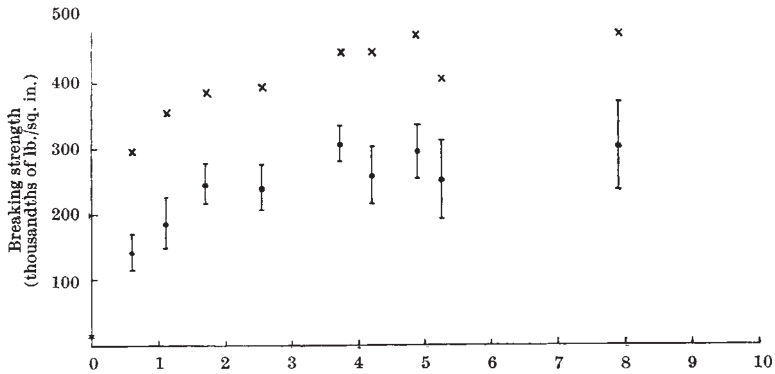

Fig. 1. Breaking strength as a function of depth of material removed from the surface. ×, Highest strength value in one group of rods ; ●, mean strength and 95 per cent confidence limits for one group of rods

particular etching solution removes material from a glass surface it is possible to study the strength of etched specimens as a function of the depth of material removed from the surface. Such a study may give some information about the size and nature of the surface imperfections.

Commercially available soda-glass rods, of 6–8 mm. diameter, have been etched and broken in four point bending over a constant bending moment span of 1 in. The rod diameters and loads at fracture were measured and the breaking stresses calculated using the simple bending formula. Groups of rods (containing 16–32 rods) were given different periods of etching, and the depth of material removed from the surface of the rods was calculated for each group.

The variation of the mean breaking strength of these groups of rods, with depth of material removed from the surface, is shown in Fig. 1. Also shown on Fig. 1 are the 95 per cent confidence limits on the mean strength and the highest strength value recorded in each group of rods. Fig. 2 is a histogram comparing the distribution of breaking stresses for a group of rods which have been etched for 40 min. with that for unetched rods. The maximum strengths obtained with these bulk glass specimens are in the region 450,000–500,000 lb./sq. in. and closely approach the value obtained by Thomas[2] for fine glass fibres.

The glass rod used in these experiments had the following approximate composition by weight (percentages) : SiO_2, 69 ; Na_2O, 16 ; CaO, 4 ; Al_2O_3, 3 ; MgO, 3.

The etching solution contained about 15 per cent hydrofluoric acid, 15 per cent sulphuric acid by weight and the remainder water.

Experiments are being continued to determine the effect on these results of varying the concentration, temperature and nature of the etchant ; and of changing the thermal history, size and composition of the glass.

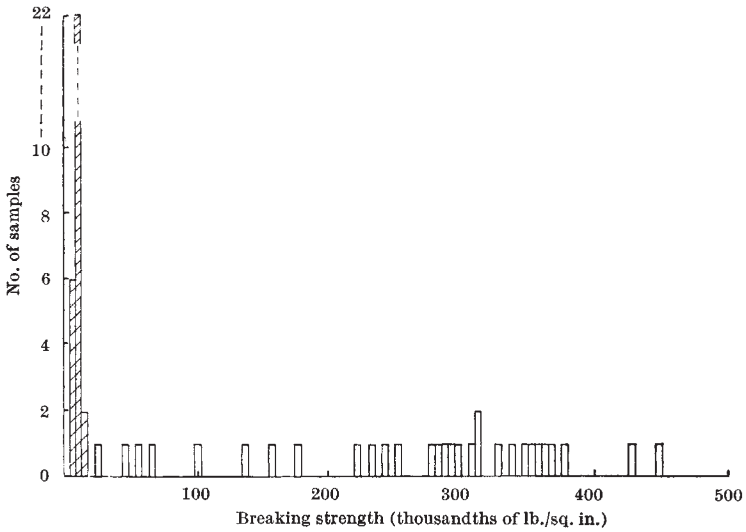

Fig. 2. Frequency of results as a function of breaking strength for etched (unshaded) and unetched (shaded) rods. The former were etched for 40 min. ; depth removed from surface = 4·2 × 10^{-2} cm.

B. A. PROCTOR

Rolls-Royce, Ltd.,
Aerophysics Laboratory,
Littleover,
Derby.
June 22.

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Stimulated Optical Radiation in Ruby

Schawlow and Townes[1] have proposed a technique for the generation of very monochromatic radiation in the infra-red optical region of the spectrum using an alkali vapour as the active medium. Javan[2] and Sanders[3] have discussed proposals involving electron-excited gaseous systems. In this laboratory an optical pumping technique has been successfully applied to a fluorescent solid resulting in the attainment of negative temperatures and stimulated optical emission at a wave-length of 6943 Å. ; the active material used was ruby (chromium in corundum).

A simplified energy-level diagram for triply ionized chromium in this crystal is shown in Fig. 1. When this material is irradiated with energy at a wave-length of about 5500 Å., chromium ions are excited to the $^4F_2$ state and then quickly lose some of their excitation energy through non-radiative transitions to the ^2E state[4]. This state then slowly decays by spontaneously emitting a sharp doublet the components of which at 300° K. are at 6943 Å. and 6929 Å. (Fig. 2*a*). Under very intense excitation the population of this metastable state (^2E) can become greater than that of the ground-state ; this is the condition for negative temperatures and consequently amplification via stimulated emission.

