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Contract No. W-7405-eng-48

# CHECKING THE TRAVELING MICROSCOPE

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September 16, 1954

Berkeley, California

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A 0.002-inch tungsten wire was used as a reference point to test the accuracy of measurement in the traveling microscope. One end was fastened to the rim of the translucent screen of the stereo projector and a mounting block (for the microscope) was bolted over it. The other end of the wire was stretched by a 2.5-gram lead weight and taped to the other side of the rim. The other mounting block was bolted over this end.

## MEASUREMENT

The microscope was set at the number "1" on the centimeter bar. This position was taken as the starting point because the scope could not be set at zero. The reading of the micrometer dial was taken to the nearest whole number on the dial. The reading was taken when the crosshair was believed to be over the center of the wire (which is 0.005 cm in diameter, or five divisions on the dial). The carriage was allowed to fall naturally into each click-stop position. Readings were taken up and down the scale three times, making six readings for each of 32 points. The readings were averaged to the nearest thousandth of a centimeter, or one dial division. The wire was approached from the same direction on each reading.

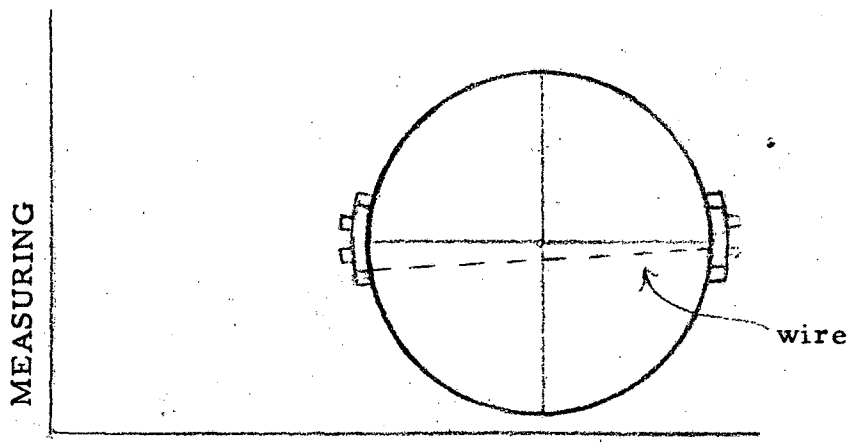
The reading at the start was 0.917 and the reading at the other end was 1.653; 0.917 was subtracted from each averaged reading, making the start read zero. The last reading was therefore 0.735. A twenty-inch slide rule was then used to find the intermediate points by proportion.

The error introduced by the slide rule is small enough that the calculated points are correct to the third decimal place.

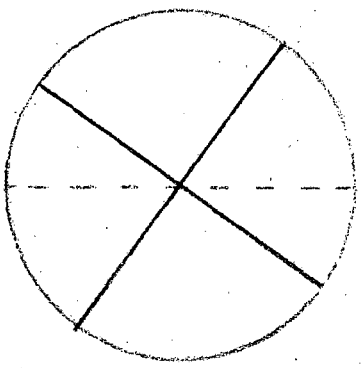
A graph was made of the numerical deviations of the averaged readings from the calculated points. A plus deviation means that the average was greater than the calculated point. Fig. 1 showed an error coincident with each revolution of the micrometer dial. It was felt that the surfaces on which the ballbearing ran were not perpendicular to the axis of the screw, so the two bearing pieces were taken to the main shop to be ground flat. The pieces are mounted in such a way that getting them perpendicular to the axis of the screw very accurately will be difficult. Possible suggestions for improvement are (1) that the end of the screw that receives the ballbearing could be drilled and tapped to a larger size to eliminate the bad tapping job that was done before, and (2) the face on the end of the screw could be checked to be sure it is perpendicular to the axis of the screw.

The graph of the second set of readings (the set whose figures have been used here) showed that there is still an error associated with each turn of the micrometer dial, as well as one that can be attributed to a slight curvature of the bars on which the microscope rides in the click-stop direction.

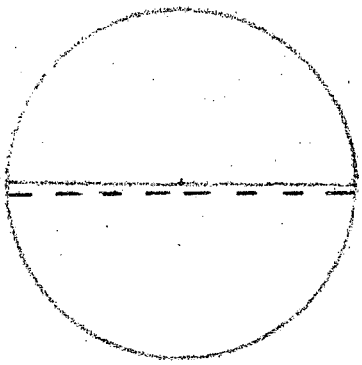
This is a plan view of the top of the projector screen when set up to measure:



The diagrams below show the positions of the crosshair with respect to the wire in the first and second runs.



