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METALLURGIST'S FACTUAL REPORTS
SUPPORTING MATERIAL
10 PAGES

BY: JEAN BERNSTEIN

TABLE 1
Measurements of Fatigue Striations

Distance from Origin "O1"		Striation Spacing		n *	N **
in. x 10^{-3}	mm	inch x 10^{-6}	microns		
11.8	0.3	Beginning of visible fatigue progression		-	-
15.7	0.4	16	0.406	244	244
23.6	0.6	15	0.381	527	771
43.3	1.1	22	0.559	895	1666
55.1	1.4	42	1.070	281	1947
70.9	1.8	19	0.482	832	2779
78.7	2.0	26	0.660	300	3079
196.9	5.0	35	0.889	3377	6456
326.8	8.3	44	1.110	2952	9408
456.7	11.6	130	3.300	999	10407
704.7	17.9	100	2.540	2480	12887
826.8	21.0	End of Clear Striation Evidence			
1401.6	35.6	Last Macroscopic Crack Arrest Mark (Fatigue Terminus)			

* Number of striations from the previous point

** Accumulated striations from the reference point at base of the thumbnail zone

TABLE 2
Microhardness Traverse (section X-X)

Distance from Edge		KNOOP (100 gram load)	HRC (converted)
1 x 10^{-3} inch	mm		
1	0.025	581	52
2	0.051	409	40
3	0.076	389	38
4	0.102	402	40
5	0.127	382	38
6	0.154	399	39
7	0.178	402	40
8	0.203	402	40
9	0.229	402	40
10	0.254	438	43
11	0.279	446	43
12	0.305	438	43
13	0.330	389	38
14	0.356	416	41
15	0.381	364	36
18	0.457	359	36
21	0.533	337	33
24	0.610	382	38
27	0.686	359	35
30	0.762	347	34
33	0.838	359	35
37	0.940	347	34

Figure 1. Overall view looking aft on the fan hub pieces, as received. Arrows "f" denote the primary separation through the tierod hole 6T.

