SPRING MANUFACTURERS' RESEARCH ASSOCIATION

The Effect of Shot-Peening on the Fatigue Properties of Helical Compression Springs made from Continental Oil-Tempered and Patented Hard Drawn Spring Steel Wires

Report No. 131

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J.W. Mee, A.Met., A.I.M.

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Summary

The shot-peening of helical compression springs made from a "commercial" and a "valve quality" oil-tempered wire and a 0.9% C music wire produced increases in fatigue limit of 6.5, 9 and 16 tons/sq.in. respectively.

The fatigue ratio for the peened "valve spring" quality wire was higher than that for the other two materials.

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THE EFFECT OF SHOT-PEENING ON THE FATIGUE PROPERTIES OF HELICAL COMPRESSION SPRINGS MADE FROM CONTINENTAL OIL-TEMPERED AND PATENTED HARD DRAWN SPRING STEEL WIRES

by J.W. Mee, A.Met., A.I.M.

1. INTRODUCTION

The fatigue properties of helical compression springs manufactured from Continental patented hard drawn and oil-tempered spring steel wires have been reported earlier.(1) Batches of each type of spring were given a commercial shot-peening treatment and fatigue tested to determine the improvement in fatigue limit.

2. EXPERIMENTAL PROCEDURE

2.1 Spring Materials

Two oil-tempered wires (a commercial quality and a valve quality) and a patented hard drawn music wire (commercial quality) were used in the manufacture of the experimental springs. The chemical analysis of each wire has been given earlier.(1) It should be noted that the carbon content at 0.92% and the diameter of 0.104 in. of the music wire are both greater than those in normal use in this country.

2.2 Spring Manufacture

Approximately 100 springs were coiled from each type of wire on an automatic machine to the design given in Report No. 122.

After rough grinding, each batch was shot-peened in a Wheelabrator machine for 25 minutes using 0.040 - 0.060 in. diameter round steel shot. An Almen test was made under similar peening conditions.

Shot-peening was followed by a low temperature heat treatment at 220°C for 30 minutes. The springs were then prestressed and finish ground.

2.3 Load Testing

From the dimension of the springs the loads for the required minimum and maximum stresses were calculated. Load testing gave the amplitude of stroke and the compression to be applied on the fatigue testing machine.

2.4 Fatigue Testing

Fatigue tests were carried out at 1500 compressions/min. and an initial stress of 5 tons/sq.in. on machines described earlier[2] and complete S-N curves constructed.

The fatigue limits of the shot-peened springs together with those of similar unpeened springs are given in Table I. All the results are shown graphically in Figs. 1 - 3, together with the S-N curves for the unpeened condition reported previously.[1]

3. RESULTS

The fatigue limits obtained for the shot-peened springs together with similar results obtained in an earlier research on unpeened springs are given in the following table.

Table I

Wire Quality	U.T.S. tons/ sq.in.	Fatigue Limit unpeened (tons/sq.in.)	Fatigue Limit shot-peened (tons/sq.in.)	Increase due to shot-peening (tons/sq.in.)
"Commercial" oil-tempered	107	42	48.5	6.5
"Valve quality" oil-tempered	94	45	54	9
Music wire	127	43	59	16

The Almen test gave an arc rise of 0.011 in.

The fatigue ratios for the three types of spring (both peened and unpeened) are as follows:

Material	Fatigue ratio*	
	Unpeened	Peened
"Commercial" oil-tempered	0.39	0.45
"Valve quality" oil-tempered	0.48	0.57
Music wire	0.34	0.46

* NOTE These fatigue ratios are based on a fatigue limit with an initial stress of 5 tons/sq.in.

Examination of tested springs

The fractures of the broken springs and the shot-peening coverage were examined at a magnification of x 20. The fractures were normal for the particular quality of wire and the shot-peening coverage was complete.

4. DISCUSSION AND CONCLUSIONS

1) The music wire showed the biggest improvement in fatigue limit due to shot-peening and also the highest fatigue limit in the shot-peened condition.

2) The "valve quality" oil tempered wire had a relatively low U.T.S. but the highest fatigue ratio for any of the three materials.

3) The "commercial" quality oil tempered wire was inferior in fatigue properties to the "valve spring" quality.

