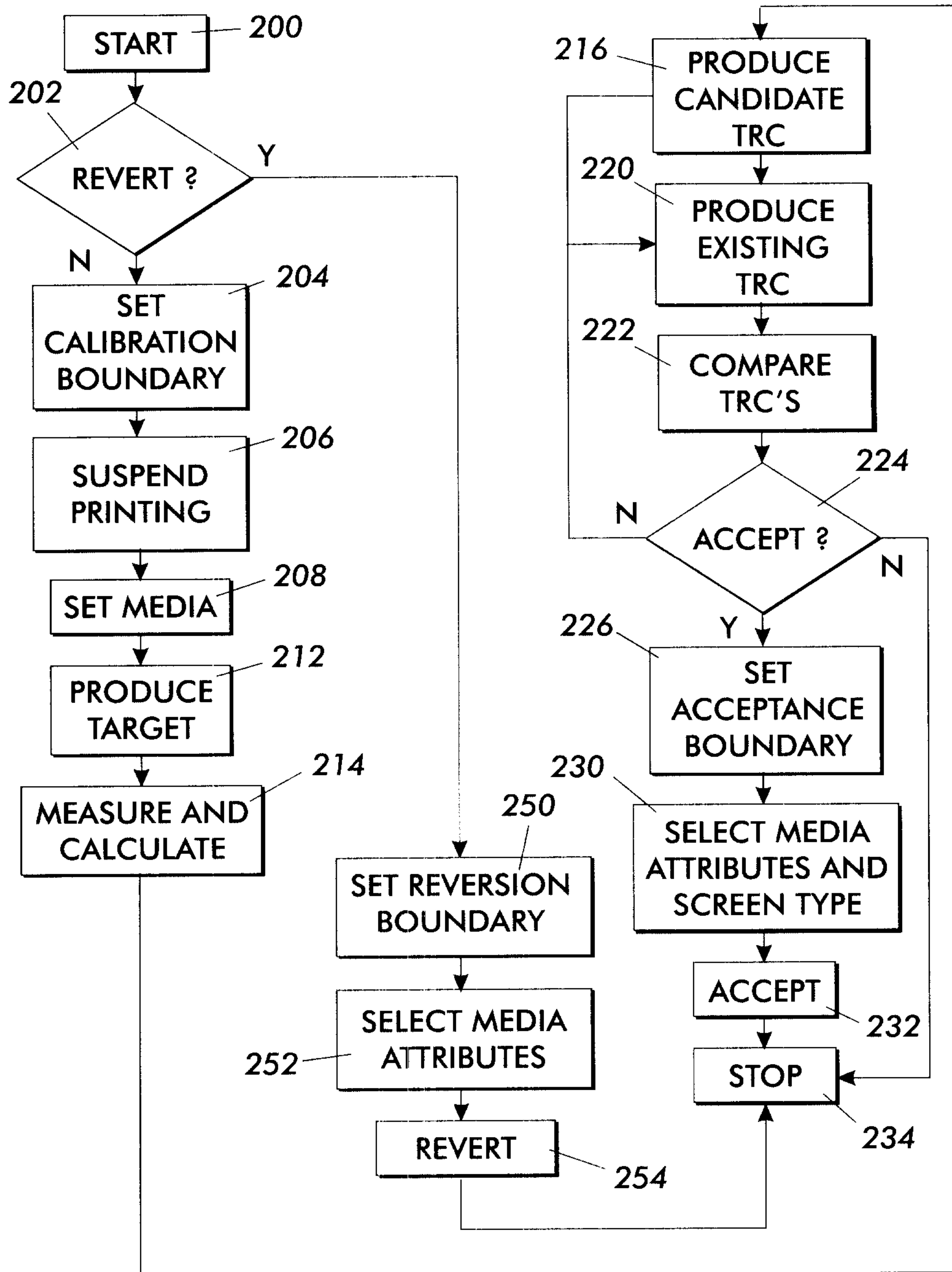


FIG. 2