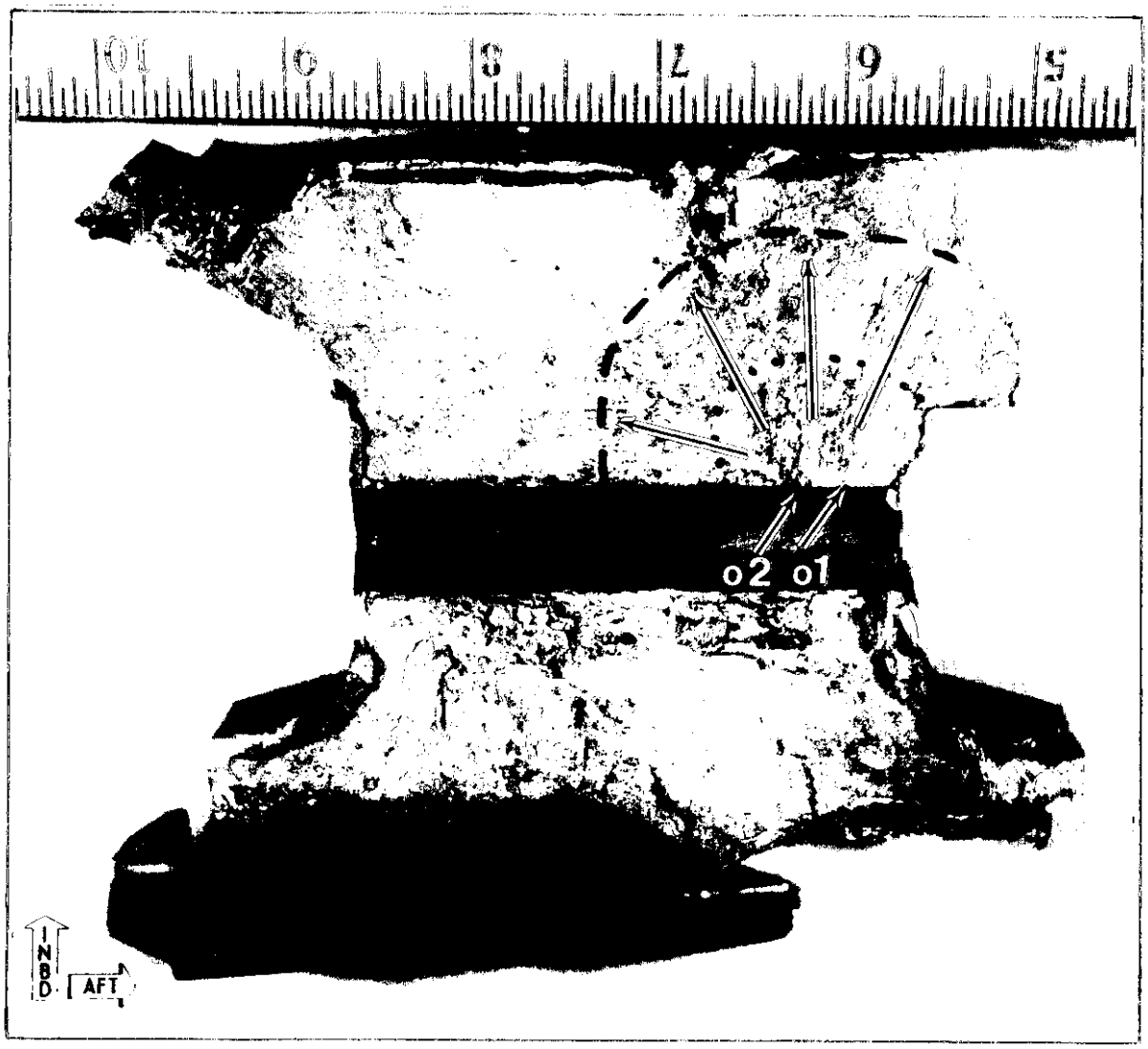

Figure 2. View of the fracture face on the segment of the hub labeled "1" in figure 1. Arrows "o1" and "o2" denote the two fatigue fracture origins. The extent of the fatigue fracture region is outlined by a dashed line. The discolored area on the fracture surface is outlined by the dotted line

Figure 3. Angled views of the fatigue fracture initiation area: top photograph - segment labeled "2" in figure 1, bottom photograph - segment labeled "1". The mating fatigue origins areas are denoted by brackets "o1" and "o2". Arrows "s1" and "s2" show scuff marks on the surface of the tierod hole and arrows "g" indicate gouge marks. Magnification 7.32X.

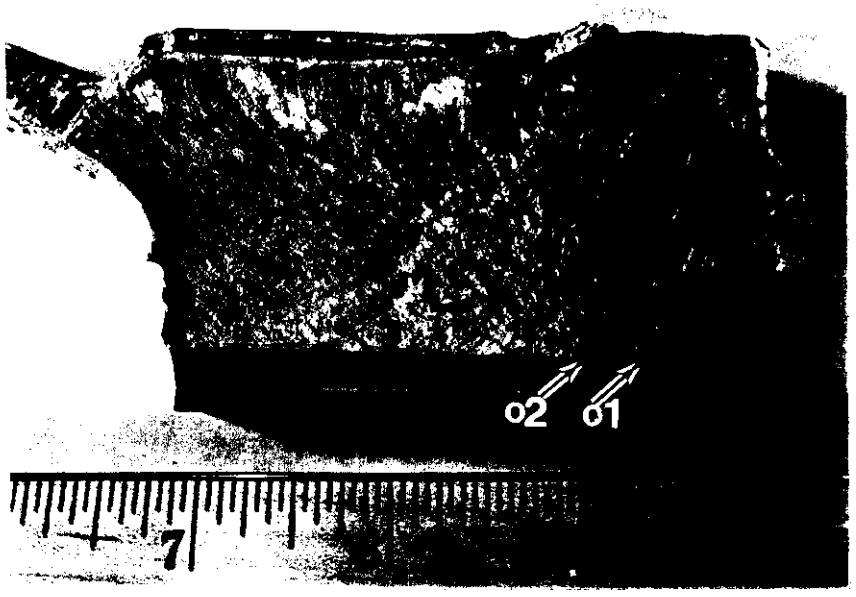

Figure 4. View of the inboard fracture face on piece 1 after further sectioning and cleaning, showing the two fatigue fracture origins by arrows "o1" and "o2" and the extent of the fatigue cracking by the dashed line.

