7.0 by the addition of 0.5 N ammonium hydroxide. The concentrate thus obtained has approximately the same nitrogen content per unit volume as the crude vaccine indicating the elimination of 90 per cent. of the total protein originally present. A comparable proportion of formalin is also discarded in the acid supernatant fluid.

TABLE 1

IMMUNIZATION OF GUINEA PIGS WITH CONCENTRATED AND PARTIALLY PURIFIED WESTERN STRAIN EQUINE ENCEPHALOMYELITIS VACCINE

Preparation	Dose† cc	Route	Test for immunity‡	
			Vaccinated	Control
Crude vaccine	0.5	Subcu.	4/4	
Concentrated vaccine	0.1	"	5/5	
	0.05	"	5/5	
	0.1 *	"	3/3	0/5
	0.05*	"	5/5	
	0.1	Int. derm.	5/5	
	0.05	"	4/4	

† The amount given in each of 2 injections with an interval of 7 days.
‡ 500–1,000 mouse infectious units of virus were given intracerebrally 14 days after the second injection of vaccine. The numerator indicates the number of animals surviving the challenge dose and the denominator the number of animals in the test.
* Diluted to corresponding volume of crude vaccine.

The capacity of a Western strain vaccine concentrate to immunize guinea pigs is illustrated by the results of a typical experiment shown in Table 1. Similar experiments have been made in which the effectiveness of smaller volumes of crude vaccines was compared with that of corresponding volumes of concentrated vaccines. The results have shown that, within the limits of the immunological tests, the immunizing principle is quantitatively concentrated and not damaged by precipitation in acid solution. This is substantiated by examination of the concentrate with the analytical ultracentrifuge. Like findings were obtained with Eastern strain material similarly prepared.

As shown in Table 1, the concentrated material confers protection, whether it is given subcutaneously or intradermally. The small volumes of it containing an effective immunizing dose are compatible with the practical utilization of the concentrated vaccine through routine intradermal administration.[8] The elimination of most of the formalin and chick embryo protein associated with the necessary amount of vaccine may be of considerable significance with respect to lessening or abolishing reactions sometimes attending the vaccination of horses[9] and man,[10] especially following the second or subsequent course of injections of crude vaccines. Of still greater promise in this direction are the possibilities associated with combination of intradermal injection and the greatly reduced quantities of formalin and inert protein.

A. R. TAYLOR
D. GORDON SHARP
DOROTHY BEARD
H. FINKELSTEIN
J. W. BEARD
DUKE UNIVERSITY SCHOOL OF MEDICINE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN A-C POWERED PH SET

ONE method to determine the PH of a solution is to measure the EMF developed between a glass PH electrode and an "indifferent" electrode, both placed in the solution. This EMF is of the order of a few tenths of a volt and changes about 60 millivolts per PH unit. In practice any steady component of this EMF may be balanced by means of a potentiometer in series with the indifferent electrode. The changes of EMF, which reflect the changes of PH, are observed and recorded by suitable apparatus. Such an apparatus is commonly called a current amplifier or an impedance changer, though the latter term is a misnomer. The chief requirements of such a device are (1) that it have high input impedance, and (2) that it not fluctuate spontaneously. An A–C powered current amplifier which fulfils these conditions is described below.

In Fig. 1, the controlling voltage is applied to the third grid of a 6J7 pentode tube. This grid is biased about 3 volts negative, the second grid and the plate are each about 25 volts positive. The first grid is tied to the cathode. Thus the usual connections of G_1 and G_3 are interchanged. The effect of G_3 then is to change the distribution of current between G_2 and the plate.

Fig. 2 illustrates 3 possible paths for an electron after it leaves the cathode: (A) it may go straight to screen; (B) it may go through screen and G_3 and on to plate; (C) it may go through screen and be so repelled by negative G_3 that it is sent back to the screen.

If G_3 is now made more negative, the number of electrons following path C will be increased and the number following path B will be correspondingly decreased. Thus screen current increases, plate current decreases, but the sum of the two remains constant. Now, it is the difference of plate and screen currents that affects the galvanometer G.

Any disturbance in the tube, such as a change in cathode emission, or a change in B supply voltage, will affect both plate and screen currents in the same direction, but will have little effect on their differ-

[8] H. W. Shoening, M. S. Shahan, O. L. Osteen and L. T. Giltner, *Vet. Med.*, 35: 377, 1940.
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[10] D. Beard, H. Finkelstein and J. W. Beard, *Jour. Immunol.* In press.

