ORP/EERF 73-3

PORTABLE ANNEALER FOR THERMOLUMINESCENT DOSIMETERS

U.S. ENVIRONMENTAL PROTECTION AGENCY

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PORTABLE ANNEALER FOR THERMOLUMINESCENT DOSIMETERS

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FOREWORD

The Eastern Environmental Radiation Facility participates in the identification of solutions to problem areas as defined by the Office of Radiation Programs. The Facility provides laboratory capability for evaluation and assessment of radiation sources through environmental studies and surveillance and analysis. The EERF provides technical assistance to the State and local health departments in their radiological health programs and provides special laboratory support for EPA Regional Offices and other federal government agencies as requested.

Charles R. Porter
Acting Director
Eastern Environmental Radiation Facility

CONTENTS

	Page
Foreword	ii
List of Figures	iv
Introduction	1
General Description	1
Circuit Description	2
Performance Characteristics	2
Parts List	5
Summary	6

FIGURES

Page

1. Portable TLD Annealer 3

2. Schematic of Portable TLD Annealer 4

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INTRODUCTION

The requirement for low-level environmental radiological monitoring has led to the development and widespread use of thermoluminescent dosimeters (TLD's) for this purpose. TLD's offer a sensitive and accurate means for integrating exposures over extended periods of time, and are especially well suited for determining environmental radiation levels in the vicinity of nuclear facilities. The EERF, as well as several other organizations, has used the EG&G TL-15 TLD for environmental radiological monitoring.

The TL-15 is "read out" by applying a current to the heating element within the dosimeter and measuring the light output from the CaF_2:Mn chips. For the magnitude of exposure normally found in environmental monitoring for exposure periods of one month and in general for exposures below 200 mR, the "read out" process is adequate to anneal or dedose the dosimeter and permit reuse with no further annealing. Immediately prior to placing dosimeters in the field for a monitoring period, it is necessary to anneal dosimeters if they have been shipped and possibly exposed, or if some time has elapsed since they were last annealed. To avoid unnecessary shipment of the reader or an annealing oven into the field for this purpose, a small, portable annealer was designed and built by the Electronics Instrumentation Section at the Eastern Environmental Radiation Facility. This report describes the design and operation of the annealer.

GENERAL DESCRIPTION

In function the annealer performs similar to the heating circuit of the EG&G TL-3 reader, but without the photomultiplier tube and associated recording and control circuitry. The TL-3 reader uses a heating time of 13 seconds and a current of 6.5 amperes to "read out" the TL-15 dosimeter. Likewise, the annealer delivers a regulated current through the heating element of the TLD for a selected length of time. The heating time is adjustable from 0-30 seconds and the current is adjustable from 3-7.5

amperes. A meter is used to aid in adjusting the current to the desired value. With the current and time easily adjustable, it is possible to use the instrument to anneal vacuum tube dosimeters of other manufacturers simply by changing the socket in which the dosimeter is inserted for annealing.

