C.P. No. 228
(15,012)
A.R.C. Technical Report

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MINISTRY OF SUPPLY

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CURRENT PAPERS

Wake Survey and Straingauge Measurements on an Inclined Propeller in the R.A.E. 24ft Tunnel

Part II

Comparison of Measured and Calculated 1P Stresses

By

R. Doust and E. J. Hellier

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Project Stress Report No. 418

Wake Survey and Straingauge Measurements on an Inclined Propeller in the R.A.E. 24 ft Tunnel.

Part II. Comparison of Measured and Calculated 1P Stresses

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1. Introduction

The general nature of the problem of 1P vibratory stresses has been dealt with in Part I* of this report, together with a description of the instrumentation, test procedure and prediction of the fluctuating loading on the blades.

This part of the report deals with the comparison between measured straingauge results and the values computed from the predicted loadings.

2. Stressing Calculations

The basis of determining the net bending moment in the blade, and hence the stresses for a given applied moment is found in Ref. 1. This method, which has been provisionally approved, has subsequently been modified (Ref. 2) and considerable experience has been obtained in the usual iteration process. Flight straingauge checks have confirmed calculations in several cases, in addition to which comparisons with measured results as given in Refs. 3 and 4 have been made. Results in most cases were encouraging. It is hoped to review the question of establishing a reliable stressing method in a further report, details of the existing methods being withheld in the meantime.

3. Results

The results as shown in Figs. 1 to 18 were somewhat disappointing. Agreement is very good in some cases and bad in others, the lower forward speed cases being the best. It is difficult to state the cause of the discrepancies, other than to note that as the stresses were low, small errors in recording and measurement could add up in some cases to give appreciable errors. Agreement is very good over the outboard portion of the blade in most cases, but not so good over the inboard portion. One case was worked for the measured excitation (Fig. 19, Part I), since there was a possibility that the discrepancy between measured and predicted excitation at the tip sections would account for the errors in maximum stress. Very little change in maximum stress, however, was found and the outboard stresses based on measured loading were, in fact, worse than the predicted stresses.

These observations, together with the fact that Figs. 17 and 18 show measured stresses at $\psi = 0^\circ$ suggest that there is some imperfection in the installation.

4./

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*C.P. 117.

4. Conclusion

Considering the possible sources of error and the small stress figures involved the comparison of measured and calculated 1P stresses is reasonably good.

References

No.	Author(s)	Title, etc.
1	L. H. G. Sterne	The Structural Aspects of Propeller Design. R.A.E. Report Structures 5. A.R.C. 11,064.
2	D. W. Wright and E. J. Hellier	Rotol Project Stress Report No. 352.
3	R. C. Doust and E. J. Hellier	A Comparison of some NACA and Rotol Calculated Stresses with Measured Wind-Tunnel Results. Rotol P.S.R. 412.
4	R. C. Doust and E. J. Hellier	A Comparison between Measured and Calculated 1P Stresses for a Curtiss Hollow Steel Propeller Blade Operating in the Flow Field of a Wing Nacelle Fuselage Combination. Rotol P.S.R. 414.
5	K. Boydell, W. A. J. Wall and E. J. Corben	Strain Meter Report on a Proteus Brabazon Propeller to Blade Drawing Number RA. 25680 Operating on a 1500 H.P. Electric Motor in the 24 ft Wind Tunnel at the R.A.E. Farnborough. Rotol Research Dept. Report 093.1.190.

FIG. 1

KEY –

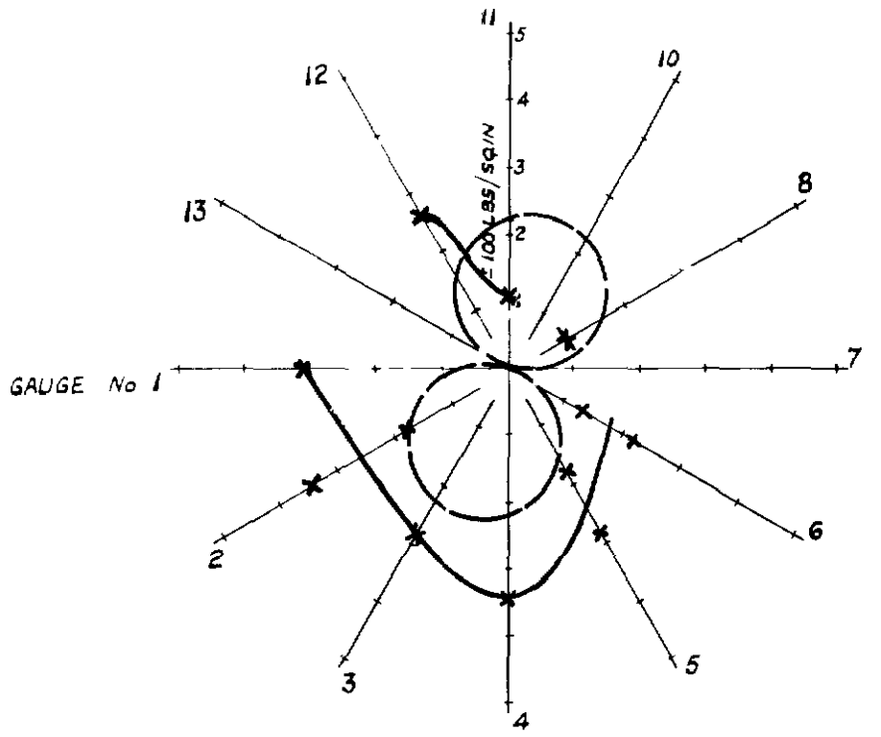
——— TEST RESULTS

— — — THEORETICAL VALUES

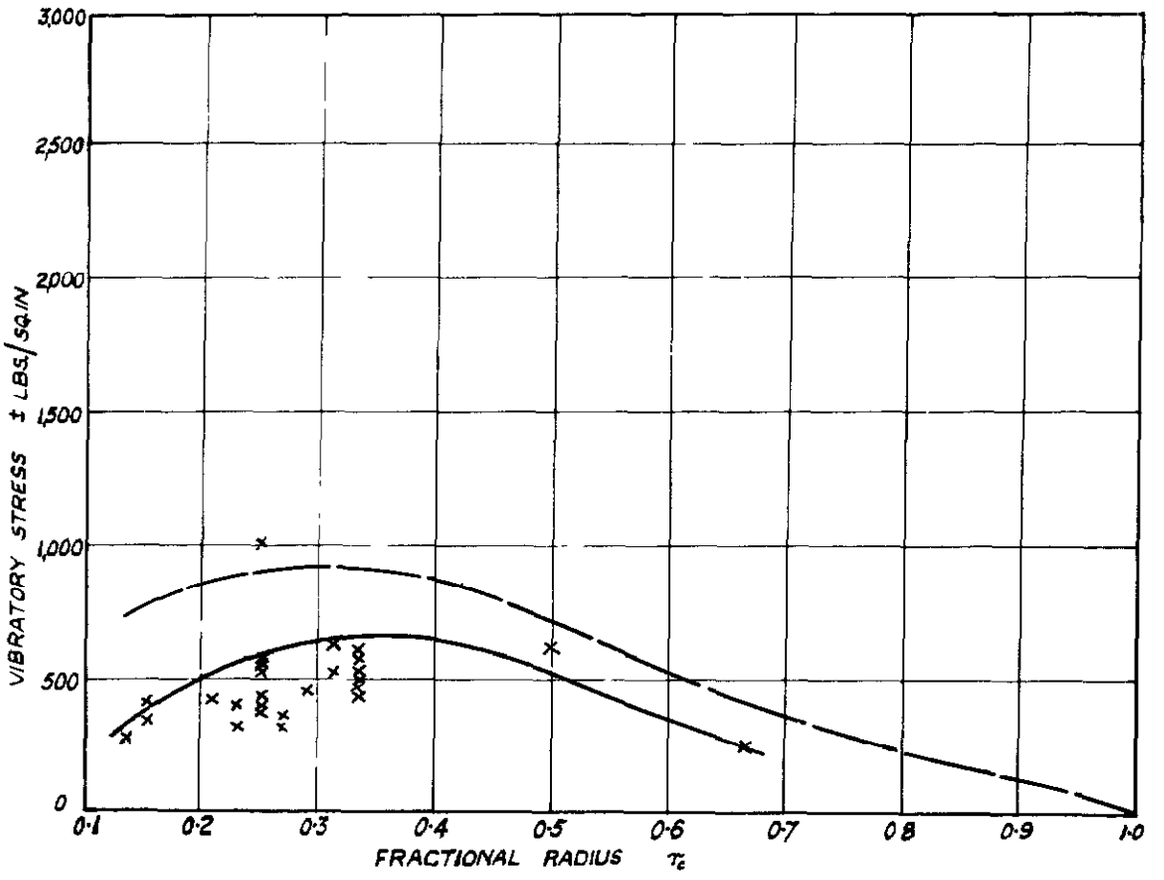
CONDITIONS –

$V = 170$ FT/SEC $\quad \psi = 5°$

$\theta = 26° 55'$ $\quad N = 750$ RPM



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

RAC 110

RAC 1493 – R/2

C/6394/2

FIG. 2

KEY:–

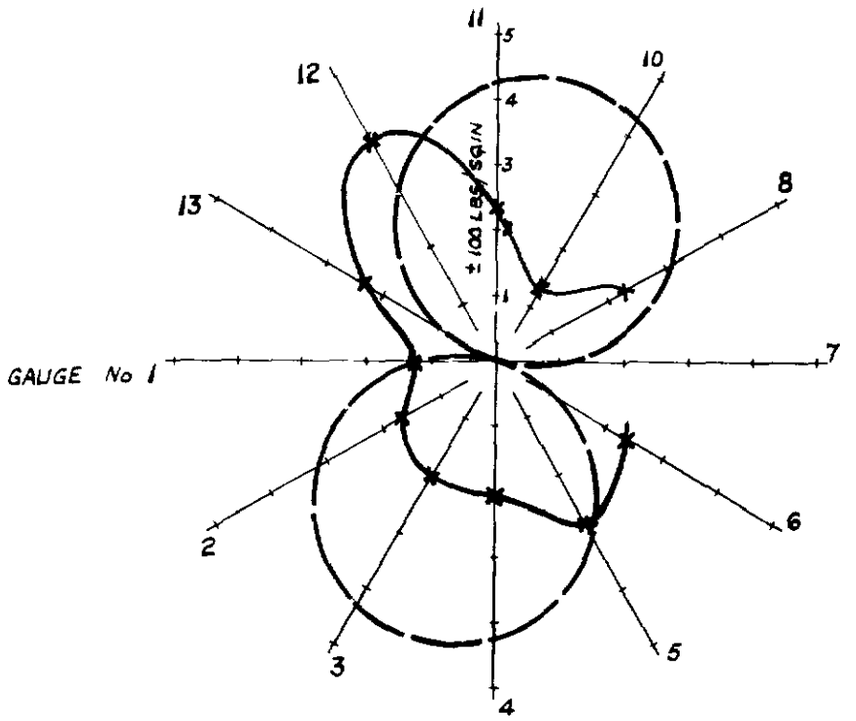
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

