crete required to reduce intensities to a half value. It was found that the effectiveness of this shielding material provides a saving in floor space that more than offsets the slight additional cost of the special concrete. E.C.

Magnetite Concrete for Radiation Shielding. By E. Creutz and K. Downes. *J. Appl. Phys. 20: 1236, December, 1949.*

Ferromagnetic Crystals

Much of our knowledge of the solid state of matter depends on the study of the properties of single crystals. Research on crystal structure, elasticity, piezoelectricity (fundamental and applied), and ferromagnetism, to mention only a few examples, has depended on the successful growing of crystals to a size larger than that occurring in natural or technical materials. The technique described in this article is directed toward the growing of ferromagnetic crystals, which have already been used for investigating magnetic domains, magnetic anisotropy, elastic constants, and the damping of elastic vibrations. It is believed that the methods of growing, orienting, and cutting metal crystals of rather high melting point (1400 to 1600°C), as described in this paper, will prove helpful to investigators in other laboratories. The many requests for these crystals, received at the Bell Laboratories and not fulfilled because the crystals were not available, show that they are desired in an increasing number of investigations. Work on elastic constants and neutron diffraction, as well as on various ferromagnetic phenomena, could be carried forward more rapidly if more ferromagnetic crystals were available. R.M.B.

Growing and Processing Single Crystals of Magnetic Metals. By J. G. Walker, H. J. Williams, and R. M. Bozorth. *Rev. Sci. Inst. 20: 947, December, 1949.*

Electric Breakdown

Pure single crystals subjected to an intense electric field under carefully controlled conditions break down at characteristic minimum field strengths (about 10^6 volts per centimeter). The breakdown takes the form of a thin conducting channel which suddenly and rapidly punctures the crystal. Although the breakdown paths lie along definite crystallographic directions, the breakdown field strengths are, surprisingly, found to be independent of the relative orientation of the applied field and the crystallographic axes.

It has been suggested by A. von Hippel that the breakdown process results when the applied field is capable of accelerating the few electrons in the conduction band to such energies that they are able to ionize the negative ions of the crystal by collision. The population of the conduction band then builds up locally in the form of an avalanche, which melts the crystal and produces a breakdown path.

The frictional drag on the electron, which determines the breakdown field strength, is exerted by the interaction of the electron with the vibrational modes of the crystal. This interaction is computed for ionic crystals by an adaptation of a method developed by H. Fröhlich. The drag is greatest for very slow electrons, which therefore determine the breakdown strength. These slow electrons interact only with vibrational modes of long wavelength, which are insensitive to direction. The fast electrons, however, interact with the direction sensitive modes having wavelengths comparable to the distance between atoms, thus producing the direction sensitivity of the observed breakdown paths. The computed breakdown field strengths are also in good agreement with experiment. H.C.

Electric Breakdown in Ion Crystals. By Herbert Callen. *Phys. Rev. 76: 1394, November 1, 1949.*

Ultrafast

Voltage impulses may be helpful, among their other uses, in studying the starting characteristics of physical phenomena which they themselves have initiated. The electric breakdown of solids and gases at atmospheric and higher pressures has been particularly challenging over the years, for instance, because the starting times involved can be so extremely short, being in some cases less than 5×10^{-10} seconds. It was necessary, in exploring the problem, to produce and measure twenty kilovolt impulses arising in times of less than 10^{-9} seconds. The techniques of working with such fast impulses posed many new problems, for these transients may have frequency components over the range from 10 to 3000 megacycles per second, which requires extremely broadband ultrahigh-frequency circuits. These impulses have thus been called ultrahigh-speed impulses.

The method used for producing these short impulses has been to arrange a spark gap containing 600 pounds per square inch of nitrogen along the center conductor of a coaxial transmission line. The use of the transmission line as a connection has the advantage that lead inductances and capacitances are made to look like a pure resistance. The impulses have been measured with the micro-oscillograph through a voltage divider. The knotty problem of a voltage divider was solved only by abandoning lumped circuits altogether and using instead two concentric coaxial transmission lines, the ratio of whose characteristic impedances gives the desired divider ratio. By these means voltage impulses have been produced and measured with rise times as small as 4×10^{-10} seconds. R.C.F.

Production and Measurement of Ultrahigh-speed Impulses. By R. C. Fletcher. *Rev. Sci. Inst. 20: 861, December, 1949.*

Conductivity at Microwave Frequencies

If a high frequency electric field is applied to an ionized gas, the resulting oscillatory motion of the free electrons will give rise to an alternating current. At very low gas pressures the inertia of the electrons causes this current to lag ninety degrees behind the electric field; as the pressure, and hence the density, is increased, frequent collisions of electrons with gas atoms will produce an energy loss which must be supplied by a component of current in phase with the field. This behavior may be described by assigning a complex conductivity to the ionized gas whose real and imaginary components correspond to the in-phase and out-of-phase current components. A knowledge of this conductivity is necessary in the analysis of ionosphere problems and in several phases of microwave work, such as the switching or modulation of large amounts of microwave power by means of relatively low energy gaseous discharges.

