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Office of Scientific Research and Development
NATIONAL DEFENSE RESEARCH COMMITTEE
Section 16.1 - Optical Instruments
Institute of Optics
UNIVERSITY OF ROCHESTER

RESTRICTED

Report on
Anti-Oscillation Mount Tests

Contract No. OEMsr - [160]

Oct. 2, 1945

Listed

Section 16.1 Report No. 113
OSRD Report No. 6034

Copy No. 26

Office of Scientific Research and Development
National Defense Research Committee
Section 16.1 - Optical Instruments

Institute of Optics
UNIVERSITY OF ROCHESTER

Report on
ANTI-OSCILLATION MOUNT TESTS

Contract No. OEMsr-160

October 2, 1945

Section 16.1 Report No. 113
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of Report on

ANTI-OSCILLATION MOUNT TESTS

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FOREWORD

This report describes tests conducted by the University of Rochester on anti-oscillation mounts for binoculars which were developed under the following contracts:

	Contract	OSRD Report No.
University of Rochester	OEMsr-160	1479
Eastman Kodak Company	OEMsr-1090	4444
Eastman Kodak Company	OEMsr-392	6126
Technicolor Motion Picture Corporation	OEMsr-617	4183

Those tests are not adequate to assess fully the relative effectiveness of the various mounts. Additional laboratory and service tests are much to be desired.

The gimbal mount developed by the University of Rochester and redesigned by the Eastman Kodak Company (OEMsr-1090) for production gives the best overall performance but is complex and expensive, and requires careful adjustment and servicing. The simpler mounts developed by Eastman (OEMsr-392) and by Technicolor should be developed further. Except for static boresighting, it seems likely that these mounts would give satisfactory performance in aircraft and on ships.

Theodore Dunham, Jr.
Chief, Section 16.1, NDRC
Optical Instruments

22-241 Radiation Laboratory
Massachusetts Institute
of Technology
Cambridge 39, Massachusetts
June 7, 1946

ANTI-OSCILLATION MOUNT TESTS

In the course of the development of the anti-oscillation mounts at the Institute of Optics it was also necessary to develop and construct suitable equipment for making accurate laboratory tests of their performance. The most important of this equipment was a special shake table for measuring the effect of various types and amounts of mechanical vibration upon anti-oscillation mounted optical systems. Since this shake table was essentially a precision instrument, not easily duplicated, the Institute of Optics was asked on numerous occasions to test other types of anti-oscillation mounts besides those developed in its own laboratory.

As a result of many shake table performance tests on its own anti-oscillation mounts, the Institute of Optics established a standardized testing procedure, and a criterion for acceptable performance. This criterion was set up after the results of the shake table tests had been correlated with a considerable amount of field experience with mountings in various types of aircraft. The acceptable performance so arrived at was chosen to guarantee satisfactory performance in flight under any conditions which might be encountered in any type of military aircraft. It is obvious that such a criterion must necessarily be severe, and not easily met. Nevertheless, the acceptable performance specification finally established was one which was met by the anti-oscillation mounts designed and built at the Institute of Optics, not only before leaving the laboratory, but even upon their return from extensive field service. The design of the testing equipment and the testing procedure is described in Appendix I, while the acceptable performance specifications are given in Appendix II.

The anti-oscillation mounts made by others and submitted to the Institute of Optics for tests fall into two groups. In the first group are the ones which employ the Institute of Optics gimbal and air dash-pot principles, but which depart in design details. This group includes the mountings discussed in Appendices III and IV. Here the testing procedure and performance criterion is directly applicable. The second group employs a different principle of anti-oscillation mounting and departs radically in design. These mountings are discussed in Appendices V and VI. Here the testing procedure serves as a common ground for evaluating relative performance. The mounting discussed in Appendix VII will be considered later.

Of those instruments in the first group which have been tested at the Institute of Optics, none completely meets all the acceptable performance requirements. In general, at the higher frequencies, which include those frequencies encountered in normal flight, their performance is satisfactory. All of them have natural frequencies which are higher than has been found desirable in the Institute of Optics mounts, and most of them are not sufficiently damped. This deficiency is apt to cause trouble in planes which have a tendency to yaw, or in the presence of low frequency vibrations arising from gun fire or bumpy air. Another serious shortcoming is the poor boresighting performance, since these instruments are intended for use as gun sights.

It may be that these acceptable performance specifications have been made unnecessarily severe in an effort to insure satisfactory performance under all conditions. If so, they should be modified for any particular application in which operating conditions are found by experience to be more favorable.

The final criterion must, of course, be satisfactory performance under actual service use.

The instruments in the second group utilize a different principle and are intended for a different application. Since they are primarily for use as visual aids in searching or observing, and not for sighting devices, the boresighting requirements are considerably less severe. This is fortunate, for the principles employed in these instruments do not seem to lend themselves readily to good boresighting. As far as the transmissability of these mountings is concerned, the Sandvik-Chandler type compares favorably with the gimbal mounts over part of the frequency range. It is inferior, however, at frequencies above 1800 rpm, and below 1000 rpm. The Technicolor mounts are inferior over the entire range, and are unusable at certain frequencies.

In evaluating the performance of these mounts, it should be borne in mind that they are a less precise and consequently less expensive design. There may be many applications, therefore, in which some sacrifice in performance can be tolerated in the interest of economy. The Sandvik-Chandler mount appears to be a good compromise in this direction.

The Kollsman mount discussed in Appendix VII employs the gimbal principle, but differs from the rest of the group in many important ways. The air dash-pot damper is not used, and no satisfactory substitution is made for it. The gimbal principle itself is not well executed, as the system is not properly balanced. In fact, the departures from the Institute of Optics design do not appear to have greatly simplified the construction, but unfortunately have affected the performance so adversely that this mounting does not even compare favorably with the simpler types in group two. On the basis of the shake table tests, the applicability of this mounting would seem to be extremely limited.