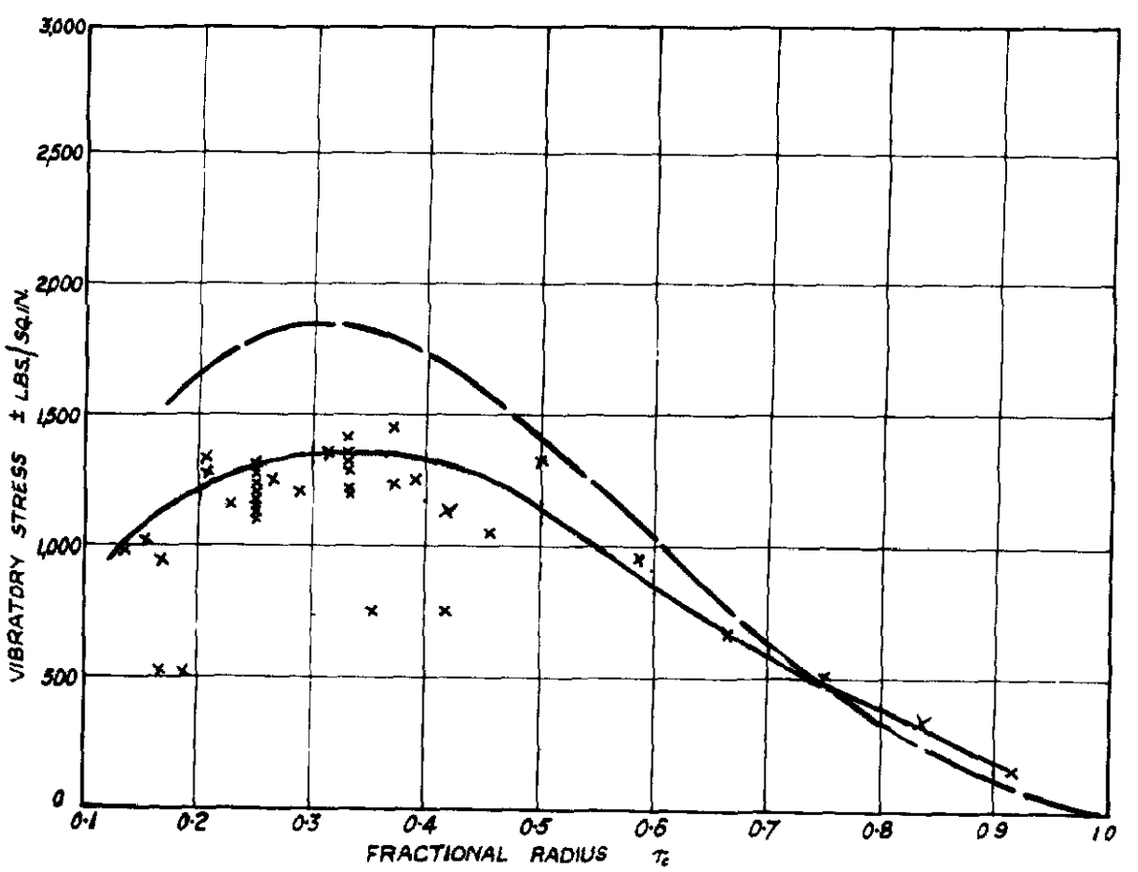
CONDITIONS –

$V = 170$ FT/SEC $\quad \psi = 10°$

$\theta = 26° 55'$ $\quad N = 750$ RPM

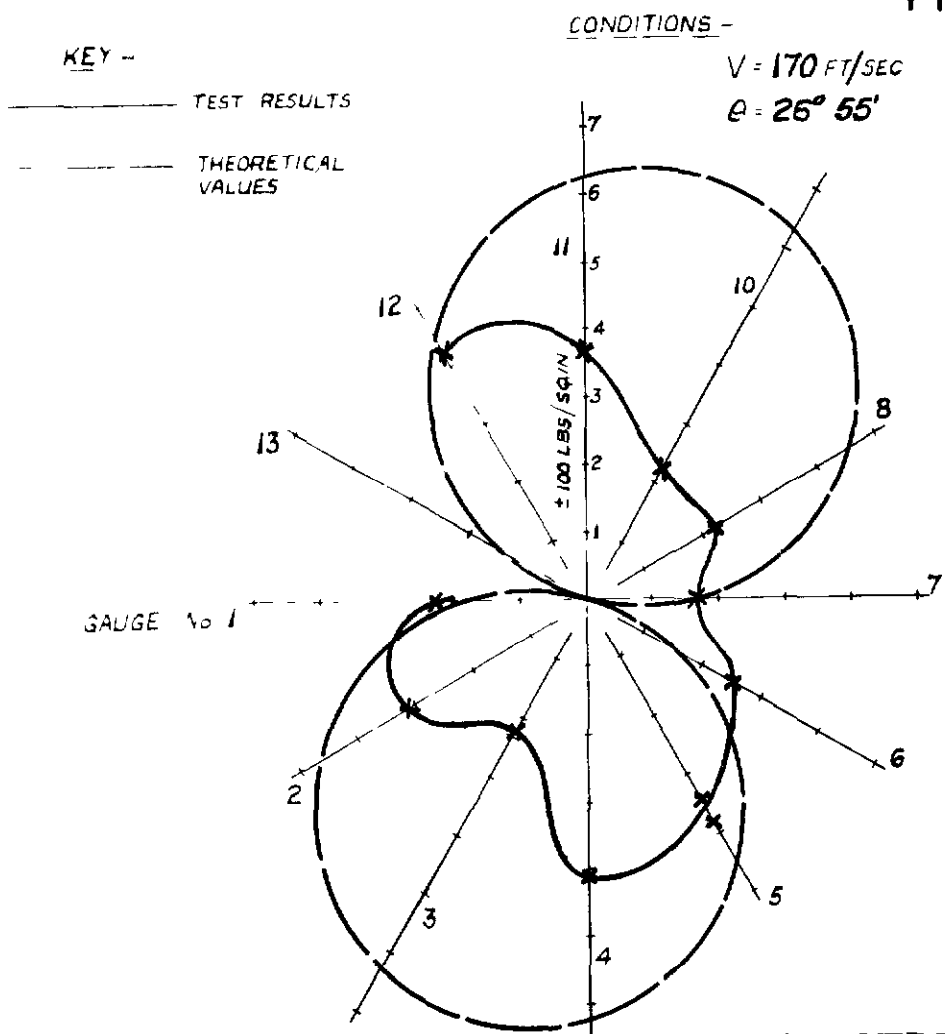


VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT

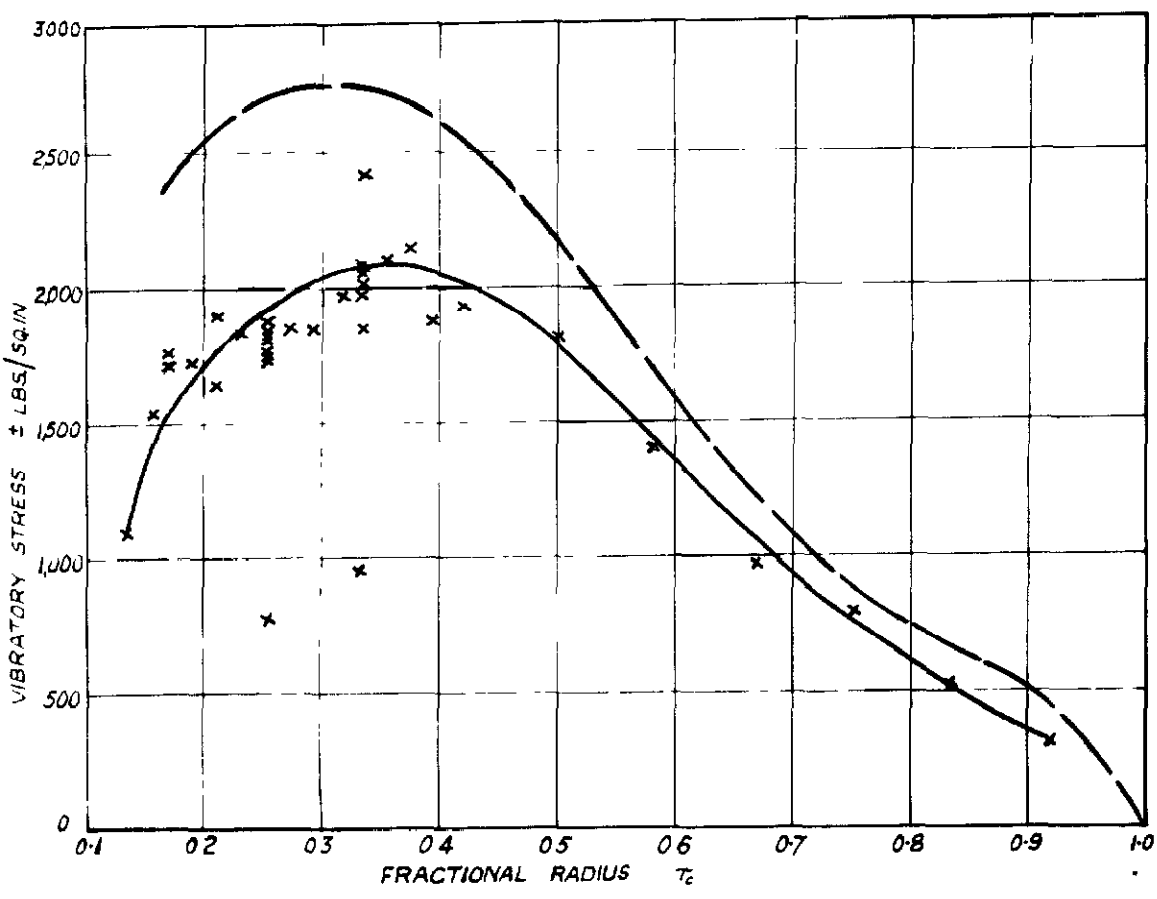


VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 3



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 4

KEY:-

TEST RESULTS

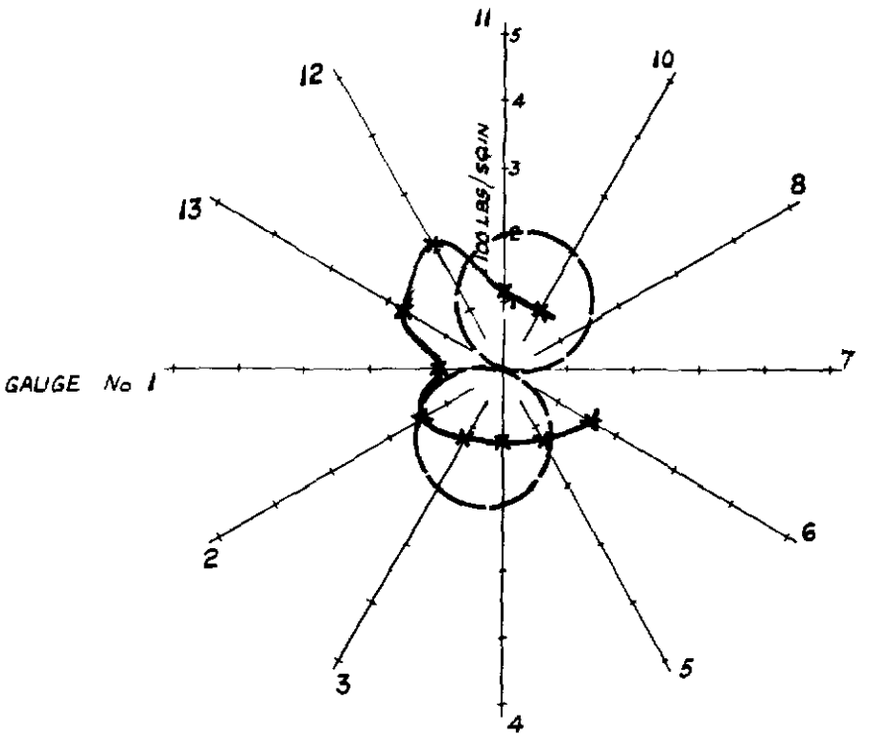
THEORETICAL VALUES

CONDITIONS -

$V = 170$ FT/SEC $\quad \psi = 5°$

$\theta = 23°$ $\quad N = 850$ RPM

c/6408/16 RAC 1493 - R/16 RAS 110



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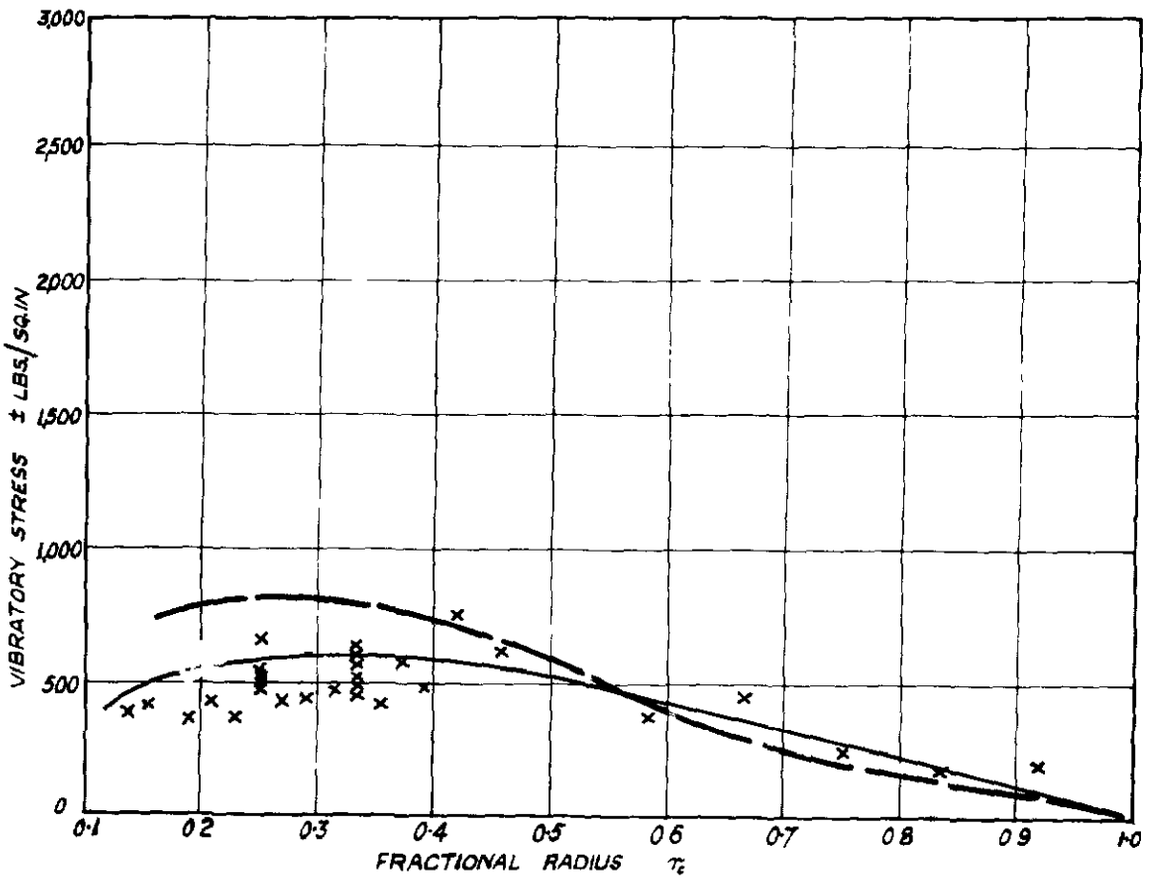


VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 5

KEY:-

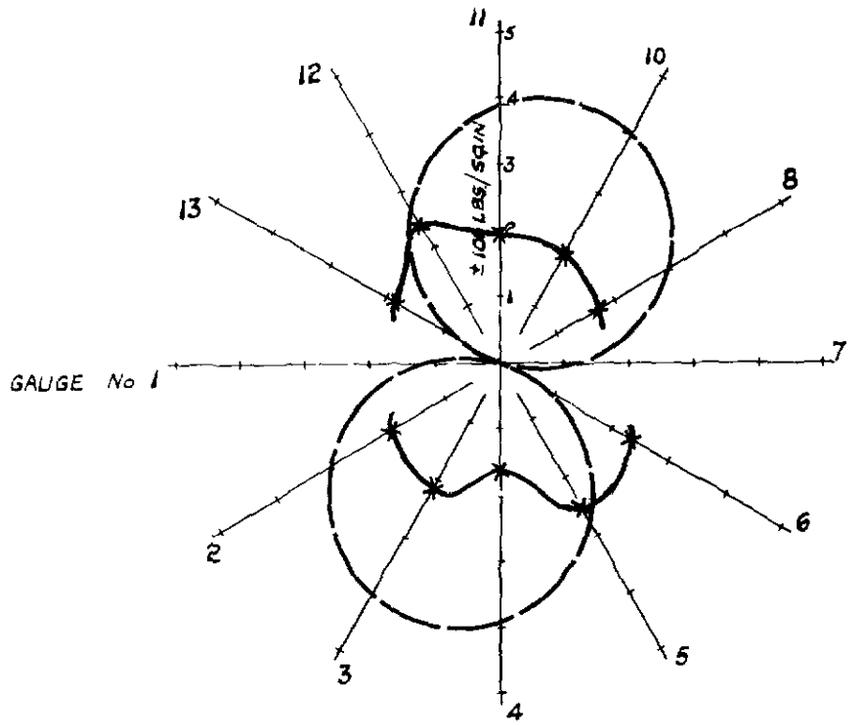
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

