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ENGINEERING MEMO #112

November 5, 1976

Mr. J. F. Crews
National Radio Astronomy Observatory
P. O. Box 2
Green Bank, W. Va. 249440

Dear Mr. Crews:

As I told you in our recent phone conversation, we finally have finished our report on the NRAO Brake Spring. Klamut's and Chow's memo is straightforward and suggests that either a larger radius on the inner corner of the brake shoe or a bevel will probably remove enough material i.e. the decarburized layer so as to reduce the probability of crack initiation.

If we can be of any further help, please contact us.

Sincerely yours,

David H. Gurinsky

David H. Gurinsky
Associate Chairman for
Chemistry and Materials

DHG/ln
Enc.

BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

DATE: Oct. 13, 1976

TO: D. H. Gurinsky

FROM: C. J. Klamut, J. G. Y. Chow and A. P. Cendrowski

SUBJECT: Metallurgical Examination of NRAO Brake Spring

Two pieces of a broken Stowbrake spring from the 140 ft NRAO telescope were received at BNL for metallurgical examination.

The two pieces weighed about 80 lb and are shown in Fig. 1. To facilitate the examination small sections about 3/4" wide were cut from the area adjacent to the crack.

Material used to fabricate the spring was type 4340 heat treated to 210,000 psi yield and Rc 46-48.

Visual Examination

All external surfaces of the spring were coated with a thin, adhering oxide layer. The fracture surfaces were also oxidized with the surfaces closer to the inner diameter more oxidized than those surfaces closer to the outer diameter, Fig. 2. Appearance of the fracture surface is shown in the photograph, Fig. 3. It is a typical fatigue fracture, with the crack appearing to initiate at a corner of inner surface of the spring as indicated by the arrows in Fig. 3. The crack appears to have propagated through the spring toward the outer diameter with fracture finally occurring at the outer diameter.

Microscopic Examination

Small samples were cut from the spring in the region of the crack origin for metallographic examination.

In general the material was found to be sound, i.e. free of defects such as porosity and slag inclusions. There was no evidence of cracks internally or on any of the surfaces. A typical microstructure is shown in Fig. 4 and is of tempered martensite which is the microstructure for 4340 steel heat treated to hardness of RC 46-48.

A detailed metallographic examination was made of the spring inner diameter surface in an attempt to identify the cause of crack initiation. The microstructure and microhardness profile in the area of the crack, Fig. 5, showed that the surface was not decarburized. However, the microstructure and microhardness profile of the flat surfaces of the spring showed some decarburization to a depth of about .012", Fig. 6. The hardness in this area was about half that of the base material. As shown in the photomicrograph, Fig. 7, the decarburized zone extends around the radius between the spring flat face and the inner diameter surface.

Conclusions and Recommendations

Visual examination of the fractured surface indicates fracture of the spring initiated at the inner diameter and near a corner.

This would be expected since this region is subjected to the highest stress on opening the brake. The metallographic examination revealed a decarburized zone about 0.012" thick on the spring flat surfaces and the radius between the flat surface and the inner diameter surface. The crack appears to have initiated in the general area of this radius. Since no decarburization was found on the spring inner radius which was a machined surface, the decarburization probably took place during hardening heat treatment.

Fatigue strengths are proportional to the hardness of the steel. The decarburization found at the radius between the flat surface and the inner diameter surface decreased the hardness in this area and could have contributed to an earlier failure of the brake spring.

The choice of alloy, heat treatment and quality of material used to fabricate these springs appears to be suitable for this application. Also, the suggestions made by the Goodyear Tire and Rubber Company to extend the life of the springs are sound and should be implemented. Care should be taken in the manufacture of the springs to eliminate the surface decarburization if it is economically feasible to do so. If the decarburized layer is removed by machining, care should be taken to ensure the resulting surface is smooth and free of stress raisers.