App. I

Testing Procedures

The requirements of a shake table for testing the performance of anti-oscillation mounts are as follows:

1. The shake table must provide both linear and angular vibrations of known and controlled amplitude and frequency.

2. The amplitudes and frequency must be independently adjustable so that various conditions of use may be simulated.

3. At any one time, vibrations of only one frequency may be present. The amplitude of harmonics, sub-harmonics or of any other frequencies must be negligible.

4. The conditions of a test must be reproducible at any later time, and must be essentially the same for any weight or size of instrument likely to be tested.

5. Both the linear and angular amplitudes should be essentially constant over the range of frequencies tested.

Commercially available shake tables designed to test the mechanical effects of linear vibration upon various types of instruments and equipment do not fulfill their requirements. Neither did the spring suspension type of table built and used at the Institute of Optics in the early stages of the development of anti-oscillation mounts. (See report "Aids to Night Vision", February 1, 1942, Appendix VII). Consequently, a shake table was developed with these special requirements in mind. The latest modification of this equipment is shown in Figures 1 and 2.

The vibration platform, upon which the instrument under test is mounted, is capable of both linear and angular motion. The rear of the platform is

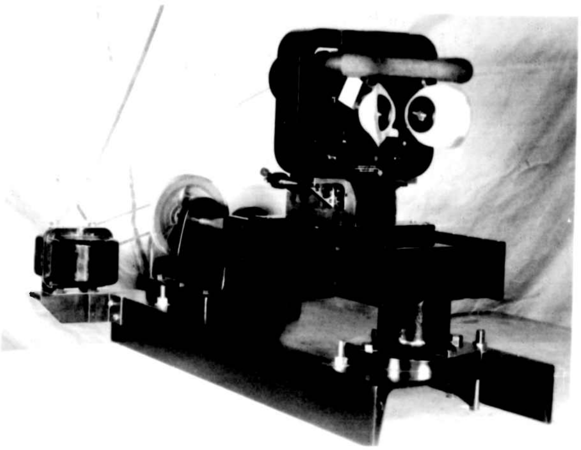


Figure 1

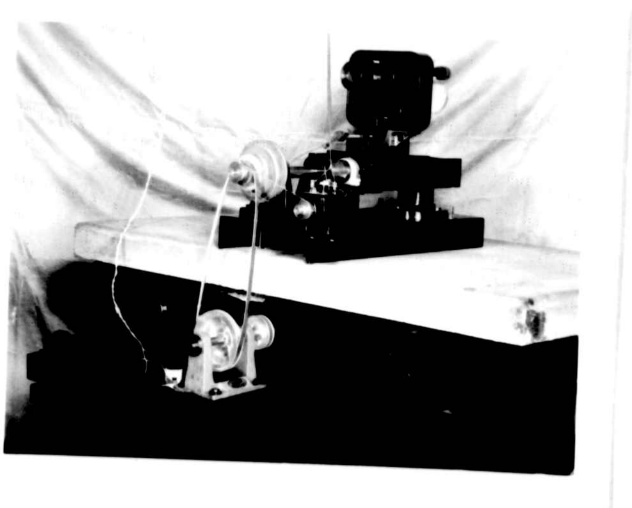


Figure 2

attached to the base through crossed axes lying in a plane perpendicular to the longitudinal axis of the platform. Since the instrument under test is mounted with its optical axis parallel to the longitudinal axis of the platform, this pivot permits rotation about any axis normal to the optical axis, but does not permit rotation about the optical axis.

The front end of the platform is moved in a circle whose plane is normal to the optical axis, thus providing all components of angular vibration which affect optical performance. A positive eccentric drive insures a constant angular amplitude, independent of frequency. The conventional type of double eccentric permits an adjustable control of the angular amplitude. The three components of linear vibration are determined by the position of the instrument with respect to the pivot point. The top of the vibration platform is provided with a series of drilled and tapped holes, so that various types of instruments may be mounted, and in various positions.

The eccentric is driven by a shunt wound d. c. motor through a jack shaft and V-belt arrangement shown in Figure 2. Gross changes in frequency are accomplished by changing pulley ratios, while a fine continuous control is provided through a rheostat in series with the armature. The frequency is measured by an electric tachometer belted to the eccentric drive shaft.

The vibration platform is made of dural, and designed to provide maximum stiffness with a minimum of enertia. The pivot axes have heavy duty ball bearings properly pre-loaded to give freedom from shake with very low friction. All other parts of the equipment are of cast iron or steel, with large cross-section, and table and drive are mounted on a heavy concrete base. Mass and stiffness are essential in the prevention of flexures and resonances which give rise to unwanted frequencies and variation in amplitude with frequency.

The performance specifications of this shake table are as follows:

1. Normal range of frequency - 50 to 2000 rpm. This range may be extended in either direction by a change in the motor-jackshaft pulley ratio.

2. Angular amplitude about vertical and horizontal transverse axes - 0 to 2 mils (0 to 4 mils double amplitude). The angular amplitude is adjustable by means of the double eccentric.

3. Linear amplitudes depend upon angular amplitudes and upon distance from intersection of pivot axes. Maximum linear amplitude at 10 inches from pivot axes - .020 of an inch (.040" double amplitude).

4. With instrument weights up to 20 pounds, angular and linear amplitudes are constant within 25% over the frequency range from 0 to 2000 rpm.

5. Angular and linear amplitudes having frequencies other than the drive frequency are negligible over the above ranges of amplitudes and frequencis

An optical lever is used to measure the angular amplitude of the vibrating platform as well as that of the instrument under test. A plane galvanometer mirror is waxed to the vibrating member. Light from a point source is collimated by a simple lens mounted independently of the table, is reflected by the mirror and then re-imaged by the same lens upon a screen adjacent to the source. The screen is provided with a rectangular coordinate system so that quantitative measurements of amplitude can be made. Linear amplitudes are measured with a dial indicator.

