The molding was cleaned in a mixture of teepol and hydrogen peroxide solution. It was mounted in a massive metal holder suitably drilled to expose the part on which the coating was required. The holder was solidly connected th the large baseplate of the evaporator so that heat rediated from the filament was rapidly conducted away. Radiation shields were arranged to minimize this heating of the mounting. The spiral was mounted flexibly to reduce the strains set up in heating; this procedure was found necessary to avoid premature breakage. The spiral was heated to about 2000°C by a current of 45 amp for short bursts of the order of one second's duration. In this way sufficient quantities of rhodium were evaporated without detectable heating of the molding which was vertically above the spiral at a distance of 15 cm.

It was found unsatisfactory to plate sufficient rhodium on a single filament to produce the desired opaque coating. Such heavily plated filaments fractured before any appreciable quantity of rhodium had been evaporated. By using two or three more lightly plated filaments, the bulk of the rhodium could be evaporated before the filament burnt out and a hard, opaque, durable layer, about 1000°A in thickness, deposited.

The contour of the coated surface of the molding was examined by reflection interference fringes, and the contact lens as a whole was compared with the original mold: these procedures confirmed the absence of distortion.

Our thanks are due Miss D. M. Clarke of Messrs. Clement Clarke, Ltd., for the final examination of the lens and to the Department of Scientific and Industrial Research for the provision of main finance and apparatus grants.

A New Magnetic Period Mass Spectrometer*

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UTILIZATION in a mass spectrometer of the perfect time- and astigmatic space-focusing of ions after one or more complete revolutions in a homogeneous magnetic field and measurement of their mass essentially by determining their rotation period were first proposed by Bleakney and Hipple.[1] In their crossed field instrument a uniform electric field E normal to H moves the center of each circular orbit prependicularly to both at a steady rate cE/H so that (a) all ions miss the source and (b) period $T=2\pi\ (mc/eH)$ and hence mass m are proportional to the distance from source slit to the nth image thereof (or to $1/E$ for fixed exit slit). The linear scale, high dispersion, and other advantages, particularly for measurement of large masses, of a large instrument of this type were described by Bleakney and H. A. Thomas at a Brookhaven symposium on precision mass measurements held April 10, 1948, following my proposal to construct such a spectrometer or investigate possibilities for an equivalent less costly one here. Shortly thereafter Goudsmit[2] proposed an instrument, which he later christened the "chronotron," wherein the same focal properties are utilized, while nT is measured by direct electronic timing of the flights of ion pulses from source to detector. Its technical and economic advantages are: (a) considerably less transverse area of magnetic field; (b) no large electric field whose role of imparting motion such that ions miss the source is obviated by allowing them to spiral from source to detector placed some distance apart on the same field line.

After designing, constructing, and participating in early experiments with the present chronotron it occurred to me that an instrument wherein an electric field of small extent in space and time performs both the functions of forming pulses and deflecting them so that they miss the source without the centers of their subsequent orbits having to move steadily either transversely or axially would have distinct advantages over both the above instruments. Figure 1 shows how this has been accomplished in the new instrument as it now exists. Ions of a limited mass range from source slit S_1 are focused after a half-revolution on the triple slit forming a "pulser" of which S_2 and S_4 are grounded while S_3 is connected to a generater of square voltage pulses. A group of ions of small length (ΔL) near S_3 when pulse one starts is decelerated between S_3 and S_4 sufficiently to miss the source housing on subsequent revolutions. Pulse two, applied a measured time later equal to nT, again decelerates the remaining ions of this group causing them after another half-turn to enter slit S_5 of the detector.[3] The present instrument is in a metal chamber in the 2-inch gap of an electromagnet with poles 15 inches in diameter. The diameter of orbit 2 of Fig. 1 is 10 inches. With $H=\times820$ oersteds and pressure $\sim5\times10^{-6}$ mm Hg, ions of masses 18, 28, and 44 formed in the residual gas have been observed respectively after 70, 40, and 25 rotations between pairs of pulses. The respective values of the resolution[4] $M/\Delta M=nT/\Delta(nT)=L/2\Delta L$ are about 8.5 and 3×10^3. To avoid background due to scattered ions a (fairly long) pulse of ions rather than a dc beam is drawn from the source.