Dist: I. Polk

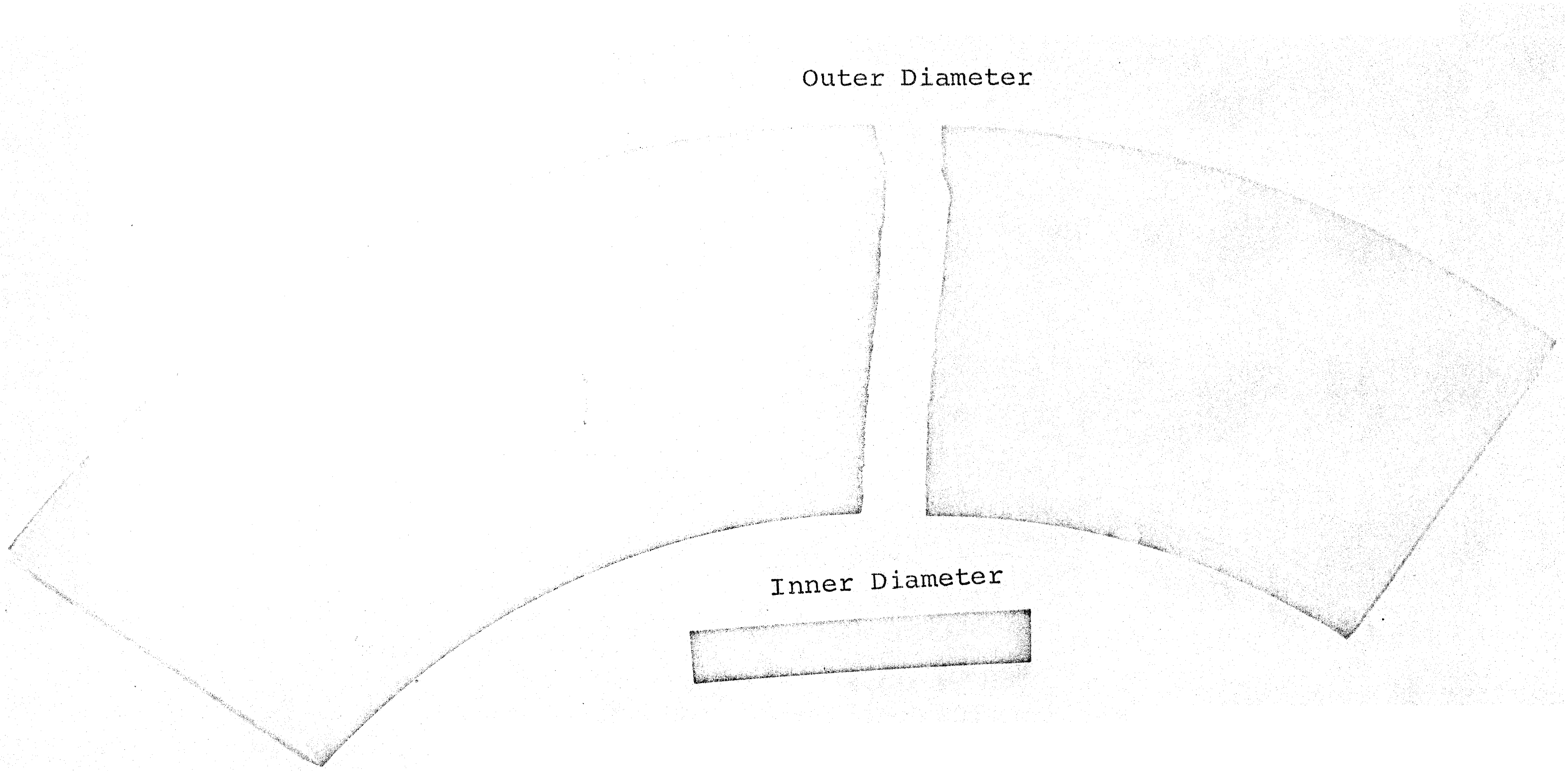


Fig. 1. Broken segments of Stowbrake spring