App. II

Acceptable Performance

The effectiveness of an anti-oscillation mount is measured in terms of transmissibility. The calculation of the theoretical transmissibility of such mounts has been previously reported ("Anti-oscillation Mounts", March 1, 1943). The experimental transmissibility is the ratio of the angular amplitude of the optic axis of the instrument to the angular amplitude of the outer frame of the mounting. The latter is also the angular amplitude of the shake table, if flexure is negligible.

In order to insure satisfactory field performance, and to provide a fair basis of comparison between various anti-oscillation mounts, a standardized testing procedure has been set up, and certain minimum performance requirements have been established. The transmissibility is measured with both linear and angular vibrations greater than are encountered in flight. The conditions of the transmissibility tests are:

1. Constant angular vibration about two perpendicular axes normal to the optical axis, with double amplitude between 1.5 and 3.0 mils.

2. Constant linear vibration in three perpendicular directions, with double amplitudes at the instrument center of gravity between .010 and .020 of an inch.

3. Measurements made at frequency intervals of 100 rpm or less, from 2000 rpm down to 50 rpm, or below the natural frequency of the mounting.

An "Acceptable Performance Curve" of transmissibility has been established to determine whether the instrument meets the minimum requirements for field use. As a basis for this criterion, six tests of the Type II-b Anti-Oscillation Mounted Binoculars were selected. These tests were made on three different instruments built at the Institute of Optics. They were made at different times over a period of four months, by three different observers. Three of the tests were run of mountings before they were sent out for flight tests, and the other three were made on the mountings after they had returned from flight tests. Although a great many other flight tests. Although a great many other tests have been run, these six were selected as representative of good, but not exceptional, shake table performances in mounting which gave good flight performance.

The experimental values of transmissibility for these six tests are represented by the points in Figure 1. It will be noted that these points, with one or two exceptions, all fall below the solid curve. The latter is a theoretical curve so computed as to include not only all of these experimentally measured points, but also the transmissibility of other mountings having equally satisfactory performance characteristics. In order to compute such a curve, definite values of natural frequency and damping ratio have to be selected. The natural frequencies of the mounting tested were between 60 and 80 rpm, but to provide somewhat greater tolerance in this characteristic a value of 100 rpm was chosen for the theoretical natural frequency. This has the effect of increasi g the transmissibility at higher frequencies. It has been determined from flight tests that best results are obtained if the natural frequency is not higher than 100 rpm, and the damping ratio is between 0.3 and 0.5 critical. Since the lower value gives a larger value of transmissibility at low frequencies, it has been used to compute the curve between zero and 141 rpm. At higher frequencies, the larger value of damping ratio gives higher transmissibility, hence it has been chosen for the range from 141 to 2000 rpm.

It should be noted that, although this composite curve is computed from theoretical considerations, it represents an upper limit of transmissibility versus frequency which flight tests have demonstrated as satisfactory. It is therefore an experimentally determined tolerance curve expressed analytically. It is not necessary that any particular mounting have these chosen values of natural frequency and damping ratio in order to be satisfactory; it is merely necessary that its experimentally determined transmissibility lie below this curve. The coordinates of this curve are given in Table I.

Table I

RPM	TRANS	RPM	TRANS
20	1.04	160	0.85
50	1.29	180	0.72
70	1.61	200	0.62
80	1.80	250	0.46
90	1.92	300	0.37
100	1.87	400	0.26
110	1.68	500	0.21
120	1.42	1000	0.10
141	1.00	2000	0.05

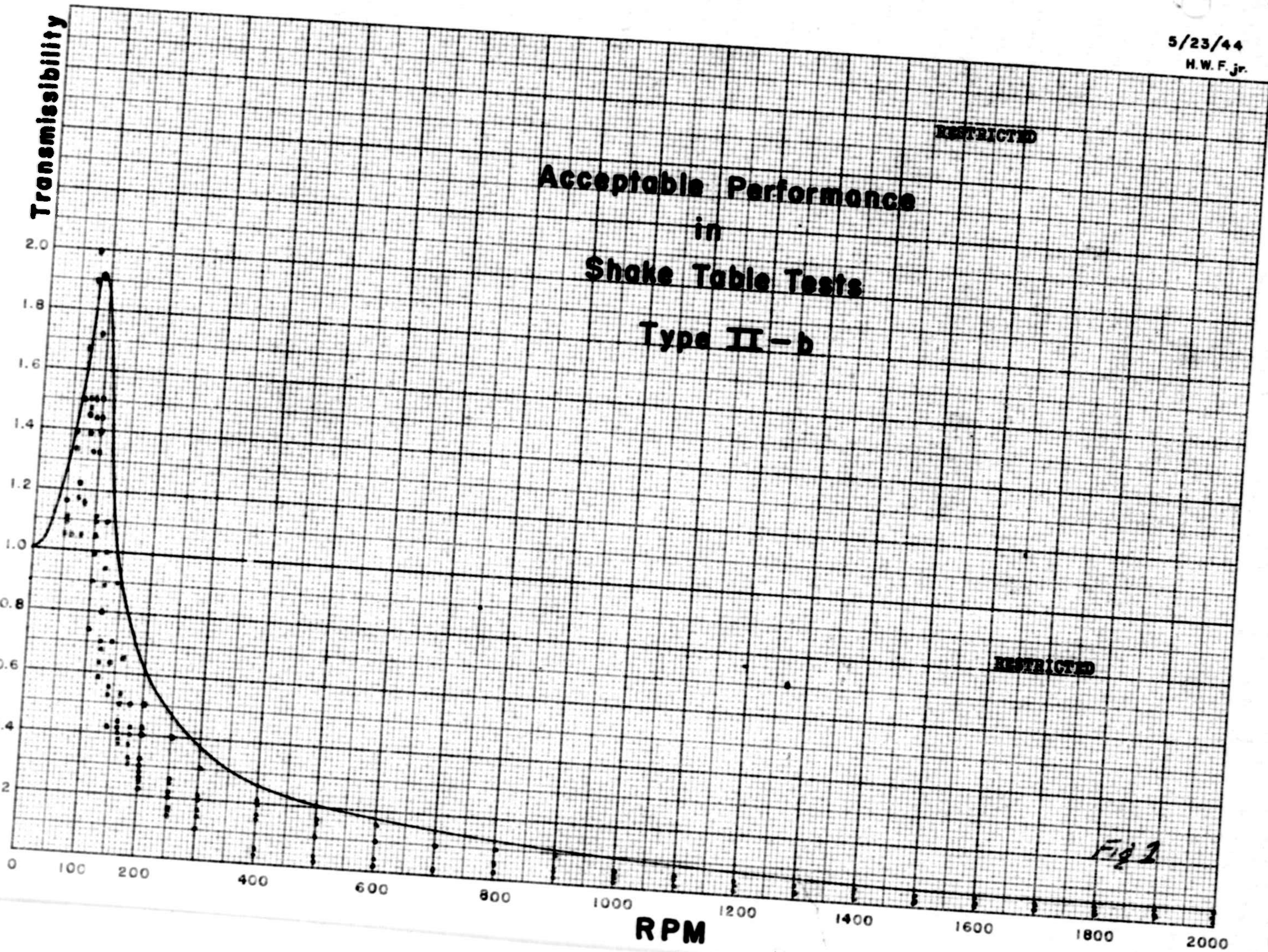
Since one of the important applications of the anti-oscillation mount is for optical gun sights, a second type of measurement is included in the acceptable performance tests. This measurement, called boresighting, is the angular relationship between the direction of the optical axis and a direction fixed with respect to the outer frame of the mounting. The boresighting error or deviation from the desired relationship is usually specified in mils, or thousandths of a radian. It may be measured conveniently on the shake table with the same set-up used to determine the angular amplitude of the optical axis.