CONDITIONS -

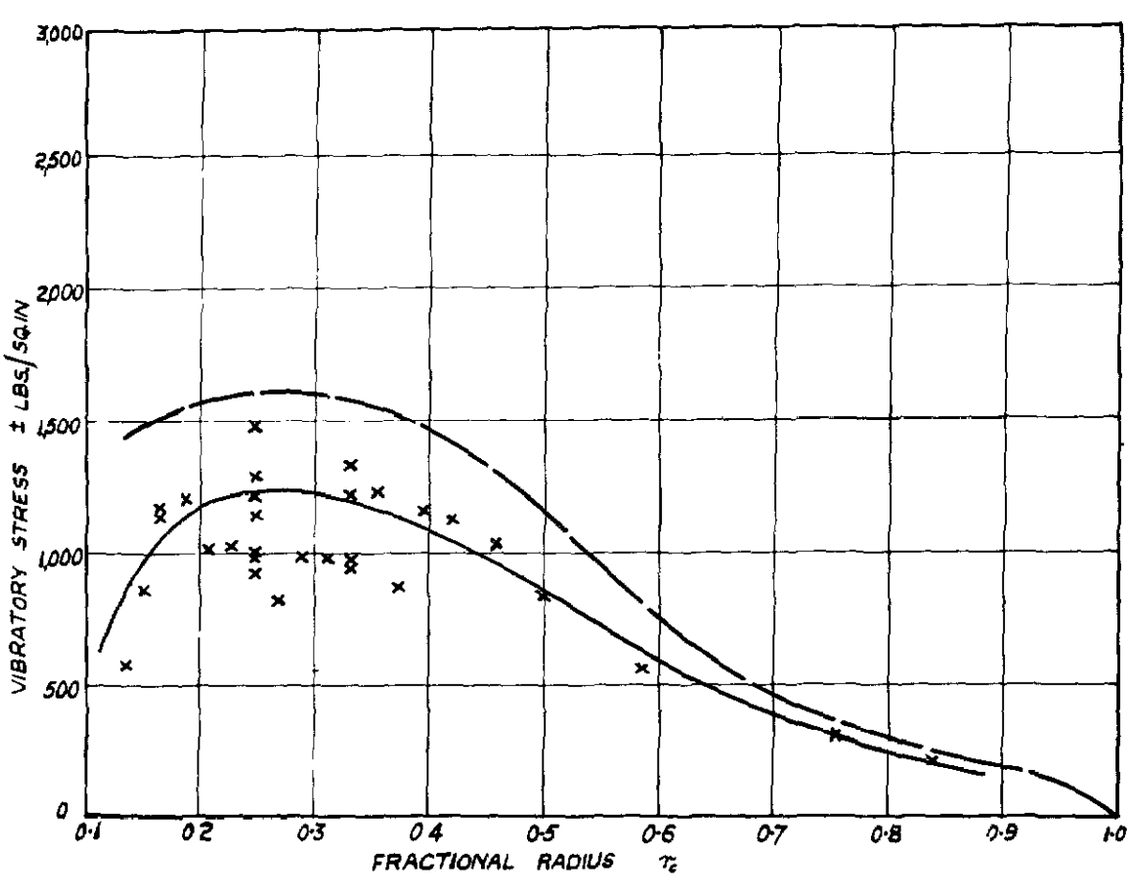
$V = 170$ FT/SEC $\quad \psi = 10°$

$\theta = 23°$ $\quad N = 850$ RPM



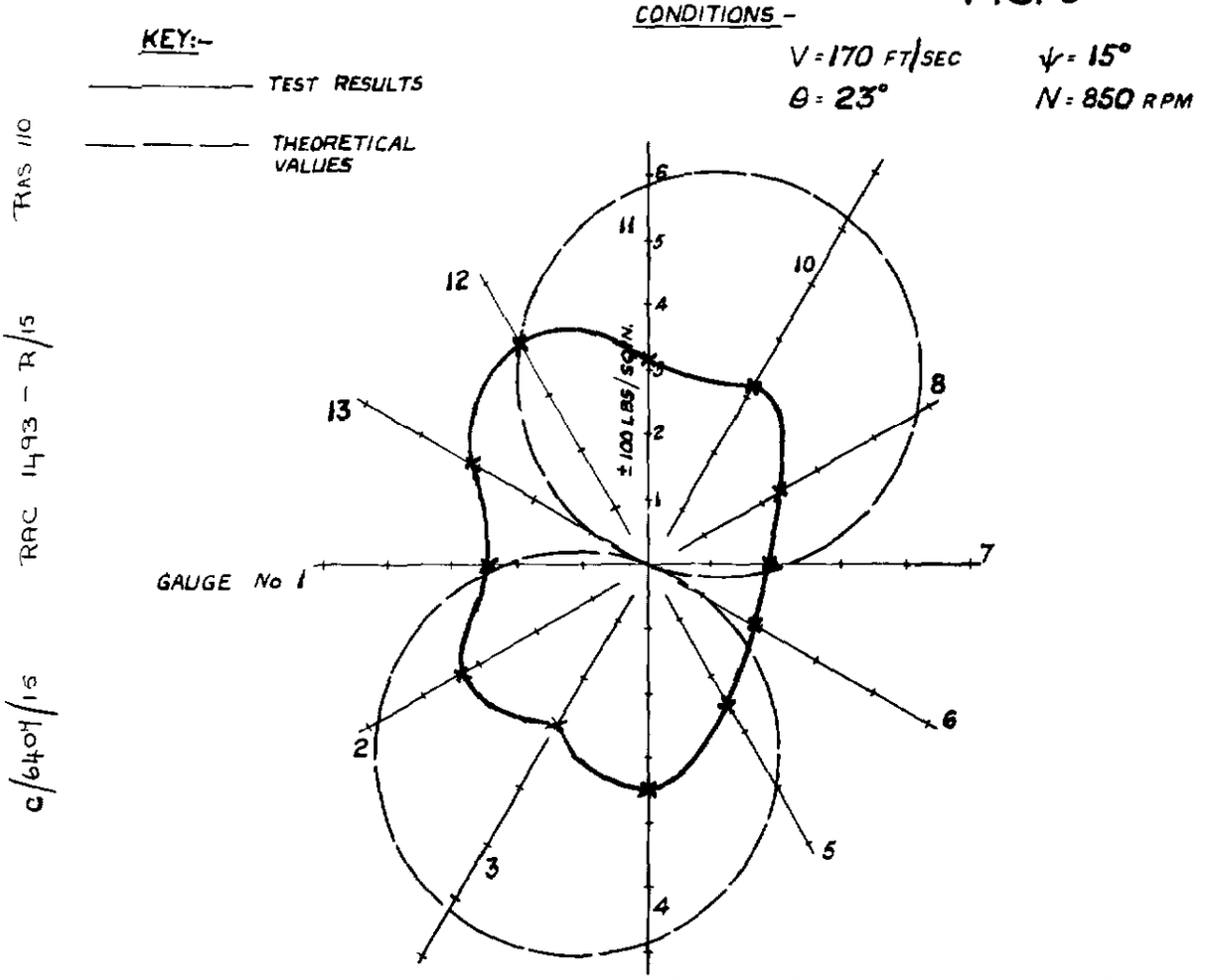
C/6406/14 RAE 1493 – R/14 RAS 110

VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



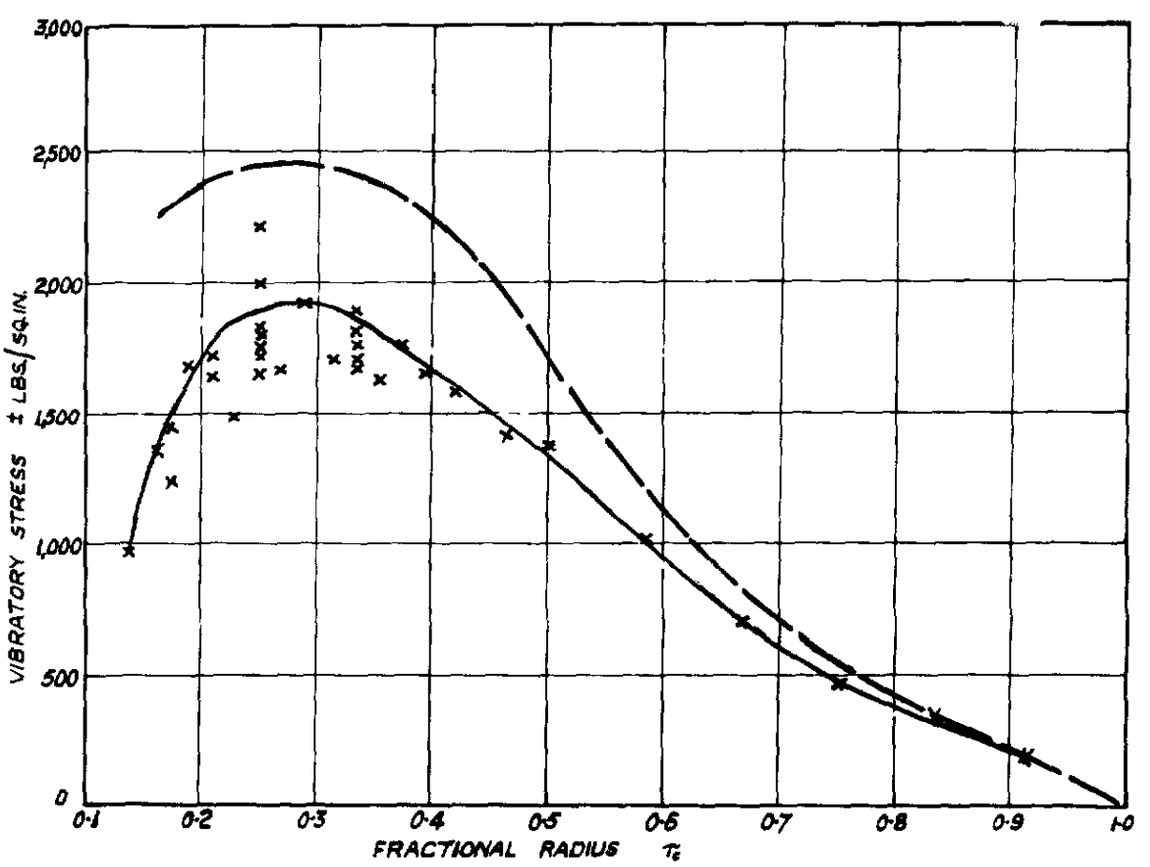
VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 6



