FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 2 OF 1963.

A RECORDING OPTICAL EXTENSOMETER.

BY:

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An optical extensometer was devised for measuring the linear expansion and contraction of solid blocks of coal occurring during the adsorption or desorption of moisture from the surrounding atmosphere. The expansion or contraction is so small under these circumstances that it is wellnigh impossible to measure and record it by mechanical means (a dial gauge for example). This extensometer has the advantage that the expansion or contraction of the sample can be followed and can be automatically recorded for extended periods.

The apparatus is shown schematically in Fig. 1. Newton rings are formed between the surfaces* of a long focal length plano convex lens A and a total reflecting prism B. The lens is fixed to the outer casing C and the mounted prism rests on the coal sample D (a solid block ca. 1" x 1" x 2" cut so as to measure the expansion normal to the bedding plane). The sample rests on an adjustable base E which is held in position by means of the grub-screw F.

Any vertical movement of the sample is transmitted to the prism which in turn moves relative to the fixed lens. As a result the Newton rings, viewed from above, move outward or inward depending on whether the sample is expanding or contracting. This part of the apparatus is enclosed in an airtight, thermally insulated glass cover.

A low-power microscope is focussed on the rings from above. The crosshairs in the eyepiece are replaced by a pinhole screen to limit the field of view to the central Newton ring (which in this limiting case takes the form of a bright or dark circular patch). A photomultiplier tube** in a light-tight casing is placed over the microscope eyepiece to record the change in intensity of the central

Newton/....2/...

* By half-silvering these surfaces the clarity and number of rings visible were greatly improved. With a clearance of 0.004" between the lens and the prism rings were still discernable.

** R.C.A. 931 A.

Newton ring caused by the vertical expansion (or contraction) of the sample. The output of the photomultiplier is fed to a line recorder to yield a permanent record. A "peephole" is placed between the photomultiplier and the eyepiece to monitor the rings visually and determine in which direction they are moving.

A commercial sodium vapour lamp as used for street lighting purposes, although rather bulky, proved a very suitable source of monochromatic light. The prism is shown mounted in a block of aluminum which rests directly on the sample. By mounting the prism in this manner any slight change in vertical dimension of the sample is smoothly and accurately followed.

The upper and lower flanges of the glass housing for the extensometer are ground plane and provide excellent vacuum tight seals for the optical "window" and plate glass base respectively. The complete extensometer should be placed on a sandbath to isolate it from external vibration. A heat shield around the sodium lamp is also necessary.

Since the photomultiplier is used at its lower limit, a stable high tension source has to be provided. A typical value of the plate current is 5μA with a variation of 1-3μA due to the movement of the Newton rings. The high tension source consists of a step-up transformer fed from the mains via a constant voltage transformer and a "Variac". The output of the high tension transformer is rectified by five half-wave rectifiers (250V each) in series and shunted by a 2μF capacitor to minimise voltage ripple. The rectified output is stabilized at 900V by six voltage stabilizer tubes (VR 150) in series and shunted by a 4μF reservoir capacitor before being fed to the potential divider network of the photomultiplier. The output for the potensiometric line recorder is tapped from a variable resistance in the anode line of the photomultiplier. The h.t. source and recorder are earthed to a common point to prevent stray leakage currents and capacitative coupling from affecting the latter.

The attached recorder strip-chart shows the results which can be obtained. In this case a sample from the Orange Free State(Vereeniging) coalfields was cut to yield a block approximately 1" x 1" x 1½" with the longer dimension normal

to the/....3/...

to the bedding plane. The sample was placed in the extensometer and allowed to attain equilibrium for three days in an atmosphere of 45% relative humidity. At the point marked A on the attached strip-chart the relative humidity was increased to 95%. The sample began to expand immediately and 180 peaks were recorded over a period of five hours. Since each peak represents an expansion equivalent to one half* the wavelength of the monochromatic light used, the sample expanded 0.0021" in five hours.

* One half wavelength = $\frac{5890}{2}$ Å = $\frac{5890 \times 10^{-8}}{2 \times 2.54}$ inch.

= 0.0000116 inch.

(SIGNED) A.A. MEINTJIES.
ASST. TECHNICAL OFFICER.