The inner gimbal system comprising the optical instrument and inner gimbal axis is pushed by hand against the stops which limit its angular excursion and then released. When the system has come to rest, its direction is noted by the position of the spot on the screen. This process is repeated several times (usually 10) with the direction of the displacement different for each measurement. The greatest difference between any two measurements is the boresighting error. The differences are usually resolved into vertical and horizontal components, and specified as vertical and horizontal boresighting errors.

If the measurements are made while the mounting is vibrating on the shake table, they are called "dynamic boresighting" errors, but if they are made with the shake table stationary, they are called "static boresighting" errors. A maximum error of not more than 2 mils, in both static and dynamic boresighting, is considered acceptable.

Any change in the mean direction of the optical axis during a shake table test, not the result of an external force, is called "wandering". Any such change is undesirable, but a change of greater than 2 mils in a gun sight is not acceptable.

In the University of Rochester Type II-b mountings whose transmissibilities are shown in Figure 1, the static and dynamic boresighting and wandering errors are all less than 2 mils.


KEUFFEL & ESSER CO., N. Y. NO. 359-11
20 × 20 to the inch, 10th lines heavy.
MADE IN U. S. A.
5/23/44
H. W. F. jr.
RESTRICTED
Acceptable Performance
in
Shake Table Tests
Type II-b
RESTRICTED
Transmissibility
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
100
200
400
600
800
1000
1200
1400
1600
1800
2000
RPM
Fig 2

The 6 x 42 Night Binocular AOM

This classification includes several instruments, all based upon a design by J. Mihalyi at Eastman Kodak Company, and intended for use in P-61 night fighter planes. The Mihalyi design employs the ball-bearing gimbal and air dash-pot damper construction of the Institute of Optics type II-b AOM (See Anti-Oscillation Mounts, March 1, 1943), but is modified to fit the swivel and bracket requirements of the P-61 installation. While these modifications result in an increase in size and weight, and a change in physical appearance, no appreciable change in performance characteristics is to be expected.

A few of these instruments were made in the model shops of the Eastman Kodak Camera Works. Although they were brought to the Institute of Optics on several occasions for quick visual checks of shake table performance, only one was submitted for a complete performance test. The horizontal and vertical transmissibility of this mount, Serial 02, shown in Figure 1, should be compared with the Acceptable Performance Curve in Appendix II. The performance of this mount above 200 rpm is excellent. Below this frequency, however, the transmissibility is considerably greater than the acceptable value. This is due primarily to insufficient damping, but the somewhat high natural frequency, particularly in the vertical component (vibration about the horizontal axis), is a contributing factor. It should be noted that increasing the damping enough to bring the transmissibility within the acceptable performance curve below 200 rpm, will cause some deterioration in performance above 200 rpm. Decreasing the natural frequency will result in an overall gain in performance.