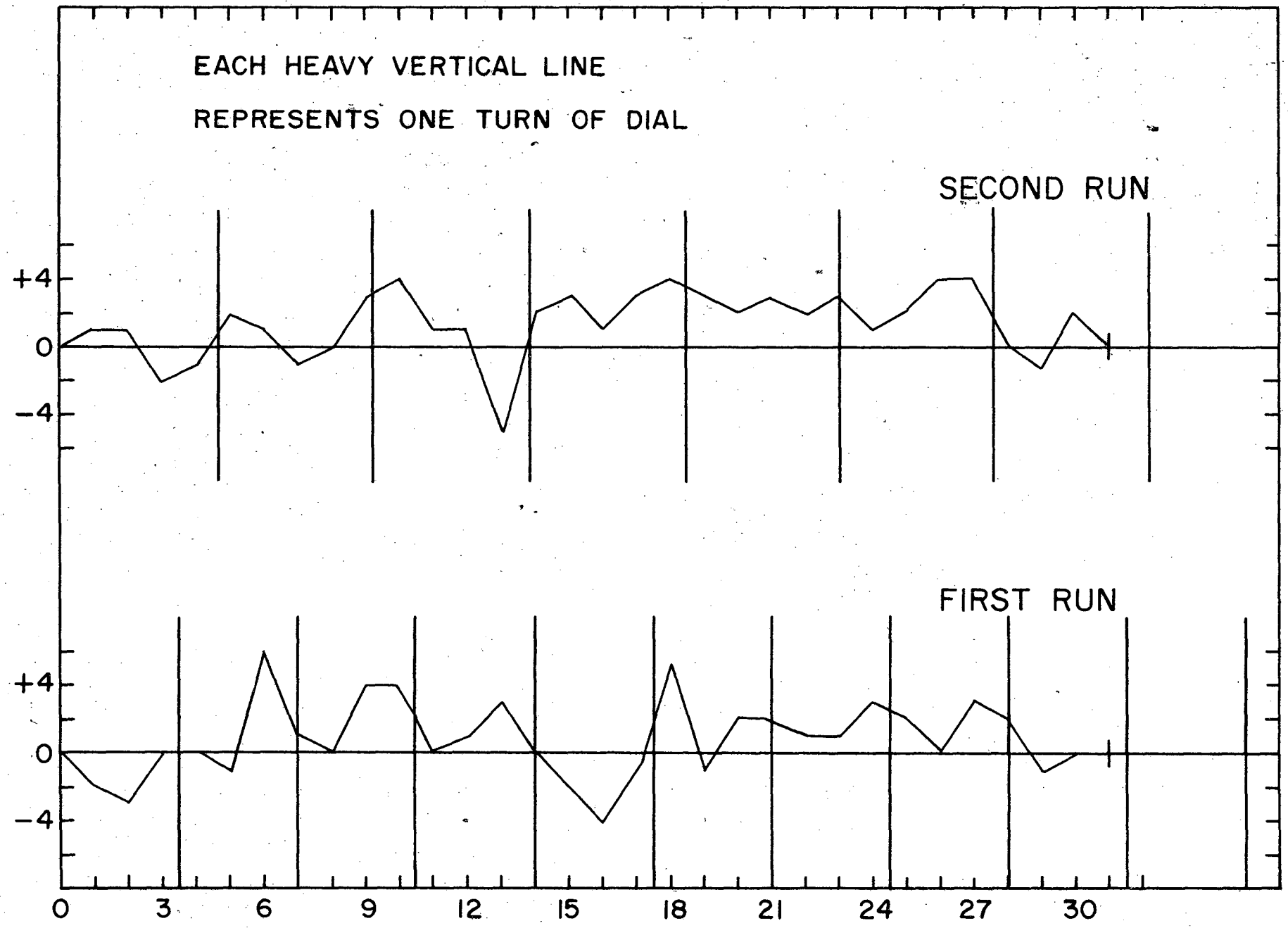
I



II

SECOND RUN

| | Reading Number | | | | | | Average | Reading from zero | Calculated Point | Difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| 0 | 0.917 | 0.917 | 0.916 | 0.917 | 0.917 | 0.918 | 0.917 | 0.000 | 0.000 | 0 |
| 1 | 0.942 | 0.942 | 0.941 | 0.944 | 0.943 | 0.940 | 0.942 | 0.025 | 0.024 | + 1 |
| 2 | 0.966 | 0.966 | 0.963 | 0.966 | 0.965 | 0.963 | 0.965 | 0.048 | 0.047 | + 1 |
| 3 | 0.989 | 0.988 | 0.987 | 0.984 | 0.984 | 0.985 | 0.986 | 0.069 | 0.071 | - 2 |
| 4 | 1.013 | 1.012 | 1.012 | 1.010 | 1.009 | 1.011 | 1.011 | 0.094 | 0.095 | - 1 |
| 5 | 1.039 | 1.039 | 1.036 | 1.035 | 1.036 | 1.038 | 1.037 | 0.120 | 0.118 | + 2 |
| 6 | 1.062 | 1.060 | 1.061 | 1.060 | 1.059 | 1.058 | 1.060 | 0.143 | 0.142 | + 1 |
| 7 | 1.084 | 1.083 | 1.082 | 1.082 | 1.081 | 1.081 | 1.082 | 0.165 | 0.166 | - 1 |
| 8 | 1.110 | 1.107 | 1.106 | 1.107 | 1.106 | 1.105 | 1.107 | 0.190 | 0.190 | 0 |
| 9 | 1.134 | 1.134 | 1.135 | 1.132 | 1.134 | 1.131 | 1.133 | 0.216 | 0.213 | + 3 |
| 10 | 1.158 | 1.158 | 1.156 | 1.155 | 1.156 | 1.156 | 1.158 | 0.241 | 0.237 | + 4 |
| 11 | 1.181 | 1.180 | 1.178 | 1.178 | 1.177 | 1.177 | 1.179 | 0.262 | 0.261 | + 1 |
| 12 | 1.206 | 1.202 | 1.203 | 1.205 | 1.202 | 1.200 | 1.203 | 0.286 | 0.285 | + 1 |
| 13 | 1.231 | 1.230 | 1.228 | 1.227 | 1.226 | 1.227 | 1.228 | 0.311 | 0.316 | - 5 |
| 14 | 1.253 | 1.253 | 1.254 | 1.253 | 1.253 | 1.252 | 1.253 | 0.336 | 0.334 | + 2 |
| 15 | 1.277 | 1.274 | 1.275 | 1.275 | 1.274 | 1.275 | 1.276 | 0.359 | 0.356 | + 3 |