RAS 110
RAC 1493 - R/15
C/6401/15

VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 7

RAC 110

RAC 1493 - R/12

C/6404/12

CONDITIONS -

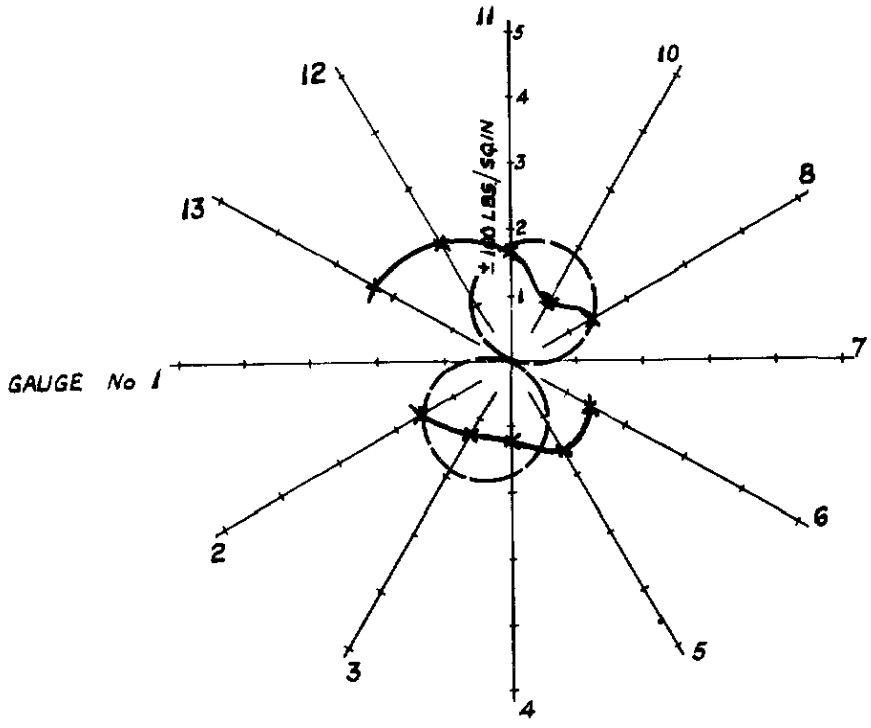
V = 170 FT/SEC ψ = 5°

θ = 20° N = 950 RPM

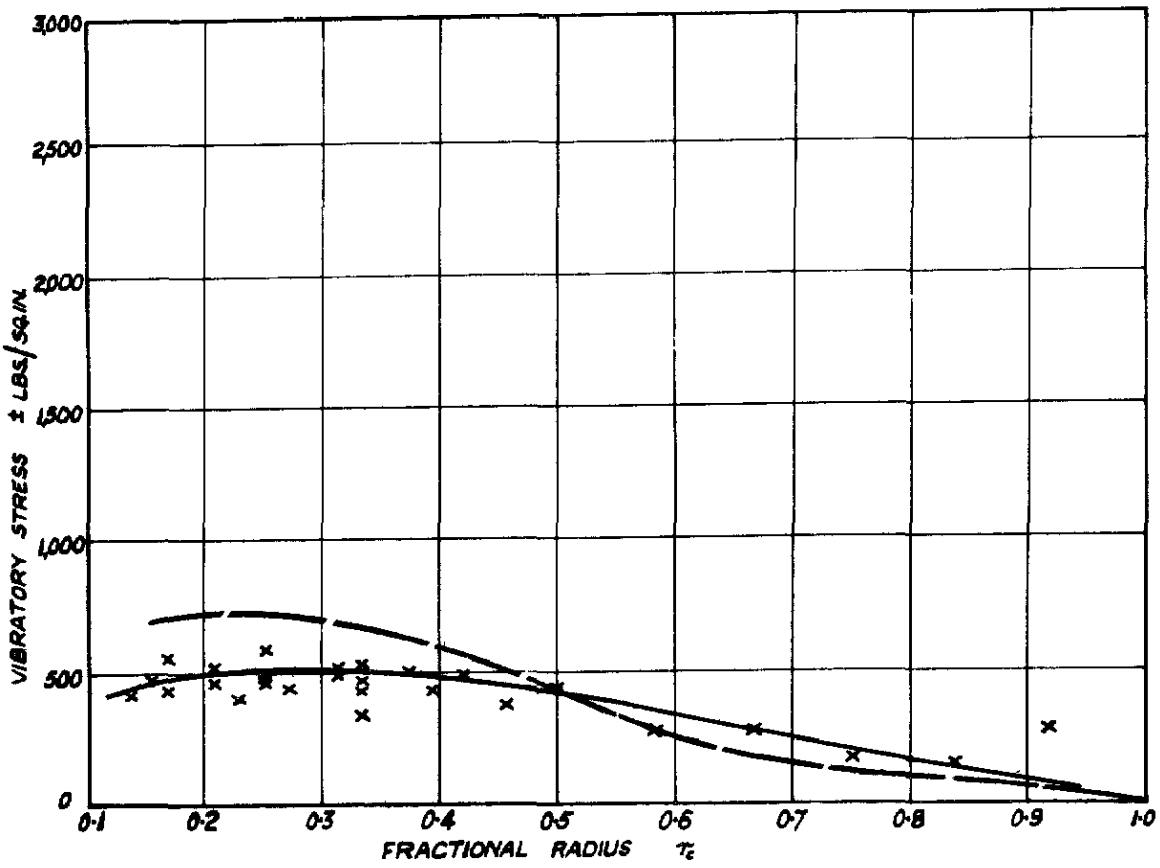
KEY:-

——— TEST RESULTS

— — — THEORETICAL VALUES



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 8

RAC 110

RAC 1493 - R/11

C/6403/11

KEY:-

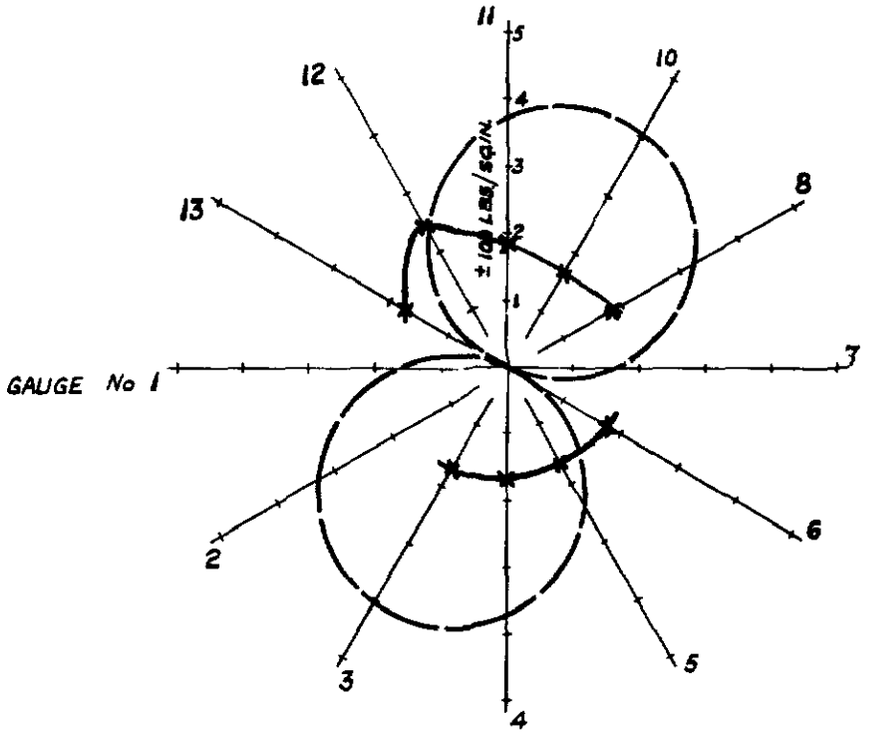
——— TEST RESULTS

— — — THEORETICAL VALUES

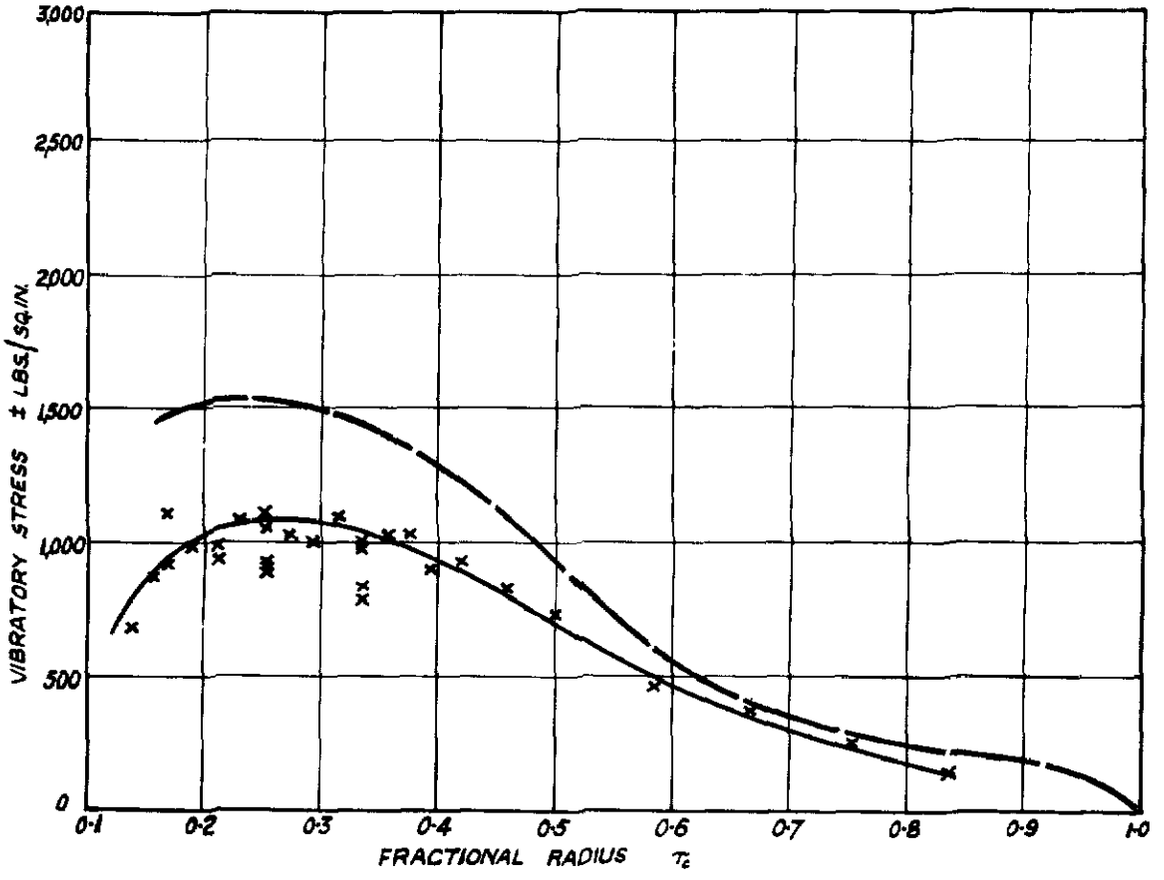
CONDITIONS -

$V = 170$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 950$ R.P.M



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 9

CONDITIONS –

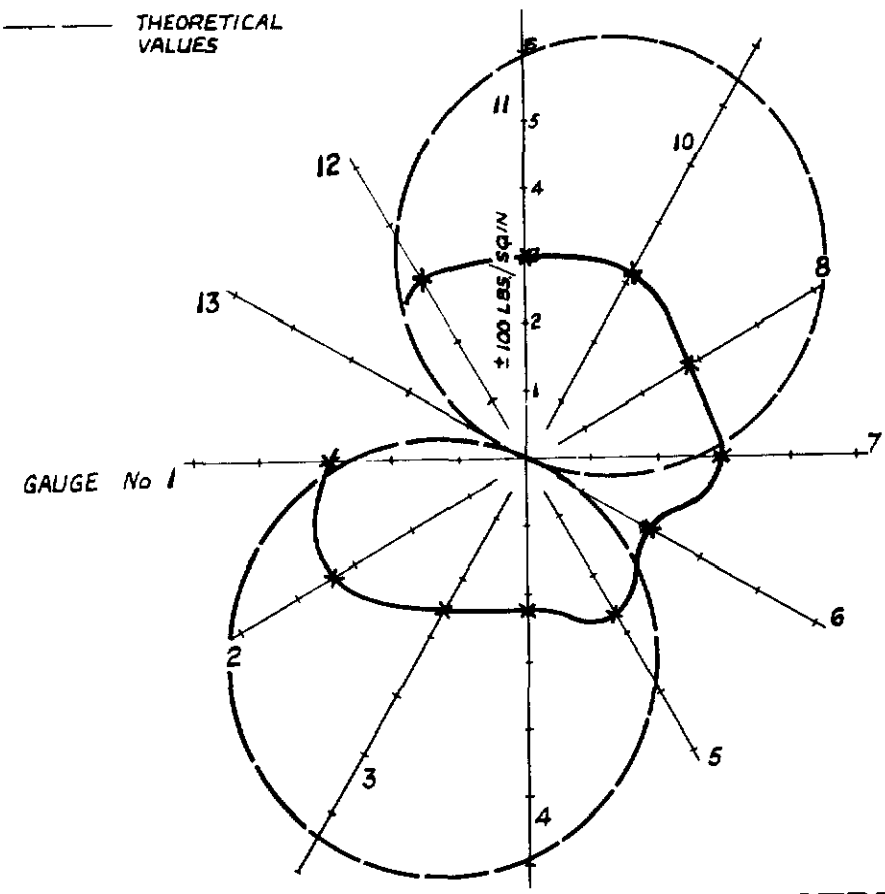
V = 170 FT/SEC ψ = 15°

θ = 20° N = 950 RPM

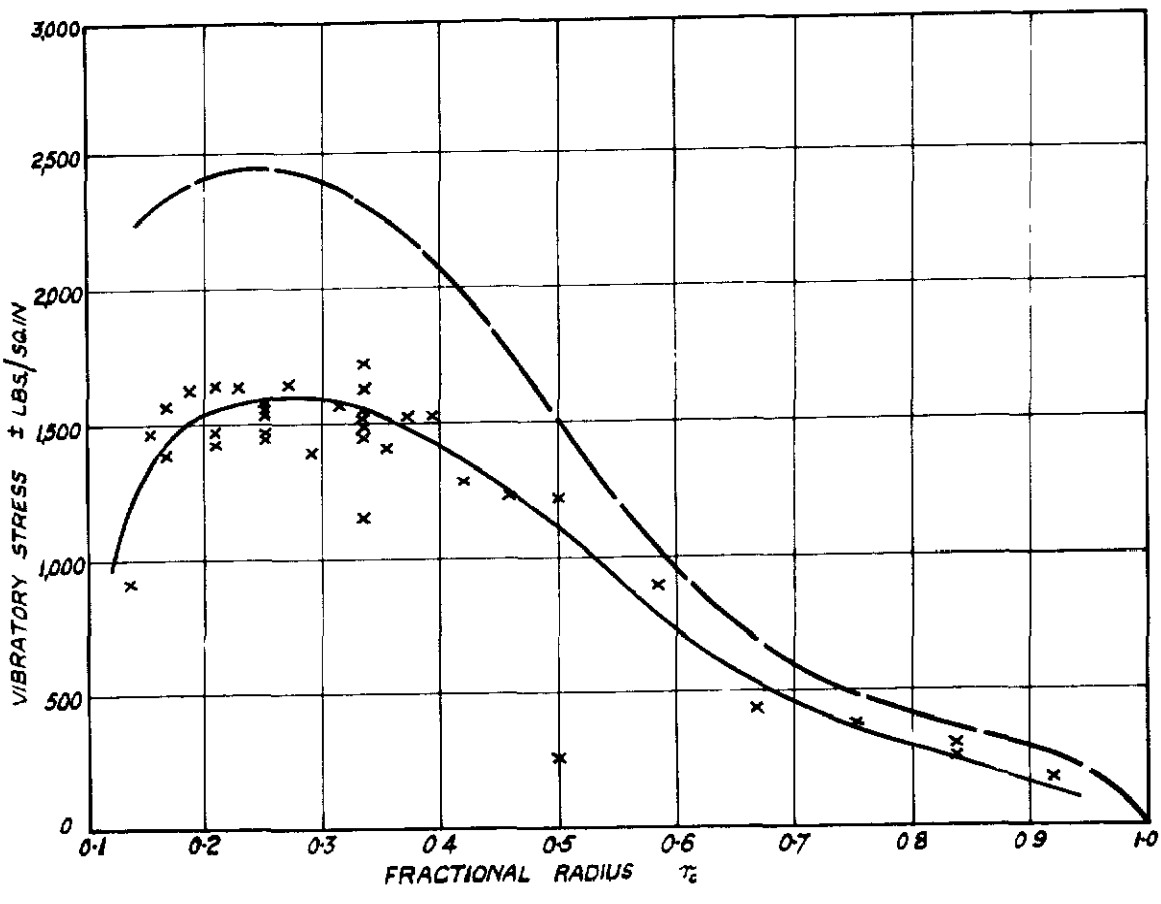
KEY:–

——— TEST RESULTS

— — — THEORETICAL VALUES



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 10

KEY:-

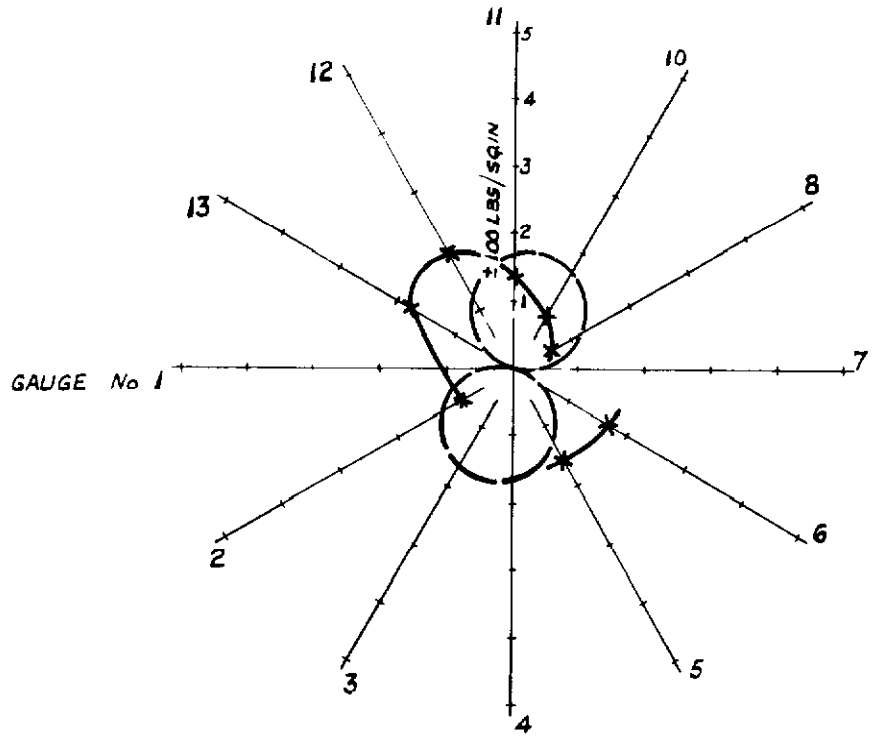
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

