

LABORATORY AND SHOP NOTES

Note on Making Beryllium Targets

Beryllium is used as a target in the cyclotron when it is desired to produce a large yield of neutrons. The large amount of heat delivered to the beryllium by the ion beam makes it desirable to establish good thermal contact between the beryllium and the water-cooled holder. Considerable difficulty has been experienced in making solder stick to beryllium. I have found that this can be done successfully in the following way: Clean the surface of the beryllium by grinding it lightly on an emery wheel. Support it horizontally so that it can be heated with a gas torch from below. Cover the surface with a layer of ammonium chloride about $\frac{1}{8}$ inch deep, and place several pieces of wire solder on top of this. Heat the under side of the beryllium until nearly all of the ammonium chloride has evaporated, or until the experimenter is nearly suffocated. If the entire surface is not wet by the solder, wipe the excess off while it is still molten, and repeat the process. Several such treatments may be necessary. After the beryllium has been wet with solder by this process, it can be joined and re-joined to other materials many times, provided it is not overheated.

Grinding wheels $\frac{1}{32}$ inch thick and several inches in diameter made of carborundum with a shellac or Bakelite binder are commercially available, and are ideal to use as "saws" (in a milling machine) for cutting slices of beryllium out of a chunk. A large target can be made by soldering small slices of beryllium onto a copper block in a mosaic fashion, and then facing it off in a lathe with a tool-post grinder. I have made a two-inch disk in this way, which, for nuclear physics work, is as good as a solid piece.

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Greaseless Vacuum Valves

Greased vacuum stopcocks cannot be used in many cases because stopcock grease reacts with or absorbs certain gases with which it may be in contact, it gives off objectionable vapors, or because stopcock grease melts at temperatures commonly encountered in experimental work, precipitating leaks. The usual *U* tube mercury cut-off of course eliminates grease from the vacuum system, but it cannot be cut on or off against pressure differences of more than a few centimeters of mercury without bad splattering, and requires an atmospheric column or some other bulky source of mercury for regulation. The vacuum valves figured—the first for pressure differences less than a few centimeters of mercury, the second for higher pressure differences—relieve most of these objections to the usual type, and introduce only mercury, or mercury and finely divided graphite into the vacuum system.

The magnetically operated mercury cut-off of Fig. 1 is compact and allows fairly fast pumping. Its use, and building the necessary electromagnet, is economical if several cut-offs are needed. The bar of iron, encased in glass, is rectangular in cross section so that it may be turned 90 degrees to its resting position on the *V* shaped projections from either side of the outside wall (Fig. 1*a*) and slid down between these projections to cut-off position (Fig. 1*b*). Glass wool may be packed in the dome at top to prevent breakage if the movable piece is thrown upward by a sudden build-up of pressure on the lower side. This design was suggested by that of Schmitt* but differs in purpose from the latter in minimizing the volume of the cut-off, and allowing no iron exposed to the vacuum system.

Figure 2 illustrates a valve for use in horizontal position only, in which graphite provides the greasing action, mercury the sealing action of stopcock grease. In open position, shown in Fig. 2*a*, communication between the two chambers of the stopcock takes place through holes in each chamber which open into a small trough in the outer wall. If the cock is turned 180 degrees, these holes are safely submerged in mercury, and the valve tight. Two holes should be blown 180 degrees apart in the right-hand chamber so that it is open to the right-hand lead in both open and closed positions. A small amount of gas is of course left in the communicating trough and may leak around the barrel of the stopcock to send a few bubbles into whichever chamber is at low pressure. The size of this trough, however, and consequently, the volume of dead gas trapped in it, can be made very small before it resists the flow of gas appreciably more than does the bore of a standard stop-

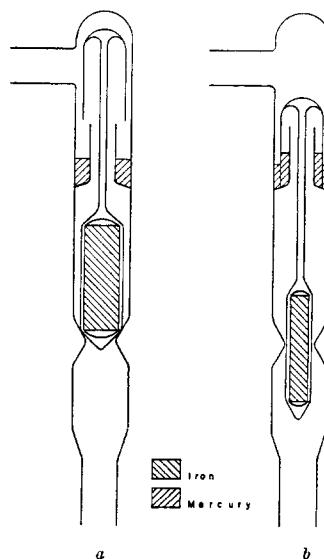


FIG. 1.