4) It is recommended that the relationship between the U.T.S. and fatigue limit of spring wires be investigated for a range of tensile strengths.

5. REFERENCES

1. "The Static and Dynamic Mechanical Properties of three Continental Spring Steel Wires" by R.A. Varo, J.W. Mee and G.B. Graves. C.S.I.R.O. Report No. 122, Jan. 1961.

2. "The Mechanical and Fatigue Properties of Helical Compression Springs made from Patented Hard Drawn and Oil Tempered Wires" by J.W. Mee. C.S.I.R.O. Report No. 114, Jan. 1960.

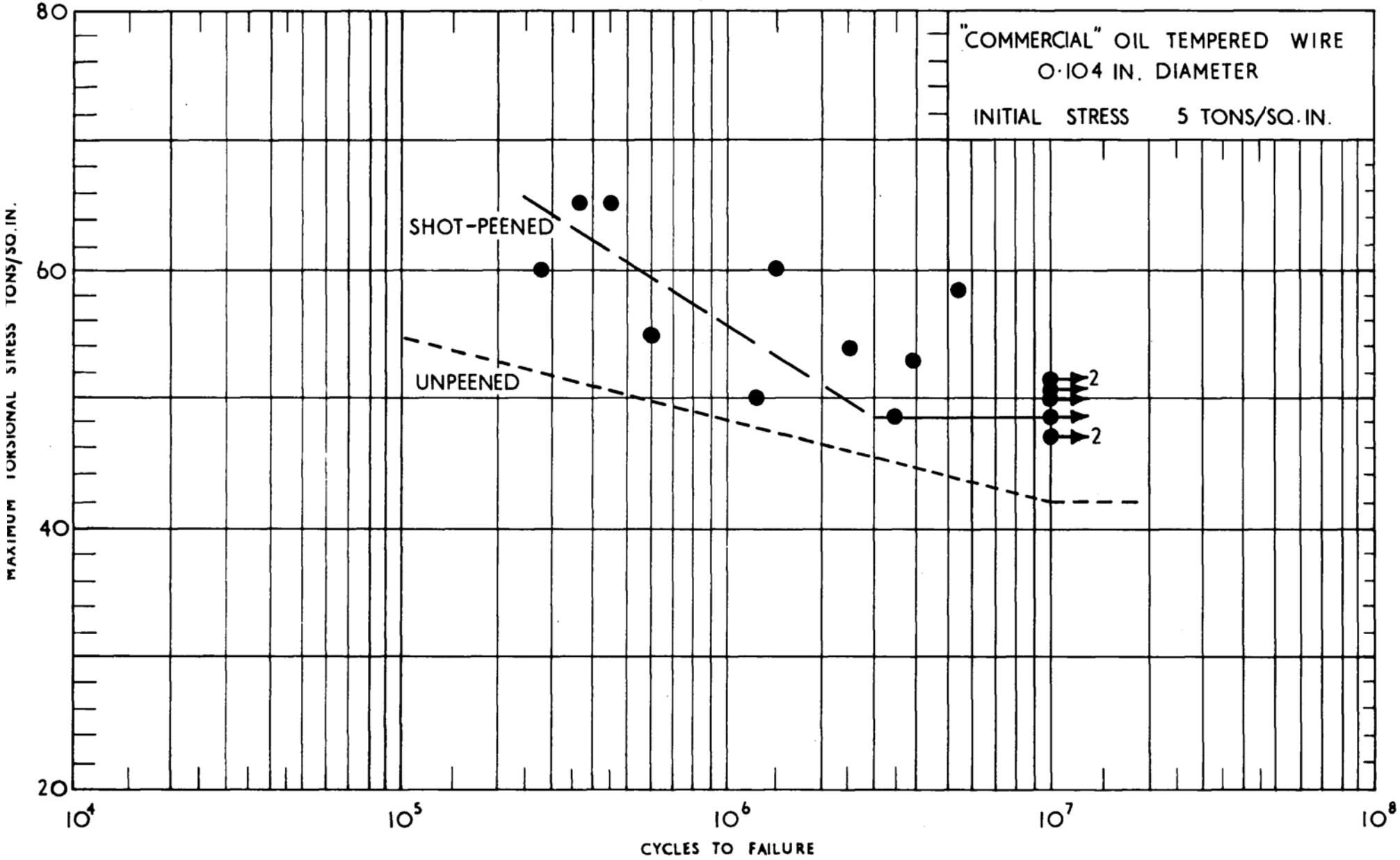

FIG.1. S-N CURVES FOR SPRINGS MADE FROM "COMMERCIAL" OIL TEMPERED WIRE.