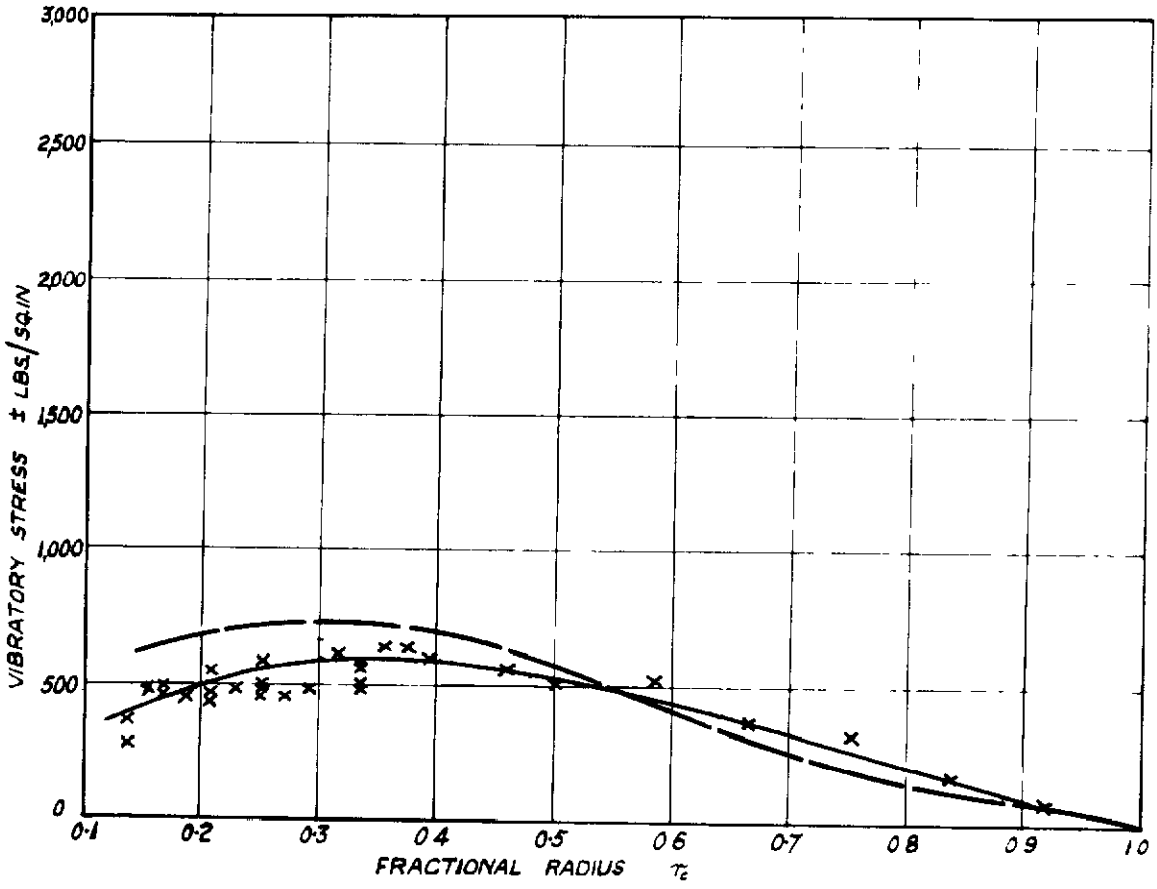
CONDITIONS –

$V = 100$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 750$ RPM



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

RAS 110

RAC 1493 - R/6

C/6397/6

FIG. 11

KEY:-

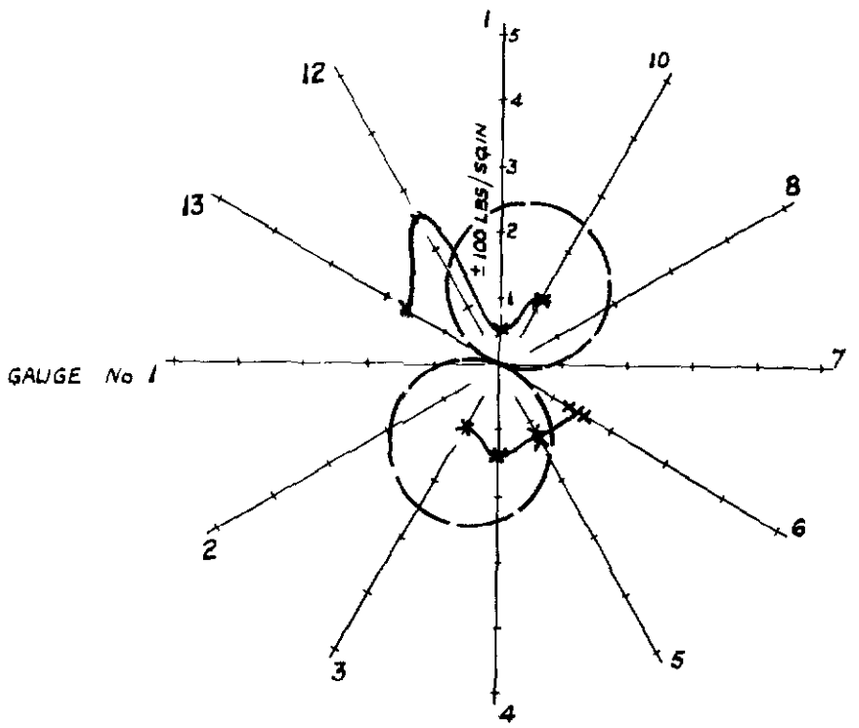
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

