slow down its movement by virtue of competition by their higher mobility. They eventually reach the cathode. At this point the following reaction competes with reaction (2):

$$4e^- + 4HR = 4R^- + 2H_2(g) \qquad (3)$$

In the HR electrolysis reactions (1) and (3) there is no net production of the hydrogen form of the resin. Thus the yield of HR at the end of the electrolysis measures the extent to which the current is carried by sodium ions. For a total current of 252 and 1,140 mah (milliampere-hours) the yields varied between 100 and 67%, respectively, of the value to be expected if only reaction (2) occurred at the cathode.

At the beginning of the electrolysis the movement of the activity maximum is proportional to the current. The spread was found to increase with the particle size of the resin. In electrolyses where the slower ions follow the faster, sharp boundaries may be obtained. Thus when the system $Pt|NaR|ZnR_2|Zn$ is electrolyzed with the zinc and platinum electrodes as anode and cathode, respectively, metallic zinc dissolves in the resin and the boundary between the zinc and sodium resin remains sharp while moving toward the cathode, as shown by the results of an experiment in which the boundary was traced with 250d Zn^{65} (Fig. 2). In this case the displacement of the boundary from its original position is proportional to the electric charge passed, and practically only the following reaction occurs at the cathode:

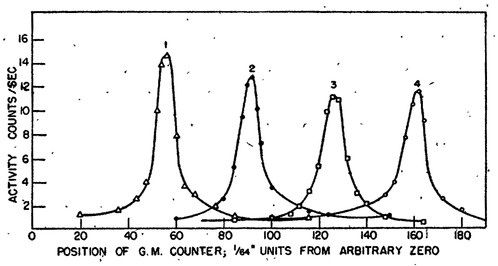

FIG. 2. Electrolysis of Na Dowex-50 and Zn Dowex-50 between platinum and zinc electrodes, respectively. Boundary between NaR and ZnR_2 traced with Zn^{65}. Cell, resin mesh size, and current as in Fig. 1. Traced layer initially 4.8 cm from anode. Activity corrected for room background. Designation of curves and time intervals as in Fig. 1.

$$2R^- + Zn = ZnR_2 + 2e^- \qquad (4)$$

The observed small flattening of the curves is probably due to the effects of diffusion, inhomogeneous packing of the column, temperature gradients, and in the case of the sodium resin also to the penetration of hydrogen ions.

The aspects of separations by resin electrolysis are different from those of regular chromatography, as both adsorption affinity and frictional resistance to ionic movement determine the movement of a band in an electric field, whereas in regular chromatography the mobility of the band is determined by the distribution of the adsorbate between solid and solution. In resin electrolysis there is no solution in the conventional sense unless the extensive ionic double-layer be considered as such. It is thus possible to induce band movement in the adsorbent column without its coming in contact with solution.

Apart from its possible application as a separation method, resin electrolysis may find use as a method for regenerating resins without using regenerant solutions; for instance, the conversion of the sodium into the hydrogen or zinc forms as shown in these experiments. Further studies are in progress.

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A New Electronic Apparatus for the Measurement of the Fusion Frequency of Flicker

Curtis Fritze[1] **and Ernst Simonson**

Veterans Administration Hospital,[2] ***Medical Service, and Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis***

After introduction of the fusion frequency of flicker (fff) for the study of fatigue (*1*), anoxia (*2*), and various types of pathology (*3–6*), a rather large number of papers has appeared, and it is likely that this method will find rather general application in applied physiology and clinical medicine.

In the past the method has been applied in one standardized condition, which unfortunately differed in the investigations of various authors. It is highly desirable to provide for the variability of the brightness level, the visual angle, and the light: dark ratio, in order to test the effect of these fundamental variables on the response in physiological stress situations and to reproduce the testing conditions of other authors.

The classical experiments on the fff have been performed with rotating disks or cylinders with openings cutting a beam of light. An electronically produced and regulated flicker would have the advantage of freedom from vibration and noise and of a perfect square wave form of the light stimulus with a transition time not exceeding 1% of the cycle length.

The construction of the new apparatus was made possible by the recent development of a "glow modulator tube" (R1131A) by the Sylvania Electric Company for facsimile transmission (*7*). This tube emits, at maximum current flow, from a circular area of 3-mm diameter, a bright light of mixed white char-

[1] Now with Engineering Research Associates, Inc., St. Paul, Minn.

[2] Published with the approval of the chief medical director. The statement and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or the policy of the Veterans Administration.

