formation of an acid containing two primary amino groups from the acidic biotin, the inactivation of biotin with nitrous acid without evolution of nitrogen are all in keeping with the interpretation which we placed on the action of $Ba(OH)_2$ on biotin. We should now like to report the resynthesis of biotin from this diaminocarboxylic acid.

If our interpretation of the degradation reaction were correct, it should be possible to convert the diaminocarboxylic acid back to biotin through reactions employed for the synthesis of urea derivatives. Accordingly 10 mg of the diaminocarboxylic acid were treated with phosgene under conditions ordinarily employed. Crystalline biotin was obtained from the reaction mixture in 98 per cent. yield. The compound melted at 228–230° (uncorrected), which agrees with that recorded by us for natural biotin.[3] The melting point of a mixture of the synthetic compound with biotin isolated from natural sources showed no depression. The specific rotation of the resynthesized biotin was $[\alpha]_D^{22} = +92°$ (0.2 per cent. solution in 0.1 N NaOH). By treatment of the synthetic compound with diazomethane, a methyl ester (m.p. 166–167°) was formed which showed no depression in melting point when mixed with a sample of biotin methyl ester. As tested by the yeast-growth method the synthetic biotin exhibited the same degree of activity as natural biotin.[4] Since the resynthesized biotin is identical in melting point, optical activity and biological potency with the natural product, it is obvious that little or no racemization could have taken place during the $Ba(OH)_2$ treatment of biotin. The synthesis of biotin from the diamino compound affords additional and conclusive proof for the cyclic urea structure in biotin. The possible relation of the urea structure of biotin to the affinity of biotin for avidin is being subjected to experimental test.

DONALD B. MELVILLE
KLAUS HOFMANN
VINCENT DU VIGNEAUD

DEPARTMENT OF BIOCHEMISTRY,
CORNELL UNIVERSITY MEDICAL COLLEGE,
NEW YORK, N. Y.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INEXPENSIVE SQUARE-WAVE GENERATOR

BECAUSE the square wave contains an infinite series of harmonics of its fundamental frequency, and because its precise wave-form is readily recognizable on an oscilloscope it is an easily applied severe test for an amplifier. It shows at a glance the high and low frequency cut-offs, other frequency and phase discrimination, resonance, overshoot, etc.

The generator here described is light, compact,

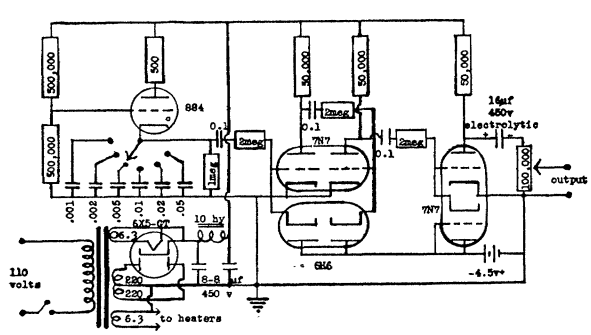

FIG. 1. Circuit of square-wave generator. (Values are not critical.) The 100,000 ohm output potentiometer should be tapered as for an audio gain control.

simple and portable. Its principle is to feed the output of an oscillator first into a limiter which clips off the peaks and gives waves with flat tops and bottoms, thence into an amplifier and second limiter, etc. The sides of the wave become steeper with each amplifier stage.

Frequency stability is provided by the thyratron oscillator. The fundamental is variable in six steps from 35 to 1,200 cycles. The grids of the amplifier tubes together with the diodes constitute effective limiting circuits. The output is variable from 40 volts to less than 100 microvolts by a single control. The rates of rise in the two sides of the square wave are not exactly equal, but the slow one is faster than 10 microseconds. Thus the generator will test an amplifier to over 50,000 cycles.

The power transformer should be a well-shielded one, and should be mounted a few inches away from the thyratron tube to prevent magnetic action on the latter.

CRAIG W. GOODWIN

LABORATORY OF NEUROPHYSIOLOGY,
YALE UNIVERSITY SCHOOL OF MEDICINE

AN ADJUSTABLE RESISTOR FOR FLOWMETERS

ONE of the most common types of flowmeters for air is that consisting essentially of a resistor and a gage for measuring the pressure drop across it. The pressure gage may be a manometer with its two arms connected to the air line, one ahead of and the other following the resistor; or if one end of the resistor is open to the atmosphere, so may be the correspond-

[3] V. du Vigneaud, K. Hofmann, D. B. Melville and J. Rachele, *Jour. Biol. Chem.*, 140: 763, 1941.