CONDITIONS -

$V = 170$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 750$ RPM

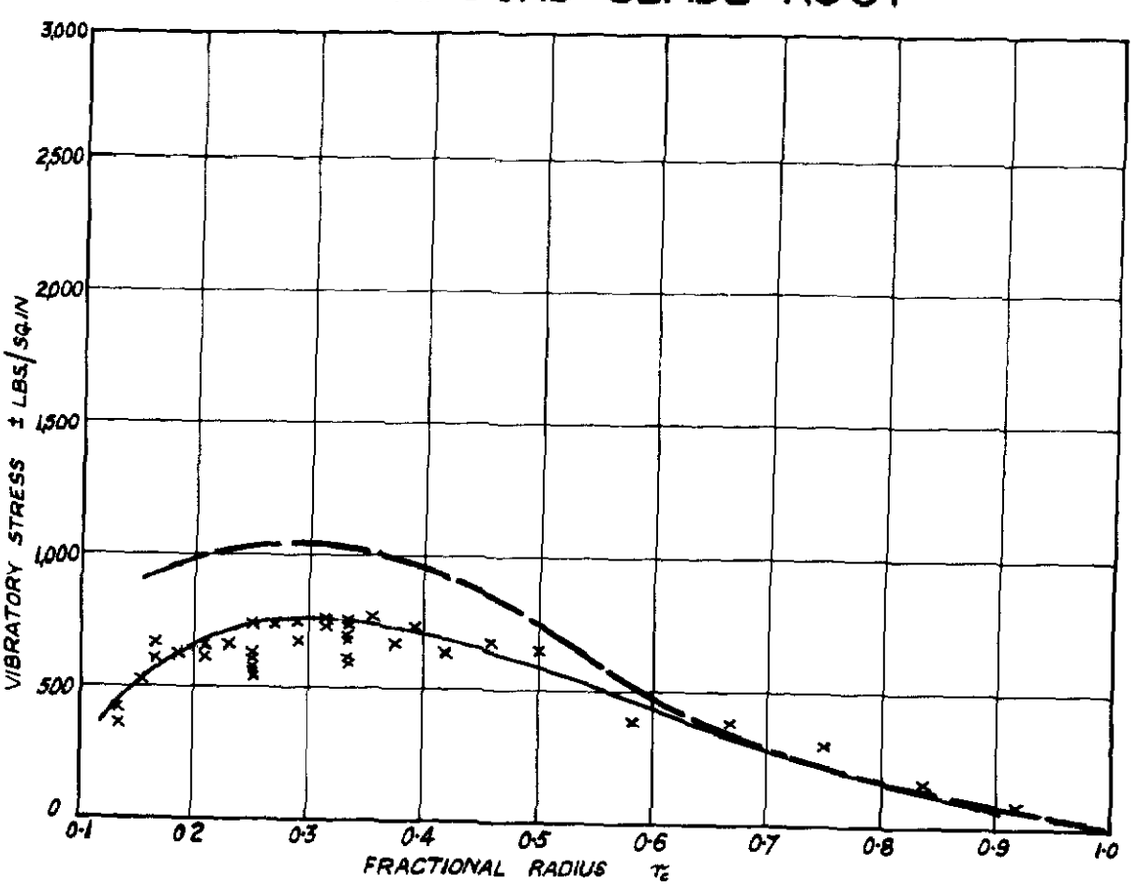


RAC 110

RAC 1493 - R/8

C/6300/8

VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 12

KEY:-

——— TEST RESULTS

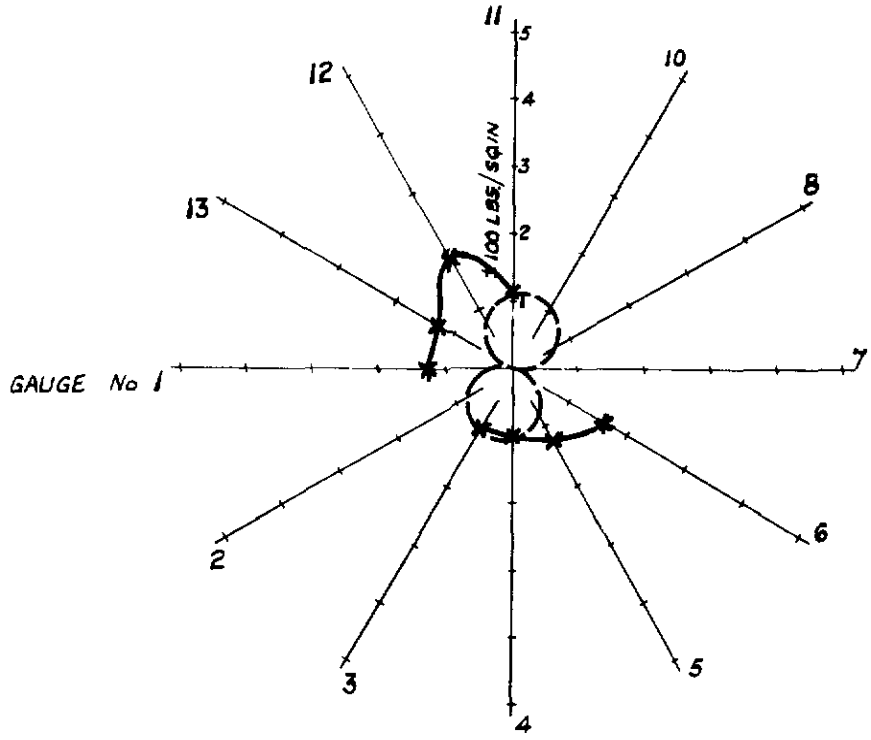
— — — — THEORETICAL VALUES

CONDITIONS -

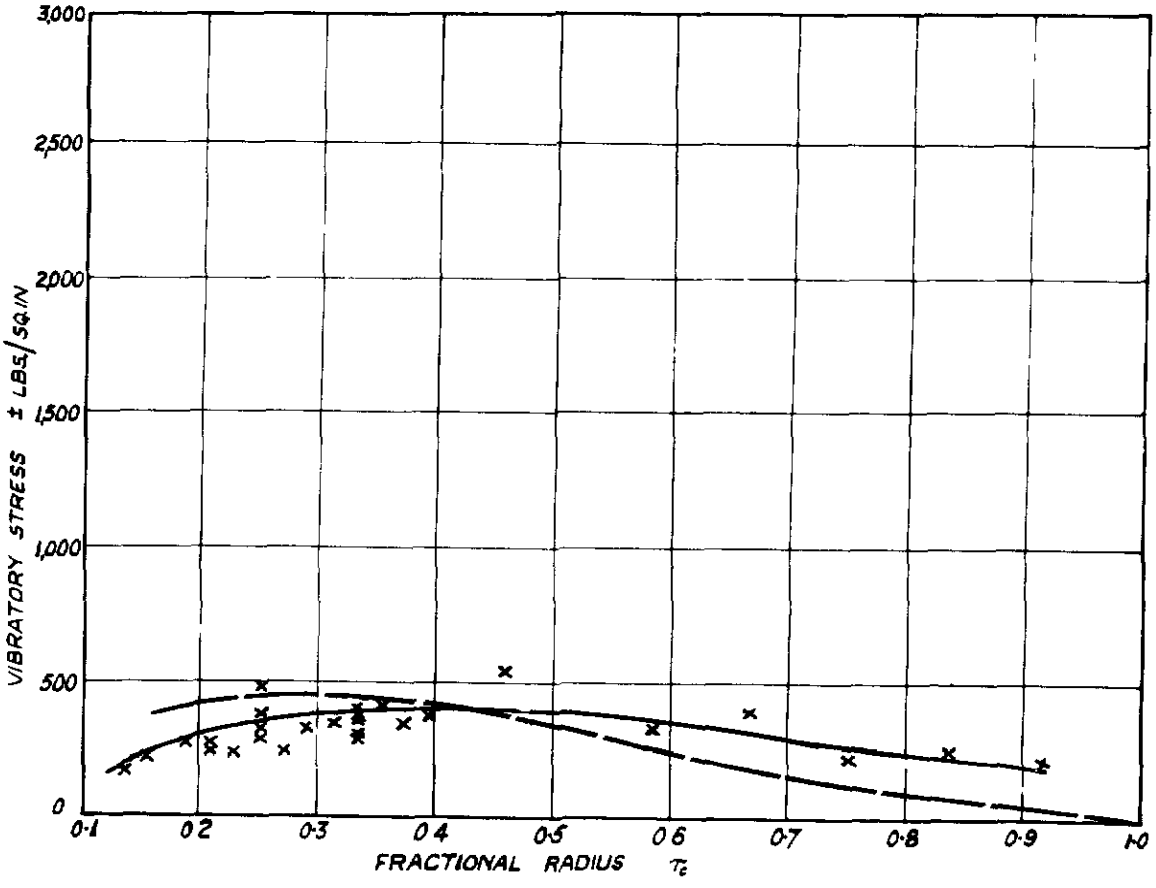
$V = 100$ FT/SEC $\quad \psi = 5°$

$\theta = 23°$ $\quad N = 750$ RPM

C/6402/10 RAC 1493 - R/10 RAS 110



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 13

CONDITIONS –

$V = 100$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 650$ RPM

KEY –

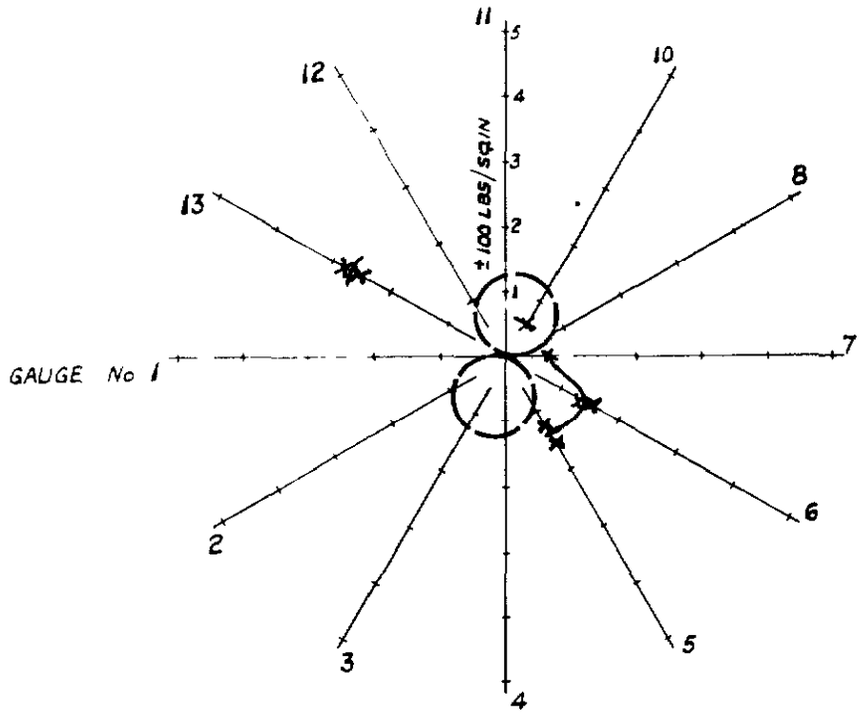
——— TEST RESULTS

– – – – THEORETICAL VALUES

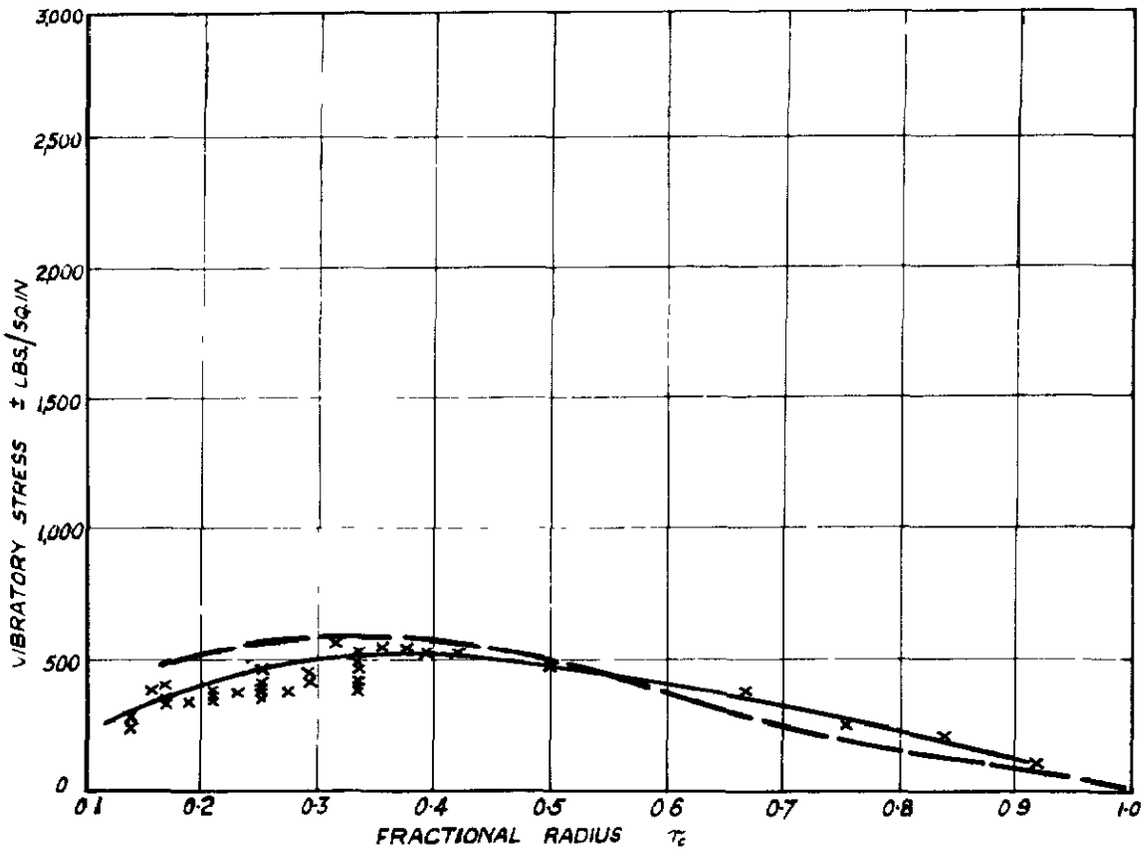
RAS 110

RAC 1493-R/5

C/6391/5



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 14

KEY -

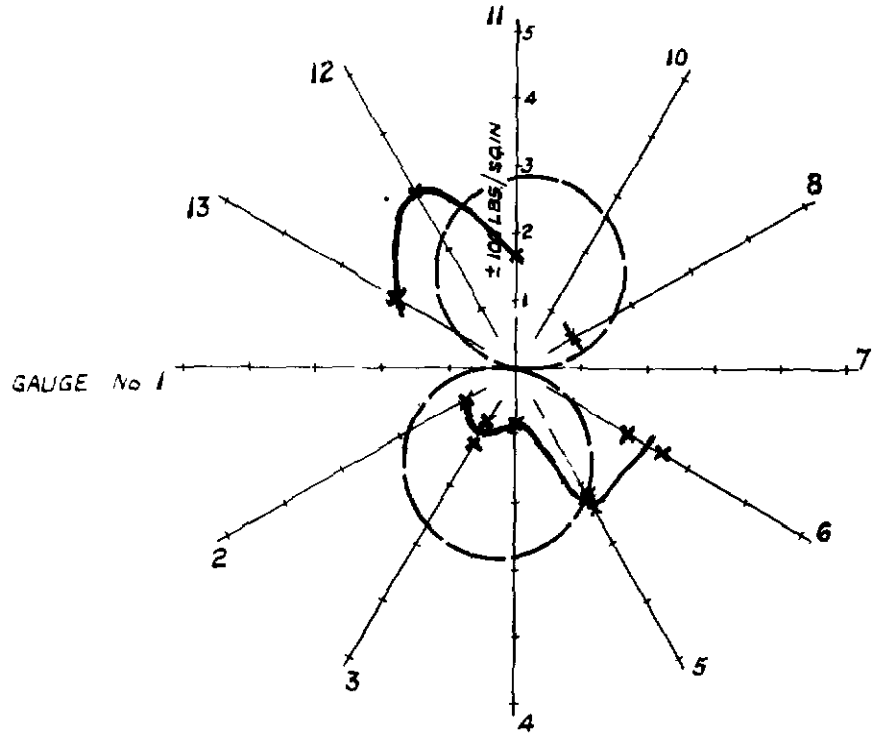
——— ——— TEST RESULTS

- - — - - THEORETICAL VALUES

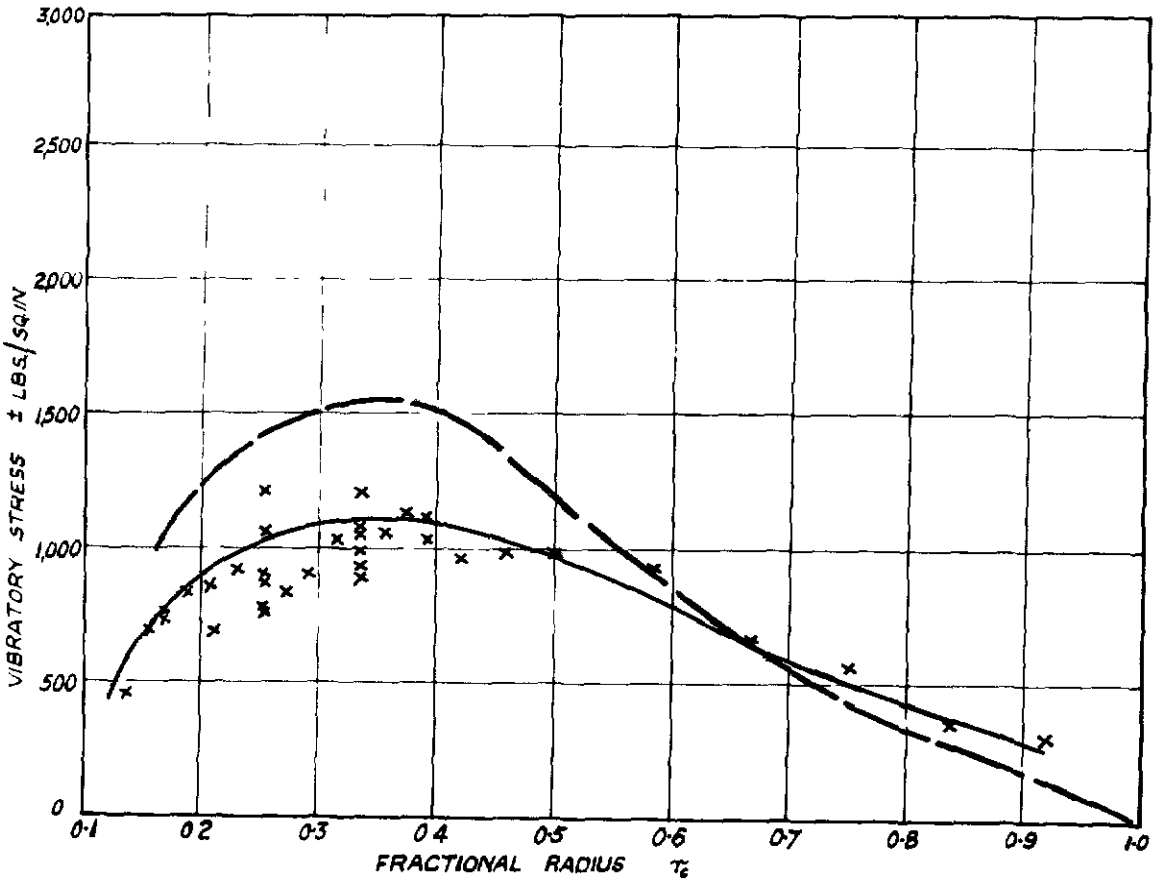
CONDITIONS -

$V = 100$ FT/SEC $\quad \psi = 15°$

$\theta = 26°55'$ $\quad N = 650$ RPM



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 15

KEY:-

TEST RESULTS

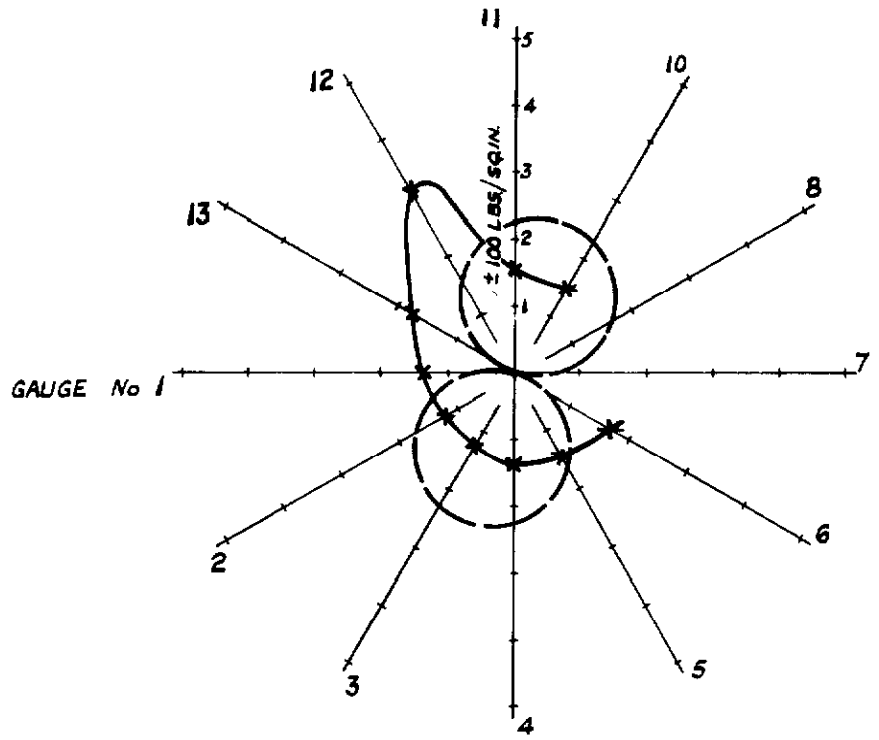
THEORETICAL VALUES

CONDITIONS:-

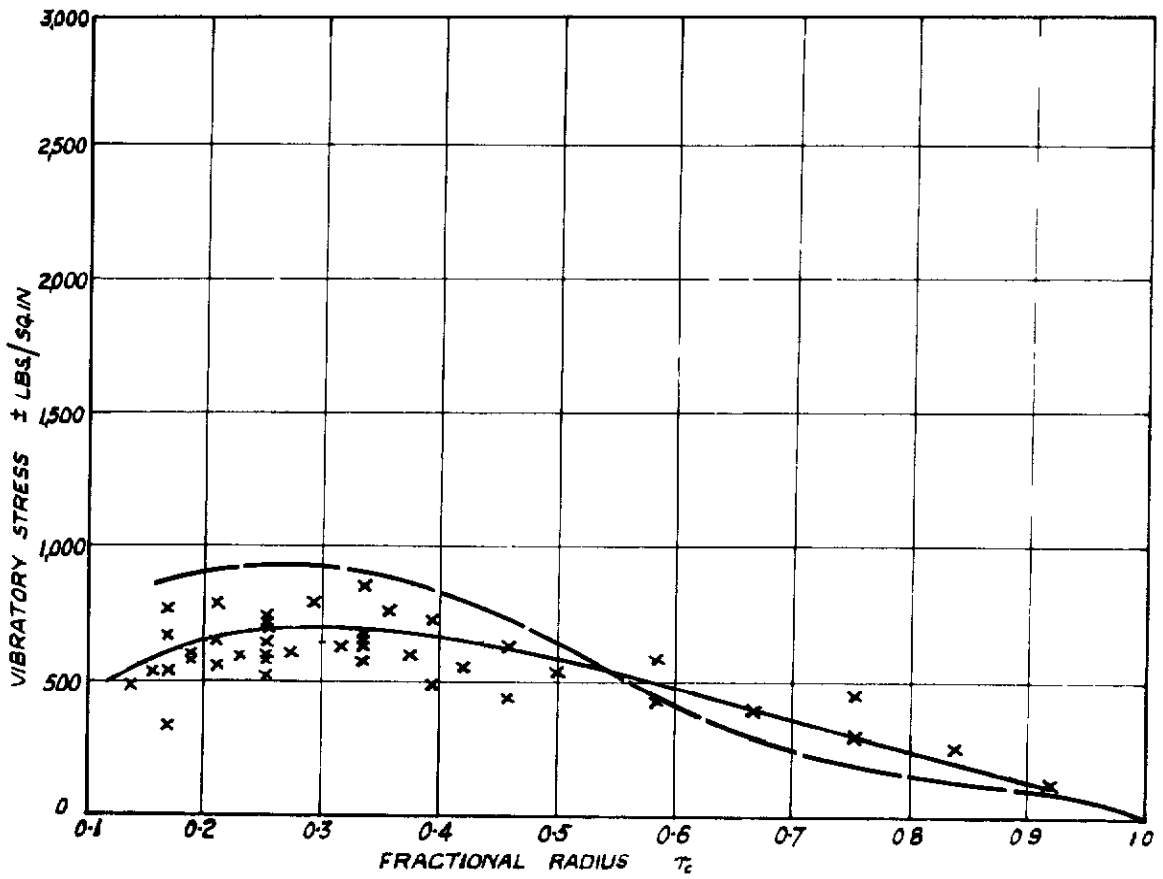
$V = 100$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 875$ RPM