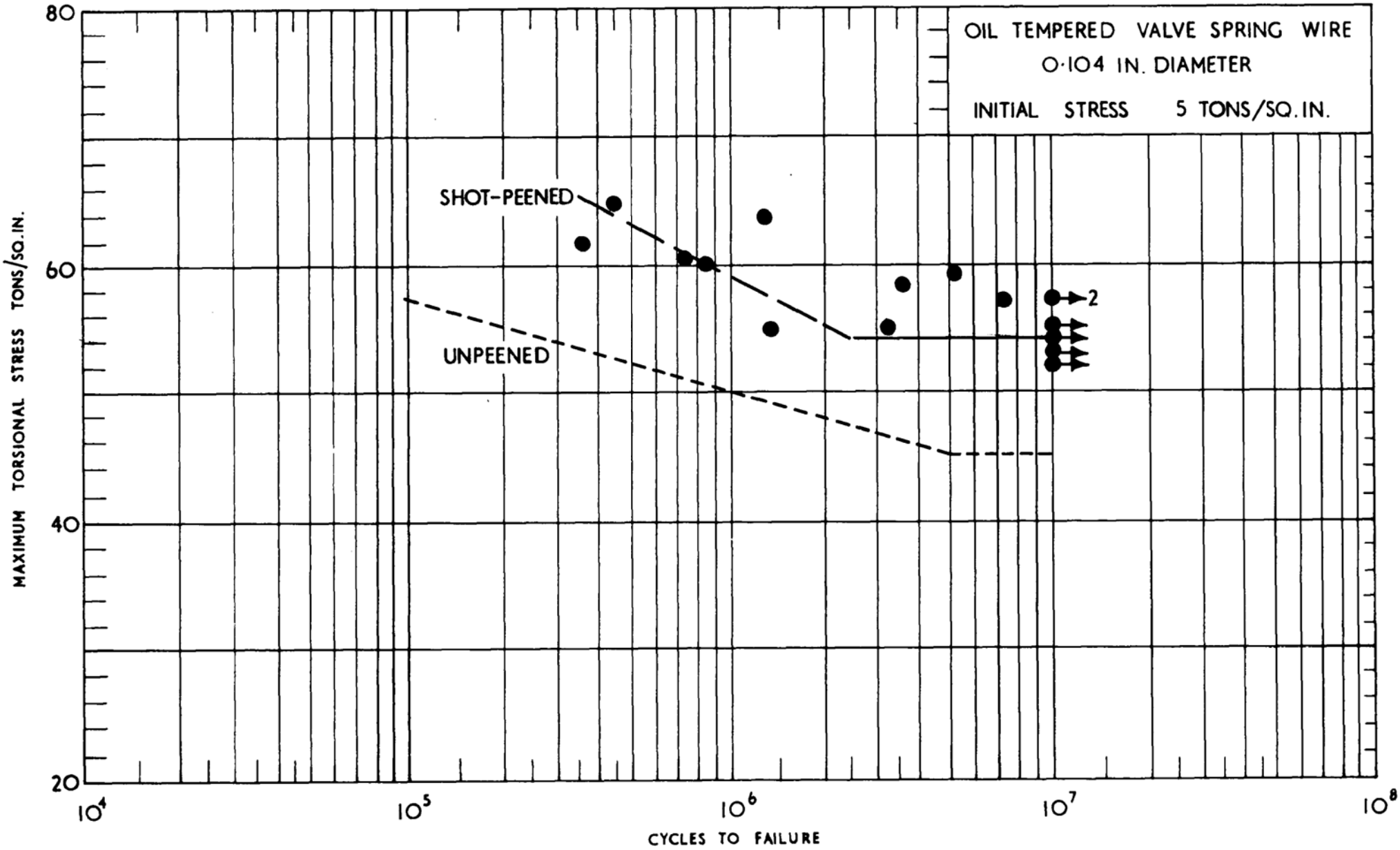

FIG.2. S-N CURVES FOR SPRINGS MADE FROM OIL TEMPERED "VALVE SPRING" QUALITY WIRE.

