A SIMPLE AND COMPACT ARRANGEMENT FOR MEASURING THE $\beta$-ACTIVITY OF WEAK RADIOACTIVE SAMPLES

In recent years greatly increased importance has been attached to the measurement of very weak radiations, particularly in connection with the radioactive contamination of the atmosphere, rainwater, foodstuffs and the waste water from medical, radiochemical and nuclear-physics laboratories. For all such purposes, detectors are required that combine extreme sensitivity with the utmost reliability.

In the majority of cases the aim is to monitor the beta activity, for example of the hazardous isotope $\text{Sr}^{90}$. The Geiger counter tube with end-window, such as the Philips types 18505 and 18506, is still the most commonly used beta detector, because of its high sensitivity to beta rays, its great stability, and the simplicity of the auxiliary equipment $^1$.

Among the most important factors governing the lower limit of detection are the background counts of the detector. The background count is the number of discharges in the tube per unit time caused by any agency other than that which is to be detected. They are caused, inter alia, by:

1) gamma radiation originating from the surroundings, e.g. from neighbouring radioactive preparations, natural radioactivity of building materials (in which the isotope $\text{K}^{40}$, for instance, is often present), or from the air (which may carry radon or disintegration products of radon);

2) mesons of cosmic radiation;

3) beta and gamma radiation originating from impurities in the materials of which the counter tube is made.

The interference from neighbouring gamma radiation can be eliminated by shielding. Obviously, the shielding materials must themselves contain no radioactive impurities, particularly that part of the shielding in the immediate vicinity of the counter tube. Lead has generally too much radioactive contamination for the purpose. Iron is more satisfactory, but best of all is mercury, because it can readily be purified. Reasonable shielding is possible with a mercury shield of, say, 3 cm thickness, enclosed in a 15 cm thick iron shield; the mercury then absorbs the radiation from the radioactive impurities in the iron.

Owing to the very great penetrating power of mesons, other means must be sought of overcoming this source of error. Hitherto it has been customary to surround the counter tube with a number of guard counters, which are so disposed that every meson triggering the central counter necessarily triggers one or more guard counters also. The circuit operates on the anti-coincidence principle, that is to say a count from the central tube is recorded only when none of the guard counters are simultaneously triggered.

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Such an arrangement, consisting of 10 to 15 counter tubes, is naturally fairly voluminous. If it is surrounded by a 3 cm shield of mercury plus a 15 cm shield of iron to screen it from gamma radiation, the aggregate equipment weighs something like 2000 kg, which is too cumbersome in many cases.

Fig. 1 illustrates an arrangement of counter tubes using a new type of guard counter. The two electrodes of the guard counter are concentric hemispheres to which coaxial cylinders are connected. The beta counter fits inside the hollow anode of the guard counter. With this arrangement no meson can actuate the inner counter tube without at the same time actuating the exterior counter. In its operation this tube is similar in many respects to the counter tubes described in an earlier publication by the Philips laboratory, Amsterdam 3). The complete monitoring equipment is shown in fig. 2 4).

The fact of there only being one guard counter offers the following advantages:

1) the smaller size entails a great saving in the weight of the shielding (a saving of more than 1000 kg).
2) the layout and supervision of the equipment are greatly simplified, and
3) the electronic apparatus is simpler.

The central counter tube in fig. 1 is a modified experimental version of type 18505. The main differences are:

4) A more detailed description of this measuring arrangement was given by K. van Duuren, W. K. Hofker and J. Hermsen at the 1958 Geneva Conference (to be published as contribution P. 2343 in the Proceedings of this conference).
Fig. 3. Guard counter as in fig. 1.

1) the length has been cut down to 1/3 of the original length, to reduce the tube's sensitivity to gamma radiation;
2) the materials used have been carefully chosen to keep the contribution made by the tube wall to the background counts as low as possible.

In a particular case the background counts of the counter tube inside the guard counter were reduced to 0.7 per minute, as compared with the 20 background counts recorded in the same laboratory with a normal counter tube, type 18505, having the same sensitivity to beta rays but without shielding.

Photographs of the guard counter tube are shown in fig. 3.

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ABSTRACTS OF RECENT SCIENTIFIC PUBLICATIONS BY THE STAFF OF N.V. PHILIPS' GLOEILAMPENFABRIEKEN

Reprints of these papers not marked with an asterisk * can be obtained free of charge upon application to the Philips Research Laboratory, Eindhoven, Netherlands.


This article deals with the statistical theory of fading phenomena, in particular with respect to the propagation by scattering of microwaves. The fading occurring at large distances (far beyond the horizon) is compared with that within the horizon. In both these cases special attention is paid to the difference in fading rate for the amplitude and that for the phase. These two fading rates differ at large distances; for short-distance scattering they are equal as far as the approximations used here are concerned.