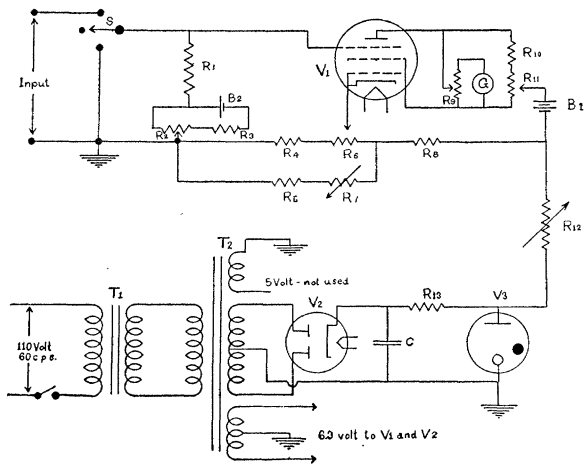

FIGURE 1

R_1 100 meg S S white 65 X Resistor
R_3 10 meg " " "
R_4 500 ohm International Resistance Co.—Type A B Resistor
R_5 2000 " " " " "
R_8 2000 " " " " "
R_{10} 5000 " " " " "
R_{13} 7500 " " " " "
R_2 1 meg Potentiometer (on panel)
R_6 200 ohm (Yaxley X) " " "
R_7 200 " " " " " "
R_9 20000 " " A–20–MP " " "
R_{11} 5000 " " A –5–MP " (behind panel)
R_{12} 10000 " " A–10–MP " " "
S switch " 161–C (on panel)
C 8 μfd 450 volt electrolytic condenser
T_1 constant voltage transformer (Sola 3000)
T_2 Thordarson T 13R19 transformer
V_1 RCA 6J7 in Steatite socket (Amphenol R–SS–8)
V_2 6 X 5 tube
V_3 VR–105 tube
G galvanometer

One PH unit or 60 millivolts input will cause 8 microamperes to flow through G when R_9 is set at maximum sensitivity. Thus the required galvanometer sensitivity can be calculated in terms of the PH range it is desired to cover.

ence. Hence the galvanometer is not much affected by such disturbances.

The response of the galvanometer to changes in filament voltage can be reduced nearly to zero by the proper adjustment of R_{11}.

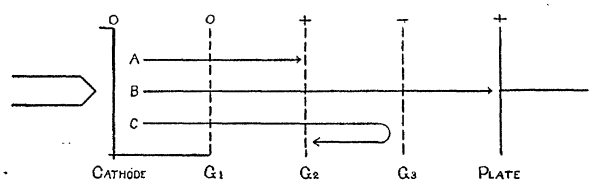

FIGURE 2

If a small extra source of voltage such as a battery be inserted in series with the plate and screen supply, it becomes possible to adjust R_{12} so that the set is practically insensitive to changes in B voltage. The effect of fluctuations of B voltage is always small, however, and the above expedient may not be necessary. We find 1.5 to 4.5 volts suitable for the battery.

The resistor R_6 is used to adjust to free grid—*i.e.*, so that the galvanometer does not shift as the switch is rotated from the short to the open position. The grid current, however, is always very small in this tube, so this adjustment and the bias cell might well be omitted.

We have used RCA 6J7 tubes. They must be selected, as they are not uniform. The shell must be grounded—not connected to cathode. 6SJ7 and 6J7-G tubes have not been satisfactory.

The important features of this design are (1) the push-pull connection between plate and screen of a single tube, and (2) the cascaded use of several devices to secure isolation from line voltage variations.

In the present design we have (1) the regulating transformer, (2) the gaseous discharge tube, (3) the push-pull connections. None of these would be good enough alone to absorb line voltage variations completely and provide stable operation. Since each of these devices gives only a moderate degree of isolation, none is critical in design or adjustment.

If the whole task of isolating the set from the line depended on one regulator or one push-pull connection this would involve a quite critical adjustment. Such an adjustment might be subject to spontaneous drifts. The cascade circuit gives ample isolation with no critical parts.

Since most experimenters wish to record PH over a relatively long period of time, the elimination of batteries without loss in stability will prove to be a convenience.

CRAIG W. GOODWIN

YALE UNIVERSITY

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