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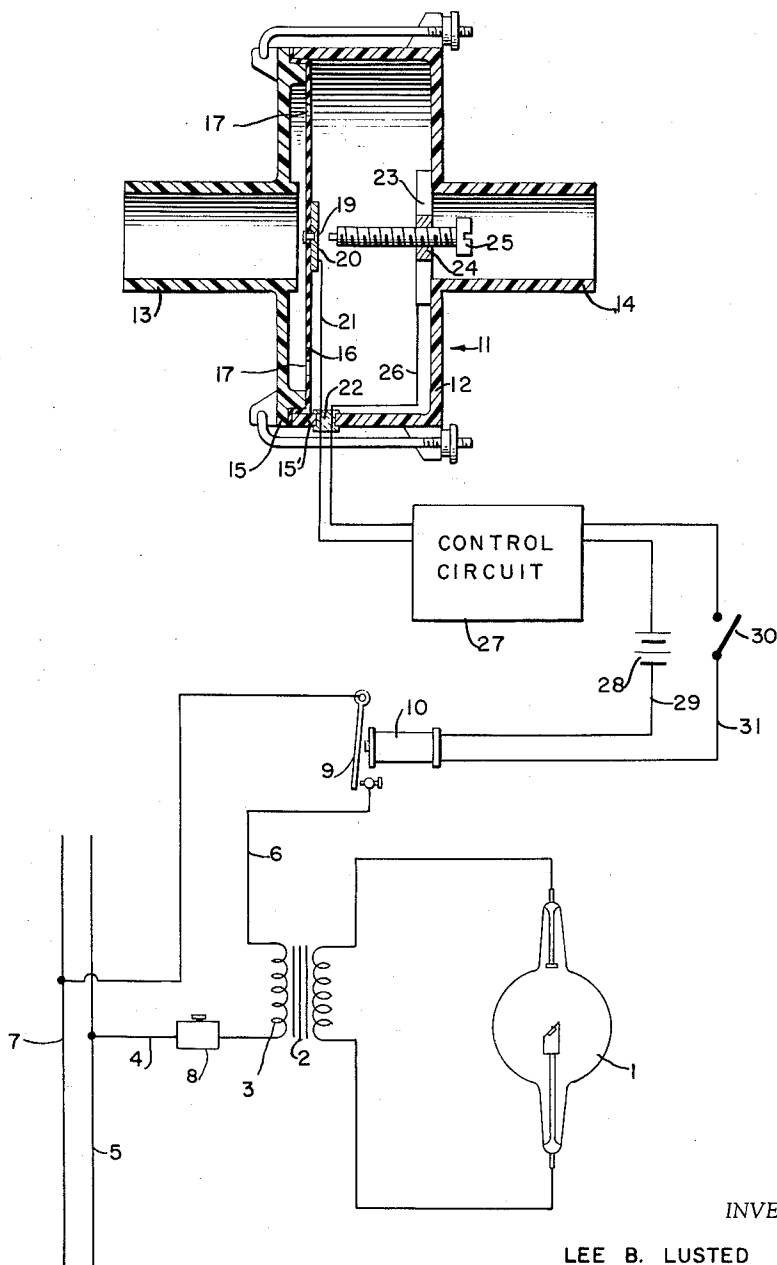
L. B. LUSTED  
X-RAY INITIATING SYSTEM