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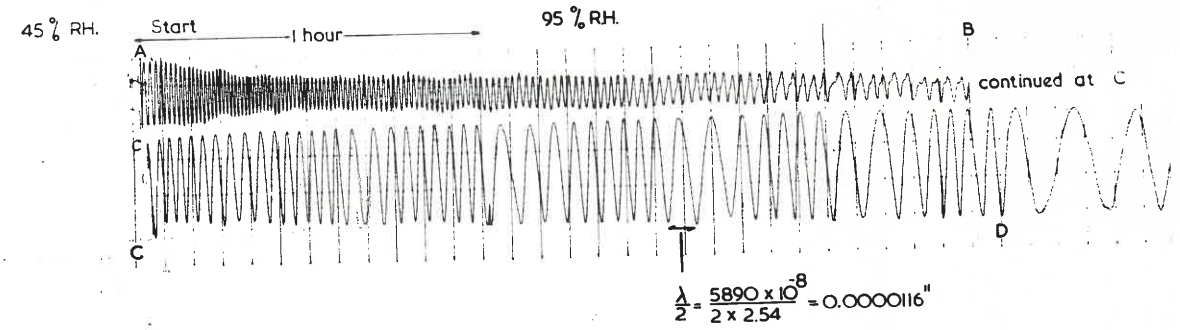

The decrease in amplitude between A & B is due to the gradual movement of the microscope from a central position. At point C the microscope was recentred.

Typical Strip Chart.

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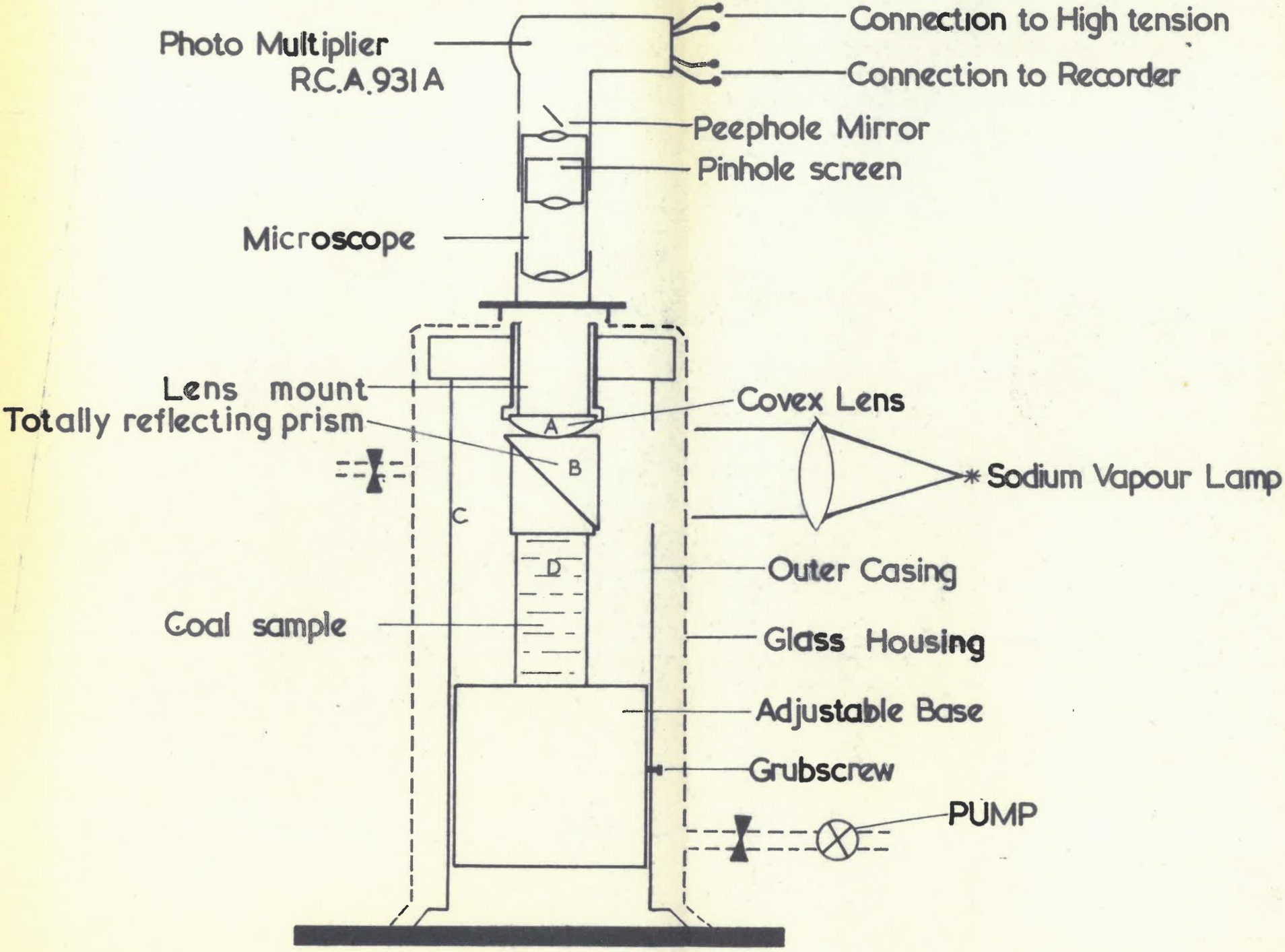

fig.1