A mass spectrometer leak detector of the Nier type with a radius of curvature of 5 cm is described using an electron multiplier for measuring the ion current. In this manner the sensitivity is increased so far that one can use as probe gas for leak testing a mixture containing only 1% of helium. The apparatus can also be used as an analyser for masses up to about 50.

2570: J. P. M. Gieles: The measurement of group delay in triode amplifiers at 4000 Mc/s (Onde électr. 37, 781-788, October 1957).

In microwave repeaters for long distance links using frequency modulation, not only the amplitude characteristic but also the phase characteristic is extremely important. The latter can be described in terms of the group delay, which should be as constant as possible over the transmission band.
desired. The total delay variation admissible for colour television could perhaps be as low as 50 μs.
For direct UHF links equipped with EC 56, this results in a variation of less than 0.1 μs per stage if the distortion is cumulative, so that a very high accuracy in the measurement of the group delay is necessary. Measurements are performed in a closed loop that is made to oscillate by the amplifier under test. The loop also contains a precision phase shifter. A simple formula can be derived, expressing the total group delay of the loop in terms of the frequency shift resulting from an introduced phase shift. The frequency shift can be measured very accurately by a beat-tone procedure. The results have an accuracy of about 0.1 μs and indicate that the triode is indeed capable of fulfilling the severe requirements. Finally, some remarks are made concerning level to phase conversion.

2571: J. Links, J. E. Rombouts and P. Keulen:
The "bulging factor", a fungistatic antibiotic produced by a streptomyces strain, with evidence of an active water-excreting mechanism in fungi (J. gén. Microbiol. 17, 596-601, 1957, No. 3).

The "bulging factor", a new antibiotic with a chemical nature related to streptothricin, is produced by a Streptomyces strain and was isolated as reineckate and picrate. A study on its mode of action resulted in the development of a plate technique for assaying bulging factor activity. Evidence is presented in support of a theory about the existence of an active water-excreting mechanism in fungi susceptible to the bulging factor.


The complex impedance of glow discharges was measured in a discharge tube fitted with adjustable electrodes. As the electrode distance is increased the impedance is initially independent of the distance; however when the distance is so great that an anode fall begins to develop, the impedance in a given frequency region increases rapidly. The cause of this increase lies in the anode fall layer and in the Faraday dark space. An equivalent circuit is given for the anode region of the discharge when an anode fall is present.


A report on the work described here has also appeared in Appl. sci. Res. B5; 445-553, 1956 and B6, 207-221, 1956; see these abstracts Nos. 2368 and 2445.


The Langmuir probe is a very useful tool for the determination of electron temperatures in the positive column of gas discharges. Its reliability however, is subject to some doubt, especially at high current densities and comparatively high gas pressures. This article describes measurements with the probe on rare-gas discharge tubes at pressure up to 20 mm Hg, and for current densities of 0.04 A/cm². These tubes were developed as standard noise sources for the cm waveband. The electron temperatures measured with the probe are found to be in good agreement with those determined from noise measurements. In the probe measurements special attention was paid to the effect of the work function of the probe material.


Short description of a method of making colour photographs of the human retina for diagnostic purposes. A special electronic flash tube has been developed that has a very high brightness (peak value ~1.5 x 10⁶ cd/cm² (9X brighter than the sun) and a flash duration of 3.5 msec. With this very short exposure (which is sufficient because of the high brightness) sharper photographs are possible than with the usual carbon arc. A 6000 μF condenser charged to 500 V dissipates an energy of 750 joules in the lamp. See also Philips tech. Rev.15, 342-346, 1953/54.

It is shown that the spontaneous part of the Hall effect arising from the spontaneous magnetization is caused by skew scattering of the magnetized conduction electrons (in this case the 3d-electrons) due to their transverse polarization induced by spin-orbit interaction, which acts as an impact parameter in the collision process. The problem could be approximately solved for scattering on an impurity atom by converting it into that of the scattering on a vortex-like perturbing centre. The order of magnitude of the calculated Hall angle agrees with the experimental one (≈ 10⁻²). It is shown quite generally that for lattice vibration scattering the Hall effect should be proportional to the square of the resistivity, as has been found experimentally for pure iron and nickel.


The time-dependence of the initial permeability (i.e., disaccommodation) is measured on a single-crystal toroid of manganese ferrous ferrite. This effect is as high as 95% of the value immediately after demagnetization of the ring. It is shown that disaccommodation is a time-dependent blocking of domain walls. The blocked walls cause constricted minor hysteresis loops, characterized by a critical magnetic field which is necessary to overcome the blocking force. The constriction is time-dependent.