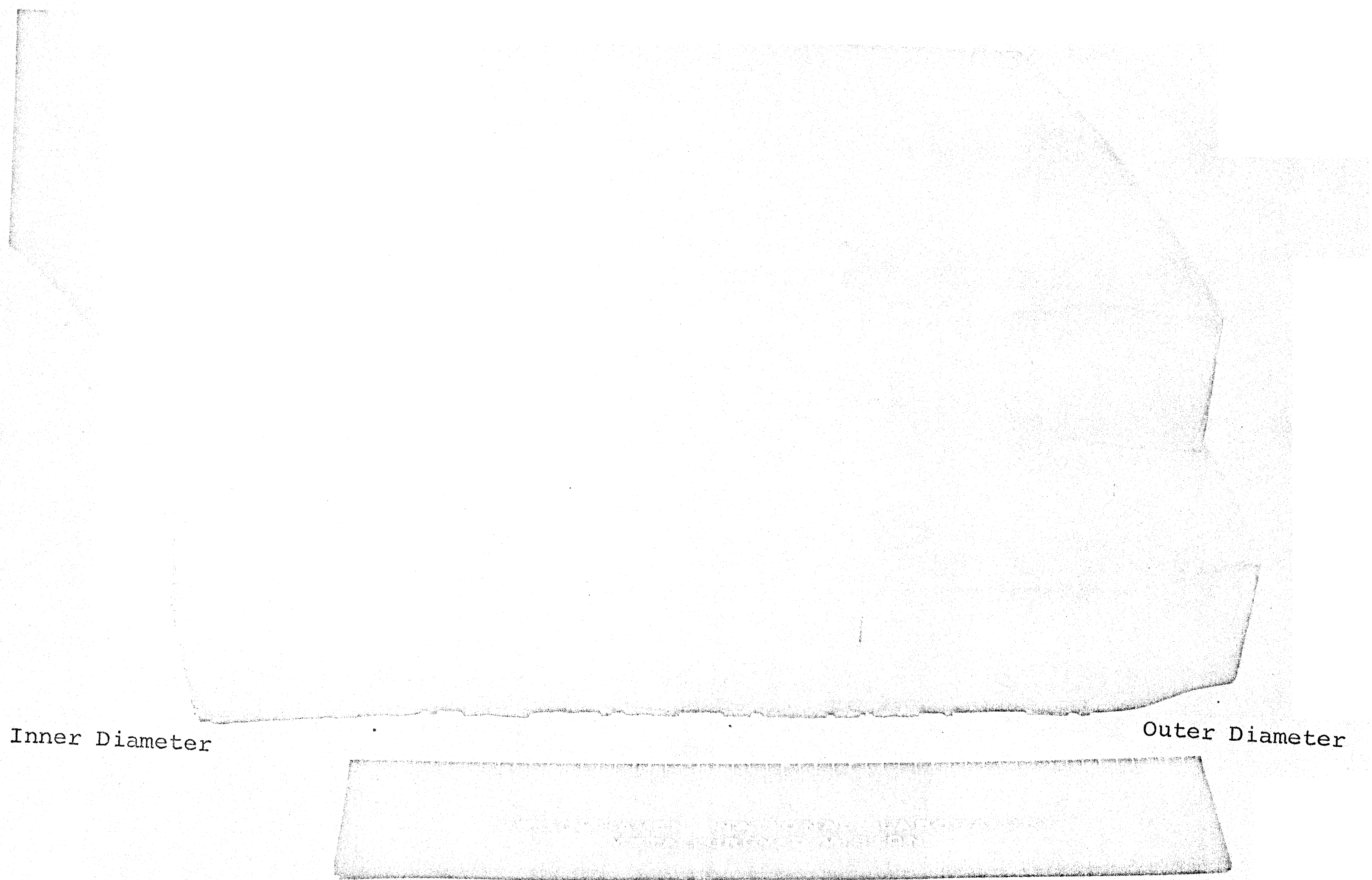


Fig. 2. Surface oxidation and fracture surface of