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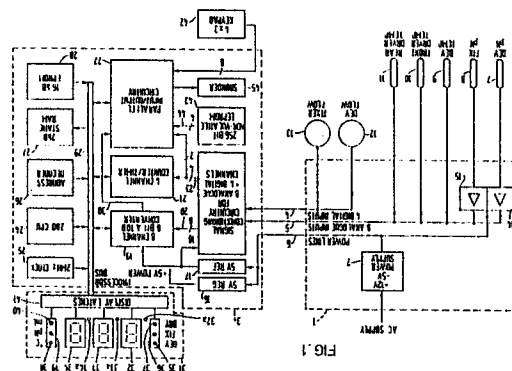
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(54) A device for use in monitoring parameters during the processing of a film.

(57) A hand-held device for use in monitoring parameters during the processing of a film comprises means (18) for receiving input signals dependent on the values of the parameters from sensing means (7, 8, 9, 10, 11 12 and 13) which are responsive to the parameters; means (19, 21, 22, 24, 26, 28) for processing the signals; display means (31) coupled with the processing means for enabling the values of the parameters to be displayed selectively by the display means.



Description

A DEVICE FOR USE IN MONITORING PARAMETERS DURING THE PROCESSING OF A FILM

Having exposed any kind of photographic film, including conventional photographic film, X-ray film, graphic arts film, etc., it is necessary to pass the film through a chemical process in order to produce the final visible image.

If this image is to be of consistent and acceptable quality, then it is essential that regular checks are kept on the various component stages forming a film processing.

Hitherto, it has been necessary to stop the routine flow of work to carry out these checks. With the use of automatic film processing equipment, the task becomes more complex, requiring additionally a knowledge of the equipment.

For example, the majority of X-ray films are currently passed through automatic film processing equipment in order to produce the final diagnostic radiograph. To assist in correct diagnosis, the radiographs must be of the highest consistent quality. Therefore, quality control of the film passing through the processing equipment is vital. The method of carrying out these checks is to stop the flow of work, which in medical radiography results in the hold-up of patient examinations, in order that the operator may open up the processing equipment and carry out tests. This is time consuming as well as requiring an understanding of the working of the equipment.

According to the present invention, there is provided a device for use in monitoring parameters during the processing of a film, comprising:-

- a) means for receiving input signals dependent on the values of the said parameters from sensing means which are responsive to the parameters;
- b) means for processing the said signals;
- c) display means coupled with the said processing means; and
- d) selection means coupled with the said processing means for enabling the values of the said parameters to be displayed selectively by the display means.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of an example of a device according to the invention coupled to various sensing means; and

Figure 2 shows a keypad of the device.

Referring to Figure 1, a distribution circuit board 1 is disposed in use in X-ray film processing equipment. The distribution circuit board 1 carries power supply circuitry 2 which is fed from an alternating current supply and provides +12 volts and -5 volts power supplies. Reference numeral 3 denotes a main circuit board in a hand-held monitoring device. The main circuit board 3 is connected to the distribution circuit board 1 via a 20-way ribbon cable, the latter providing for four digital inputs as schematically denoted by single line 4, eight analogue inputs as schematically denoted by single line 5 and power

lines as schematically denoted by single line 6.

Installed within the processing equipment are a probe 7 for monitoring the pH value of the developer, a probe 8 responsive to the pH value of the fixer (the probes 7 and 8 producing voltage outputs), a sensor 9 responsive to the temperature of the developer, a sensor 10 responsive to the equipment's front dryer temperature, a sensor 11 responsive to the equipment's rear dryer temperature (the sensors 9, 10 and 11 producing current outputs), a sensor 12 responsive to the flow rate of the developer and a sensor 13 responsive to the flow rate of the fixer (the sensors 12 and 13 producing digital, pulse outputs).

The outputs of the probes 7 and 8 are connected via high impedance amplifiers 14 and 15 on the distribution circuit board 1 to respective ones of the eight analogue inputs to the main circuit board 3. The outputs of sensors 9, 10 and 11 are connected via the distribution circuit board 1 to respective ones of three others of the analogue inputs to the main circuit board 3. The outputs of sensors 12 and 13 are connected via the distribution circuit board 1 to respective ones of the digital inputs to the main circuit board 3. The distribution circuit board 1 (which acts as interface means between sensing means and the hand-held device) has, in fact, eight inputs for receiving outputs from analogue sensing means, in the present example five of them being used and the other three (not shown) being spare. Also, the distribution circuit board 1 has four inputs for receiving outputs from digital sensing means, in the present example two of them being used and the other two (not shown) being spare.