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2 Sheets-Sheet 1

FIG. 1



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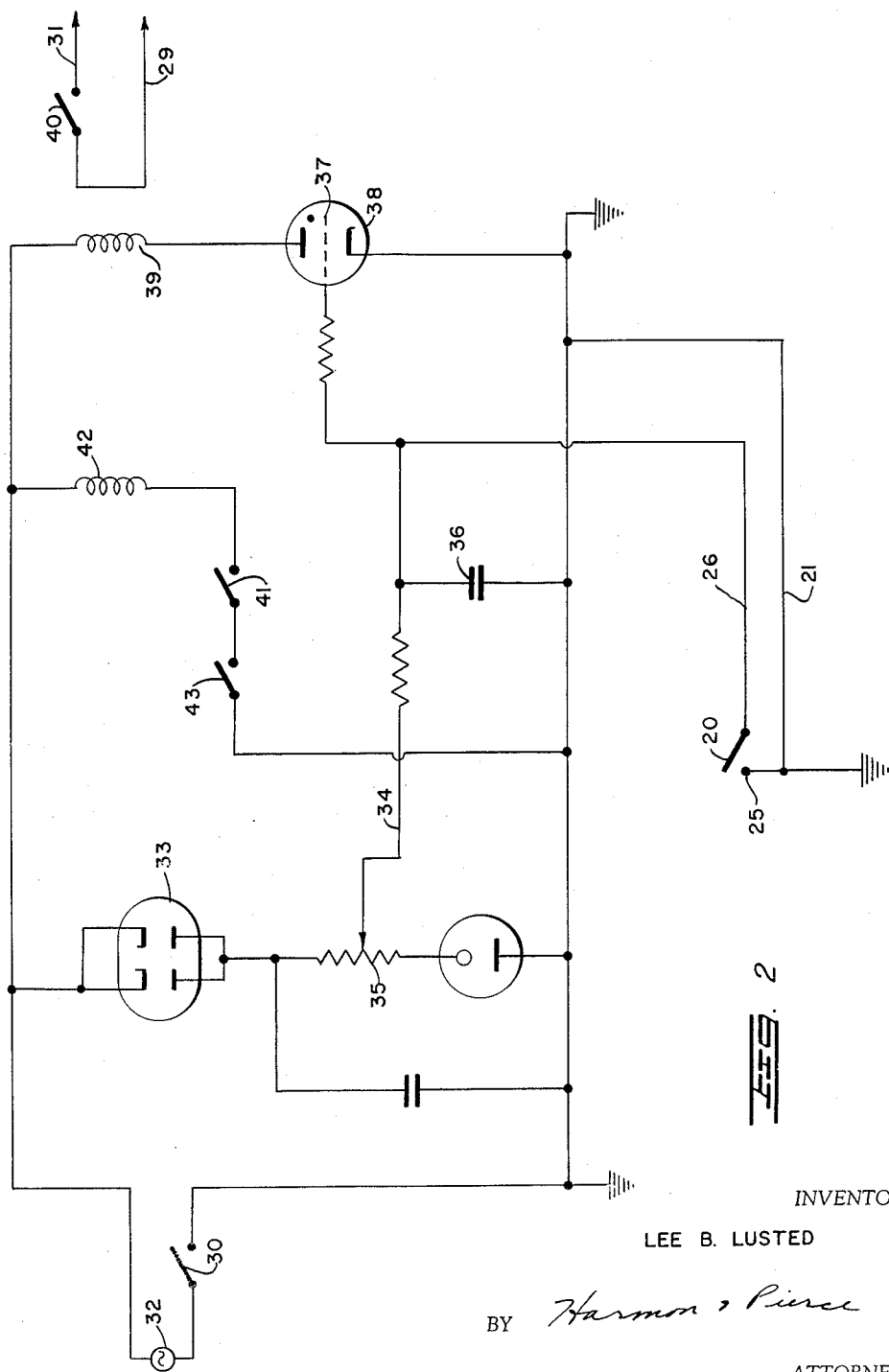
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## X-RAY INITIATING SYSTEM

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3 Claims. (Cl. 250—95)

This invention relates generally to X-ray systems and more particularly to initiating systems for X-ray circuits wherein exposures of a patient may be timed precisely with either the terminal point of inhalation or exhaust of the patient's lungs.