Stowbridge spring

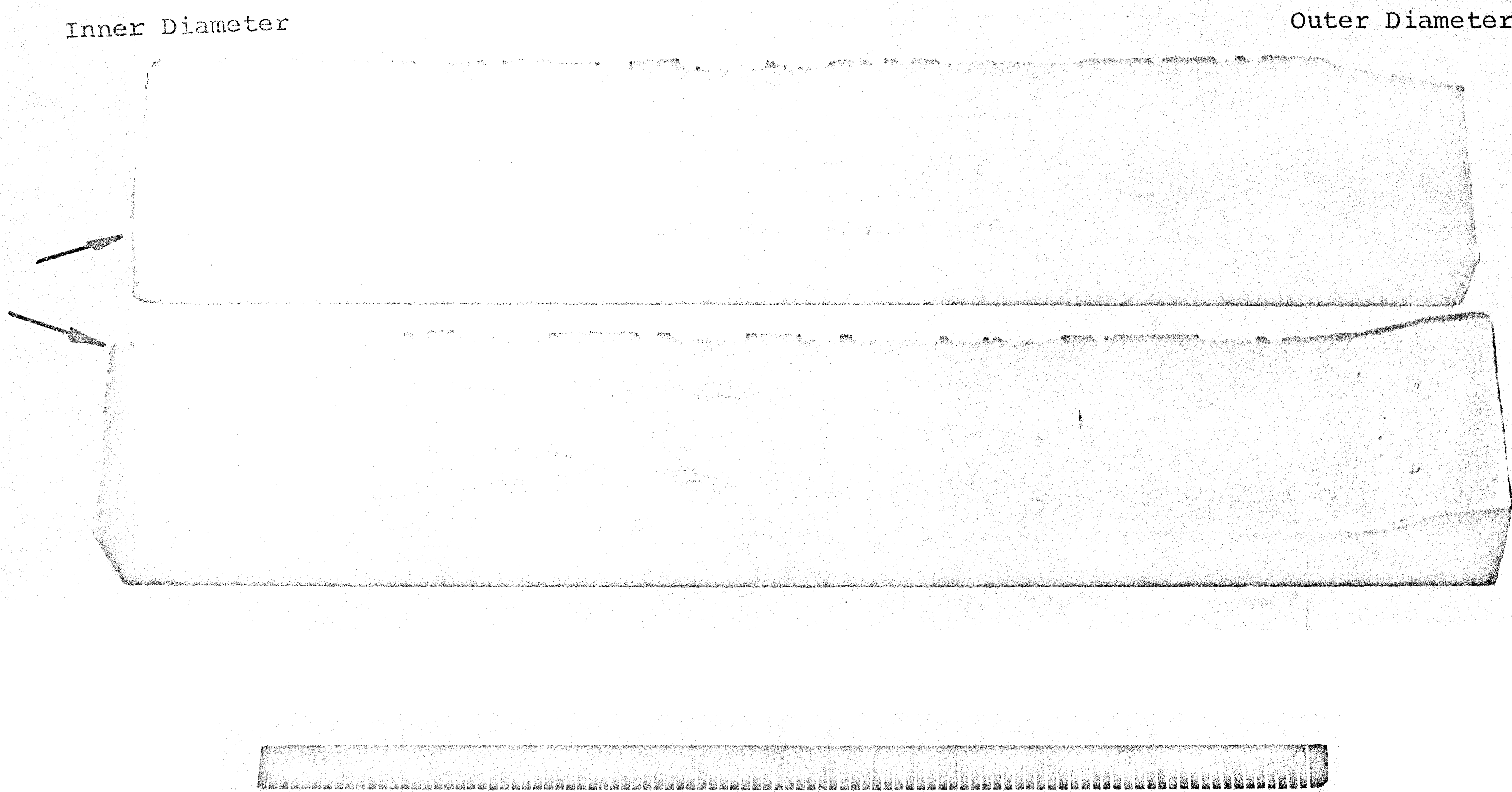
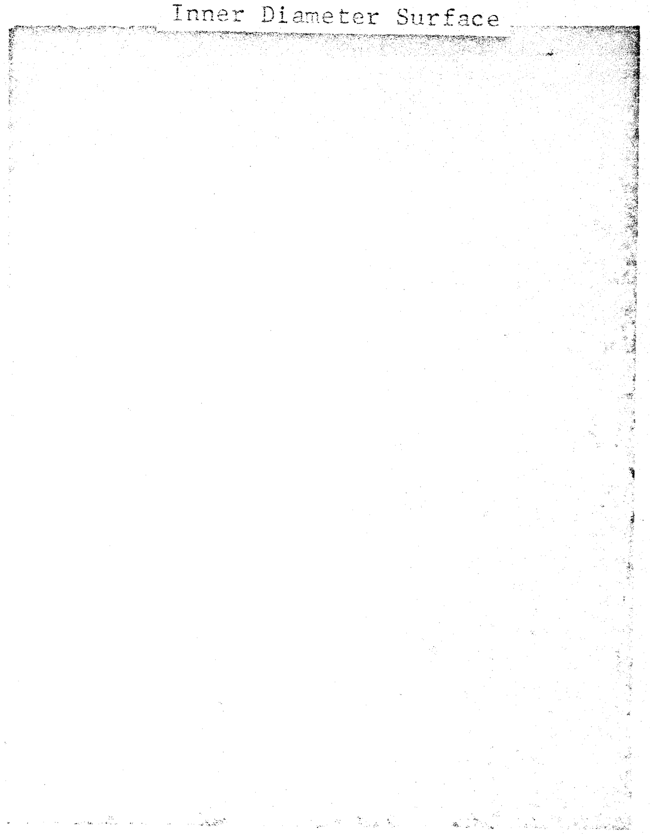


