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A.R.C. Technical Report

MINISTRY OF SUPPLY

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A Note on a Rotating Bending-Fatigue Machine for Tests at 200 deg. C.

By

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of the Engineering Division, N.P.L.

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An experimental adaptation of an air temperature rotating bending-fatigue testing machine has been made for tests on light alloys at temperatures up to 200 deg. C. The machine* is shown photographically in Figs. 1 and 2. It consists of a shaft rotating in a pair of self aligning ball bearings, driven by a direct current variable speed motor at one end, and with a chuck at the other end to hold circular-section test-pieces. The latter are held in the chuck by six set-screws. A two-point loading system is adopted and arranged with one scale pan to obviate the possibility of overstressing a test-piece during the application of the weights. Fracture or vibration of the test-piece operates a switch which stops the motor; the number of revolutions are indicated by the usual form of counter. The variable speed control permits critical speeds due to resonances of the test-piece assembly being avoided.

For tests at 200 deg. C., a somewhat longer test-piece (*see* Fig. 3) than the standard air temperature type is used, and the temperature measurements are made by two thermo-couples (iron-eureka) secured one to each end of the effective portion of the test-piece. The thermo-couples are connected directly to four insulated terminals on the chuck, which are permanently joined by wires through the middle of the main shaft to the brass slip-rings seen in the photographs. The thermal E.M.F. is picked up from the slip-rings by carbon brushes, so arranged that the contact pressure is obtained by dead-weight loading ; the brushes are only in contact with the rings whilst observations are being made; at other times a cam lifts them clear. The usual potentiometer method, with sensitive galvanometer, is adopted for the E.M.F. determinations, so that troubles due to variation of contact resistance at the brushes are minimised.

The furnace is of simple wire-wound type, with eight separate heating coils; series-parallel connections can be made to obtain constant temperature over the effective portion of the specimen. The chuck is enclosed in a wooden cover to reduce heat losses at this end.

Preliminary tests showed that the thermo-couple arrangement worked reasonably well up to a speed of about 3,500 r.p.m. Air temperature readings taken with the machine at rest were only about 1 deg. C. different from those at 3,000 r.p.m., and the thermo-couple measurements at different speeds and temperatures with various combinations of slip-ring connections suggested that the effect of stray E.M.F.'s was small. Temperature-time curves plotted after stopping tests showed that the running conditions were quite different from the stationary ones. In general, a fall of 2 or 3 deg. C. in the first one or two minutes was succeeded by a rise of 15 or 20 deg. C. in the next few minutes.

* Briefly described in A.R.C. 7128.

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A few rotating bending-fatigue tests were carried out at 3,300 r.p.m. on specimens of the form shown in Fig. 3 machined from a bar of RR56 alloy; the results are given in the following Table, and are shown plotted in Fig. 4.

TABLE

Results of Fatigue Tests on RR56 at 200 deg. C.

Applied stress ton/sq. in.	Number of cycles of stress millions	Duration of test hours
±8·0	1·47	7·5
±8·0	3·32	18·0
±7·0	6·95	33·3
±6·0	12·1	60·5
±6·0	9·9	50·0
±5·5	44·9	227
±5·0	48·9	243

Remarks.—No attempt was made in these initial tests to obtain a very accurate control of temperature, and variations of ± 5 deg. C. occasionally occurred.

Further Work.—It is hoped that experiments will be carried out in the immediate future with two other forms of slip-ring pick-up—(a) stainless-steel rings and carbon-silver brushes (b) thin flanges dipping into mercury troughs.