For purposes of X-ray examination of the heart it is most desirable that the lungs be substantially exhausted so that the heart may expand to its greatest extent. On the other hand examination of the lungs by X-ray is materially aided by the inhalation of the patient to expand the lungs to the greatest extent. For purposes of X-ray examination of the heart and lungs of babies and invalids, it becomes difficult for the technician to time the X-ray exposure to coincide with proper degree of inhalation or exhalation by the patient.

It is, therefore, the primary object of this invention to provide an initiating system for an X-ray circuit which is automatically responsive to the degree of inhalation or exhalation of the patient to energize the X-ray circuit to make an exposure of the patient at the most desirable moment.

A more specific object of this invention is to provide an initiating system for an X-ray circuit wherein a switch is operable by a breath responsive valve inserted in or placed adjacent to the patient's mouth to energize upon closure, at a preset level of inhalation or exhalation, the X-ray circuit to make an exposure.

With the foregoing and other objects in view, the invention resides in the following specification and appended claims, certain embodiments and details of construction of which are illustrated in the accompanying drawings in which:

Figure 1 is a schematic drawing of the initiating system comprising the invention, together with the X-ray system to be energized thereby, the breath operated switch of the initiating system being illustrated in section; and

Figure 2 is a schematic circuit diagram of the initiating system.

Referring now to Figure 1, it will be seen that an X-ray tube 1 is connected so as to be energized through a transformer 2. The primary 3 of transformer 2 is connected by a line 4 to one side 5 of an alternating current supply. The primary 3 is also connected by a line 6 to the other side 7 of the alternating current supply. A timer 8, for controlling the exposure time, is placed in line 4. A normally open switch 9, controlled by an electromagnetic relay coil 10 is placed in the line 6. When the coil 10 is energized to close switch 9 the X-ray tube 1 will fire to make an exposure determined in length by the timer 8 which is selectively set to break the circuit. In order that the switch 9 will be closed at the most desirable moment, it is desirable that the coil 10 be energized in accordance with the magnitude of the inhalation or the exhalation by the patient under examination. To accomplish this end result, a breath-operated switch 11 is provided which comprises a housing 12 having tubular extensions 13 and 14 thereon. The extensions

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13 and 14 are of suitable size to act as a mouthpiece. In the case of babies, it is desirable to incorporate such a unit in a face mask which will force the child to breathe through the tube. Suitably secured between adjoining surfaces of the parts 15 and 15<sup>1</sup> of the housing 12 is a flexible diaphragm 16. The diaphragm 16 is provided with a plurality of generally peripheral perforations 17. Secured to the diaphragm by a rivet 19 is a contact plate 20. A lead line 21 is secured to plate 20 and extends through a bushing 22 to the exterior of the housing 12. Mounted directly opposite the contact plate 20, and secured to the interior of housing 12 by suitable means, is a spider 23 which is provided with a threaded central aperture 24 to receive an adjustable contact screw 25. Connected to the spider 23 is a lead line 26 which extends through the bushing 22 to the exterior of housing 12. Lines 21 and 26 are connected to the control circuit 27, which is normally inactive, to energize coil 10 but, which upon a circuit closure between contact plate 20 and screw 25, stands immediately ready to energize relay coil 10.

A source of direct current depicted as a battery 28 is provided in one line 29 leading from the control circuit 27 to the coil 10. A main "on-off" switch 30 is provided in the other line 31 connecting coil 10 with the control circuit 27.

The operation of the system, as illustrated in Figure 1 may now be described. Switch 30 is initially closed. If the X-ray exposure, desired by the technician, is one in which the patient's lungs should be contracted, then the mouthpiece 13 is inserted into or placed adjacent to the patient's mouth. Upon sufficient exhalation the diaphragm 16 will distend to the right, when viewed in the drawing, so that contact plate 20 will engage the end of the adjustable contact screw 25. The control circuit 27 will be actuated and coil 10 will be energized to close switch 9. Closure of switch 9 will instantly fire the X-ray tube 1 to make the exposure. If the exposure desired is one in which the patient's lungs should be expanded, then the mouthpiece 14 is inserted into or placed adjacent to the patient's mouth. Upon sufficient inhalation the diaphragm will be drawn to the right to close contact plate 20 against contact screw 25. The system at this point operates in the same manner as described above to fire tube 1. The perforations 17 in diaphragm 16 permit the inflow or outflow of air to or from the patient while simultaneously restricting such flow enough to render the diaphragm operative to close the contacts 20 and 25.