The will now be described the circuitry carried on the main circuit board 3. Fed from the +12 volts power supply from circuitry 2 are a regulator 16 for providing +5 volts operating power for digital circuitry on the board 3 and a device 17 for providing a +5 volts reference voltage for operating signal conditioning circuitry 18 and an analogue to digital converter 19 on the board 3. The signal conditioning circuitry 18 is adapted for handling eight analogue and four digital channels and the analogue to digital converter 19 is an 8-channel, 8-bit analogue to digital converter with an integral 8-channel analogue multiplexer. The +5 volts operating power is also fed back on one of the power lines 6 via the 20-way ribbon cable for operation of the sensors 12 and 13 and as one of the operating voltages for amplifiers 14 and 15 (the -5 volts from circuitry 2 being the other voltage for these amplifiers). Also, the +12 volts from circuitry 2 is used for operation of sensors 9, 10 and 11, the probes 7 and 8 being passive probes.

The eight analogue inputs and the four digital inputs of the 20-way ribbon cable are connected to respective inputs of the signal conditioning circuitry 18. As regards the voltage outputs from probes 7 and 8, circuitry 18 subjects them to amplification with a gain of one and subsequent filtering; as regards the current outputs from sensors 9, 10 and

11 it subjects them to current to voltage conversion together with an offset to compensate for ambient temperature followed by filtering; and as regards the digital outputs from sensors 12 and 13, it subjects them to the operation of pull-up resistors followed by filtering.

The five analogue signals are passed from circuitry 18 via respective lines of an eight line bus 20 to the converter 19. The main circuit board 3 further carries a 4-channel counter/timer 21 and parallel input/output circuitry 22, the two digital signals applied to circuitry 18 being passed to counter/timer circuitry 21 via respective lines of four lines bus 23, the other two lines of which are connected as spare lines to respective input pins of the parallel input/output circuitry 22 for providing an option for dealing with other functions.

The main circuit board 3 further carries a CMOS80 central processing unit (CPU) 24 running under the control of a 2 MHz clock 25, an address decoder 26, a 2 kB static random access memory (RAM) 27 and a 16 kB erasable programmable read-only memory (EPROM) 28, the latter storing the necessary operating program. The output signals of the converter 19 and counter/timer 21 are stored in the RAM 27 via a processor bus 29, under the control of the processing unit 24, address decoder 26 and parallel input/output circuitry 22. The converter 19 scans its inputs sequentially and provides an indication on a line 30 to the parallel input/output circuitry 22 each time it finishes a particular analogue to digital conversion. The result is that there is stored in the RAM 27 signals related to: the pH of the developer; the pH of the fixer; the temperature of the developer; dryer temperature (obtained by taking the average of the results from the front dryer temperature sensor 10 and the rear dryer temperature sensor 11); the amount of developer which has flowed (obtained by counting pulses from sensor 12 for a specific period); and the amount of fixer which has flowed (obtained by counting pulses from the sensor 17 for the specific period).

The hand-held device further has a display board 31 for displaying the values of the foregoing parameters. More particularly, the display board 31 has: three 7-segment light emissive diode (LED) displays 32, 33 and 34 and three LEDs 32a, 33a, and 34a before respective ones of displays 32, 33 and 34 for indicating a decimal point when energised. Also, the display board 31 has three LEDs 35, 36 and 37 with legends alongside them as shown; and three LEDs 38, 39 and 40 with legends alongside them as shown. The LEDs of board 31 are energised via respective ones of display latches in block 41 via processor bus 29. For selectively displaying the value one of the foregoing parameters, the hand-held device also has a manually operable 4 x 3 keypad 42 having keys numbered or marked as shown in Figure 2, with the upper row having the legend DEV. (i.e. developer) alongside it, the second row down having the legend FIX. (i.e. fixer) alongside it, the third row down having the legend DRY. (i.e. dryer) alongside it, the left-hand column having the legend TEMP. (i.e. temperature) above it, the middle column having the legend pH above it and the right-hand column having