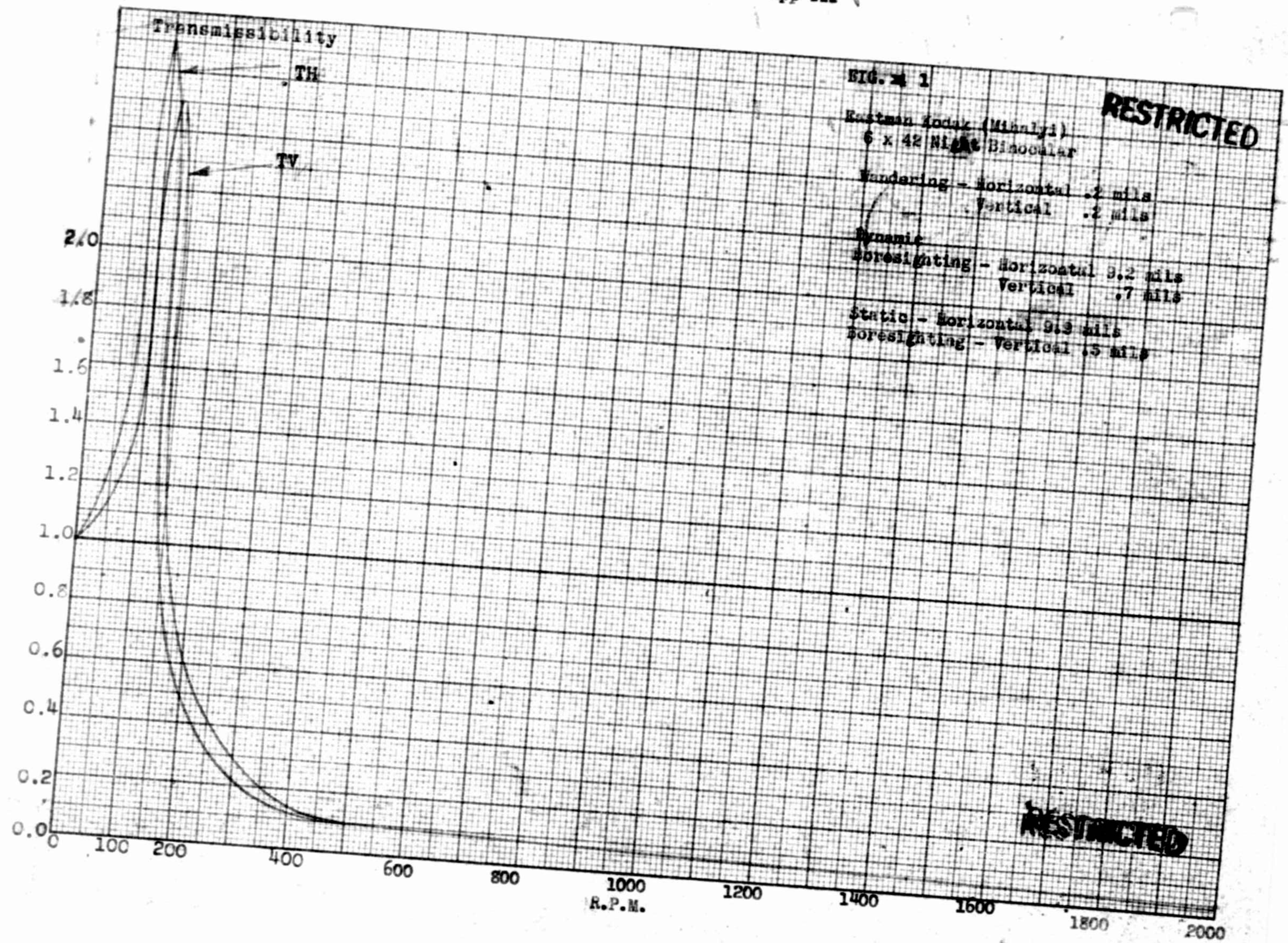
The vertical components of the static and dynamic boresighting errors exceed the acceptable maximum by a large amount. The horizontal components and the wandering are well within tolerance.

A sample instrument manufactured by American Aircraft of Dayton, Ohio was brought to the Institute of Optics for shake table tests by Mr. C. R. Wilson. This mounting was built from the Mihalyi design, but differed in some small details which had been changed to facilitate production. In the first test, very bad wandering was present, so the instrument was taken apart, several adjustments made and then re-assembled. The work was done by members of the Institute of Optics staff, with Mr. Wilson of American Aircraft observing. The objectionable wandering was absent in the second test, shown in Figure 2. The performance of this mounting is satisfactory at high frequencies, and the maximum at resonance indicates proper damping. The natural frequency of the horizontal component (rotation about the vertical axis) is somewhat high.

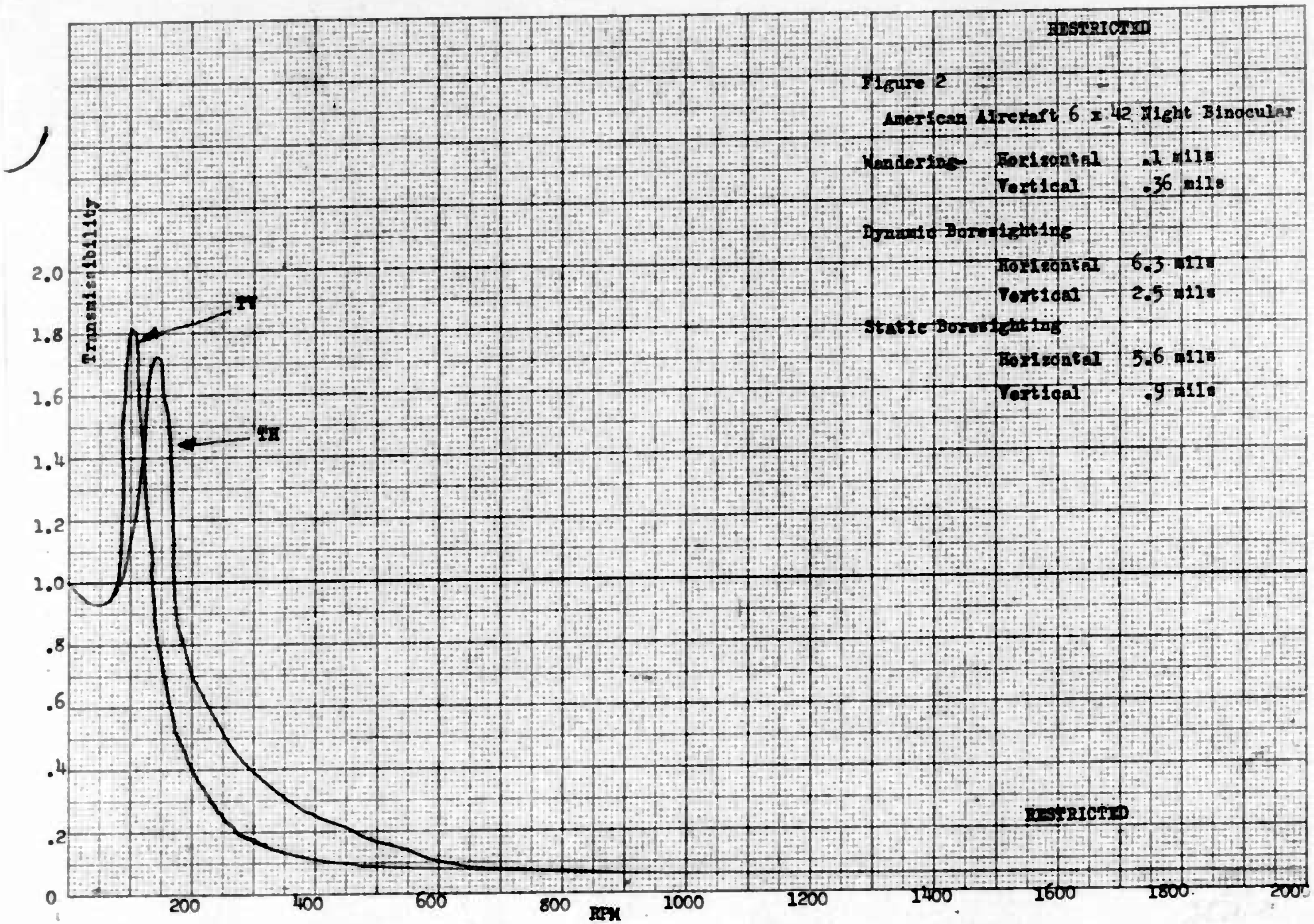
The dynamic borosighting error is above tolerance in both components, and the static error is high in the horizontal component. The wandering is well within tolerance.