The design of the breath operated switch 11 is not considered critical to this invention as it is quite obvious that other satisfactory designs could be utilized. The prime consideration of the invention is that a suitable switch be utilized which is operable by the patient's inhalation and exhalation of air.

The circuitry of the initiating system is illustrated in Figure 2. The circuit is illustrated as receiving its energy from an A.C. source 32 in lieu of the battery 28 of Figure 1. A full wave rectifier 33 is utilized to create a direct current on line 34 through an adjustable bias level resistor 35. A condenser 36 will be charged with contacts 20 and 25 open to place a negative bias on the grid 37 of a thyratron 38. Upon closure of contacts 20 and 25, under conditions described relative to Figure 1, the condenser will discharge, removing the negative grid bias and tube 38 will fire to energize winding 39. Energization of winding 39 will close relay contactor 40 to energize the lines 29 and 31 leading to coil 10 and the X-ray tube 1 will fire as previously described. The circuit 27 is further provided with a push button switch 41. To unlatch the relay contactor 40 the switch 41 is closed. In circuit with the switch 41 is a relay winding 42 and a

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second relay contactor 43 which acts simultaneously with contactor 40. Thus, when relay winding 39 was energized, both contactors 40 and 43 were closed. Then upon closure of the switch 41 the winding 42 will unlatch contactors 40 and 43 and the circuit is returned to its original condition.

It is realized that other circuitry between the pressure switch 11 and the coil 10 could be utilized to control the firing time of the X-ray circuit. The circuit utilized is for timing refinement. Thus, choice of the tube 37, the condenser 36, and the adjustment of the bias level resistor, together with the setting of the adjustable contact 25, make it possible for the technician to adjust the system to suit the patient in order to get the most desirable X-ray exposure.

It is also possible to dispense with the refinements of the control circuit 27 and to energize relay 10 directly by means of the pressure switch 11. However, this would result in instantaneous X-ray operation upon closure of the contacts 20 and 25, whereas it is generally desirable to have more control and a slight delay such as afforded by circuit 27 to render the whole system adjustable to suit the patient or to limit the tube firing in accordance with the desires of the technician to that point of adjustment where he knows the most enlightening exposures can be obtained.

I claim:

1. An initiating system for controlling the energization of an X-ray tube comprising a breath-operated switch adapted to be inserted into or placed adjacent to a patient's mouth and to be operated by the breathing processes of the patient and adjustable circuit means energized by closure of said breath-operated switch to control the energization of the X-ray tube in accordance

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with the degree of inhalation or exhalation by the patient.

2. An initiating system for controlling the energization of an X-ray tube circuit which includes a normally open electromagnetic switch means, comprising a breath-operated switch adapted to be inserted into or placed adjacent to a patient's mouth and to be operated by the breathing processes of the patient, and adjustable circuit means energized by closure of said breath-operated switch to control the energization of said electromagnetic switch means and thereby the energization of said X-ray tube circuit.

3. An electrical X-ray initiating system comprising a breath-operated switch adapted to be inserted into or placed adjacent to a patient's mouth and to be operated to a closed position by the breathing processes of a patient, an adjustable, normally inactive circuit controlled by said switch, a first relay means responsive to closure of the breath-operated switch to energize said first relay, and an X-ray circuit including a source of supply, an X-ray tube and a second normally open relay, said second normally open relay being closed in response to energization of said first relay to energize the X-ray tube.

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