MARKING PRODUCED ON SURFACES OF STEEL TARGETS BY COLLISION OF DETONATION WAVES

(Received Aug. 8, 1959)

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Detonating an explosive charge laid horizontally along a upper surface of a glass target, Pugh et al.[1] observed an advancing crack-front as well as a front of shock wave in the glass target by means of a high-speed photograph. The photographic method is unavailable for observation of a stress wave except a transparent target subjected to a detonation. Under the same experimental condition, an obliquely incident stress wave may also be produced in a steel target. In the present experiment, it has been tried to find a marking related to a front of an obliquely incident stress wave by etching a polished surface of a segment.

The marking in Photo. 1 was produced on the surface of the sectioned target attacked with the rectangular charge of cast TNT in contact with the mild steel target. The explosive charge was detonated from th left side and the detonation wave progressed tothe right side along the surface of the target. No trace related to the obliqely incident stress wave induced within the target can be found. A fracture was produced at the right hand region of the sectioned plane, as seen in Photo. 1

On the other hand, when the rectangular charge of TNT laid on a surface of a mild steel target was detonated simultaneously from both ends of the charge, a unique markings were produced on the sectioned and upper surfaces of the target, as shown in Photos. 2 and 3. The marking revealed on the flattened upper surface is remarkable.

Photo. 1

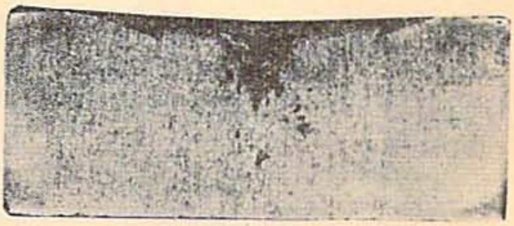

Photo. 2

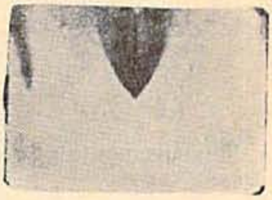

Photo. 3

Such a marking was observed very clearly on the specimen of Ni-Cr-steel target (JIS-SNC2, 100×75×22mm.) which was attacked with a rectangular charge of composition *B* (TNT/RDX=2/3, 25×25×65mm.). Photo. 4 shows the marking revealed on the surface of the target sectioned along the major axis of the rectangular target through the center of the deformation cused by the detonation. The upper surface roughened by the detonation was flatly cut by 2mm. in thickness. Photo. 5 shows the marking revealed on the flatened upper surface. The marking in Photo. 5 was schematicaly illustrated in Fig. 1. The lines E' E'' and F' F'' in Fig. 1 unite with the line OH′ without flattening. The illustration of the marking is shown solidly in Fig. 2. The area CLG-GMD in Fig. 2 was the zone subjected to the impulse caused from collision of two detonating waves of opposite direction. Photo. 6 was obtained by an optical enlargement (×5) for the spindle portion of the marking in Photo. 5. Segregation-lines of cementite-compornent are almost straight in the area *CH′D* in Fig. 1, while they are strongly deformed in the outside of the area *CH′D*.

It seems to the authors that the boundary CLG-GMD and the line *OH* do not show the flozened trace of the front of the obliquely incident stress wave, and that the line, OE (or *OF*), shows the trace in question, because the incident angle between the advancing wave front within the target and the upper surface may be obtained from the Hygens construction. From the known detonation velocity (u=7,560m/sec.) of the charge and the angle (α=62.5°) between *OE* and *OA* in Fig. 2, the velocity (v) of the obliqely incident wave in the layer near the upper surface can be calculated from $v=u \sin \alpha$. In this case, v is found to be 6,700m/sec, in the layer of about 7mm in width below the explosive-metal interface. This value exceeds an ordinary value of elastic sound velocity in the steel. On detonating cast TNT with the detonation velocity of 6,500m/sec, the angle β in Fig. 2 was about 50° almost independently of steel samples: mild steel (C= 0.17%), Ni-Cr-steel (JIS-SNC2) and Ni-Cr-Mo-steel (JIS-SNCM2). While β depended greatly upon the detonation velocity of the explosive charge. The value of β was 90° on detonating a charge of cast TNT/NH_4NO_3 (50/50), the detonation velocity of which was 4,300m/sec.

Photo. 4

Photo. 5

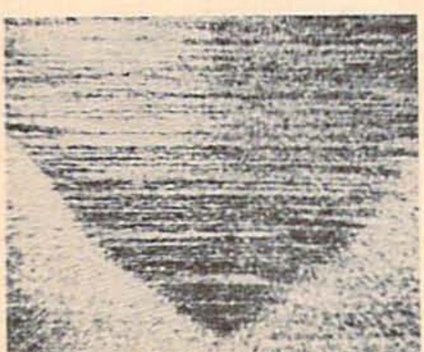

Photo. 6

References

1) E. M. Pugh, R. v. Heine-Geldern, S. Foner, and E. C. Mutschler: J. Appl. Phys. 22 (1951), 487; 23 (1952), 48.

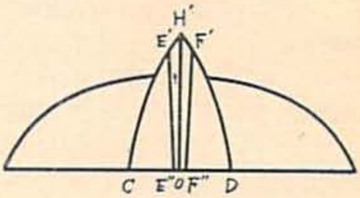

Fig. 1

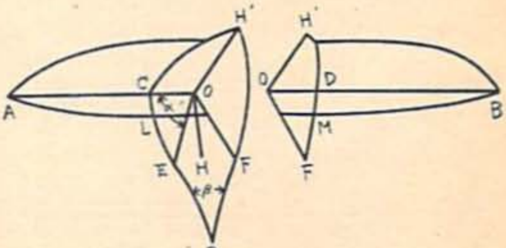

Fig. 2