C/6399/H RAC 1493 - R/H RAS 110



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 16

RAS 110

RAC 1493 - R/4

C/6401/9

KEY:-

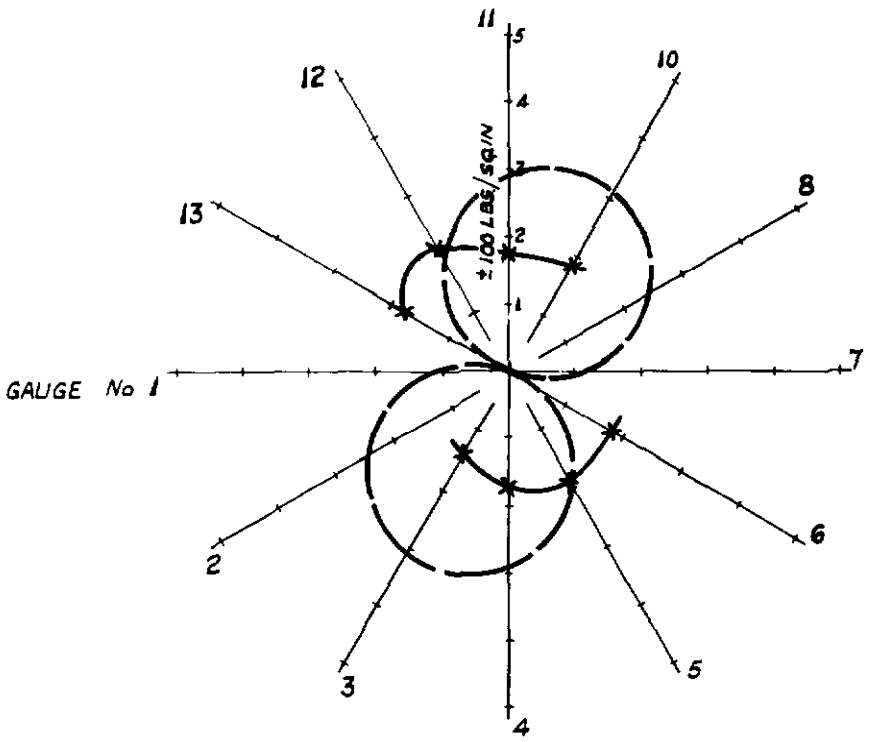
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