To demonstrate the above effect a ruby crystal of 1-cm. dimensions coated on two parallel faces with silver was irradiated by a high-power flash lamp ;

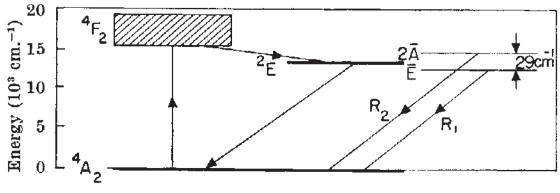

Fig. 1. Energy-level diagram of Cr^{3+} in corundum, showing pertinent processes

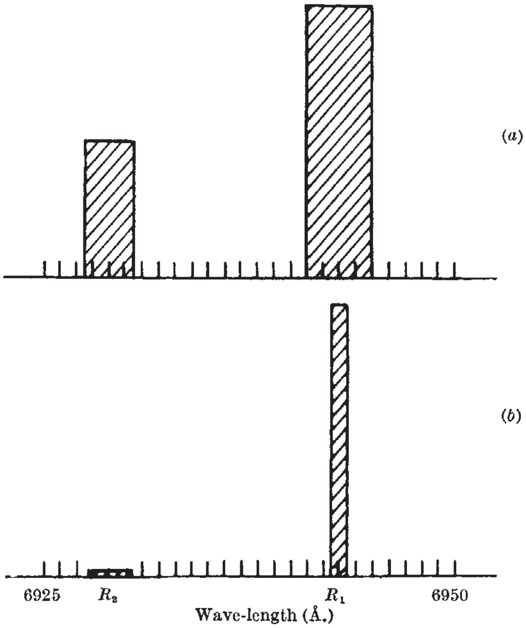

Fig. 2. Emission spectrum of ruby: *a*, low-power excitation; *b*, high-power excitation

the emission spectrum obtained under these conditions is shown in Fig. 2*b*. These results can be explained on the basis that negative temperatures were produced and regenerative amplification ensued. I expect, in principle, a considerably greater ($\sim 10^8$) reduction in line width when mode selection techniques are used[1].

I gratefully acknowledge helpful discussions with G. Birnbaum, R. W. Hellwarth, L. C. Levitt, and R. A. Satten and am indebted to I. J. D'Haenens and C. K. Asawa for technical assistance in obtaining the measurements.

T. H. Maiman

Hughes Research Laboratories,
A Division of Hughes Aircraft Co.,
Malibu, California.

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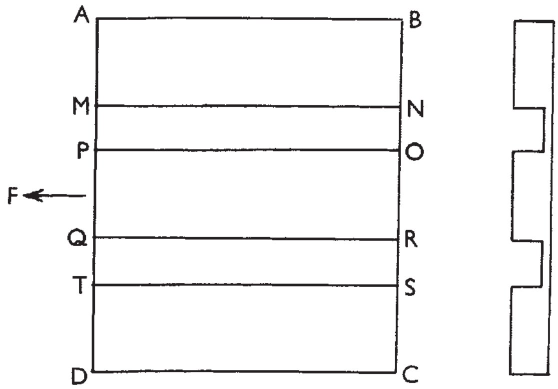
METALLURGY

A Simple Method of investigating the Creep of Metals under Simple Shear

Dr. K. H. Jolliffe and I[1] have investigated the creep of metals under simple shear by the use of a disk of the metal in question, in which is cut a concentric circular annulus, the metal external to the annulus being securely gripped, while that internal to the annulus is subjected to a constant torque. We have shown that the behaviour of the metal in these circumstances is in many ways simpler and more informative than that exhibited by wires or rods under tension.

From the point of view of the industrial study of creep, the method has the disadvantage that the specimens are somewhat troublesome to prepare and measure. To get over this difficulty I have devised a method in which the specimen has the form shown in Fig. 1. In the plate *ABCD* (Fig. 1*a*) are cut rectangular grooves *MNOP*, *QRST*, as shown in cross-section in Fig. 1*b*. The metal *ABNM*, *TSCD* is securely held, and a force *F* applied to the metal *PORQ* in a direction parallel to the grooves. Under these conditions the shear stress distribution in the rectangular plates *MNOP*, *QRST* is not strictly uniform, as it is in the disk method, which is clear from the fact that the shear stress over the free ends must be zero. The distribution has been worked out by me[2] and by C. E. Inglis[3].



(*a*) (*b*)
Fig. 1

Mr. D. B. Gilding has been working under my direction on the best form of the plate and has established that if the ratio of *MN* to *NO* is in the region of 7, the results on creep obtained with the disposition described correspond closely to those obtained by the method of Andrade and Jolliffe[1]. It seems possible that the new method may be of use in further investigations of creep and may also have applications to the problem of fatigue.

E. N. da C. Andrade

Department of Metallurgy,
Imperial College of Science and Technology,
London, S.W.7.

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An Improvement in the Ductility of Beryllium at High Temperatures

The outstanding problem in beryllium metallurgy is the lack of ductility exhibited by the metal, both at room temperature and at elevated temperatures. At room temperature, brittleness can be attributed to the ease of cleavage of basal planes of the hexagonal lattice, and to the high yield-strength of the prismatic planes, while at temperatures above 400° C., intergranular failure predominates. A ductility maximum occurs at intermediate temperatures depending on the strain-rate used, tensile specimens failing with