exposure circuits are shown in the diagram (Fig. 2) by heavy lines.

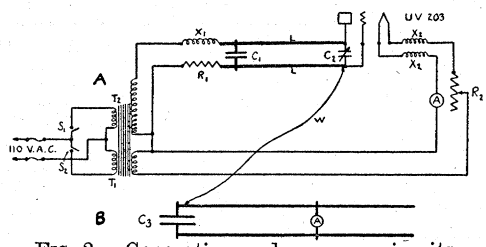


FIG. 2. Generating and exposure circuits.

On the exposure circuit there are also two parallel rods of ¼-inch copper tubing, in this case at 3½ inches separation; and, in order to give sufficient tuning range, they are 34 inches long. Along these rods, acting as a shunt, slides the ammeter A of the exposure circuit. This ammeter provides a means of determining the point of resonance of the circuit, and also a relative measure of the output. A Jewell, pattern No. 64, Radio Frequency, 0–5 amperes, is used. The actual tuning of the exposure circuit may be accomplished either by changing the position of the ammeter along the two parallel rods or by changing the separation of the condenser plate $C_3$.

Two metal posts about four inches high hold the condenser plates at $C_3$. These posts are connected at their bases with the two parallel rods; they may be insulated by a cross member of bakelite or some other insulating material. Although not absolutely necessary, the whole of the exposure circuit may be insulated from its wooden support. The plate posts are drilled and threaded for a ¼-inch bolt. Circular sheet copper plates of varying size may be screwed to these bolts by soldering the proper-sized nut to the back of each plate.

Coupling between the oscillatory and the exposure circuits presents somewhat of a problem when dealing with frequencies as high as here used. It has been found best to use a very loose inductive coupling and then provide a single wire feeder much like the usual radio antenna feeder. This wire feeder is shown at W on the circuit diagram. The coupling may be varied by changing the position of the feeder clip on the grid inductance rod of the oscillator. However, in practice it has been found that little change in coupling is required.

Several types of standard vacuum tubes could be adapted to this apparatus, but the UV 203, 50 watt tube has proved very satisfactory. It has a high filament emission as compared to tubes with thoriated filaments, and it gives sufficient output for nearly all kinds of biological experimentation. With this tube the lowest wave-length available is about three meters, although it is possible by tuning to the second harmonic on the exposure circuit to use a wave-length of less than two meters. Higher wave-lengths are easily obtained by extending the length of the rods in the oscillatory circuit. For lower wave-lengths a push pull oscillator composed of tubes of very low internal capacity is necessary. Amplifiers to increase the output of vacuum tube oscillators at these wave-lengths have not proved satisfactory.

To the apparatus here described may be added an A. C. voltmeter at the 110 volt A. C. source. If it is desired, larger animals than rats may be treated by adding a set of square exposure plates of large size and wide separation. These plates may be mounted on the slanting panel and connected by copper rod feeders to the exposure circuit.

All the parts listed are standard electrical equipment and may be obtained from radio supply houses at remarkably low cost.

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## REDUCING MOISTURE EVAPORATION FROM PETRI DISH CULTURES

GROWTH-RATE studies and other laboratory studies of wood-rotting fungi require a constant moisture content of the wood upon which such tests are made. This is essential to the control of the moisture factor, which is an extremely important one in all such studies. In one of the growth-rate studies now under way, octagonal disks of wood 3″ x 3″ x ⅛″, having a moisture content of 100 per cent. oven-dry basis, were placed in 100 mm x 15 mm Petri dishes, inoculated with the fungus and then placed in an incubator at 27° C. In a few days it was observed that a loss of water from the wood disk by evaporation through the space between the two parts of the dish proceeded at such a rapid rate that growth of the mycelium was inhibited, and if continued for a longer period death of the fungus resulted.

To prevent this loss of water, it was suggested that the space between the cover and the bottom of the dish be filled with a plastic, impervious substance, such as modeling clay, paraffin or beeswax. However, the inconvenience of sterilizing, then introducing these materials into the crevice, presented difficulties that were reduced by the use of another method. This method is simple but effective and consists in the application of a wide rubber band to the periphery of the dish so that it covers the opening between the two parts and overlaps on the bottom and top sufficiently to prevent slipping off (Fig. 1). The bands were especially made by A. W. Faber in two sizes, 3⅜″ long by 2″ wide, for use with Petri dishes of 15 mm depth, and 3⅜″ x 1¾″ for those of less depth.