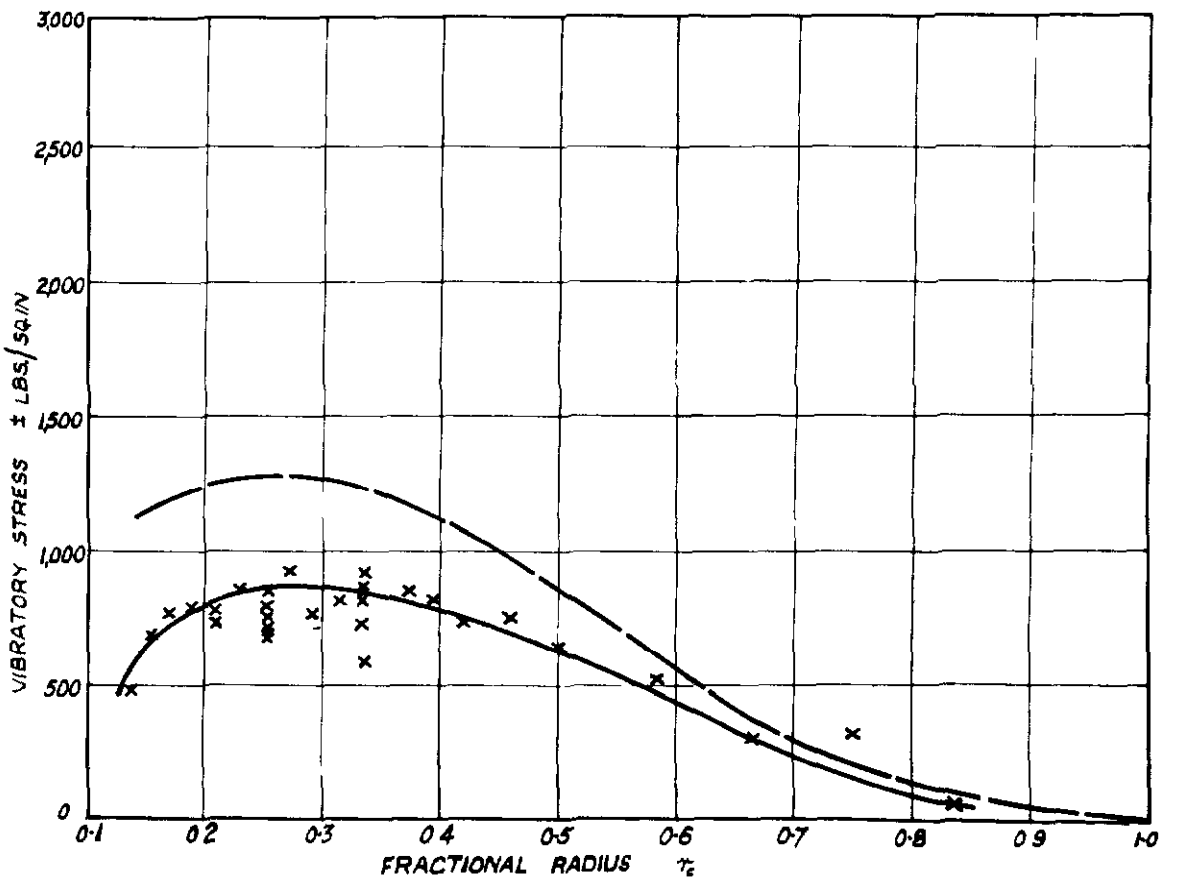
CONDITIONS -

$V = 170$ FT/SEC $\quad \psi = 10°$

$\theta = 20°$ $\quad N = 850$ RPM



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 17

CONDITIONS –

$V = 170$ FT/SEC $\quad \psi = 0°$

$\theta = 26° 55'$ $\quad N = 750$ RPM

KEY.–

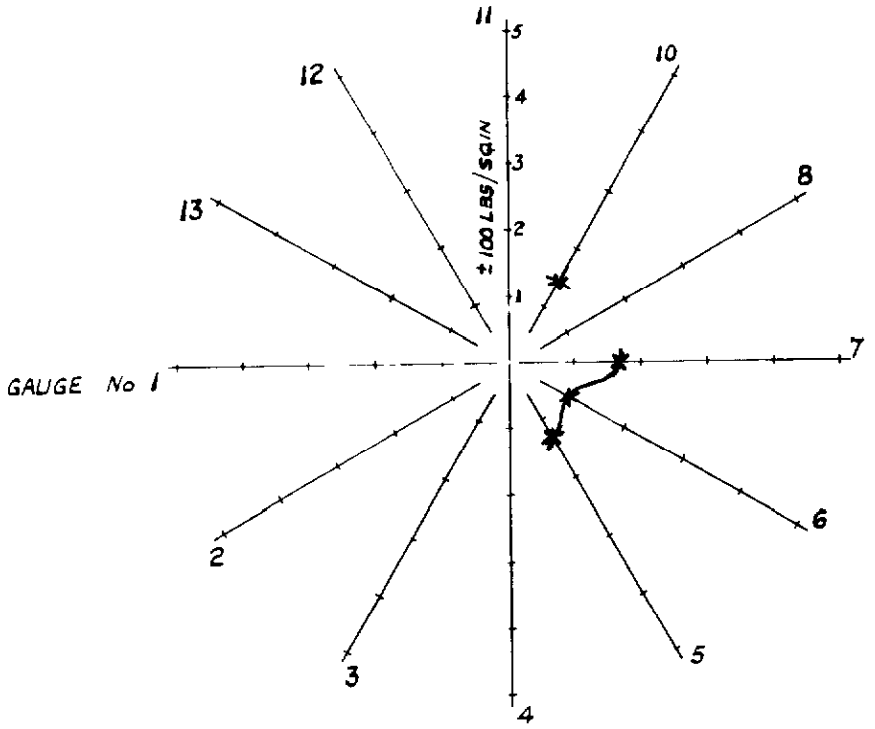
——————— TEST RESULTS

— — — — — THEORETICAL VALUES

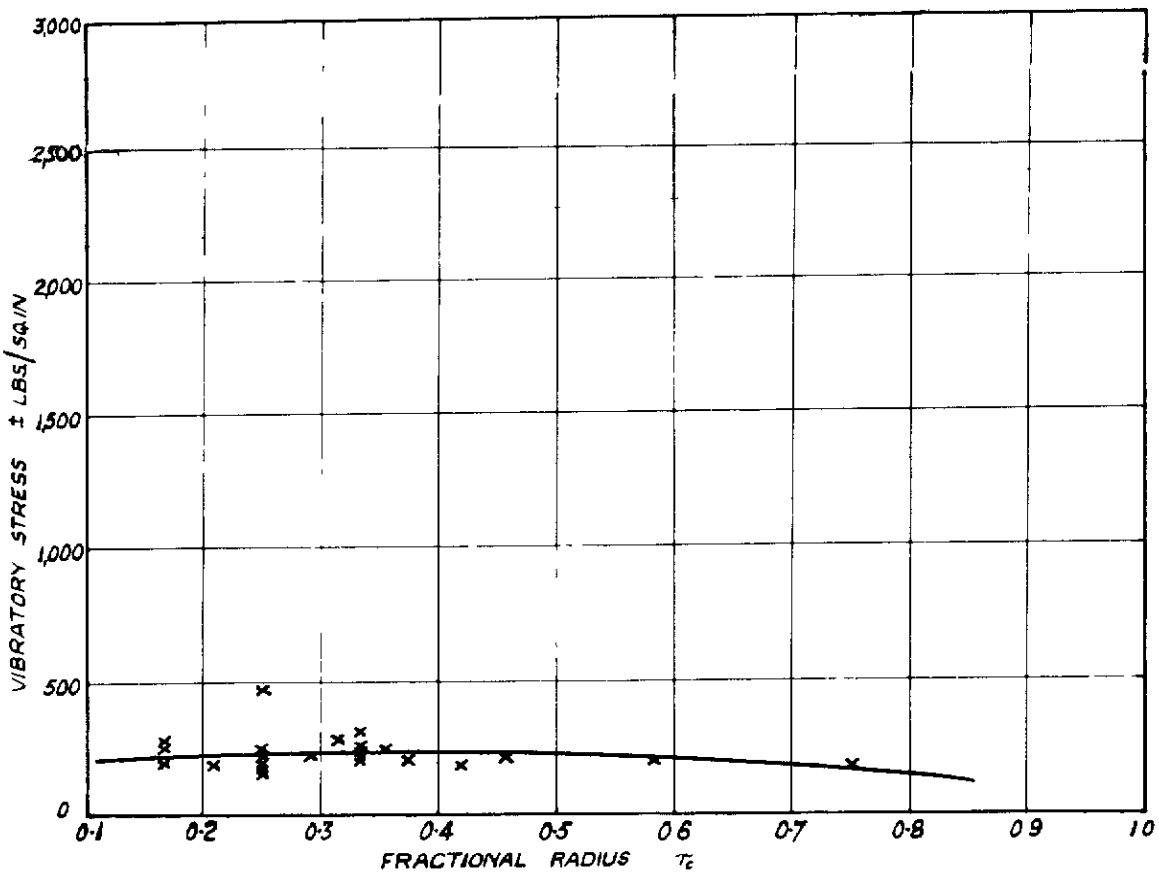
RAS 110

RAC 1493 - R/18

c/6410/18



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

FIG. 18

KEY –

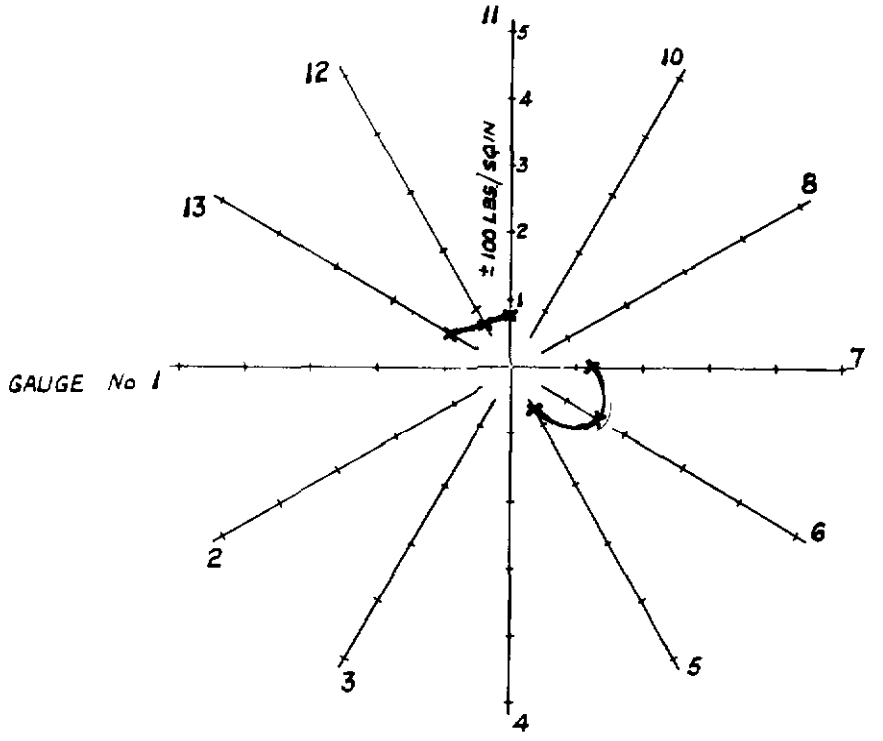
——— TEST RESULTS

— — — THEORETICAL VALUES

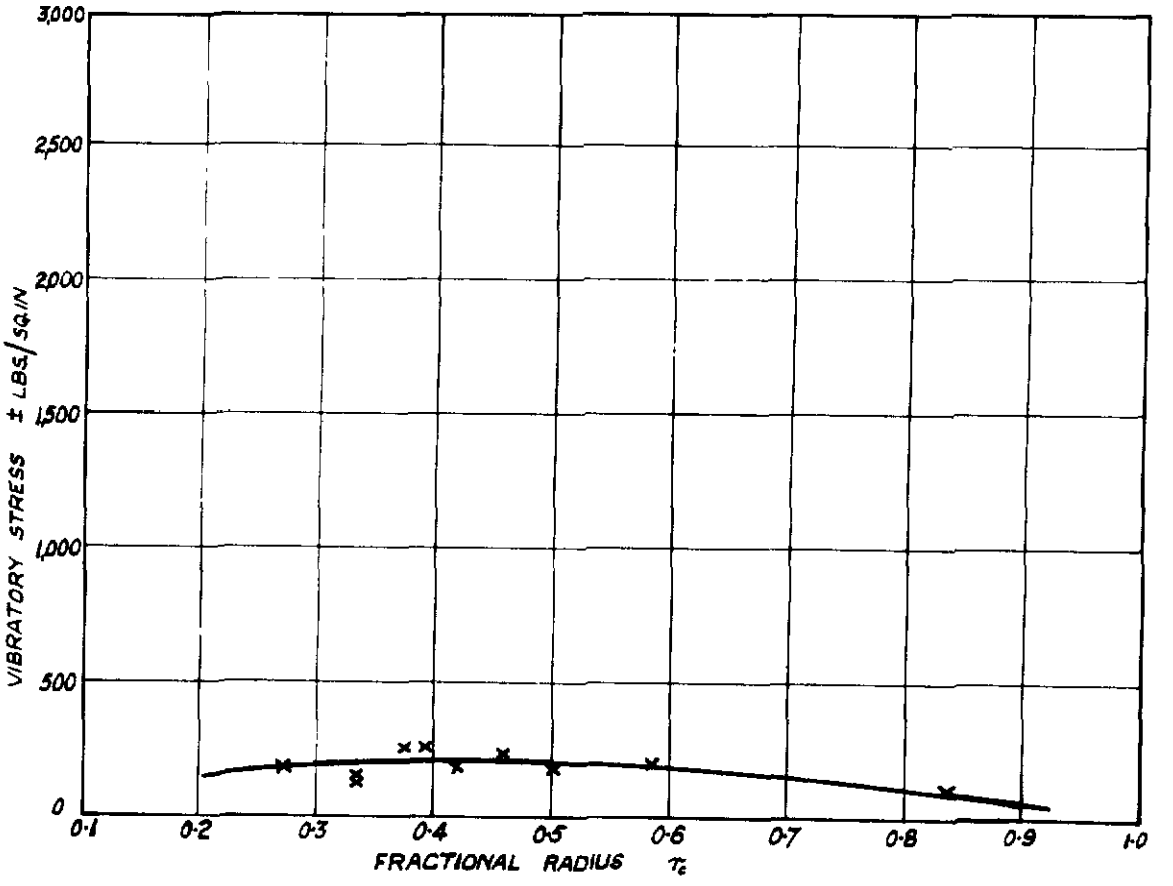
CONDITIONS –

$V = 170$ FT SEC $\quad \psi = 0°$

$\theta = 20°$ $\quad N = 950$ R.P.M



VARIATION OF VIBRATORY STRESSES AROUND BLADE ROOT



VARIATION OF VIBRATORY STRESSES ALONG BLADE

RAS 110

RAC 1493 – R/17

C/6409/17

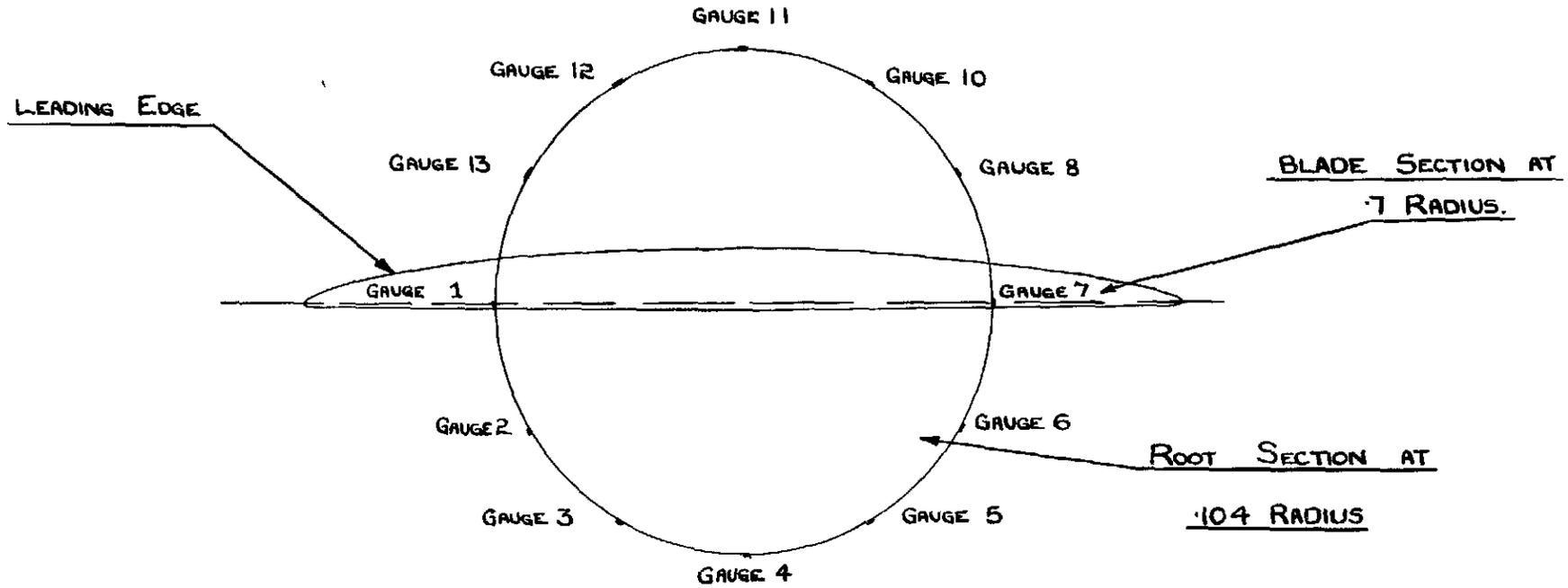


FIG. 19

POSITION OF STRAINGAUGES ON PROPELLER BLADE ROOT.

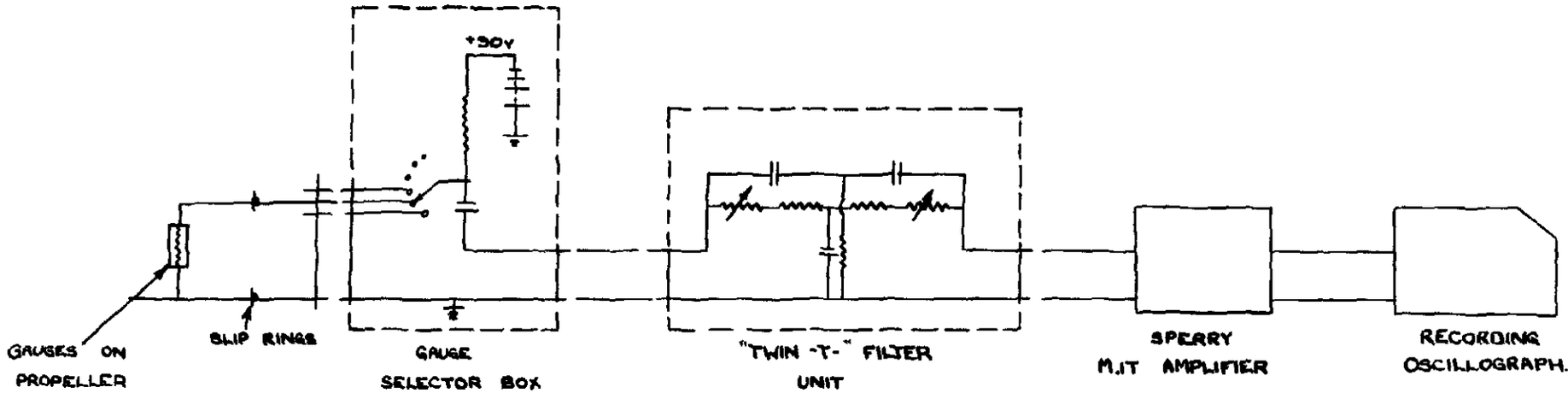
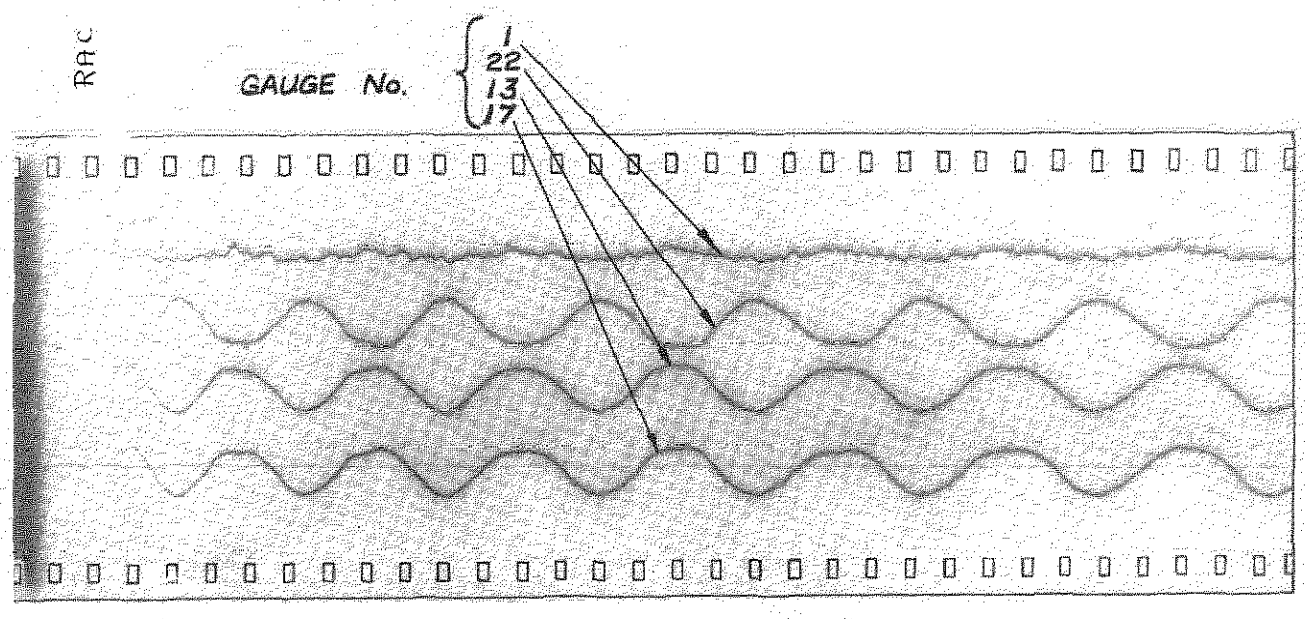


FIG. 20

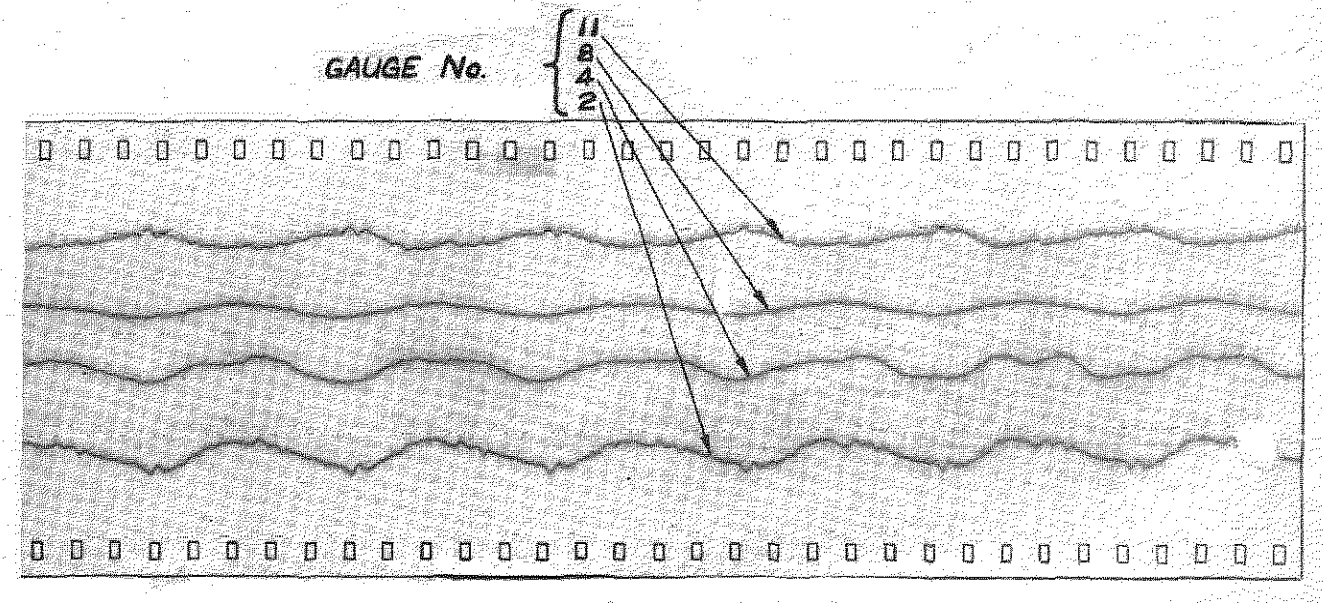
FINAL CIRCUIT FOR EACH CHANNEL OF STRAINGAUGE RECORDING APPARATUS

FIG. 21

RAC 1493 (v)



BLADE GAUGES



ROOT GAUGES

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