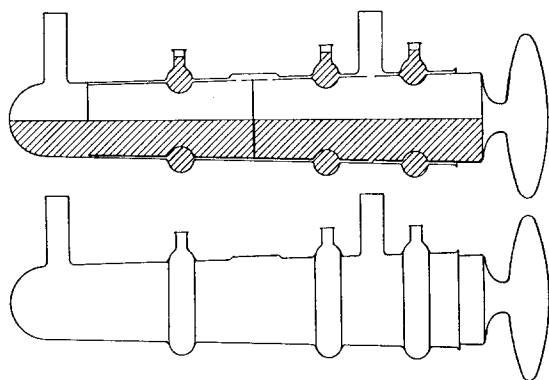


FIG. 2. (a) above, (b) below.

cock. The ground surfaces must be in good contact so that atmospheric pressure will not push mercury between them. In grinding, there is some tendency to form shoulders on the left edge of each circular mercury channel; these must be removed before good contact at other points can be secured. After the grinding is done, penciling one of the ground surfaces with soft graphite and introducing the necessary mercury completes the stopcock.

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* Otto H. Schmitt, Rev. Sci. Inst. 8, 68 (1937).

Stabilized Regenerative Amplifier

A regenerative amplifier of the stabilized type gives a very simple tuned amplifier of high selectivity for use in audiofrequency measurements. Improved performance of regenerative amplifiers, just as in the case of oscillators,^{1, 2} may be obtained by applying degenerative or negative feedback.^{3, 4} Identical circuits may be used in either case, the difference being that the regenerative amplifier is not quite oscillating, while the oscillator is just barely oscillating. The usual disadvantages of regenerative amplifiers, namely nonlinearity and instability with respect to variations in power supply voltages, may be minimized by application of negative feedback.

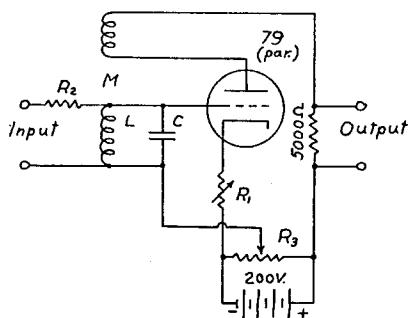


FIG. 1. Stabilized regenerative amplifier circuit.

A simple regenerative amplifier circuit with negative feedback is shown in the diagram. A type 79 twin-triode with amplification factor of 80 is used with the two sections in parallel. The plate current is adjusted by means of the potentiometer R_3 to about 1.5 milliamperes. The input resistor R_2 is chosen much larger than the impedance of the tuned circuit $L-C$ alone at resonance. The regenerative or positive feedback is fixed by the mutual inductance M between the plate and grid windings so that the tube is on the verge of oscillation when the resistance R_1 is about 15,000 ohms. This resistor controls the amount of degenerative feedback. As resistance R_1 is decreased above the threshold of oscillation the effects of regeneration become more pronounced. One effect is that the selectivity of the amplifier becomes sharper.

Measurements at 1000 cycles per second with an amplifier A similar to the figure showed that for a certain adjustment of resistor R_1 the amplifier would have exactly the same stability as an otherwise similar amplifier B with no feedback either positive or negative. However, for amplifier B to have a selective response equivalent to that of amplifier A , amplifier B would require a coil having a Q thirty times that of winding L . Thus the combined action of regenerative and degenerative feedback has the effect of apparently increasing the Q of winding L without making the amplifier more unstable. At a sacrifice of stability the apparent Q may be further increased many times.

This type of amplifier has applications in audiofrequency measurements such as indicating balance of bridges where a high percentage of harmonics are present, or in measurements of harmonic components of an alternating voltage wave where the components may be a small percentage of the fundamental.

I am indebted to Professor E. L. Bowles for suggesting the broad idea of combining regenerative and degenerative feedback and also for bringing the Langmuir reference to my attention.

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October 27, 1938.

- ¹ P. M. Honnell, "Feed-Back Oscillator," Rev. Sci. Inst. 9, 258 (1938).
- ² H. H. Scott, "A New Type of Selective Circuit," Proc. I. R. E. 26, 234 (1938).
- ³ I. Langmuir, U. S. Patent 1,273,627. Filed February 5, 1914.
- ⁴ H. S. Black, "Stabilized Feedback Amplifiers," Bell Sys. Tech. J. 13, 1 (1934).

A Simplified Construction of Hull-Davey Charts

It has been found in this laboratory that the use of a logarithmic scale for the axial ratio simplifies the construction of the Hull-Davey charts¹ for the hexagonal and tetragonal systems by making straight lines of all the curves for the pinacoid (001) spacings, and giving all of the curves for the pyramid (hkl) spacings the same shape, so that all of these can be drawn with the same template. The method can be extended to the orthorhombic system by the use of a series of these simply-constructed charts.

The exact matching in shape of the pyramid-face curves depends on an asymptotic relation between the interplanar spacing of a pyramid (hkl) face and the spacings of the