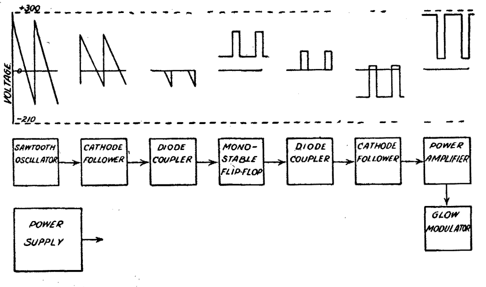

FIG. 1. Block diagram of the circuit with the resulting voltage wave forms at different stages of the circuit.

acter. The spectral emission curve is continuous, with a maximum at 5,100 A.

The electronic circuit is relatively simple in principle. First a saw-tooth voltage of the desired frequency is generated by means of a saw-tooth oscillator (Fig. 1). The oscillator is then coupled to a monostable multivibrator (commonly called a flip-flop circuit) in such a manner that the circuit is triggered when the voltage reaches a predetermined value as set by means of the time on-off control. Thus the flip-flop plate current will transfer at a given time and stay for the remainder of the period. By changing the trigger level or the d.c. component of the saw tooth, the flip-flop may be triggered at any time during the cycle, and the speed of transition may be made so short that square waves are generated. By this means the frequency, as well as the on-off proportion, may be varied. This flip-flop circuit is then coupled through a power amplifier to the glow modulator tube used as a light source. The brightness of the glow tube is regulated by limiting the current through the tube by means of a series resistance in the cathode circuit of the power amplifier.

Fig. 1 shows the functions of the various parts of the circuit and the voltage wave forms with reference to the power supply voltages. Fig. 2 shows the more

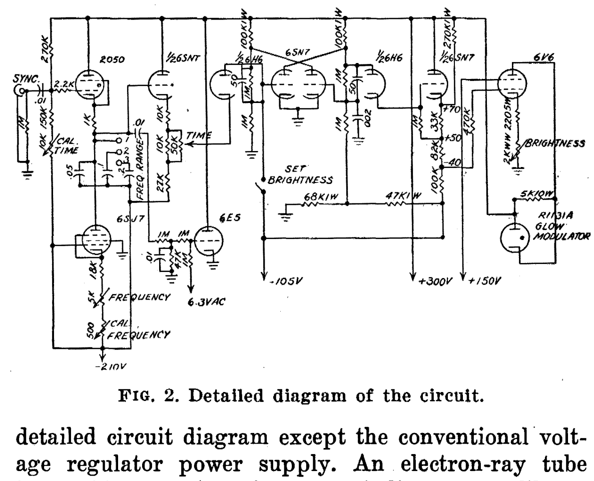

FIG. 2. Detailed diagram of the circuit.

detailed circuit diagram except the conventional voltage regulator power supply. An electron-ray tube is provided as a beat frequency indicator to calibrate the saw-tooth oscillator frequency to the 60-c line frequency or its harmonics or subharmonics. This is accomplished by mixing the output of the oscillator with the 60-c voltage obtained from the heater supply. The frequency range extends from 11.75 to 130 c but could be easily extended. Three continuous frequency ranges are provided for this purpose. For measurement of the fff the second range, extending from 20 c to 56 c, is most frequently used.

Three dials are provided for variation of the flicker rate, the light: dark ratio (from 20:80 to 98:2), and the brightness (by 15 times). The change of the brightness due to the change of the light: dark ratio can be compensated by changing the brightness dial, so that only one factor is varied at one time.

Calibration curves for constant brightness at different light: dark ratios were obtained for different light levels, using a G-E light-meter. Control measurements were made by means of subjective brightness comparison, using a flashlight bulb with a set of filters to make the brightness identical to that of the glow modulator tube. Readings of three observers gave identical values.

The color of the glow modulator tubes becomes reddish at low brightness. Although color does not affect the fff for the brightness range provided in this apparatus (*8*), for certain problems it might be preferable to vary the brightness by means of filters.

The scale of the frequency dial was calibrated by means of the scaling unit (Model 163) of the Nuclear Instrument and Chemical Corporation (Chicago), with an accuracy of 1/100 c. Before each experiment, the calibration is checked by setting the frequency dial at a rate corresponding to a harmonic or subharmonic of the power line frequency, and eliminating the beat in the electron-ray tube by means of a calibration dial. The calibration was found to be stable over a longer period of time.

The scale of the light: dark ratio dial was calibrated (1) by means of an audio-oscillator and oscilloscope, and (2) photometrically at high flicker frequency.

The glow modulator tube is housed in a wooden block. Two filters consisting of ground microscopic slides in front of the lamp give a sufficient and uniform diffusion on a circular test patch of 10-mm diameter, and reduction of light intensity to 150 ft-L, measured in front of the filter, at maximum current flow. A photographic shutter, operated by a 3-ft cable, is placed in front of the test patch, since a uniform exposure time is advantageous for the precise measurement of the fff. The exposure time can also be regulated by a switch in the glow modulator tube circuit. The shutter has the advantage of variability of the visual angle by using a set of lenses. The visual angle can also be varied by changing the distance between eye and light source.