[4] We wish to express our appreciation to Miss Eleanor Hague of this laboratory for carrying out the assays.

ing manometer arm. The resistor is often represented diagrammatically as a short capillary, but in practice it takes on a variety of forms, for a simple short section of capillary glass tubing in the readily available bore sizes often fails to provide enough resistance.

The most frequently adopted way of obtaining high resistance, no doubt, is to use a long capillary, sometimes an unwieldy bundle of tubes several meters in total length. A common alternative is to decrease the diameter for part of the path by reworking the glass to form a constriction; a compact element results, but the danger of clogging is increased. A resistor that is both compact and nonclogging may be formed by packing small-bore glass tubing with fine sand, preferably narrowly fractionated as to size—say, 200–325 mesh—and washed free of dust. A resistor recommended by Bruun[1] comprises a short capillary tube containing an exchangeable wire, different magnitudes of resistance being obtainable by use of different sizes of wire in the same tube.

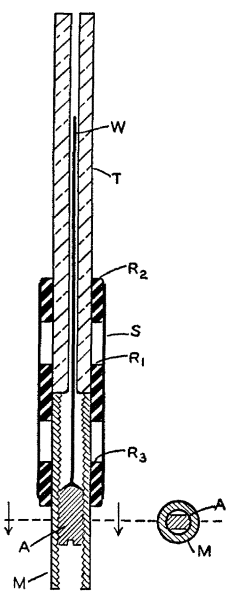

FIG. 1. Resistor in longitudinal section, with cross section of threaded parts.

All these types of resistors have one feature in common that is sometimes a serious drawback. When for purposes of standardization it is desirable to have precisely a given amount of resistance, accurate construction is at best a tedious job, and in some cases practically impossible. This fault is obviated in the device described below.

In this resistor (Fig. 1), as in that of Bruun, resistance is effected by a short capillary containing a corrosion-resistant wire. Unlike Bruun's device, however, the wire (W) extends through somewhat less than the whole length of the glass capillary tube (T), the length of the inserted portion being determined roughly in advance by calculation and subsequently corrected experimentally to a close approximation. The protruding end of the wire is soldered to one end of an adjusting screw (A), which fits within an inside-threaded metal tube (M). The screw is grooved on the other end for operation with a screw driver, and is cut down flat throughout its length on two opposite sides to allow free passage of air through the metal tube. The glass and metal tubes are approximately the same in outside diameter, and are connected closely by one (R_1) of three similar short sections of heavy-wall rubber tubing. The other two sections (R_2, R_3) are slipped around the glass tube and the metal tube, respectively, some distance from the connecting section (R_1). A sheath (S) of springy sheet metal nearly surrounds the three rubber-tube sections, which it grips firmly by reason of its tension, and thereby serves as a splint to hold the assembly rigid. A ready-made article that lends itself admirably to use as the sheath is the spring element of a well-known type of paper clip.

The resistor may be installed in the flowmeter by the use of one or two connections of rubber tubing, depending on whether or not one end is to be left open to the atmosphere. When the assembly is otherwise complete, the wire, having been cut originally somewhat too long, is clipped down to give as nearly as possible the correct resistance when the adjusting screw is about midway between the ends of the threaded tube. Fine adjustment can then be made by turning the screw.

It should be pointed out that in a capillary containing a wire, where both are perfectly straight, the resistance will depend on how nearly centered they are with respect to each other. In practice, however, if the wire is nearly as large as the bore, the tendency of the former to kink will prevent any troublesome variation of the resistor as a whole.

This device has a wide field of usefulness, has a material cost of only a few cents, and is easily constructed without special tools.

ERNEST L. GOODEN
BUREAU OF ENTOMOLOGY AND
PLANT QUARANTINE,
U. S. DEPARTMENT OF AGRICULTURE

[1] J. H. Bruun, *Ind. Eng. Chem., Anal. Ed.*, 11, 655 (1939).

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