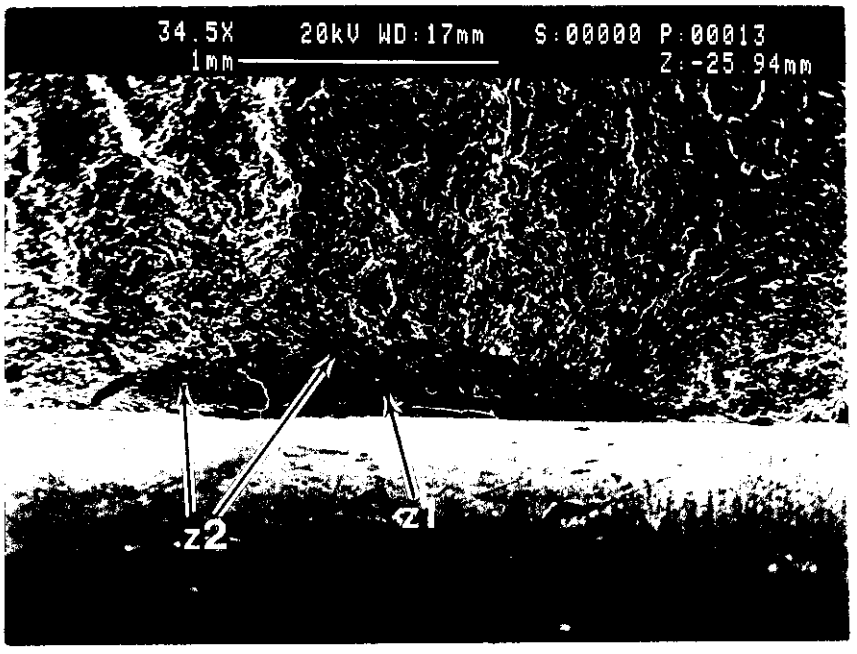

Figure 5. SEM view of the fatigue origin denoted by arrow "o1" in figure 4. The two fracture zones in the thumbnail mark are denoted by arrows "z1" and "z2"

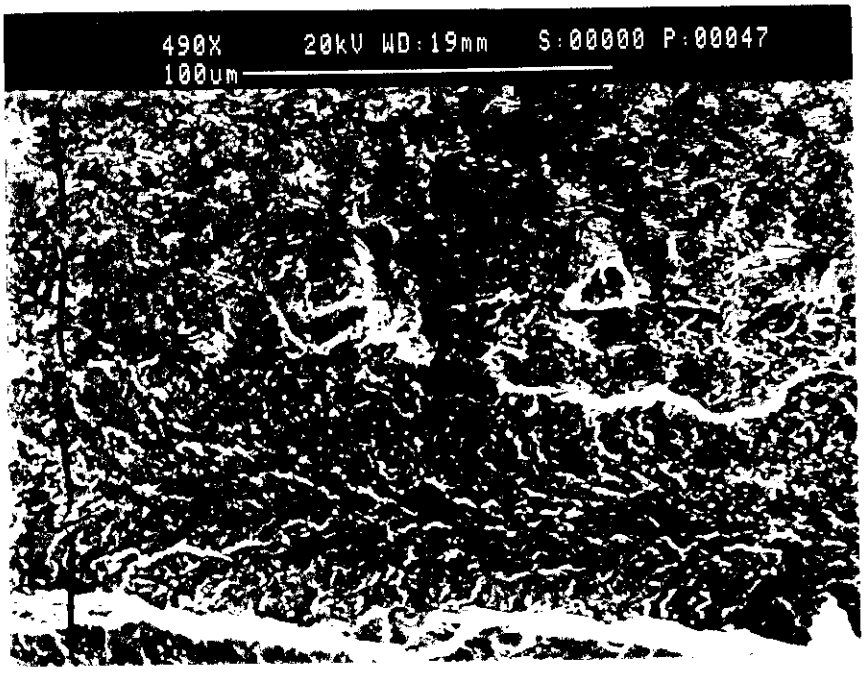

Figure 6. The interface between zones shown by arrows "z1" and "z2" in figure 5. The two zones are indicated by the brackets