The tube is clamped in a conventional laboratory stand, and can be adjusted to any desired angle. It can therefore be easily used at the bedside, with the patient in a reclining position. The tube can also be clamped on a perimeter for flicker perimetry. The view of the dials may be concealed from the patient during the test; in fact, the cabinet with the dials can be operated from another room.

The apparatus can be built at a cost below the price of commercially available models, which provide, as a rule, only one testing condition. The device may also be used as a square wave stimulus generator, for nerve and muscle physiology, replacing the glow modulator tube by coupling capacitor and potentiometer to chassis ground.

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A Method for Preparing Slide Mounts of Small Invertebrates

M. W. Boesel and Charles M. Vaughn[1]

Department of Zoology, Miami University, Oxford, Ohio

For some years the writers have been working on methods of mounting insects and other small invertebrates on slides for permanent preservation. Basically the procedure finally adopted follows that suggested by Middlekauff (*1*), but several major modifications have been made to adapt it to different needs. Furthermore, the method here presented has been found excellent for mounting both immature and adult insects, as well as other arthropods, helminths, and so on.

Adult insects are collected in 95% ethyl alcohol. Soft-bodied stages that are subject to shrinkage and discoloration are collected in a killing fluid recommended by Alvah Peterson and composed of 95% ethyl alcohol, 10 parts; glacial acetic acid, 2 parts; kerosene, 1 part; and dioxane, 1 part. Larvae should be kept in the solution until properly distended and then placed in 95% ethyl alcohol. For most adults, no special killing fluid is necessary or even desirable. It is important to note, however, that in many instances, color features may be preserved by mounting immediately after collecting. This is true, for example, of some greens in adult midges, which ordinarily fade considerably. Helminths fixed by usual laboratory methods can be washed and stored in 95% ethyl alcohol. Formalin-preserved specimens must be washed carefully and carried up to 95% alcohol before utilizing this method.

To prepare specimens, use three 5-ml beakers containing 95% alcohol, absolute alcohol, and beechwood creosote, respectively. Total volume of the specimens processed should not exceed about 10% of the volume of the fluid. Specimens are left in 95% alcohol a few minutes, in absolute alcohol at least a minute, and then transferred to creosote, where they invariably float; they should be retained in it until they sink to the bottom of the beaker. This may take 10 min or longer. Specimens may be kept in the creosote indefinitely without apparent harm. Ticks, other arthropods, and helminths have been stored in creosote for 12–15 months prior to their preparation as permanent mounts. After several hours in the creosote, specimens may be mounted whether they sink or not, although failure to sink is usually indicative of the presence of air spaces in the specimen, and such specimens are not likely to make the best mounts. Some nematodes require an immersion in a fourth 5-ml beaker containing an equal mixture of beechwood creosote and diaphane, to facilitate the penetration of the mounting medium into the body spaces of the specimens. Before transferring specimens to a glass slide, a drop of diaphane is placed on the slide. Specimens are moved from the creosote to the diaphane droplet, covered with more diaphane, and then covered with a cover slip. Mounts should be examined daily, and diaphane added until air spaces cease to develop under the cover slip.

If specimens are thick enough to cause a noticeable tilting of the cover slip, clear celluloid or plastic supports, about 3 × 6 mm, may be placed on the slide so as to hold the cover slip in a perfectly horizontal position. If materials of several different thicknesses are available, the correct thickness may be selected for the specimen at hand, but very thin supports may be used for all purposes by creasing them across the middle. Such creased supports have a desirable degree of springiness.

Perhaps the principal advantages of the method here described are its simplicity and broad applicability.

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[1] Now at Institute of Tropical Medicine, The Bowman Gray School of Medicine, Winston-Salem, N. C.

Roentgen Irradiation of Para-aminobenzoic Acid Solutions

Peter G. Mar and Ivan C. C. Tchaperoff

Biochemical Research Laboratory* and *Department of Radiology, St. Joseph's Hospital, Victoria, B. C., Canada

Recent progress in radiation therapy of neoplastic diseases has focused attention on the radiation chemistry of the action of ionizing radiations on aqueous solutions of biologically significant organic compounds (*1*). Studies on certain amino acids, vitamins, enzymes, nucleotides, proteins, and steroids have already been reported. Dosages of radiations, however, were much greater than those therapeutically employed, whereas concentrations of solutions used were generally much higher than those obtained under physiological or therapeutic conditions. Studies under conditions more closely approximating those found clinically may yet prove steppingstones to the