the legend FLOW above it. Thus, by pressing the key numbered 1, the value in degrees Centigrade ($^{\circ}\text{C}$) of the dryer temperature will be displayed (the LEDs 37 and 38 being energised to indicate this); by pressing the key numbered 5, the value of the pH of the fixer will be displayed (the LEDs 36 and 39 being energised to indicate this); by pressing the key numbered 6, the value in millilitres (mL) of the flow of fixer will be displayed (the LEDs 36 and 40 being energised to indicate this); by pressing the key numbered 7, the value in degrees Centigrade of the developer temperature will be displayed (the LEDs 35 and 38 being energised to indicate this); by pressing the key numbered 8, the value of the pH of the developer will be displayed (the LEDs 35 and 39 being energised to indicate this); and by pressing the key numbered 9, the value in millilitres of the flow of developer, will be displayed (the LEDs 35 and 40 being energised to indicate this).

For converting signals the stored in RAM 27 into corrected signals for display purposes, there is provided on the main circuit board 3 a 256 bit non-volatile electrically erasable programmable read-only memory 43 which stores appropriate calibration factors and is connected with circuitry 22 via a four line bus 44. Finally, connected to an output of the parallel input/output circuitry 22 of the main circuit board 3 there is also provided a sounder 45 for producing an audible sound as will be described below.

In typical X-ray film processing equipment, the developer and fixer baths operate at about 32°C , and the dryers operate at about 55°C . Typically, the converter 19 spans a 25°C range around these values with a resolution of 0.1°C , the display resolution being in 0.1°C increments.

Typically, the pH probes 7 and 8 would cover a range from 0 to 14 in value, the developer having a pH of about 10.5 and the fixer a pH of about 5.5. If the converter 19 has a span of 2 to 13 this would give a resolution of 0.05 pH. Display resolution could be typically in 0.1pH increments.

Typically, the display resolution for flow could be in 1 mL increments.

Eachs of the temperature sensors 9, 10 and 11 produces an output proportional to absolute temperature and the output at room temperature needs to be offset to cover the required range. In addition, the pH probes 7 and 8 need an offset to enable their bipolar outputs to be measured by the unipolar converter 19. This offset voltage is 1/2 full scale of the converter 19 to give an equal range about the normal operating point. Any errors in this voltage are corrected by the calibration routine which will be described below.

Readings from the probes 7 and 8 and sensors 9, 10, 11, 12 and 13 are taken continuously, and an average calculated for each of the temperature and pH channels. For the flow sensors, the start and stop of flow is determined, and the volume for each film processes is calculated.

Pressing the appropriate key on keypad 42 displays the value of the relevant parameter. Five seconds after the key is released, the circuitry of the display board 31 returns to a standby mode where

only the centre segment of the middle display 33 is energised, unless another valid key is pressed in which case the value of the new parameter is displayed.

Pressing a valid temperature or pH key causes a short sound from sounder 45 and the measured value is displayed for 5 seconds. Holding the key pressed gives a continuous display.

Pressing a flow key causes a short sound from the sounder 45, and the display shows 0. Feeding in a film operates the replenishment pumps, and the display counts up the volume of liquid passed. After the pumps stop, the display remains for 20 seconds. If another film is inserted during this time, the display continues counting, enabling the average volume per film to be determined.

Pressing an invalid key, for example key 2 (DRY. pH) results in a long sound from sounder 45 and no display.

To ensure accuracy without analogue adjustments, a calibration routine may be used whereby each of probes 7 and 8 and sensors 9, 10, 11, 12 and 13 is subjected to a known condition, and the measured value entered into the device, calibration factors for correction of future signals being stored in the non-volatile memory 43.

To ensure measurement accuracy at the normal operating levels without electrical adjustments, calibration is performed by software via the keypad 42, and to prevent tampering with the calibration factors, a three digit security code is used.

As with any calibration method, an independent reference is required for the parameter being measured. This would normally be a thermometer for temperature, a pH meter or buffer solution for the pH probes and a measuring cylinder or similar for flow. The reference accuracy should be better than the accuracy required from the hand-held device. Before calibration, the processing equipment should be allowed to stabilise for 30 minutes after reaching normal operating conditions.