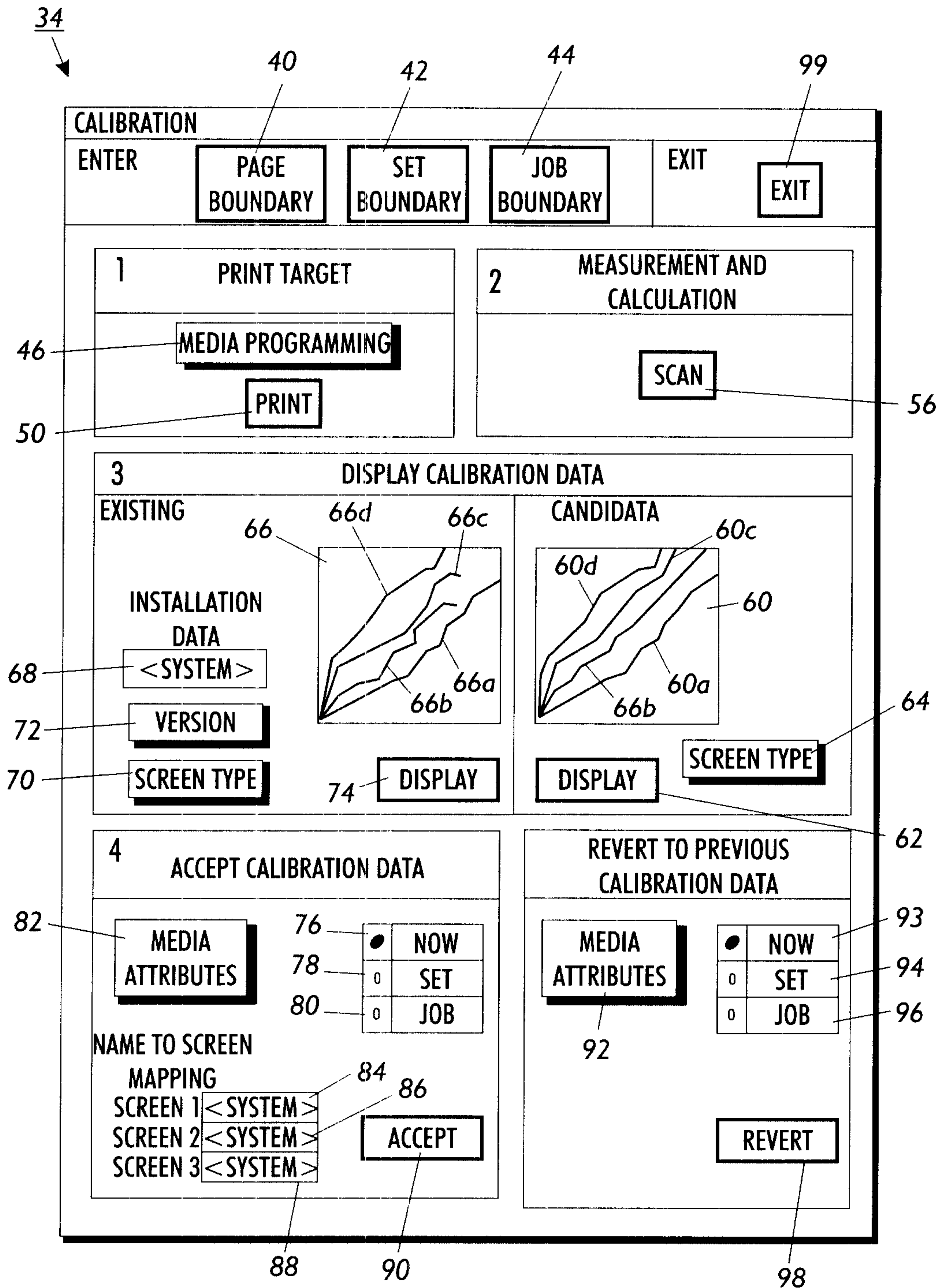
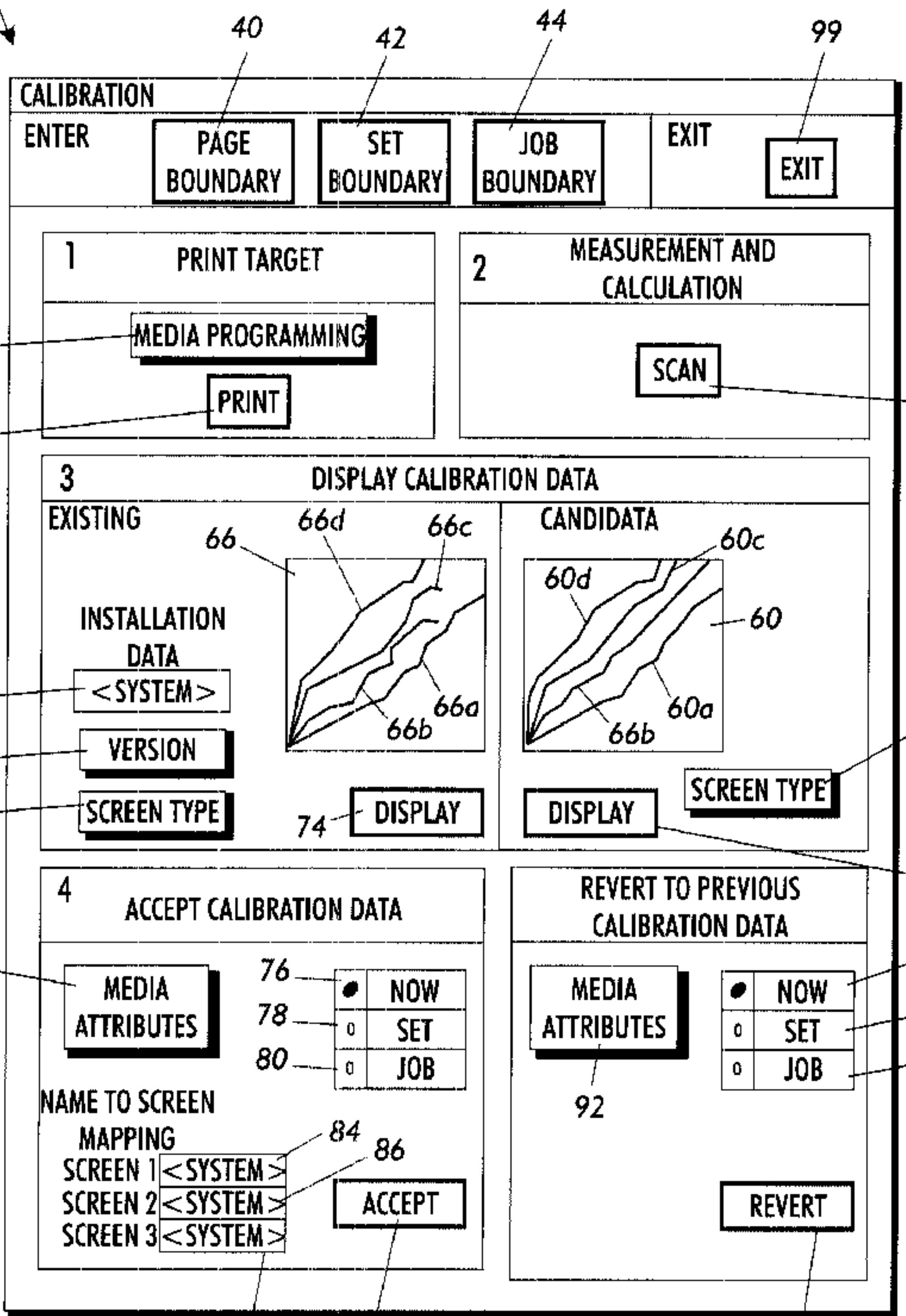