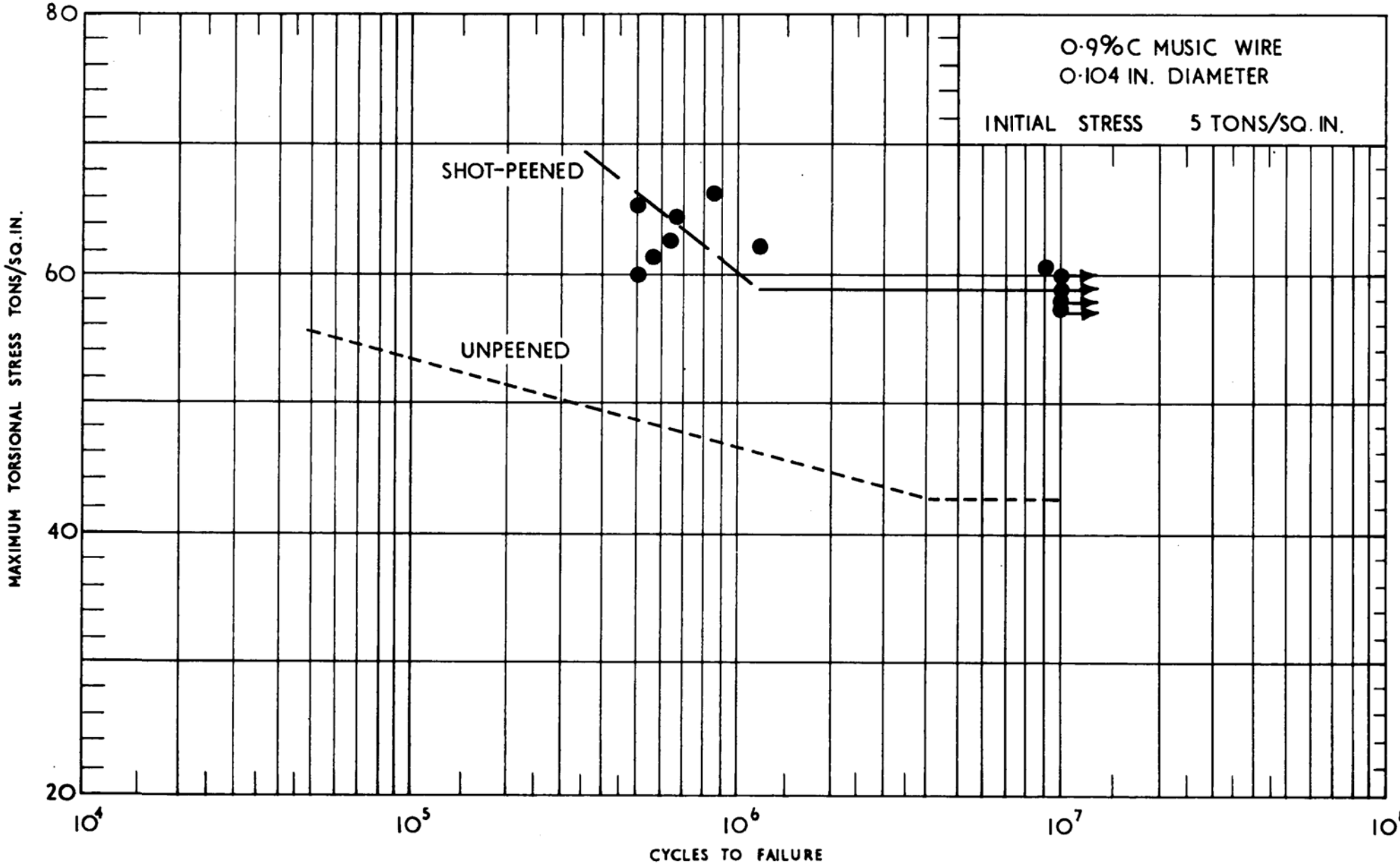

FIG.3. S-N CURVES FOR SPRINGS MADE FROM 0·9% C MUSIC WIRE.