An instrument manufactured by the Robinson-Houchin Company of Columbus, Ohio, under contract with the Univis Corporation of Dayton, was submitted for shake table tests. This mounting was built from the same design as the American Aircraft unit. The performance curves, in Figure 3, show insufficient damping, and too high a natural frequency about one axis. In addition, the high frequency performance is not quite acceptable over most of the range. The wandering is satisfactory, but both static and dynamic borosighting in the horisontal direction are very poor.

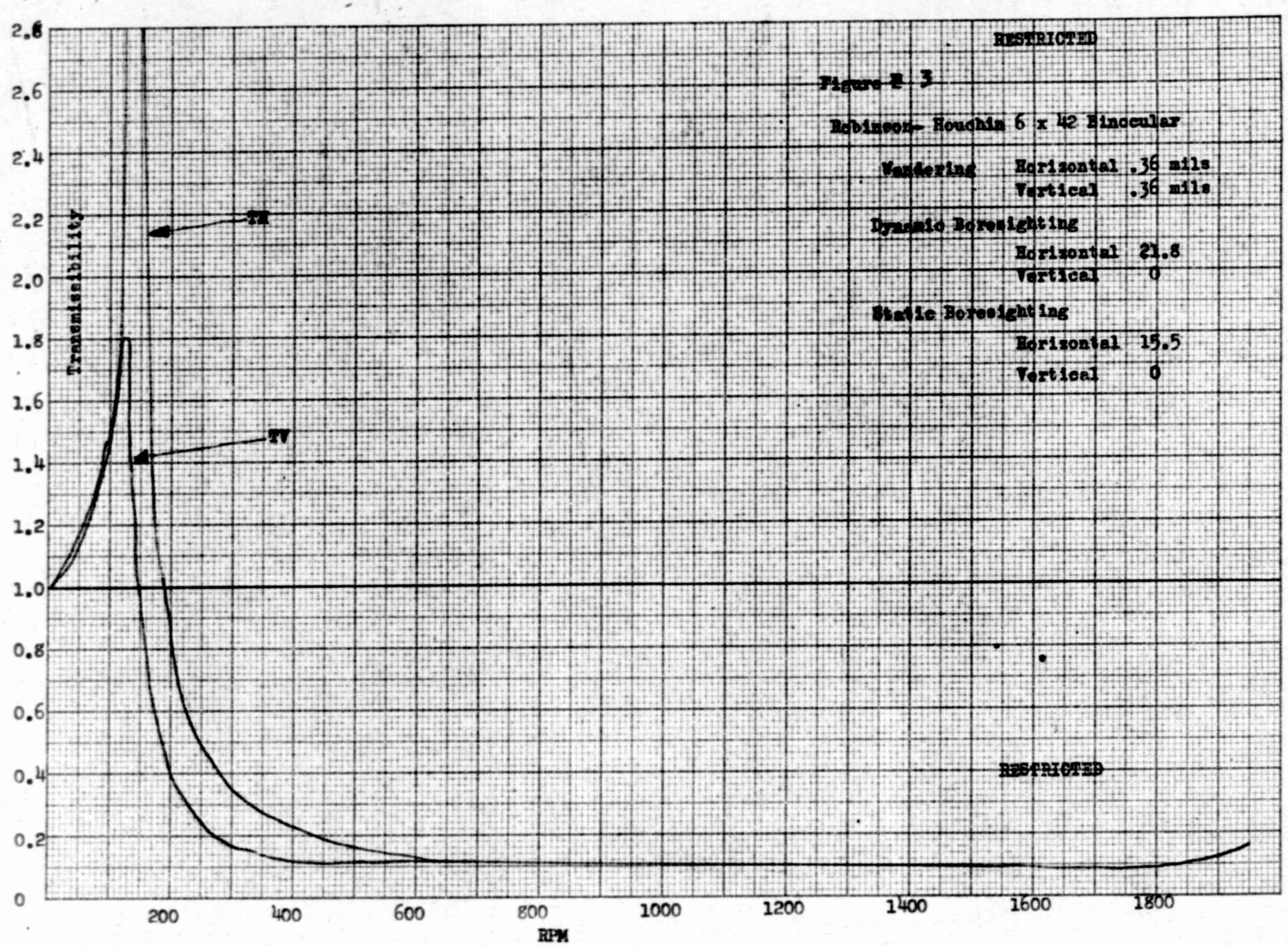
App III


Transmissibility
TH
TV
FIG. 1
RESTRICTED
Eastman Kodak (Mihalyi)
6 x 42 Night Binocular
Wandering - Horizontal .2 mils
Vertical .2 mils
Dynamic
Boresighting - Horizontal 9.2 mils
Vertical .7 mils
Static - Horizontal 9.3 mils
Boresighting - Vertical .5 mils
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
400
600
800
1000
1200
1400
1600
1800
2000
R.P.M.
RESTRICTED