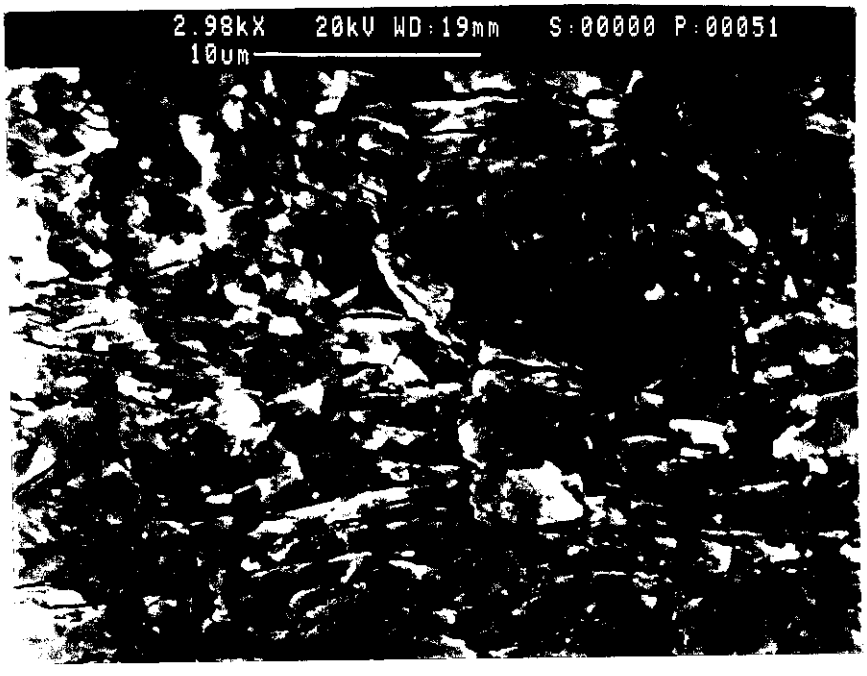

Figure 7. Typical appearance of fatigue fracture in zone 2

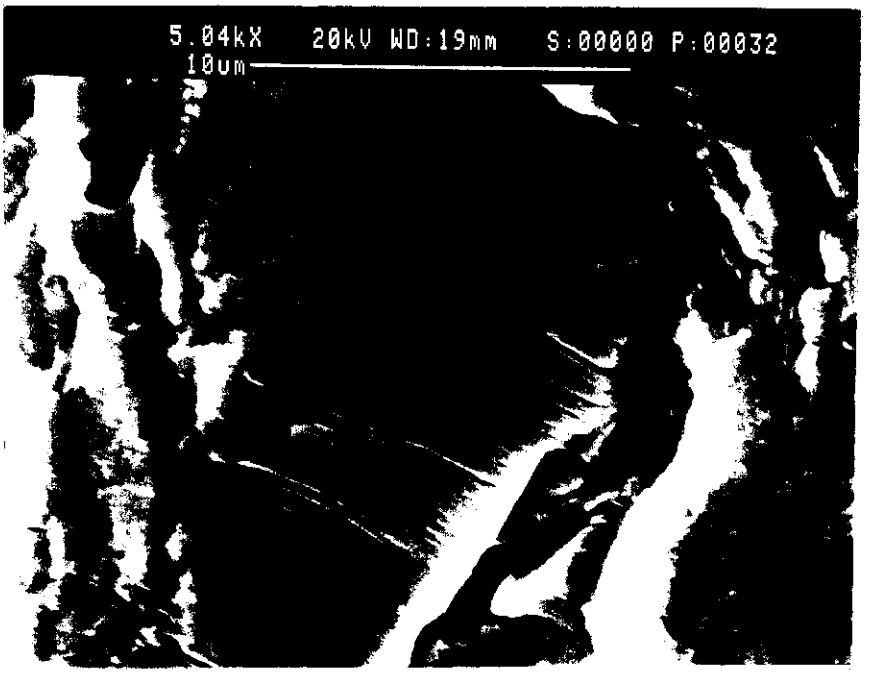

Figure 8. Typical fatigue striations observed from the base of zone 2 to an approximate distance of 0.70 inch from the origin area at the surface of the hole