To calibrate for developer temperature, a reference thermometer is immersed in the developer bath and the key marked CAL. and then key 7 (DEV.TEMP.) pressed. A particular value will be displayed and if this is not correct, the correct value is entered (e.g. 32.3) via the keypad 42. The entered value then flashes on the display board 31. CAL. is pressed and then the security code (e.g. 123) is entered via the keypad 42. After a short delay, the device reverts to the standby mode, and a new DEV.TEMP. reading should now agree with the reference.

At any stage, the calibration is aborted if the correct key is not pressed within a certain time. Entering an incorrect security code results in "Err" being displayed via displays 32, 33 and 34, and calibration is aborted.

To calibrate for dryer temperature, the procedure is the same as for developer temperature, except that as the average of two sensors is used for the display, each can be individually calibrated. Key 1 (DRY. TEMP.) is used to select the front dryer sensor for calibration, and key 2 for the rear sensor. As the dryer temperature accuracy is not critical, a

single reference probe is normally adequate, and is used for both front and rear sensor calibration.

To calibrate for pH, calibration of both developer and fixer pH is performed in a similar fashion to the temperature calibrations, although the reference method used requires some differences in procedure. Only a single calibration point is used, there being no necessity to use the usual pH 7 point. The simplest method is to have an independent pH meter and probe, and use this to measure the pH values of the bath solutions. However, the probe must be capable of operating in a solution contaminated with silver. An alternative method is to use buffer solutions with a value near to the normal developer and fixer values. To do this, the probes must be removed from the baths, rinsed in distilled water, and immersed in the buffer solution. The buffer solution must be in electrical contact with the processing equipment, else the pH values may be significantly incorrect. The simplest way to achieve this is to connect a wire to the metalwork of the equipment, with the other end dipping in the buffer solution. Note that the buffer solution should be at approximately the same temperature as the bath solutions. Whichever method is used to obtain the reference value, the calibration method proceeds as before.

To calibrate for flow, the replenishment pipes of the processing equipment should be positioned to discharge into a suitable measuring cylinder. CAL. is pressed and then a flow key. The displays 32, 33 and 34 read 0. The processing equipment's pumps are activated by inserting a film. Several films should be used to pump a reasonable volume (say 250 mL) into a measuring cylinder. The device will count up the total volume passed. The volume in the cylinder should be accurately noted, and this value keyed into the device as previously.

During the calibration procedure, unless otherwise stated, the device reverts to the standby mode if no key is pressed for 60 seconds, and any calibration changes are ignored.

Claims

1. A device for use in monitoring parameters during the processing of a film, comprising:-

a) means for receiving input signals dependent on the values of the said parameters from sensing means which are responsive to the parameters;

b) means for processing the said signals;

c) display means coupled with the said processing means; and

d) selection means coupled with the said processing means for enabling the values of the said parameters to be displayed selectively by the display means.

2. A device according to Claim 1, wherein the said receiving means is adapted for receiving first such signals as analogue signals and second such signals as digital signals.

3. A device according to Claim 2, wherein the said processing means includes conversion means for converting the said analogue signals to digital signals.

4. A device according to any preceding claim, wherein the said processing means includes storage means for storing processed signals, the said selection means being adapted for selecting stored signals and causing them to be supplied to the said display means for selectively displaying the values of the said parameters. 5
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5. A device according to any preceding claim, wherein the said processing means includes means for storing calibration values for calibrating processed signals. 15

6. A device according to any preceding claim, wherein the said selection means comprises a manually operable keypad.

7. A device according to any preceding claim, wherein the said processing means includes a central processing unit and memory means with a stored program for use in controlling operation of the processing means. 20

8. A device according to any preceding claim which is a hand-held device including the said receiving means, processing means, display means and selection means. 25

9. A device according to any preceding claim, wherein the said receiving means is coupled with interface means having inputs for connection with respective ones of a plurality of such sensing means and being adapted for supplying signals from the sensing means to the receiving means. 30
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10. A device according to any preceding claim, adapted so that the said parameters comprise at least: the pH of a liquid used in the processing of a film; a temperature occurring in the processing of a film; and a volume of liquid flow during the processing of a film. 40
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FIG. 2