App III


RESTRICTED
Figure 2
American Aircraft 6 x 42 Night Binocular
Wandering- Horizontal .1 mils
Vertical .36 mils
Dynamic Boresighting
Horizontal 6.3 mils
Vertical 2.5 mils
Static Boresighting
Horizontal 5.6 mils
Vertical .9 mils
TV
TH
Transmissibility
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
RPM
RESTRICTED

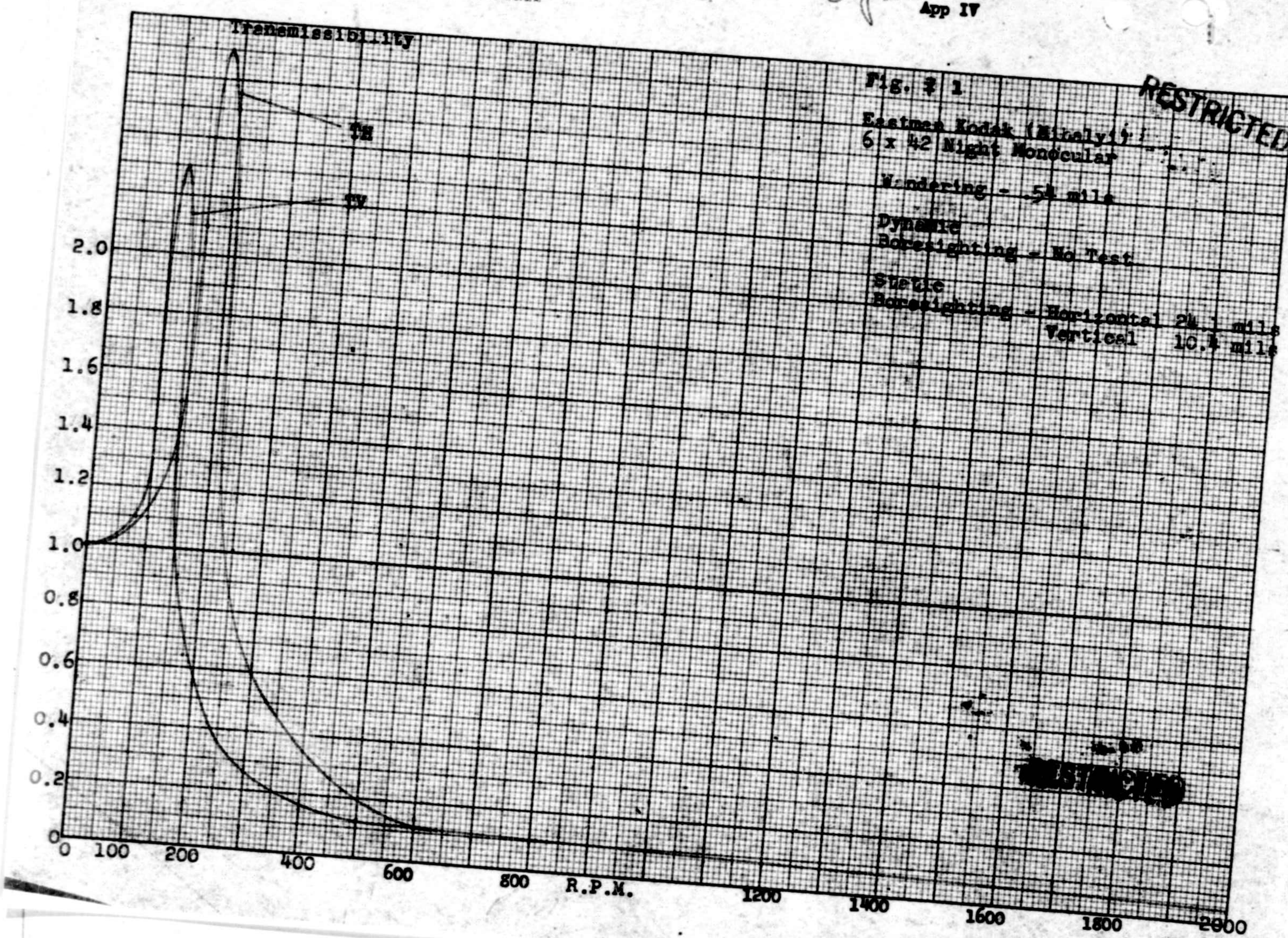
ap 3


RESTRICTED
Figure E 3
Robinson- Houchin 6 x 42 Binocular
Wandering Horizontal .36 mils
Vertical .36 mils
Dynamic Boresighting
Horizontal 21.8
Vertical 0
Static Boresighting
Horizontal 15.5
Vertical 0
TH
TV
Transmissibility
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
200
400
600
800
1000
1200
1400
1600
1800
RPM
RESTRICTED

The 6 x 42 Night Monocular AOM

This instrument, designed by Mr. J. Mihalyi of the Eastman Kodak Company, and built in the Camera Works model shop, is a development of the Institutes of Optics Type III-b Monocular AOM (See "Anti-oscillation Mounts March 1, 1943). It employs the gimbal ring and air dash-pot damper principles, but has an in-line Schmidt prism erecting system. This modification of the optical system permits a compact yet rugged mounting.

