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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 4 OF 1964.

A DEVICE FOR MEASURING THE STRENGTH OF SMALL PARTICLES.

By:

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INTRODUCTION:

In the study of the physical properties of an inherently brittle material such as coal it is of interest to determine the effect of certain physical properties (such as porosity) on the strength of the substance.

Now it is obvious that if a specimen used for strength tests should be unsound i.e. fissured or cracked, the determined strength values would be low. The chance of the specimen being unsound becomes smaller, the smaller the size of the specimen and in the limit a true or "ultimate" strength value should be approached when progressively testing specimens of smaller and smaller size.

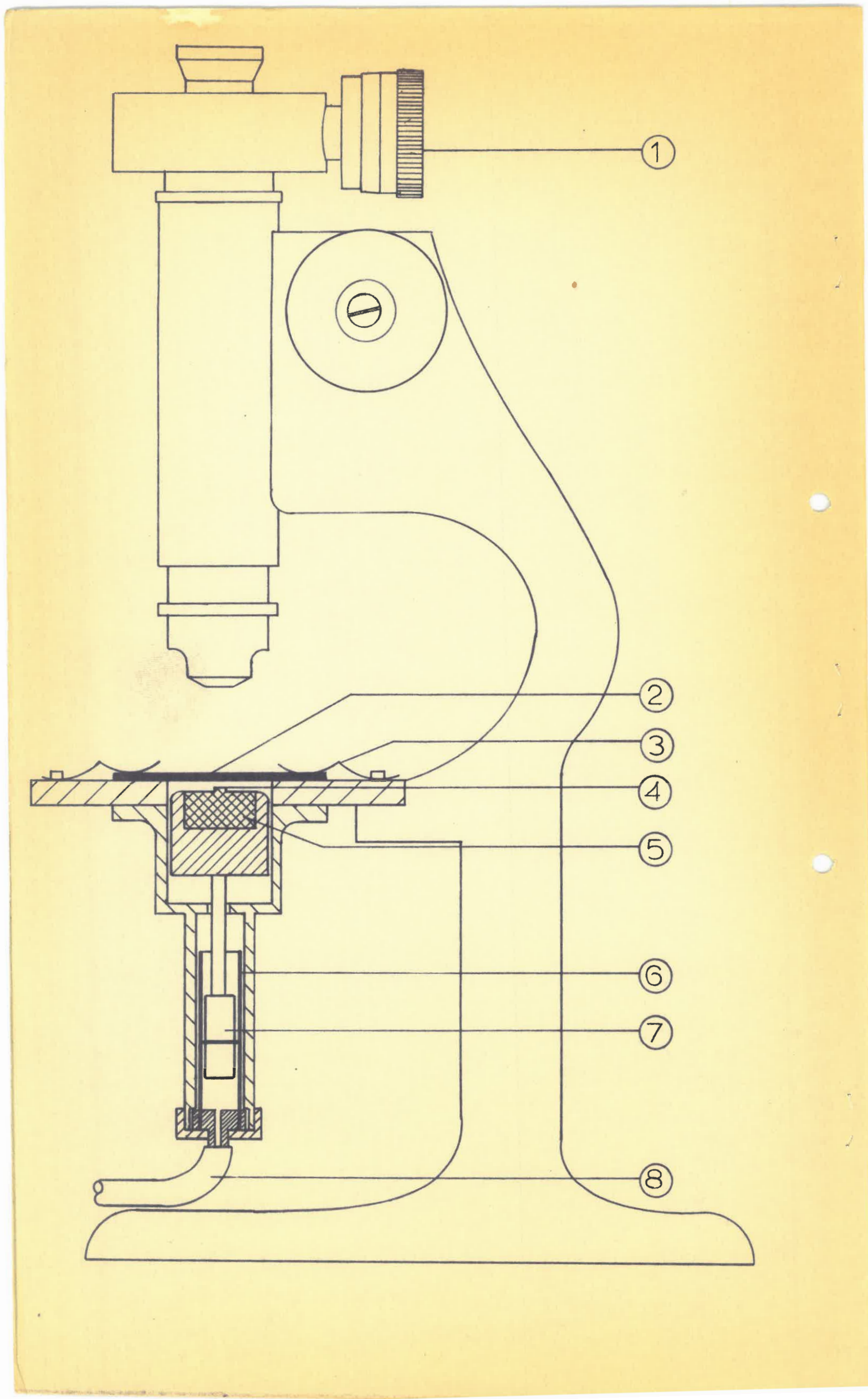
The problem arises how to determine the strength of very small particles. A practical solution to this problem, using particles of about 40μ in size was found at the Fuel Research Institute and the method is described in this paper.

Even smaller particles might be used, but about 40μ was found to be the practical limit with the equipment available to the author (viz. with regard to the isolation of a single particle and placing it in position in the apparatus).

THE APPARATUS:

The apparatus consists of a high magnification microscope to which devices have been attached, by means of which pressure could be applied (and measured) to small particles under observation.

The condenser .../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The condenser of the microscope was removed to allow accommodation for a small precision bore cylinder, (6) in Figure 1, and piston (7), which was fixed rigidly to the stage.

A 45° prism (5) was mounted on to the piston. The prism served to illuminate a specimen (4) placed on it, thereby permitting observation of the specimen.

A microscope slide (2) was clamped (3) to the stage so that when the piston moved upwards the particle was compressed between the prism and the slide.

Movement of the prism was accomplished by application of compressed air (via tube (8)), and the pressure was measured by means of a mercury manometer.

Particles of the material to be tested, obtained by careful crushing and screening, were placed on the prism, and with the aid of a pincette one particle was isolated and the others were removed.

The slide was then clamped into position and the piston was carefully moved upwards until the particle came into contact with the slide.

The size of the particle was then estimated by means of the vernier eye-piece (1).

The pressure on the particle was then carefully increased by small increments while the behaviour of the particle was observed until crushing occurred.

Strength tests on a macro scale are usually done on specimens cut to a regular shape, e.g. a cube.

If the material is homogeneous and isotropic it is immaterial how the cube is cut, but if it is layered, e.g., coal, two parallel faces should be parallel to the bedding plane, and strength tests would be done exerting pressure either parallel or vertical to the bedding plane. If a sound sample is available, only a few experiments need to be done to obtain reasonably reliable results.

Such a procedure cannot be followed with particles of about 40μ diameter. If one views such particles of most materials under the microscope it is found that the particles have an irregular shape. An orientation of the

specimen .../

specimen in terms of the bedding plane is impossible and one cannot determine the actual area that comes into contact with the pressure plate.

The nearest approach to ideal testing conditions, therefore, appears to be to prepare the sample carefully so as to reduce the width of the size spectrum of the crushed coal to a minimum and then to screen out a size fraction of very close size range.

Many particles from this fraction could be tested to arrive at a reasonably reliable result. Even then, absolute strength value cannot be expected, but the average result may suffice for comparative work or to determine certain correlations with other physical or chemical properties of the material.

The minimum number of tests on specimens of a particular material required to attain a desired reliability can be calculated by statistical analyses of a few preliminary tests.

Thus, analyses of the results obtained on 40 μ size particles of some South African coals indicated that for a confidence interval at the 95% level of approximately 5 to 10% of the mean, about 50 tests are required.

It is to be expected that a much smaller number of tests will suffice in the case of isotropic materials and which are more homogeneous than coal.

(SIGNED) P.G. Sevenster.

PRINCIPAL TECHNICAL OFFICER.

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