FIG. 3



CALIBRATION

ENTER

PAGE BOUNDARY

SET BOUNDARY

JOB BOUNDARY

EXIT

EXIT

1 PRINT TARGET

MEDIA PROGRAMMING

PRINT

2 MEASUREMENT AND CALCULATION

SCAN

3 DISPLAY CALIBRATION DATA

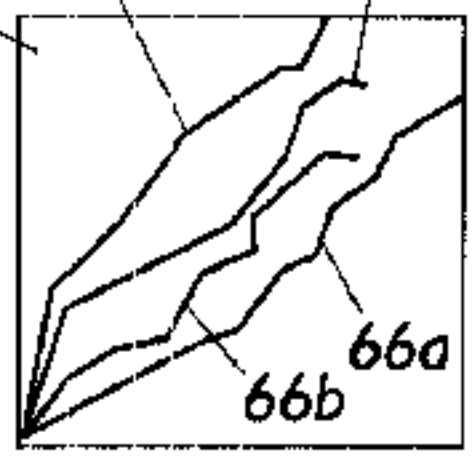
EXISTING

INSTALLATION DATA

<SYSTEM>

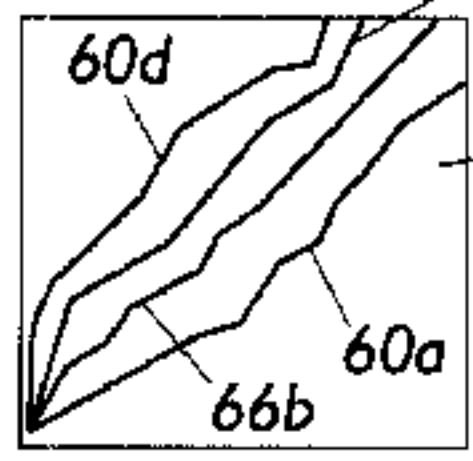
VERSION

SCREEN TYPE



DISPLAY

CANDIDATA



DISPLAY

SCREEN TYPE

4 ACCEPT CALIBRATION DATA

MEDIA ATTRIBUTES

76	<input checked="" type="radio"/>	NOW
78	<input type="radio"/>	SET
80	<input type="radio"/>	JOB

NAME TO SCREEN MAPPING

SCREEN 1	<SYSTEM>
SCREEN 2	<SYSTEM>
SCREEN 3	<SYSTEM>

ACCEPT

REVERT TO PREVIOUS CALIBRATION DATA

MEDIA ATTRIBUTES

<input checked="" type="radio"/>	NOW
<input type="radio"/>	SET
<input type="radio"/>	JOB

REVERT