grains from lodging upon it. The trays are blackened chemically and have a smooth surface. Each one is numbered to correspond to a given slot, and each may be removed and replaced independently of the others. A fluorescent tray, insertable at any wave-length, can be observed through the opening in the main casting at *Y*, Fig. 1, thus furnishing a convenient check on the alignment of the source and trays. An iris diaphragm at *Z* permits arbitrary control of the intensity and an external slot in the tray holder beneath the 3131A tray enables continuous intensity measurements to be taken during the irradiation exposures.

A photograph of the traversing slit mechanism is shown in Fig. 2. The straight exit slit, 50 mm long, is located in the frame *E*. This frame, designed to hold a thermopile or photo-cell, is held in the carriage *F* by pivots which permit it to rotate about a vertical axis. The slit is automatically maintained normal to the cone of rays from the camera lens by an arm which rides against a cam. Vertical motion of the carriage *F* permits measurements to be taken along the length of a spectral line. The carriage *F* is held to carriage *A* by a dovetailed slide, both *A* and tailpiece *A′* being mounted on a horizontal curved track whose radius of curvature is 360 mm. Carriage *A* has an index which reads against a wave-length scale; *A′* is used as a fine adjustment. Deviations of the focal curve from the curve of the track are corrected at each wave-length by turning one of the four chain-linked screws on the frame *E*, a second screw being provided with a micrometer head and index.

Percentage transmissions of the monochromator at wave-lengths 3652, 3022, 2652, and 2536A were 62, 64, 68, and 65, respectively, the highest value corresponding to the line of minimum deviation.

The authors are indebted to Dr. L. J. Stadler who, in outlining the requirements for the monochromatic irradiation of corn pollen for genetic experimentation, furnished the basic suggestions for the instrument and later made its realization possible.

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A Vacuum Tube Control Circuit for Cloud Chambers

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(Received February 14, 1938)

IN the course of setting up a new 12-inch cloud chamber at this laboratory, a control circuit was developed which it was thought might be of sufficient interest to describe in this journal. The control circuit of a cloud chamber for use in nuclear physics is designed to regulate the timing of the events that accompany the expansion of the chamber, as well as the time interval between expansions. The basic principle of the control circuit described here is an obvious application and has been used before.[1] It is believed that the present arrangement presents several improvements, however, and it has been found possible to eliminate the usual motor and cam arrangement altogether.

The circuit uses the time constant *RC* involved when a charge leaks off a condenser *C* through a resistance *R*. This *RC* circuit is placed on the grid of a vacuum tube so that the leakage current of the condenser determines the grid voltage and hence the plate current of the tube. A vacuum tube relay combination is used instead of a thyratron because it involves much less expense for a corresponding current carrying capacity. Also the vacuum tube characteristics are much more stable with regard to temperature and age, while the point on the grid voltage curve where the plate current closes the relay can be made fully as reproducible as with a thyratron.

There are several tubes suitable for this type of work, but the one that was chosen was the 25L6, a beam power tube which handles a large power on a small plate voltage, with a high amplification factor. Thus one can use an ordi-

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[1] C. C. Jones, Rev. Sci. Inst. 8, 319 (1937).

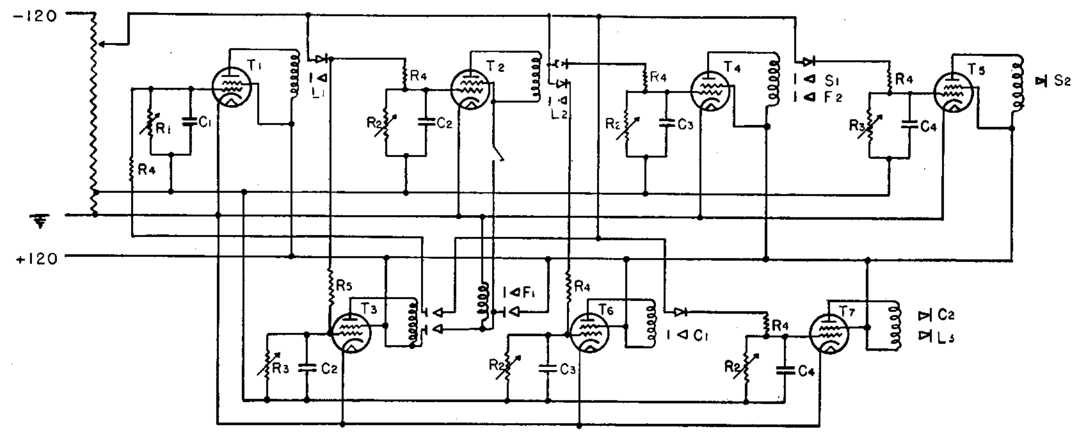

FIG. 1.

R_1 = 0.5 meg.	C_1 = 24μf	L_1: Puts lamps on low voltage	C_1: Energizes camera solenoid
R_2 = 0.1 meg.	C_2 = 8μf	L_2: Puts lamps on high voltage	C_2: Deenergizes camera solenoid
R_3 = 0.2 meg.	C_3 = 2μf	F_1: Energizes primary of clearing field transformer	L_3: Removes high voltage from lamps
R_4 = 20,000 ohms	C_4 = 4μf	F_2: Shorts out clearing field	S_2: Deenergizes expansion solenoid
R_5 = 0.5 meg.		S_1: Energizes expansion solenoid	

nary d.c. power line of 110 volts and eliminate the usual expensive power pack for the plate supply. Unrectified a.c. on the plates could be used to operate a.c. relays, of course, but it was felt that d.c. would be more positive in action.

