off-and-on relay, and is well adapted to many recording and controlling processes in the laboratory. The output is half-rectified alternating current, which operates most direct current magnets satisfactorily. The tube fits an ordinary 4-prong radio tube socket, but the plate connection is made to the metal knob on top of the tube instead of the plate contact on the base. Filament current at 2.5 volts and 5 amperes is supplied by a small transformer to be had at any radio supply store, and no rheostat is necessary. The output circuit of the tube should contain a 50 ohm resistance to limit the current flow to 0.5 ampere in case of a short circuit, since the filament can be ruined by excessive current passed through the tube.

In operation the current to the Thyratron is turned on, and the tube allowed to heat for 3 or 4 minutes until the contained mercury is vaporized. The microphone battery is then connected and the apparatus is ready to work. As the current through the transmitter and primary of the transformer may amount to 25 milliamperes, the microphone battery should be disconnected when not in use, and for long runs one 2-volt cell of a storage battery may be used for economy's sake. There are no adjustments to be made when the apparatus is in operation. The response of the Thyratron to each drop can be made longer or shorter by a decrease or increase in the negative bias impressed on the Thyratron grid by the bias battery D, so that the length of time the current continues for each impulse can be set for the inertia of the moving parts in any recording apparatus. The value of 9 volts for the bias battery is an average which will give a quick magnet response to drops falling as rapidly as they can without coalescing into a stream.

The apparatus is not at all critical in its adjustment; in fact, the transmitter has a great excess of sensitivity, and with its normal battery voltage of 4.5 volts and a small negative bias in the grid circuit will operate the Thyratron when a sheet of paper is rustled before the uncovered mouthpiece. The wires from the transmitter to the amplifying set and the wires of the output circuit can be made of any convenient length, since moderate resistance or capacity affects these circuits but little. It is convenient to mount the pipette at the edge of a table and let the drop fall about 30 inches to the transmitter resting on the floor.

The use of the apparatus is not confined to drop counting, but it can be adjusted to make a record of the fall of any body large enough to shake the diaphragm. When adapted to sound recording by an increase in the sensitivity of the transmitter, it can be used to pick up the ticks of a pendulum and send out time signals, to respond to a single note when the transmitter is placed in a tuned resonator, to record sounds in general, or to operate mechanical devices at a definite level of sound-intensity. Laboratory workers may find the apparatus useful in ways not contemplated in the present application.

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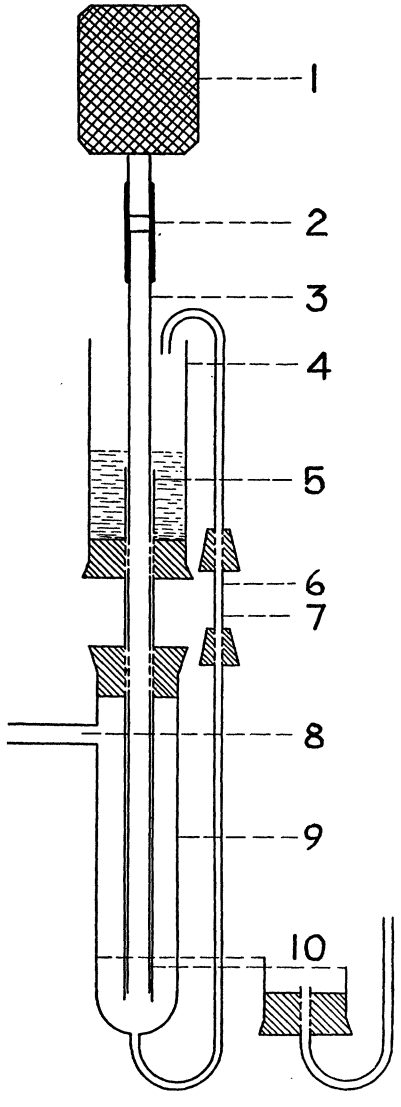
A DISINTEGRATOR FOR YEAST CELLS

A SIMPLE device to break up yeast cells is desirable in order to obtain certain growth-promoting factors which are not available without rupture of the cell wall. Such an apparatus can be made from glass rod and tubing with a few rubber connections and a suitable motor. The accompanying diagram shows the structure of the apparatus.