Note on the determination of the energy difference between the conduction band and the valency band in polycrystalline gallium nitride and aluminium nitride, by means of measurements of the diffuse reflection as a function of the wavelength of the incident radiation. The (room-temperature) values found are: for gallium nitride 3.2 eV and for aluminium nitride >5 eV.

A 3: A. Rabenau and P. Eckerlin: Die K₂NiF₄-Struktur beim La₂NiO₄ (Acta cryst. 11, 304-306, 1958, No. 4). (The K₂NiF₄ structure in La₂NiO₄; in German.)

Report of an X-ray diffraction investigation into the structure of La₂NiO₄ using Debye-Scherrer photographs and Cu Ka radiation. It is found that La₂NiO₄ has a structure related to the perovskite structure already found in K₂NiF₄ and studied by Balz and Plieth. The lattice constants of the tetragonal La₂NiO₄ were found to be: a = 5.855 ± 0.001 Å and c = 12.652 ± 0.003 Å. The K₂NiF₄ structure is also exhibited in La₂CoO₄, but here it was orthorhombically deformed. The lattice constants are: a = 5.539 Å, b = 12.66 Å, c = 5.482 Å.

A 4: K. Jost and G. Schiefer: Die Auswertung von Vierpol- und Materialmessungen mit dem logarithmischen Leitungsdiagramm (Archiv elektr. Übertragung 12, 295-300, 1958, No. 7). (The analysis and evaluation of 4-pole and material measurements with the aid of the logarithmic transmission-line chart; in German.)

A method is described that allows the quadrupole parameters, and in particular the material constants $\mu$, $\epsilon$, $\tan \delta_\mu$ and $\tan \delta_\epsilon$ to be measured with the aid of a coaxial slotted line. The numerical evaluation is greatly simplified by the adoption of a logarithmic transmission-line chart whose curves of constant VSWR and constant node displacement $l/\lambda$ simultaneously represent curves of the function $\ln \tanh (a + jb)$ for constant $a$ and $b$.


Continuation of R 337.


An investigation is carried out into the reduction with hydrogen of tungstic acid and tungsten trioxide doped with various additives. It is shown that the addition of potassium silicate and potassium silicotungstate results in a marked growth of the tungsten particles, while other additives as calcium nitrate or magnesium sulphate tend to give a small particle size. From the behaviour of the pure potassium silicotungstates during reduction, an explanation of the observed phenomena is proposed.


Several Ag-activated CdS phosphors are described, with Ga or Cl as coactivator. The fluorescence at low temperature shows two bands with maxima at
6200 Å and 7300 Å. High Ag concentration and low coactivator concentration promote the short-wave emission. Phosphors with equal concentrations of activator and coactivator show only the long-wave emission. Optimal photoconduction and low dark-current are only found with an activator-coactivator ratio slightly greater than unity. A series of mixed crystals (Zn,Cd)S activated with Ag shows clearly the relation between 6200 Å emission in CdS and a 3880 Å emission in ZnS and also between the 7300 Å band in CdS and the normal blue Ag band at 4350 Å in ZnS. The behaviour of the Ag bands in CdS is quite similar to those of Cu in ZnS. These results show that the conclusions drawn by Lambe and Klick regarding the position of the impurity level responsible for the 6200 Å Ag emission in CdS cannot be applied to the normal blue Ag emission in ZnS-Ag. These results led to an improvement of the properties of a red colour-television phosphor.


From known optical and electrical data on Cu₄O a band scheme is constructed for this semiconductor. The equilibria between the solid constituents and a vapour containing oxygen are calculated. From these data the conductivity and the concentrations of the various defect centres can be evaluated for Cu₄O at high temperatures in equilibrium with an applied partial pressure of oxygen. The results are shown to be in good agreement with experiment. The optical and electrical properties after quenching, however, do not correspond to the model mentioned above. If association between defects is considered during the cooling process, the optical properties can be explained. As to the Hall-effect data, the occurrence of chemisorption of oxygen during quenching must also be taken into account, especially if well-conducting surface layers are formed, which appears to be the case at the lower oxygen pressures preferently, whereas at high oxygen pressures conduction through the bulk of the crystals prevails. The intermediate region of mixed conduction is characterized by a very low effective mobility.


In this thesis (Delft, 1957) the synthesis of series-parallel LC three-terminal network functions from the zeroth to the sixth degree are given. Some of these conditions are essentially new, that is, independent of any previously derived conditions. They are necessary for the synthesis of series-parallel LC three-terminal networks, but it is not known whether they are also necessary for the synthesis of three-terminal networks of arbitrary structure. In principle, it is possible to apply the method to functions of higher degree than the sixth, but the amount of computation required increases in general very rapidly with the degree.


