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Messrs. Hijos de I. de la Rama & Co.,
I.de la Rama St.53,
I L O I L O ,
Philippine Islands.

M/S "DON ESTEBAN".- CRANKSHAFT.
Ref.: Your letter of January 11,1939.

Dear Sirs,

The piece received from you of the broken crankshaft has been forwarded by us to our Essen Works for investigation, as they have much better facilities than we ourselves for testing such particular pieces. From the microscopic examination of the piece made by us previous to sending it to Essen, our original presumption was that small flaws visible on the area of fracture - probably those spots standing out against the surface of fracture which by the Lloyd's surveyors in Manila had been regarded as due to pipes in the material - might have caused the fracture. Speaking against this presumption was however the fact that on the edge of the piece front-lines of fatigue-cracks were noticeable which in one place were taking the course of a bending fracture and in two other places the course of a torsional fracture. The relation between these front-lines of fatigue-cracks and the complete picture of the fracture is explained in the following report received from our Essen Works:-

"The surfaces of fracture are showing the typical picture of a fatigue fracture. The fracture seems to have initiated by fatigue starting in the fillet at the transition to the crank web (see enclosed photo No.1) due to bending stresses exceeding the fatigue strength of the material. The condition of the surface in this

place is perfect so that any detrimental effect of surface scratches is excluded. The remaining part of the surface having the formation of a torsion-fatigue-fracture shows two directions of crack spreading (photo No.2) and this part of fracture may have occurred only later after a weakening of the cross section by the bending-fatigue-fracture. No indications are found on the fracture surface pointing to any considerable defects in the material, in the shape of pipe-like blisters or flaws. Even the fact that all the fatigue-fractures start from the surface speaks against any participation in the fracture of such defects. The pickling (etching) of a section behind the fracture (photo No.3) proves that there are no defects of this kind. In the pickled area appear a few somewhat coarser core segregations which on the fracture surface come out as small irregularities and might be brought in connection with the cause of fracture. But in the area of fracture these irregularities are limited to the core zone as shown in photo No.2. As the fatigue-fractures start at the surface of the piece and as, in addition, the front lines of the fatigue cracks are not deviated through these irregularities, there is no causal connection between these segregation spots or the oil hole and the fatigue-fracture.

In investigating the condition of the material at the starting point of the bending fatigue-fracture, the following properties of samples taken longitudinally having a normal texture and no excessively coarse grain (photo No.4) were ascertained:-

Yield point:	32.3 kg/sq.mm.
Tensile strength:	55.4 kg/sq.mm.
Elongation:	30.6% on a length equal to 5 dias.
Reduction of area:	62%.
Notched-bar impact figure:	11.5 mkg/sq.cm (Charpy test-bar).

Thus the tensile strength lies at the lower limit. However, the requirements as to a yield point of 28-32 kg/sq.mm., tensile strength of 55-63 kg/sq.mm., elongation of at least 22% on a length equal to 5 diameters, and a notched-bar impact value of 5-7 mkg/sq.cm (Charpy test-bar) have all been complied with. The darker spots observed in the area of fracture, which were considered as signs of flaws or blisters in the material, must be due to a corrosion (pictural?) effect or to irregularities in the contact when the fracture surfaces rubbed each other previous to the final complete breaking of the shaft.

That the above mentioned spots have nothing to do with irregularities in the material is already shown by the fact that the course of the grain, which runs oblique to the fracture surface, is in these places perfectly the same as in the adjacent lighter spots, as shown by photo No.5.

According to the results of the examination, the fracture is not to be attributed to the quality of the material, but to overstraining presumably by an additional excessive bending."

This report which fully covers our own views shows that the crankshaft has been overstrained by some external circumstance, a violent bending strain having at first occurred. It may be possible that this overstraining has taken place when the propeller struck a rock or something else which without doubt causes an excessive strain on the crankshaft, but in this case a torsional fracture rather than a bending fracture would have been the result. More probable is the presumption that - a case known to us - during the operation of the engine for several hours after a crankshaft bearing had run out, i.e. when the shaft had been unsupported over several bearings during that time, the broken crank pin has been exposed to an excessive alternate bending strain and that its fracture has started at the fillet. From our engine erector Mr. Meyer who was engaged in the repairs to the engine in Manila and Hongkong during April and May last we understand that the shaft has fractured just in that place where the bearing had run out.

After the bending fatigue-fracture had started, the resistance against torsional strain and thus the period of natural vibration decreased. In running the engine at high speeds it got into the range of critical speed causing the spread of the fracture due to torsional vibration, and this crack was constantly increasing on the circumference of the shaft.

That this has been an exceptional case of overstraining is proved by the fact that the shaft after having been repaired, in a deficient manner with a view to strength, has been working already for several months without breaking. If the shaft were at all too weak or if in the place where the fracture occurred considerably higher stresses had to be resisted the repaired shaft had been bound to break within no time even at a moderate strain.

See sketch with Report

From the above you will note that we or the suppliers of the crankshaft are not responsible for the fracture of the shaft, but that this fracture is attributable to some unforeseen accident.

Yours faithfully,

Encl.: 4 Sheets with
Photographs.