The main essentials of the circuit in use at the present time are shown in Fig. 1. The grid bias of about 120 volts is obtained from a cheap 50 milliampere power pack. The time constants of the circuit are extremely insensitive to variations in the grid supply voltage, because the latter is so large in comparison with the grid voltage (-5 volts) which closes the plate relay. A permanent grid bias of -3 volts is used to protect the tube and relay from overload. Under these conditions it can be seen that a time delay of about $4RC$ is obtained.

The normal operation of the circuit is as follows: The negative voltage is removed from the grid condenser C_1 by the contact on the plate relay of T_3; then the charge leaks off C_1 through R_1 until after a time of the order $4R_1C_1$, when the grid has become sufficiently positive so that the plate relay of T_1 is energized. This closes contact L_1 and removes the negative voltage from the grid condensers of T_2 and T_3. After a short time, T_2 is energized and it in turn operates the cloud chamber through the relays of T_4, T_5, T_6, and T_7. After a somewhat longer delay T_3 is energized. This recharges the grid condenser of T_1 to a large negative voltage, deenergizing its plate relay. This in turn puts a negative voltage on the grids of T_2, and through it deenergizes the rest of the chain. The resistance of R_5 is made high so that there will be an adequate charging time for C_1, since it takes longer to recharge C_2 and deenergize T_3. When the latter has occurred, it results in a removal of the negative potential from C_1 and the process starts over again.

The chain following T_2 has been made very flexible, so that all reasonable adjustments can

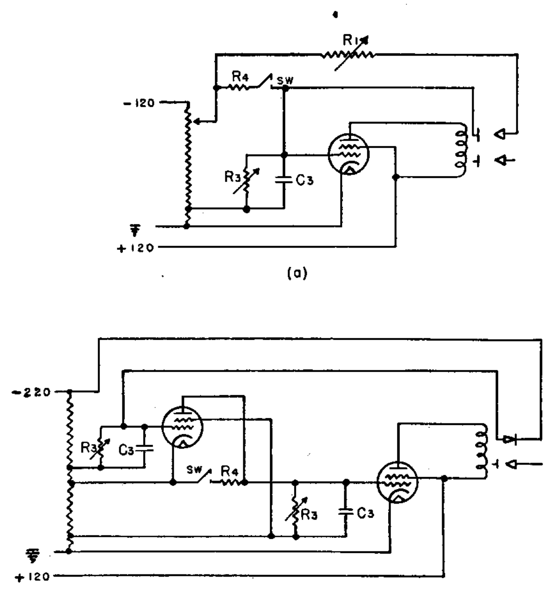

FIG. 2. Alternative time delay circuits. The symbols have the same values as in Fig. 1. SW is the switch which initiates the action.

be made during operation. An obvious advantage of the system, for example, is the fact that the exposure time of the camera is regulated only by the resistance on the grid of T_7, and by no other adjustment. Thus the initial time when the camera is opened can be varied in the sequence of events without changing the exposure time.

There are many other fundamental time delay circuits, of course, which could be adapted to the problem at hand. Two of these are shown in Fig. 2. In these arrangements, the relay which turned on the solenoid expanding the cloud chamber, for example, would also turn it off. In Fig. 2*a* the time delays are obtained by the alternate charging of the grid condenser through R_1 and its discharge through R_3. Fig. 2*b* is essentially the same circuit as the one used, except that one of the relays is eliminated. Neither of these variants seems to be quite as positive or uniform in action as the circuit employed in Fig. 1.

In obtaining high RC values for these control circuits, it is advisable to employ a high capacitance rather than a high resistance. Otherwise, humidity and temperature variations will change the effective RC values. The relays used in the plate circuits of the tubes are of the inexpensive commercial type called "midget magnetic relays" and have a coil resistance of about 700 ohms. The contacts are adequate for the direct operation of the solenoids releasing the cloud chamber and the camera shutter, and will last indefinitely if by-passed with condensers. An ordinary incandescent lamp, placed in series with a solenoid, greatly reduces the current that must be broken, without reducing the initial pull of the solenoid, since the resistance of the lamp varies so greatly with the temperature of the filament.

Using this vacuum tube type of control circuit, a very compact and portable system can be constructed, including a clearing field supplied by rectified high voltage a.c. A great advantage of the system, particularly with a new cloud chamber, is its complete adjustability while in operation. The control circuit built at this laboratory has been in satisfactory operation for several months. There has been no noticeable variation in the time delay constants, either while warming up, or from day to day.

The writer is grateful for the cooperation of Professor J. M. Cork and Dr. R. L. Thornton. The personal support of the National Research Council is acknowledged. The construction was made possible by a grant from the Horace H. Rackham Trust Fund.

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The Use of Intensifying Screens in X-Ray Diffraction Work

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(Received January 20, 1938)

In an attempt to reduce exposure times for monochromatic x-ray diffraction patterns of liquids, a Fluorazure intensifying screen has been used, and several tests of the applicability of this method to intensity measurements have been made. The intensifying factor for Mo $K\alpha$ radiation varied from 1 for very low intensities or very short exposures, to 13.3 for intermediate intensities, and for Cu $K\alpha$ radiation, it varied from 1 to 4. It appears impractical to use this screen when true intensity measurements are necessary. However, by using two ordinary x-ray films in contact, the exposure time, with Mo radiation, may be reduced to nearly one-half, and true intensity measurements may be made. With a new type of double emulsion film, true intensities are recorded and exposure times are reduced by a factor of 2.5 for Mo radiation.

A REDUCTION in the exposure time necessary for satisfactory pictures of any sort taken with x-rays is desirable, but it is especially desirable in the case of diffraction patterns which are taken with x-rays monochromated by reflection from a crystal. In the case of diffraction of monochromatic x-rays by liquids, the range of usual exposure is from 30 to 60 hours under certain fairly typical conditions, and in this case a reduction in the exposure time would be highly