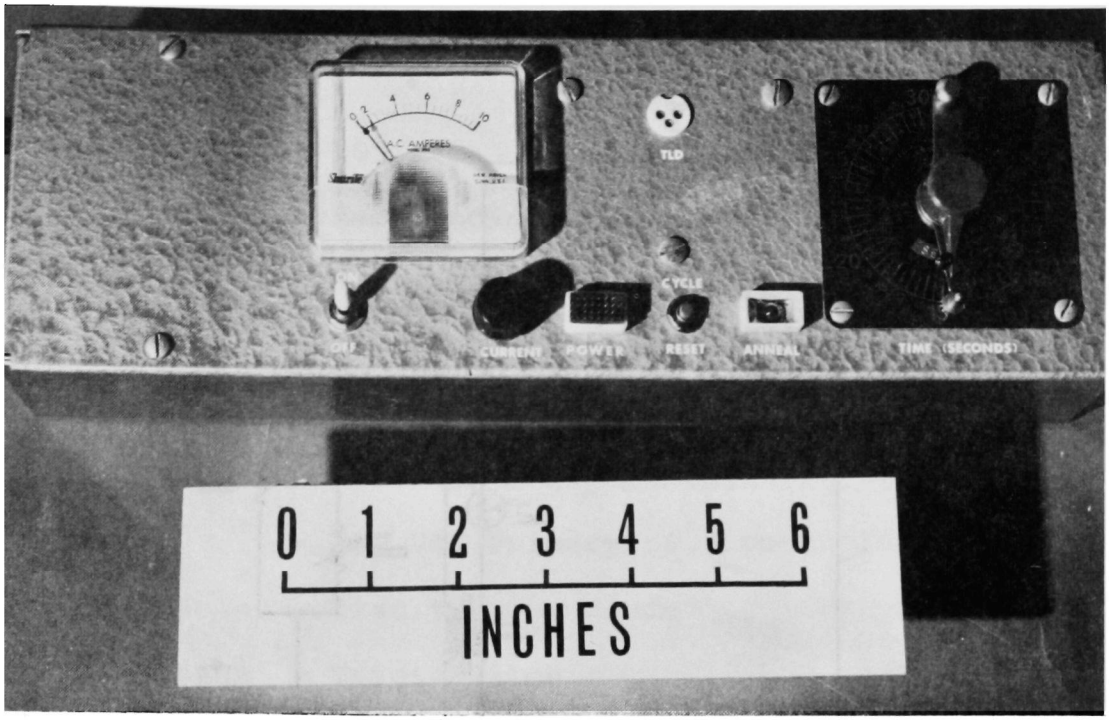
A principal consideration in the design of the annealer was to produce a small, portable instrument. The final design, as seen in figure 1, will easily fit into an attache case with room remaining for dosimeters and other accessories.

Circuit Description

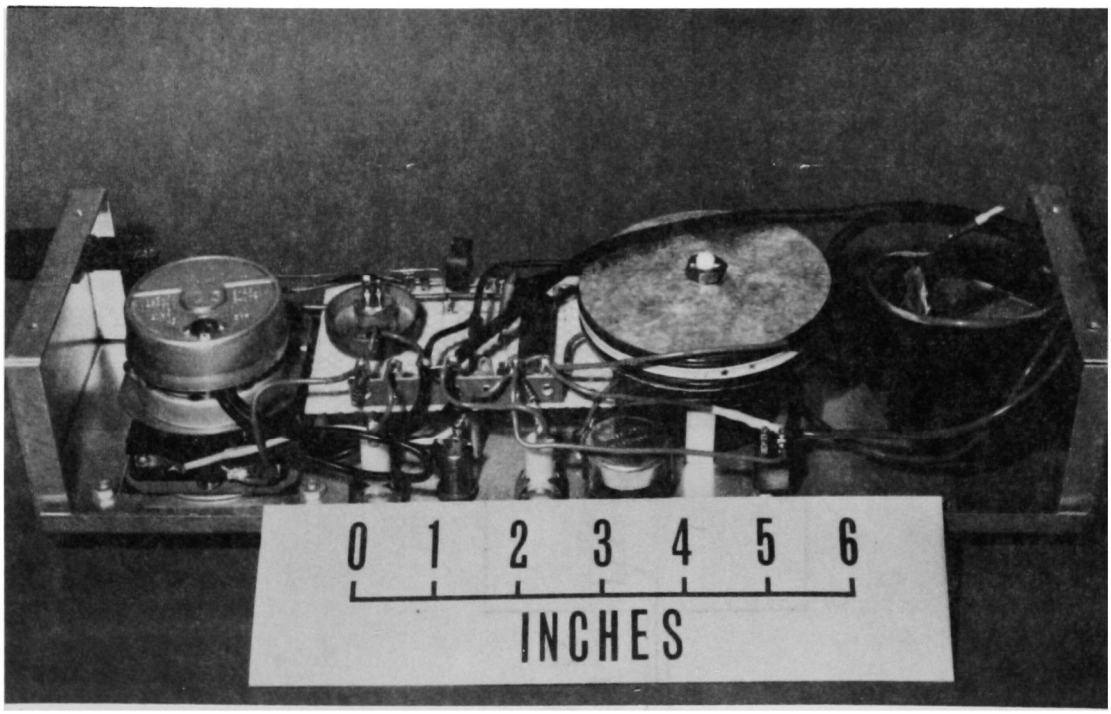
The annealer consists of a timer and a current regulated power supply (figure 2). The timer is not necessary to the operation of the circuit, but aids in obtaining consistent annealing results. The operation of the current regulator is quite simple. A phase control circuit consisting of R_3, C_1, the diac, and the triac delivers power to the primary winding of T_1, a 110 VAC transformer with a 6.3 volt, 10 ampere secondary. R_3 and C_1 have been chosen such that the triac is conducting during most of the cycle. When the anneal circuit is first energized, essentially full voltage (6.3 VAC) is produced on the secondary. Unlimited, this surge would burn out the TLD being annealed, but the drop across R_7 illuminates lamp I_3. The normally high resistance of photocell R_4 is quickly lowered which reduces the average conduction time of the triac. This reduces the current through the secondary of T_1, but maintains a constant value depending on the setting of R_6. This constant current value is independent of the resistance of the TLD heating element due to the negative feedback action obtaine with the module containing I_3 and R_4. R_5 is a thermal resistor which acts to decrease the initial surge of current and thereby damps excessive meter movement.