This article deals with the photoelectric properties of the system Ta-Ta₂O₅-electrolyte during irradiation with ultraviolet light. The electrolyte has also been replaced by a transparent layer of a metal or a semi-conductor. When the system is short-circuited, a photo-current (i₀) is produced which is proportional to the intensity of irradiation. With a high external resistance a photo-e.m.f. V appears which shows considerable inertia as a function of the time t and which can be written as

\[ V = V_{\text{max}}(1-e^{-kt}) \]

It appears that k is proportional to the intensity of irradiation. The value of k decreases with increasing thickness d of the layer. After correcting for this change of k, which is probably due to absorption, we find that \( i_0d = \text{constant} \). An attempt is made to explain the observed phenomena by assuming that the work function Ta-Ta₂O₅ is smaller than the work function electrolyte-Ta₂O₅.


Starting from the assumption that an anodic oxide layer on metals like Al and Ta has an amorphous structure, a relation between field and current during anodic oxidation is derived. It appears that this relation is somewhat different from the exponential one usually derived in literature (Verwey, Mott). With the new relation, it is possible to explain the various results obtained with the experiments presented in this paper. Probably it may explain the rather different numerical results mentioned in literature in the same way. The consequences of the amorphous structure on a more detailed picture...
of the oxidation process have also been calculated. The results point to a frequency dependence of one of the parameters as was actually observed in the experiments. The observed agreement between theory and experiments has made it possible to calculate approximately the parameters introduced in this theory.


The quantum efficiency of F-centre fluorescence at 77 °K in x-ray and additively coloured KCl has been measured using an integrating sphere. Values of up to 91% have been found, depending on the concentration of F and M centres.


A theoretical analysis is given of a diode detector stage for a modulated signal with asymmetrical sidebands of which the carrier is detuned with respect to the resonance frequency of the I.F. circuit. The equivalent circuit is found to be a three-port consisting of the impedances for upper- and lower-sideband frequencies and video frequency in series. Measurements show different overall characteristics in the case of equal positive or negative detuning of the carrier frequency; this effect is caused by the asymmetrical shape of the diode-current peak.


An experimental method is described for determining the distribution of a relatively small number of foreign non-magnetic ions between the two sub-lattices of an antiferromagnetic, in which they replace the same number of original magnetic ions. The influence of the foreign ions on several measurable quantities is investigated. This influence can be used to determine some specific constants of the antiferromagnetic. In the anisotropy energy besides the usual terms an interaction term between the two sub-lattices is taken into account. Use is made of the spontaneous magnetization, the parallel and perpendicular susceptibilities, the critical field strength and the antiferromagnetic resonance.


The disappearance of electrons from an isothermal disintegrating gaseous discharge plasma is investigated both theoretically and experimentally by considering the shift of the resonance frequency of a microwave cavity enclosing the plasma. The first few sections discuss theoretically such items as (1) the complex conductivity of a plasma at high frequencies, (2) the influence of the various loss processes on the shape of the electron density—time curve, (3) the connection between the conductivity of the plasma and the properties of the cavity for various types of cavity. In measuring the frequency shift as a function of time, it proves to be necessary to limit the power of the probing signal (frequency ≈ 10000 Mc/s) to a few microwatts. The construction and preparation of the gas containers and the measurements are presented. The disappearance process of the electrons from the plasma in helium is found to be ambipolar diffusion even at a pressure of 25 mm Hg. The mobility of the HeI + ions in helium at standard density is $\mu_0(\text{He}_I^+) = 17.3 \pm 0.7 \text{ cm/s per volt/cm}$. In the neon afterglow, however, the electrons disappear at a pressure of 20 mm Hg by dissociative recombination with NeI ions ($a \approx 2.5 \times 10^{-7} \text{ cm}^3/\text{s}$). An admixture of rare-gas atoms with a lower ionization potential than that of the main gas is found to have a great effect on the disappearance of the electrons. The afterglow is studied in the binary gas mixtures of helium with a small concentration of neon, argon, or krypton, and also in neon-argon and neon-krypton mixtures. Measurements in these mixtures all show the production of a considerable number of atomic ions of the admixture, even at very low concentrations of the latter. The process concerned in helium-neon is a charge-transfer process between a HeI+ ion and a neon atom; the relevant cross-section is found to be $Q_{ce} \approx 1.5 \times 10^{-15} \text{ cm}^2$. In the other mixtures the atomic ions are produced by the Penning effect and possibly by the above type of charge-transfer process, which cannot be separated in the present experiment. In all gas mixtures the atomic ions are found to be converted into molecular ions by three-body collisions with an atom of the main gas and an atom of the admixture. The probability of this conversion process proves to depend strongly on the difference between the ionization potential of the main gas and that of the admixed atoms, and is found highest in helium-neon. Moreover, the measurements suggest the conversion of NeI + ions into (HeNe)+ ions by a three-body collision with two helium atoms.