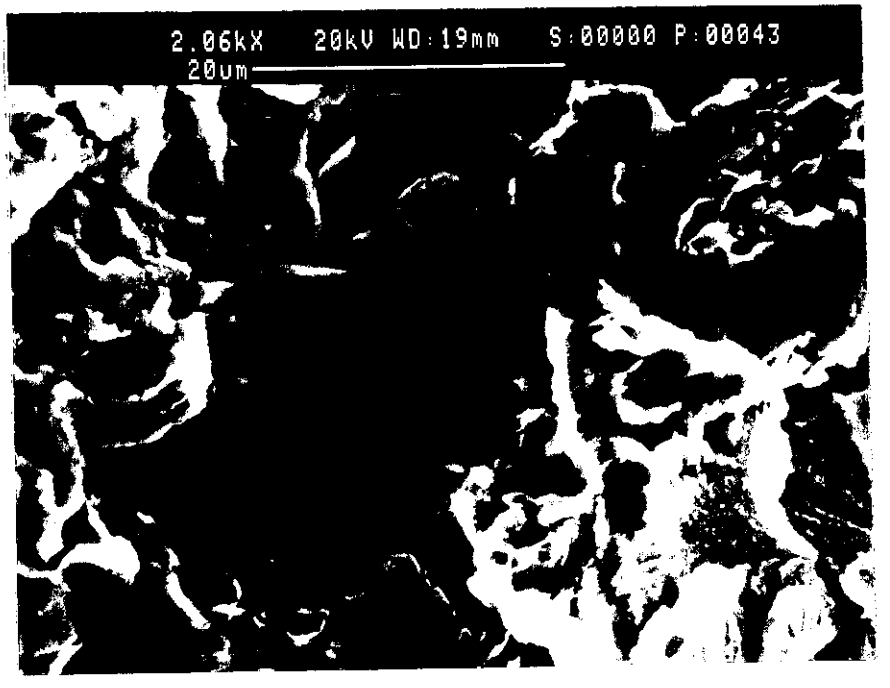

Figure 9. Typical fracture features observed between 0.70 and 1.4 inches from the origin area

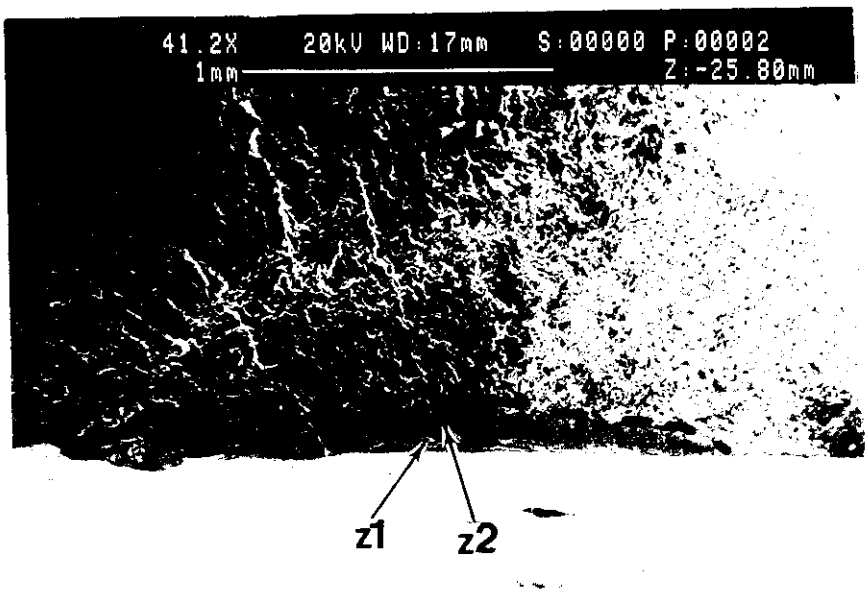

Figure 10. The SEM view of the fracture origin "o2". Arrows "z1" and "z2" show the locations of the overstress and microfissure zones, respectively.

Figure 11. Composite photograph showing an SEM view of scuff marks at and near the fracture origin area "o2". Note numerous parallel cracks (ladder cracks) within the main scuffed area, some of which are shown by the arrowheads.