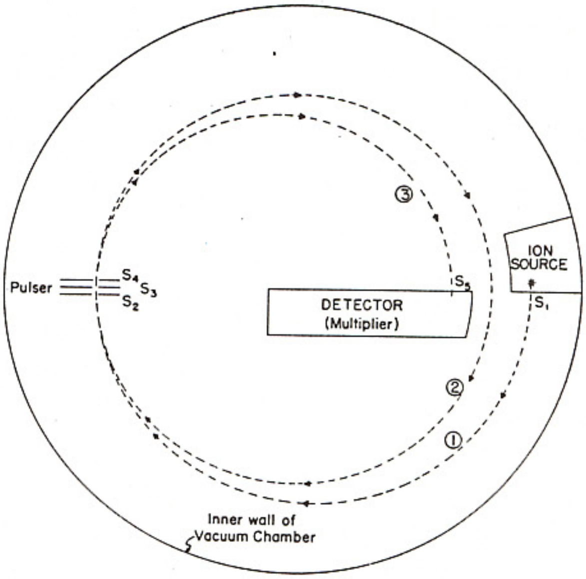

FIG. 1. Schematic cross section of the new instrument.

Separation of the pulser from the source prevents contamination of walls around the central orbit by uncharged source vapors and, through mass separation in time and space, greatly reduces overlapping orders particularly serious in the chronotron. However, the chief virtue of the new spectrometer is that its finite size does not limit L (in the crossed field instrument, the distance between slits) and through it the resolution. Also, calculations indicate that simple electrostatic or magnetic focusing, impossible in the chronotron, can greatly reduce losses of ions due to spreading along H without seriously affecting the accuracy of measurement. Finally, the smaller volume of the new instrument should make losses and beam spreading due to scattering, stray electric fields, and expecially inhomogeneities in the magnetic field easier to minimize.

These effects are harder to minimize than in the much smaller omegatron,[5] where also finite size does not limit L but where peak broadening potentially due to these causes plus space charge rather than ion losses now limits resolution. It can be shown that the resolution of the omegatron is $M/\Delta M=L/2r$, where $2r$ is the length of the r-f field. At present $2r$ is over three times $2\Delta L$ for the new instrument wherein ions have a larger value of $H\rho$ than is obtainable with reasonable values of H in the omegatron. Thus, with improvements planned (especially focusing) larger values of L and superior resolution may well be obtained.

Because of its superficial resemblance to a synchrotron and employment therewith of a synchronous method of measuring masses, I suggest the name "synchrometer" for the new instrument.

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* Research done at Brookhaven National Laboratory under the auspices of the AEC.

[1] W. Bleakney and J. A. Hipple, Jr., Phys. Rev. **53**, 521 (1938).

[2] S. A. Goudsmit, Phys. Rev. **74**, 622 (1948)

[3] The detector used in this instrument as well as the present chronotron is a beryllium copper magnetic electron multiplier. This device is described in a forthcoming article by the author in Rev. Sci. Instr.

[4] $\Delta(nT)$ is the total range of time interval over which appreciable ion current is detectable, while L is the total length of path. For mass 18: $nT \cong 1$ msec; $\Delta(nT) \cong 0.1$ μsec; $L = 56$ meters; $\Delta L \cong 2.8$ mm.

[5] Hipple, Sommer, and Thomas, Phys. Rev. **76**, 1877 (1949).

A High Power Attenuating Tuner for a High Q Ten-Cm Cavity

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THIS paper describes a device which was used in a ten-cm wave guide to perform simultaneously two functions. One function was to attenuate approximately one-half of the nine-hundred-kilowatt peak pulsed power output of a type 4J33 magnetron. The other was to serve as a fine and sensitive tuning element to tune the dimensionally fixed high Q cavity of an electron accelerator to the fixed frequency magnetron.

Several types of attenuators using fabricated polystyrene or glass have been constructed.[1,2] High power polystyrene attenuators of a cemented fabricated construction were usually unsatisfactory. With a fabricated attenuator, water leakage eventually developed along cement lines and occasional arcing and carbonizing of the polystyrene at dielectric weak points would result in complete breakdown. Water leakage was believed to be due to excessive voltage stress occurring along portions of these lines owing to the heterogeneous dielectric nature of the cement bond caused by small occluded air bubbles. This excessive voltage stress would cause localized heating, softening of the cement, and then rupture of the bond. Glass was not subject to this difficulty but presented others of a constructional nature.