| 16 | 1.297 | 1.297 | 1.295 | 1.297 | 1.299 | 1.297 | 1.297 | 0.380 | 0.379 | + 1 |
| 17 | 1.324 | 1.323 | 1.322 | 1.323 | 1.324 | 1.322 | 1.323 | 0.406 | 0.403 | + 3 |
| 18 | 1.349 | 1.348 | 1.347 | 1.349 | 1.347 | 1.347 | 1.348 | 0.431 | 0.427 | + 4 |
| 19 | 1.371 | 1.370 | 1.370 | 1.372 | 1.369 | 1.369 | 1.370 | 0.453 | 0.450 | + 3 |
| 20 | 1.393 | 1.393 | 1.393 | 1.392 | 1.394 | 1.390 | 1.393 | 0.476 | 0.474 | + 2 |
| 21 | 1.421 | 1.419 | 1.417 | 1.417 | 1.417 | 1.418 | 1.418 | 0.501 | 0.498 | + 3 |
| 22 | 1.441 | 1.440 | 1.442 | 1.440 | 1.444 | 1.441 | 1.441 | 0.524 | 0.522 | + 2 |
| 23 | 1.466 | 1.465 | 1.464 | 1.465 | 1.464 | 1.464 | 1.465 | 0.548 | 0.545 | + 3 |
| 24 | 1.486 | 1.488 | 1.487 | 1.486 | 1.487 | 1.485 | 1.487 | 0.570 | 0.569 | + 1 |
| 25 | 1.512 | 1.512 | 1.511 | 1.512 | 1.510 | 1.510 | 1.511 | 0.594 | 0.592 | + 2 |
| 26 | 1.539 | 1.536 | 1.536 | 1.539 | 1.538 | 1.533 | 1.537 | 0.620 | 0.616 | + 4 |
| 27 | 1.561 | 1.560 | 1.561 | 1.561 | 1.562 | 1.559 | 1.561 | 0.644 | 0.640 | + 4 |
| 28 | 1.582 | 1.581 | 1.581 | 1.581 | 1.581 | 1.579 | 1.581 | 0.664 | 0.664 | 0 |
| 29 | 1.601 | 1.604 | 1.605 | 1.605 | 1.605 | 1.603 | 1.604 | 0.687 | 0.688 | - 1 |
| 30 | 1.629 | 1.630 | 1.630 | 1.632 | 1.629 | 1.630 | 1.630 | 0.713 | 0.711 | + 2 |
| 31 | 1.653 | 1.652 | 1.653 | 1.652 | 1.651 | 1.650 | 1.652 | 0.735 | 0.735 | 0 |


EACH HEAVY VERTICAL LINE
REPRESENTS ONE TURN OF DIAL
SECOND RUN
+4
0
−4
FIRST RUN
+4
0
−4
0
3
6
9
12
15
18
21
24
27
30