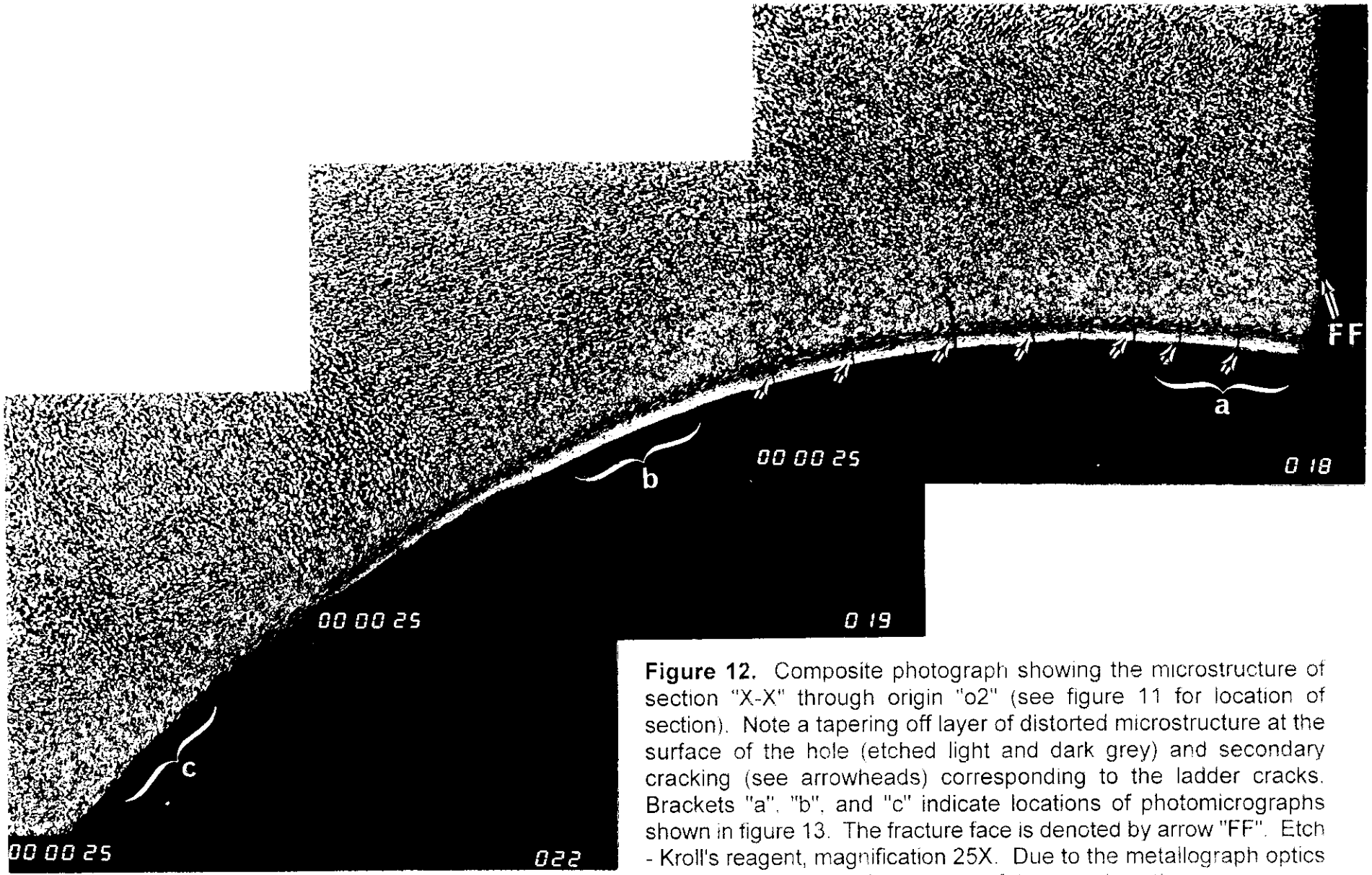

Figure 12. Composite photograph showing the microstructure of section "X-X" through origin "o2" (see figure 11 for location of section). Note a tapering off layer of distorted microstructure at the surface of the hole (etched light and dark grey) and secondary cracking (see arrowheads) corresponding to the ladder cracks. Brackets "a", "b", and "c" indicate locations of photomicrographs shown in figure 13. The fracture face is denoted by arrow "FF". Etch - Kroll's reagent, magnification 25X. Due to the metallograph optics the photograph is a mirror image of the actual section