An attenuator wholly contained within a wave guide usually encounters another difficulty such as the passage and removal of trapped air flowing through the attenuator as intermittent air bubbles. These bubbles manifest themselves as instability in transmitted power and make it difficult to conduct measurements.

The aforementioned difficulties were eliminated by the attenuator herein described. The attenuator shown in Figs. 1 and 2 has no cement lines exposed to the r-f field. It is constructed of a solid flat circular segment of polystyrene which has a circularly milled-out slot $\frac{1}{8}$-in. wide. A polystyrene cover is cemented as shown to enclose the slot. Tubes cemented to each end of the cover allow water, which is used as a power absorbing and cooling medium, to flow through the enclosed slot of the attenuator. This water-filled polystyrene attenuating segment is mounted on a carriage such that it can be positioned longitudinally in a slotted section of wave guide. The slot is $\frac{9}{32}$-in. wide. The loss of power by radiation through the slot is small, for when the wall thickness, which in this case is almost $\frac{25}{64}$ in., is comparable to or greater than the slot width, the slot acts as a wave guide far beyond cutoff for the penetrating field. The attenuator is also mounted to pivot about one end so that the degree of attenuation can be controlled by a tuning screw which adjusts the depth to which the attenuator projects into the wave guide. The attenuation is variable between 0 and 7 db. A curve of attenuation *vs.* insertion is shown in Fig. 3.

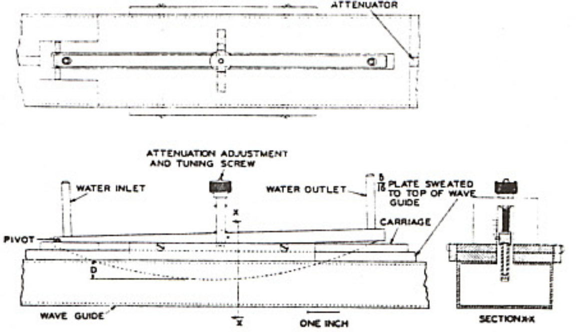

FIG. 1. View of the attenuator mounted on the carriage and wave guide.

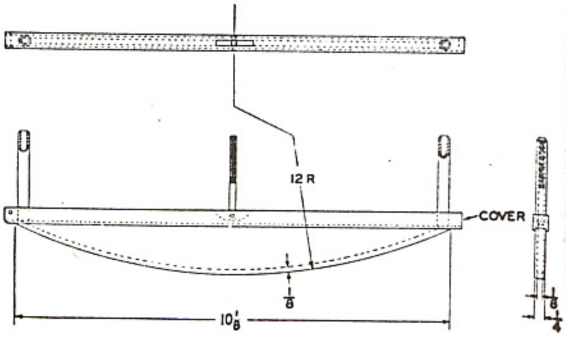

FIG. 2. Assembly detail of attenuator.

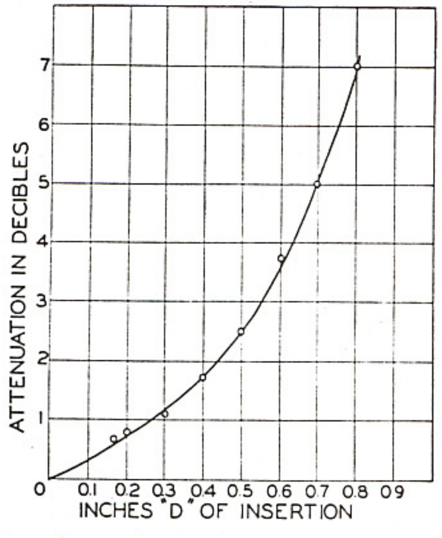

FIG. 3. Attenuation as a function of insertion "D" into the wave guide.

With this attenuator, transient air bubbles never get into the r-f field but flow along the inclined top surface and are readily bled out.

A voltage standing wave ratio ranging from 1.00 when completely withdrawn to 1.10 at maximum insertion is presented by the attenuator. This variable reflective element is used to tune the cavity; and, by sliding the carriage carrying the attenuator, the phase of the reflection can be adjusted for optimum performance.

The attenuator dimensions were chosen such that the magnitude of the reflection to tune the cavity and the one-half power absorption point occurred at about the same degree of attenuator insertion.

Tuning of the cavity in this manner can be accomplished only when the cavity is matched to the wave guide and adjusted very close to the resonant wavelength. The cavity was initially