Performance Characteristics

The manufacturer of the TL-15 dosimeter recommends a heating current of 6.5 amperes which was used throughout the performance tests of the annealer. To determine the minimum time required to dedose a dosimeter using the annealer, a group of dosimeters was exposed to 11.1 mR,



Front panel of annealer



Inside view

Figure 1. Portable TLD Annealer

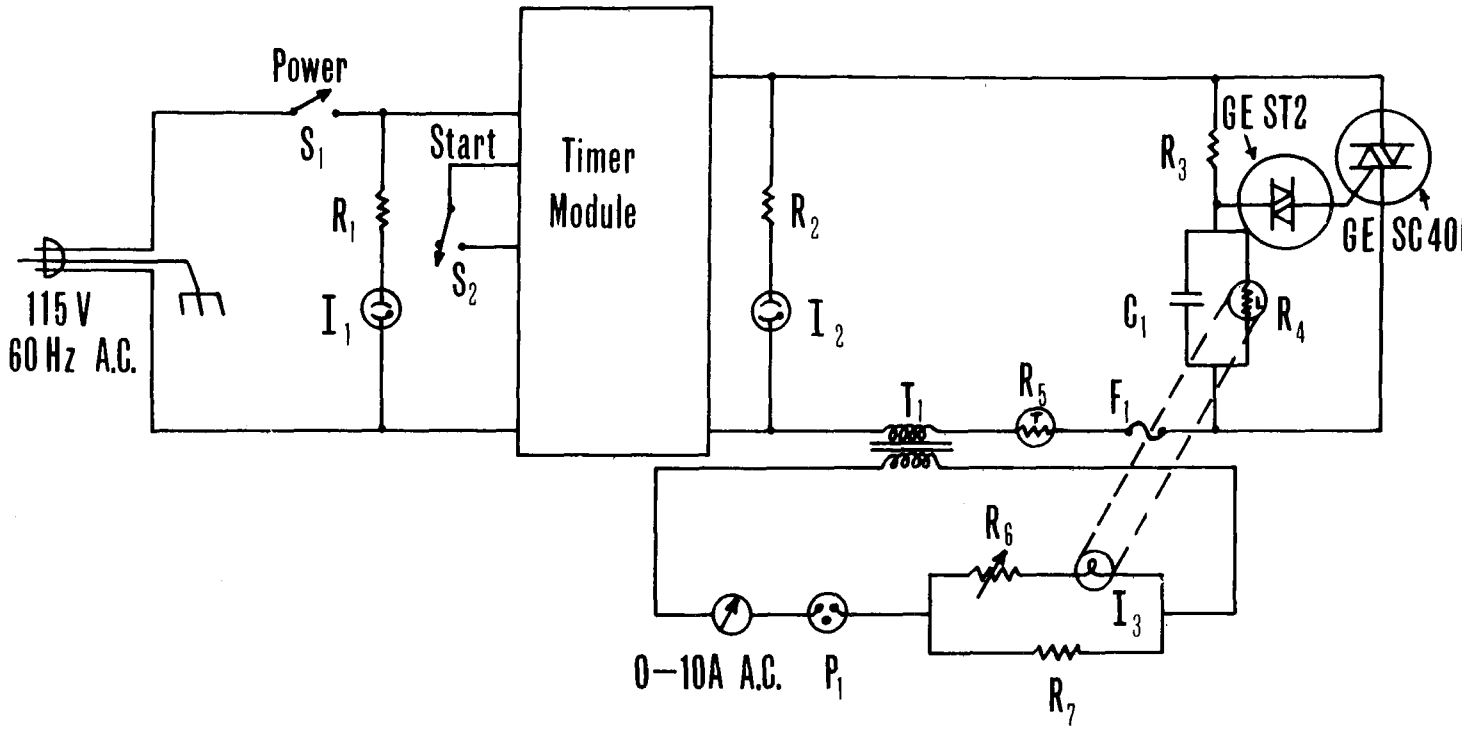


Figure 2. Schematic of Portable TLD Annealer.

PARTS LIST

C_1	- .05 μF
I_1, I_2	- neon indicator lamps
F_1	- 1 amp slo-blow fuse
I_3, R_4	- Clairex CLM 3006A Photo Mod
S_1	- SPST Power-On Switch
S_2	- SPST Momentary Contact
T_1	- 110 VAC Primary 6.3 volt 10 amp secondary
GE ST2	- Diac trigger diode
GE SC 40B	- Triac Switch
R_1, R_2	- 48k ohm, 1/4 watt resistors
R_3	- 68k ohm, 1/2 watt resistor
R_5	- Glow-Bar Surge Arrestor
R_6	- 250 ohm, 2 watt resistor
R_7	- 0.5 ohm, 100 watt resistor
P_1	- appropriate socket for TLD being used
M_1	- 0-10 ampere AC meter
Timer	- 0-30 second instant reset timer

heated in the annealer, and "read out" using the TL-3 reader. The minimum time required for complete annealing was found to be 15 seconds. This annealing technique 6.5 amperes for 15 seconds, was accepted as the routine procedure used with the TL-15 dosimeter.

For dosimeters which have been exposed to greater than 50 mR, EG&G recommends an oven annealing procedure instead of depending on the reader to dedose the dosimeters. To determine the effectiveness of the annealer in dedosing exposures greater than 50 mR, several groups of dosimeters were given known exposures, heated in the annealer, and "read out" to determine any residual exposure. The following data were obtained:

Annealing Effectiveness

6.5 amperes 15 seconds

Delivered exposure	Residual reading after annealing	Percent annealed
232 mR	0 mR	100%
400 mR	0.14 mR	99.97%
872 mR	0.24 mR	99.97%
1760 mR	0.40 mR	99.97%

From this it is seen that for normal environmental levels, less than 200 mR, the annealer is totally effective in dedosing the dosimeters. For exposures greater than this negligible residual exposure remains after annealing. For most applications this small residual exposure will be insignificant. If total annealing is necessary at these higher levels, an oven annealing procedure may be used or, possibly, longer heating times.

Summary

The annealer described has been in use for several months with good results and no malfunctions. Components used in construction of this compact annealer are readily available and construction requires no special skills or equipment. The cost of building the annealer, less than $75 including the optional timer, represents a significant savings compared to the repair cost and down time should damage to the TLD reader occur during shipment to monitoring sites. Use of the annealer makes unnecessary a number of these shipments.

The effectiveness of the annealer in dedosing the TL-15 dosimeter was demonstrated. For exposures less than 200 mR, annealing was 100%. Thus the annealer has proven to be most adequate for environmental measurement work.

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