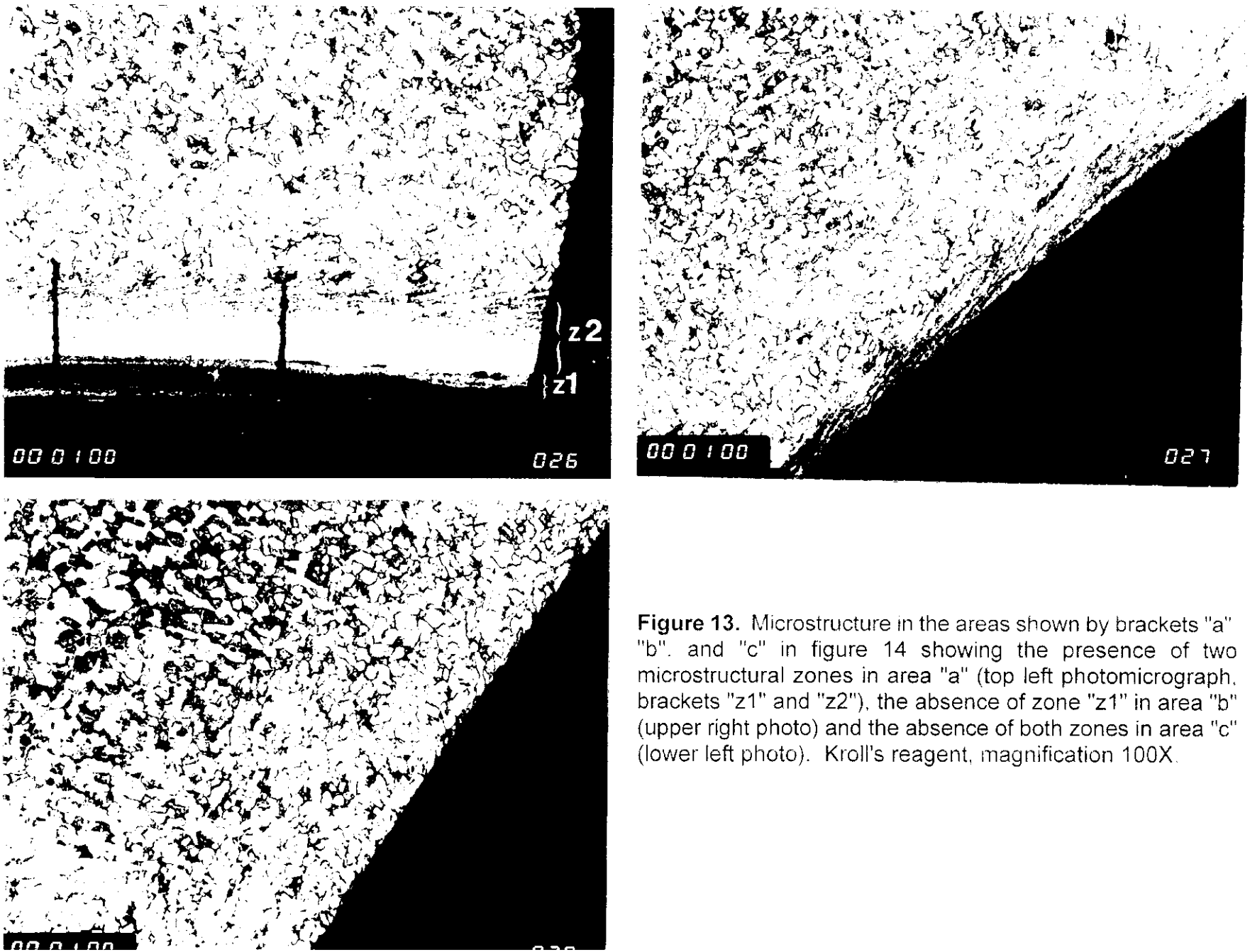

Figure 13. Microstructure in the areas shown by brackets "a" "b", and "c" in figure 14 showing the presence of two microstructural zones in area "a" (top left photomicrograph, brackets "z1" and "z2"), the absence of zone "z1" in area "b" (upper right photo) and the absence of both zones in area "c" (lower left photo). Kroll's reagent, magnification 100X.