The rubber is of the same weight as that used in Faber's large, office band, $3\frac{3}{8}'' \times \frac{3}{4}''$. These sizes fit snugly, with no loose edges, and leave the top of the dish unobstructed for observation and measurements.

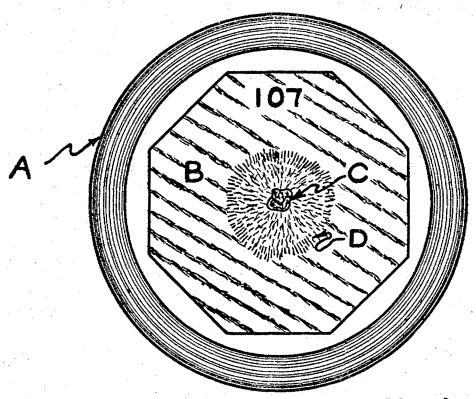


FIG. 1. Drawing showing the wide rubber band A, surrounding the edge of the Petri dish, in which is enclosed the flat, octagonal piece of moist wood, B. The fungous inoculum is shown at C, and the mycelium which spreads from it is indicated at D. The number, 107, indicates the number of the test piece.

The band method greatly reduces water loss, though it does not completely prevent it. The average loss per week when using bands was shown to be from 0.2 to 0.4 of a gram per dish containing wood test pieces at 100 per cent. moisture content, whereas without any protection this loss is from 2.0 to 3.8 grams. The difference is so marked that further explanation is unnecessary.

This method is applicable to toxicity tests of wood preservatives, studies in the decay resistance of woods, the determination of moisture and temperature requirements of fungi, cultural tests of various kinds and to a variety of uses where controlled moisture conditions are desired for test materials or living organisms contained in Petri dishes.

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# SPECIAL ARTICLES

## THE DISPLACEMENT OF TOXIN FROM NEUTRALIZED TOXIN-ANTITOXIN MIXTURES BY "TOXOID" OR ANATOXIN

MADSEN and S. Schmidt[1] have recently shown that neutralized toxin-antitoxin mixtures become toxic on addition of anatoxin. Schmidt[2] also showed that "toxoid" exerted the same effect and concluded that toxoid and anatoxin have a greater affinity for antitoxin than the original toxin itself, and can therefore displace it.

The tendency of recent immunological work (Obermayer and Pick, Landsteiner, Avery and Goebel) has been to show that even minute alterations in the structure of an antigen diminish an existing specificity rather than augment it, so that it would seem preferable to seek some other explanation.

This can readily be found in the conception of Arrhenius and Madsen[3] that the toxin-antitoxin reaction is a reversible chemical equilibrium of the type $T + A \rightleftarrows TA$, to use the simplest possible form, in which $T$ = toxin and $A$ = antitoxin. Letting this equation represent a "neutralized" mixture, we may express the equilibrium state by $\frac{[T][A]}{[TA]} = K$, or $[T][A] = K[TA]$, in which K is the equilibrium constant and the bracketed letters refer to concentrations. Since the toxin in the mixture is "neutralized," [T], and consequently K, are relatively small at equilibrium.

If the concentration of any of the reactants is changed the relative quantities of the other constituents also change so that K remains constant. Thus, if an additional amount of T is added it reacts with part of the A, decreasing [A] and increasing [TA], thus keeping K constant. If some other substance capable of reacting with A is added, [A] will also be decreased, but to keep K constant some of the TA will dissociate, increasing [T] and decreasing [TA].

Such a condition would arise when anatoxin or toxoid is added to a neutralized toxin-antitoxin mixture. If toxoid (Td) reacts with antitoxin in the same way that toxin does, $Td + A \rightleftarrows TdA$, a similar mass-law expression may be formulated, namely: $\frac{[Td][A]}{[TdA]} = K'$.

If toxoid is now added to a mixture containing neutralized toxin, the component substances will interact until their concentrations fulfil the conditions of the mass law equations $\frac{[Td][A]}{[TdA]} = K'$ and $\frac{[T][A]}{[TA]} = K$. As [A] is common to both expressions a relationship between [T] and [Td] can be derived, namely, $\frac{K[TA]}{[T]} = \frac{K'[TdA]}{[Td]}$. If the assumptions are made that one equivalent of TA is present before addition of one equivalent of Td, that the concentrations of

[1] T. Madsen and S. Schmidt, *Compt. rend. soc. biol.*, 102: 1091, 1929.
[2] S. Schmidt, *ibid.*, 1095.
[3] Arrhenius, "Immunochemistry," Chapters VI and VII, New York, 1907.