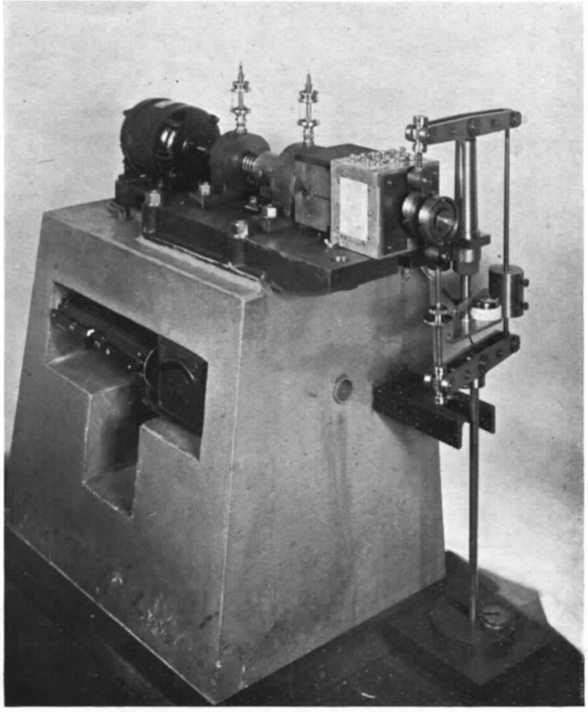

Fig. 1.

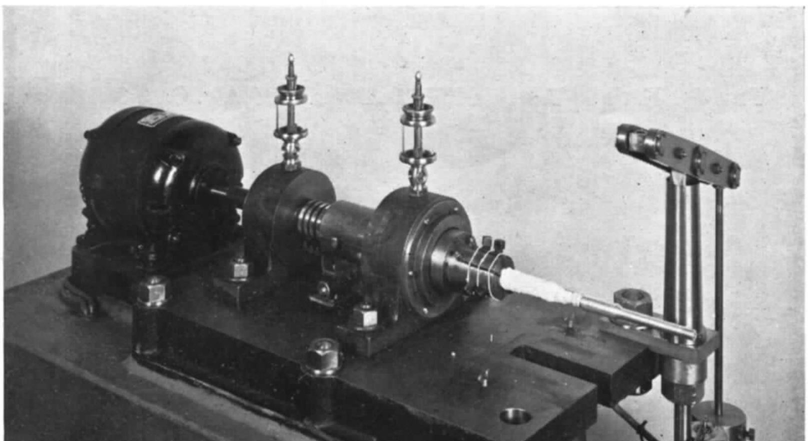

Fig. 2.

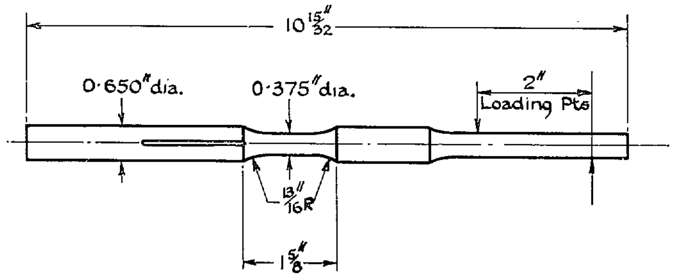

FIG. 3 Test-piece.

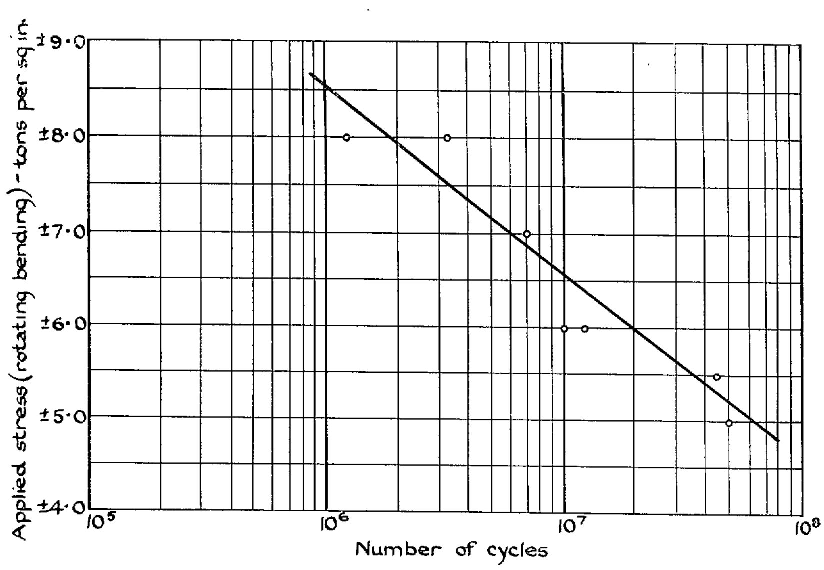

FIG. 4. Fatigue Tests on RR56 alloy at 200 deg. C., 3,300 r.p.m.

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