Fig. 3. Appearance of fracture surface showing a fatigue type failure

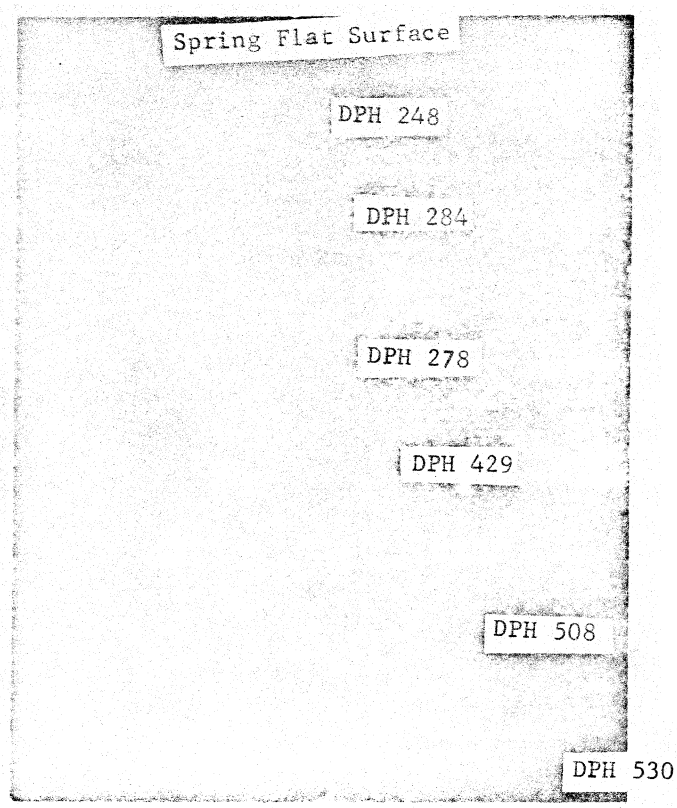
Nital Fig. 4 250X

Typical microstructure of spring material



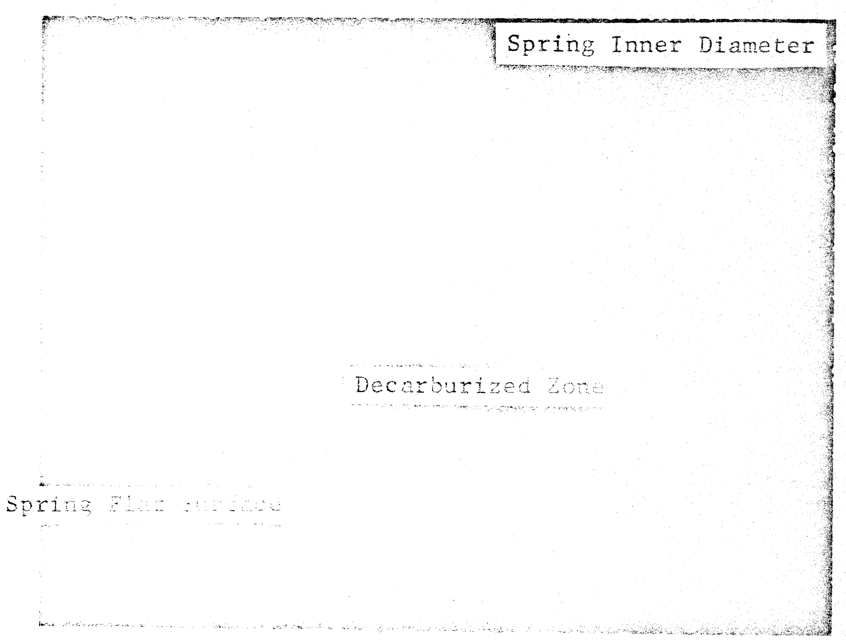
Nital Fig. 5 125X

Hardness profile of spring inner surface



Nital Fig. 6 125X

Microhardness profile near flat surface of spring showing decarburized zone



Nital Fig. 7 16X

Decarburized zone on radius between flat surface and inner diameter