A rather concentrated suspension of yeast placed in the reservoir (4) flows by gravity through a long bearing (5) in which a vibrating shaft (3) is revolv-

ing. As the material drops from the bearing into the receiver (9), it is transported by a current of inert gas through a return tube (7) to the reservoir (4) from which it may again flow between the shaft and bearing. This continuous circulation and regrinding is maintained until an examination of the material in the reservoir by the hanging drop or Gram stain methods shows that sufficient disintegration has occurred.

A number of details are essential to the success of the operation. A smooth bearing and shaft running without vibration at high speed have very little effect on the yeast cells. The surfaces of the bearing and shaft must be roughened by rubbing them with moist carborundum powder (100 mesh) before assembling the apparatus. About 0.1 g of the abrasive is added to 20 cc of suspension to insure keeping these surfaces rough. Vibration is produced by a vibrating joint. The occasional addition of a drop of octyl alcohol to prevent foaming is sometimes very effective in securing a relatively high concentration of the desired factors. Pyrex glass is used throughout to avoid the marked change in acidity which is caused by soft glass and to increase the life of the apparatus. It is desirable, although not essential, to permit the bearing to project part way into the liquid in the reservoir. An opening blown in this tube just above the stopper prevents any dead space. A current of nitrogen, air or other suitable gas is passed through a bubble counter and humidifier containing distilled water. A convenient rate is 3 to 5 bubbles per second; but when the shaft and bearing have become worn, a more rapid rate may be desirable to prevent the formation of any considerable column of liquid in the return tube. If gas bubbles up between the shaft and bearing, either the clearance between the two is too great or the current of gas has not been rapid enough to prevent accumulation of fluid in the receiver and return tube. The motor is run at 3,000 to 4,000 r.p.m.; the speed depends somewhat on the action of the vibrating joint, which should not become violent enough to damage the bearing.

The average length of run has been five hours. Examination showed that 50 to 75 per cent. of the cells had disappeared within 90 minutes and 90 per cent. in 300 minutes. The disintegration is most efficient with the more concentrated suspensions, since the rate at which the cells are ruptured depends apparently on the probability of a cell being pinched between the rotating, vibrating rod and the rough bearing surface. After centrifugation and filtration through a Berkefeld filter, the turbid sterile filtrate is used without undue delay. The apparatus may be used for disintegration of other biological materials and for securing intimate contact and mixing in chemical reactions involving combination of a gas with a suspended solid where continuous exposure of new surface is desired.

Explanation of the Diagram

The dimensions given are those of an apparatus which gave consistently satisfactory results, but there is no apparent reason why many of them could not be altered: (1) Motor—a "Sew motor" with its rheostat was used; (2) vibrating joint: a 2 inch length of glass tubing connected securely to the shaft of the motor with rubber tubing and to (3) with a two inch length of heavy rubber tubing; (3) disintegrator shaft, a straight rod or capillary tube 27 cm by 7.8 mm; (4) reservoir, a 12 cm by 3 cm glass tube attached to the bearing by a number 6 rubber stopper; (5) bearing, a straight tube 22 cm by 10 mm outside diameter, wall thickness, 1 mm; (6) return tube in three sections, 3 mm outside diameter; (7) gas outlet, identical with (6); (8) gas inlet; (9) receiver, constructed from a 6 x ¾ inch side arm test-tube either by sealing a 17 cm section of the return tube to the base as illustrated, or (10) by cutting off the base of the tube smoothly, flanging the edge, and using a number 4 stopper to connect the return tube.

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SPECIAL ARTICLES

THE DEVELOPMENT OF ORGANIZED VESSELS IN CULTURES OF BLOOD CELLS

In an experiment in which blood cells were placed for incubation in culture flasks containing a mixture of blood plasma and Tyrode solution, the usual technique for the cultivation of the leucocytes[1] was slightly modified in that coagulation was allowed to take place spontaneously and without the customary addition of embryonic tissue juice. Later, the cultures were found to contain numerous, highly organized, tubular processes that projected out from the original explant. A year ago, Hueper and Russell[2] reported

[1] A. Carrel and A. H. Ebeling, "Pure Cultures of Large Mononuclear Leucocytes," *Jour. Exp. Med.*, 36: 365, 1922.

[2] W. C. Hueper and M. A. Russell, "'Capillary-like Formations' in Tissue Cultures of Leucocytes," *Arch. f. exp. Zellforschung*, 12: 407, 1932.