which our surveys were made is not constant but varied from 19° E. in Cape Town to about 70° E. in the position of 20° S. geomagnetic latitude, some longitude effect should be included in the observed intensity-latitude curve. For example, double circles in Fig. 1 illustrate the mean neutron intensity in Cape Town, where the ship stayed for about a week every one passage. Each of them largely deviates from the respective latitude curve AA' , amounting to 5 per cent in average. Correction for this amount of longitude effect leads to upward shifting of the position of the first 'knee' by only a few degrees. Nevertheless, there should still remain some significant difference between the air-altitude 'knee' and the sea-level one. This also may be concerned with any primary spectrum around Cape Town anomaly. Detailed consideration and discussion of the foregoing problems will be published elsewhere. In this article we wish to point out the fact that some anomalous effect in the primary cosmic-ray spectrum due to the strong geomagnetic anomaly is observable even at sea-level. In any event, it will be necessary to measure altitude and latitude dependences of the various components by balloon flight around Cape Town anomaly.

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MASAHITO KODAMA

The Institute of Physical and Chemical Research,
Tokyo.

¹ Kodama, M., *Sci. Papers Inst. Phys. Chem. Res.*, **54**, 20 (1960).

² Kodama, M., Fukushima, S., and Makino, T., *J. Phys. Soc. (Japan)*, Supp. A, **2**, 441 (1962).

³ Webber, W. R., and Quenby, J. J., *Phil. Mag.*, **4**, 654 (1959).

⁴ Quenby, J. J., and Webber, W. R., *Phil. Mag.*, **4**, 90 (1959).

⁵ Quenby, J. J., and Wenk, G. J., *Phil. Mag.*, **7**, 1457 (1962).

⁶ du Plooy, N. F., Kühn, G. J., Maree, J. P., Stoker, P. H., and van der Walt, A. J., preprint (1962).

Breaking Extension of Nylon Filaments under Combined Axial and Transverse Stresses

THE normally accepted coaxial helix model of the geometrical structure of a continuous filament textile yarn¹ is such that rupture of the yarn would be expected to commence at its centre, where the filaments are aligned parallel with the yarn axis. Hearle and Thakur² have shown for short lengths of yarn extended at low strain rates that breakage of the yarn begins at a point away from the yarn centre. They concluded that this type of rupture would be expected if the centre filaments of the yarn were buckled in the unstrained state. This explanation, however, ignores any alteration in filament breaking extension which may be associated with the transverse stresses exerted by the surrounding filaments. These stresses have been shown^{3,4} to modify considerably the stress distribution in rubber filaments which form a twisted structure of the type described here. Some results which I have obtained recently on the breaking extensions of nylon monofilaments subjected to a combined axial stress and transverse compressive stress show that their extensions at break are changed under these conditions.

Model yarns consisting of a straight centre filament of low breaking extension around which are wrapped five filaments of medium breaking extension in a helical configuration have been constructed. These models are designed to ensure that, on stretching, the centre filament breaks first. Using an Instron machine, the models were stretched until the centre filament broke and the strain at this point was observed. This corresponds to the breaking strain of the centre filament when subjected to a tensile stress along its axis together with a transverse compressive stress. By varying the initial helix angle of the outer filaments, a range of values of breaking extensions and

Fig. 1

corresponding transverse stresses has been obtained. These stresses were calculated from a knowledge of the yarn geometry at the breaking point and the stress-strain property of the outer filaments. Results given here show the relation between the breaking extensions and the calculated stresses for two nylon filaments with normal breaking extensions of 13.8 and 19.8 per cent. It is seen that the strains at which the two specimens break increase considerably with transverse stress, particularly for the specimen with the lower breaking extension. This effect has also been observed in cellulose and 'Terylene' monofilaments. It should be noted at this point that an increase in breaking extension may not necessarily occur when the transverse stresses are applied via a fluid, for such a stress system would differ from that used here in that it would not be accompanied by large frictional forces acting over the filament surface. While not rejecting the likely explanation of this effect as being the presence of the transverse stresses, it might be explained by the frictional forces alone which bring about a more uniform distribution in stress along the filament.

Filaments at the centre of a yarn under tension are subjected to the largest transverse stresses so that their breaking extensions will be increased by a greater amount than those away from the centre, where the stresses are less. It follows from this that the precipitation of rupture of a textile yarn might begin at a point away from its axis even when the centre filaments are straight and parallel to the yarn axis.

An effect of this kind might be an important factor which has previously been neglected in investigating the mechanism of yarn rupture.

N. WILSON

Cotton Silk and Man-made Fibres Research Association,
Shirley Institute,
Didsbury, Manchester, 20.

¹ Platt, M. M., *Text. Res. J.*, **20**, 1 (1950).

² Hearle, J. W. S., and Thakur, V. M., *J. Text. Inst.*, **52**, T, 49 (1961).

³ Wilson, N., *Brit. J. App. Phys.*, **13**, 323 (1962).

⁴ Treloar, L. R. G., *Brit. J. App. Phys.*, **13**, 314 (1962).

ENGINEERING

Fluid Extrusion as a Drawing Process

FLUID extrusion is normally conducted as shown in Fig. 1a, where the diameter of the billet is smaller than the maximum diameter of the die opening. A high hydrostatic pressure forces the metal to flow through the die into a low hydrostatic pressure.