An experimental determination of complex conductivity at ten thousand megacycles has recently been made by placing a direct current glow discharge along the axis of a cylindrical microwave cavity. It was shown that both conductivity components can be calculated by determining two quantities: the relative change in transmission of three centimeter power through the cavity, and the shift in its resonant frequency, both measured as a function of discharge current and gas pressure. The experimental technique used can be extended so that high speed transient phenomena may also be investigated. Thus if the discharge current is suddenly stopped, the resultant deionization can be investigated by means of a suitable oscilloscope presentation of the output signal from the cavity, from which values of electron density versus time may be deduced. Since at the high frequencies used the relatively massive ions are not measurably affected by the microwave fields, only effects due to the free electrons are observed, leading to a great simplification in the interpretation of the results. Finally, the cavity technique may be used to study the behavior of dielectrics at microwave frequencies, simply by replacing the discharge tube by a columnar sample of the dielectric substance of interest; accurate determinations of dielectric losses can thus be made. F.P.A.

Measurement of the Complex Conductivity of an Ionized Gas at Microwave Frequencies. By Fred P. Adler. *J. App. Phys. 20: 1125, November, 1949.*

Sanguine

Frequently it is of interest in physiological research to study blood flow rate variations as affected by drugs or by external stimuli such as heat. The instrument described below was developed to meet the need for a reliable, easily operated device which will instantaneously and continuously measure and record blood flow in experimental animals.

The blood vessel in which one wishes to measure the flow is excised and a glass cannula inserted so that the blood flows through it. Heparin is injected into the animal to prevent clotting. The cannula contains two platinum electrodes sealed into the glass so as to contact the blood stream with a minimum of internal discontinuity. The cannula with its two electrodes is placed between the pole pieces of an electromagnet which is excited with sixty cycle power from the AC line. The blood, which is a fairly good conductor, has a voltage induced in it which is proportional to its linear velocity, in the same fashion that occurs when any conductor is moved in a magnetic field. The resulting small sixty cycle voltage is amplified by a conventional amplifier. The output stage provided is sufficiently powerful to operate both a large indicating meter and an ink-writing recorder.

The instrument is calibrated by passing a known volume of saline solution through the cannula in a measured time. The scale of the instrument is linear, so calibration at a single point is sufficient. Flow rates as low as ten centimeters per minute can be read with ease on this instrument.

The electromagnetic blood flow meter, which has seen successful experimental use, is expected to find a fairly wide field of application in physiological research. J.W.C.

An Electromagnetic Blood Flow Meter. By John W. Clark and James E. Randall. *Rev. Sci. Inst. 20: 951, December, 1949.*

Sensitive

The latent image formed on exposing a photographic emulsion to light is generally believed to consist of an agglomeration of silver atoms (a minute silver crystal) formed at the site of a "sensitivity speck" or "trap." But the mechanism of this process is still far from clear although important contributions to its explanation have been made in recent years. In the paper under review, additional information was obtained by measuring the temperature dependence of the spectral sensitivity of photographic emulsions *containing no optical sensitizer* (dye).

Experimental results show the temperature dependence of the sensitivity of the silver bromide itself to be different from that of the additional sensitivity effected by chemical sensitization. It was found that the large drop in the sensitivity of commercial emulsions when they are cooled from room temperature to -195°C is due, in the main, not to a genuine decrease in the light sensitivity of the silver bromide but to the chemical sensitization becoming less effective in enhancing the sensitivity of the silver bromide. Evidence is given that two kinds of sensitivity specks exist, one being numerous and consisting of shallow traps, responsible for the sensitivity of chemically nonsensitized emulsions, and the other kind being few in number and consisting of deep traps, responsible for the larger part of the sensitivity of chemically sensitized emulsions. The two kinds of sensitivity specks are compared with those existing in alkali halides but there are no definite clues regarding their nature. M.B.

Dependence of the Sensitivity of Unsensitized Photographic Emulsions Upon Temperature. By Martin Biltz. *J. Opt. Soc. Am. 39: 994, December, 1949.*

Colour in Nature

How dull is Nature! Few the tints she wears:
Mulberry, maple, hemlock all are green;
The cold, damp earth a yellow-red is seen,
With sky and distant hills the water shares
A dismal blue. Test then the pine that dares
To front the gale, try sycamore, a queen
Among the trees; is there no colour keen
To joy the eye of one who stands and stares?
But I have seen the primrose in the hedge,
The viridescent moss within a cave;
A snow-capped peak aglow with Tyrian hue,
And emerald gleam from mallard midst the sedge.
The sun in setting still will oft engrave
With reckless palette that pervading blue.

A. E. Dodd

On reading: The Colors of Natural Objects and Terrains, and Their Relation to Visual Color Deficiency. By C. D. Hendley and Selig Hecht. *J. Opt. Soc. Am. 39: 870, October, 1949.*