The shake table performance of this mounting is shown in Figure 1. As in the Kodak binocular instruments, the high frequency performance is good, but the system has too high a natural frequency, and is not sufficiently damped. Hence the transmissibility below 300 or 400 rpm is not within the acceptable limits. The behavior in the static boresighting test was very poor, so no dynamic boresighting tests were made. The wandering is within acceptable limits.


RESTRICTED
Fig. # 1
Eastman Kodak (Mihalyi)
6 x 42 Night Monocular
Wandering - .54 mils
Dynamic
Boresighting - No Test
Static
Boresighting - Horizontal 24.1 mils
Vertical 10.4 mils
Transmissibility
TH
TV
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0
100
200
400
600
800
R.P.M.
1200
1400
1600
1800
2000
RESTRICTED

App. V

Technicolor Mounts

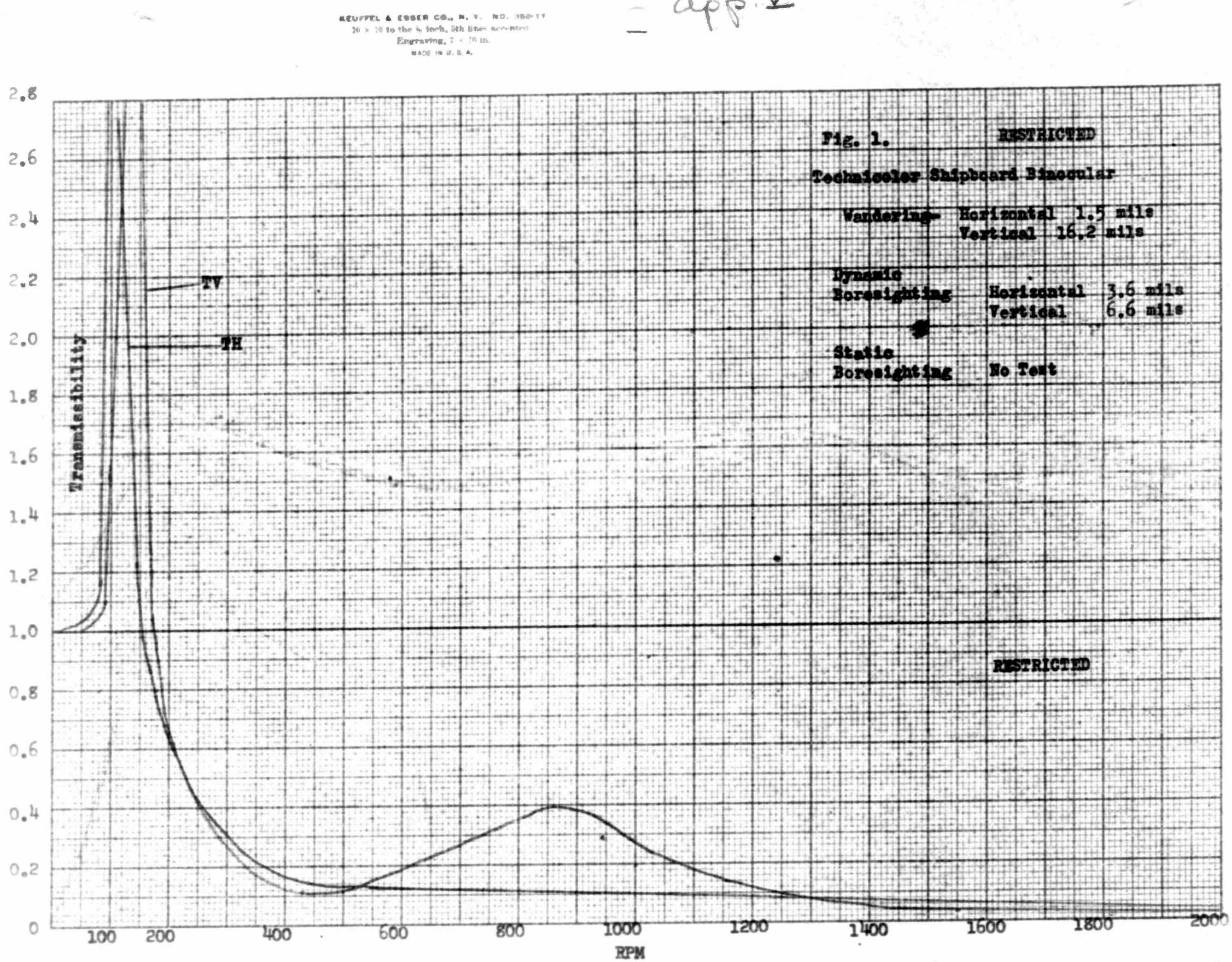
Two binocular mounts, one for shipboard and the other for aircraft use, designed and built by the Technicolor Corporation, were submitted to the Institute of Optics for shake table tests. These mounts differ radically in principle and construction from the gimbal and air dash-pot type. The binocular system is supported at approximately its center of gravity on a ball-and-socket universal point. The restoring torque is provided by rubber washers which clamp on the ball. No intensive investigation of the functioning of this design was made, but several shake table tests were run, with the various ball-and-socket units furnished. Three of these shown in Figures 1, 2, and 3 illustrate the range and type of performance observed.

It is evident from the data that this type of mounting is not comparable in performance with the gimbal mounting. Although the performance varies widely in these three representative tests, none approaches the acceptable performance curve. In Figure 1, the transmissibility above 1200 rpm is reasonable good, but there is a bad resonance at 900 rpm in the vertical component. The amplitude at resonance is excessive, indicating insufficient damping. The performance in Figure 2 is very poor over practically the entire range of frequencies. In Figure 3, the system is heavily damped, but the performance at high frequencies is only fair, not acceptable over most of the range.

This mounting principle does not appear to be suitable for gunsight applications. The dynamic boresighting in all cases but one is above tolerance, and the wandering is excessive. Because of the frictional damping, no static boresighting tests could be made. The restoring torque was insufficient to overcome starting friction. It should be pointed out that these mountings were intended for observation use, not as gunsights. They did not contain graticlee.

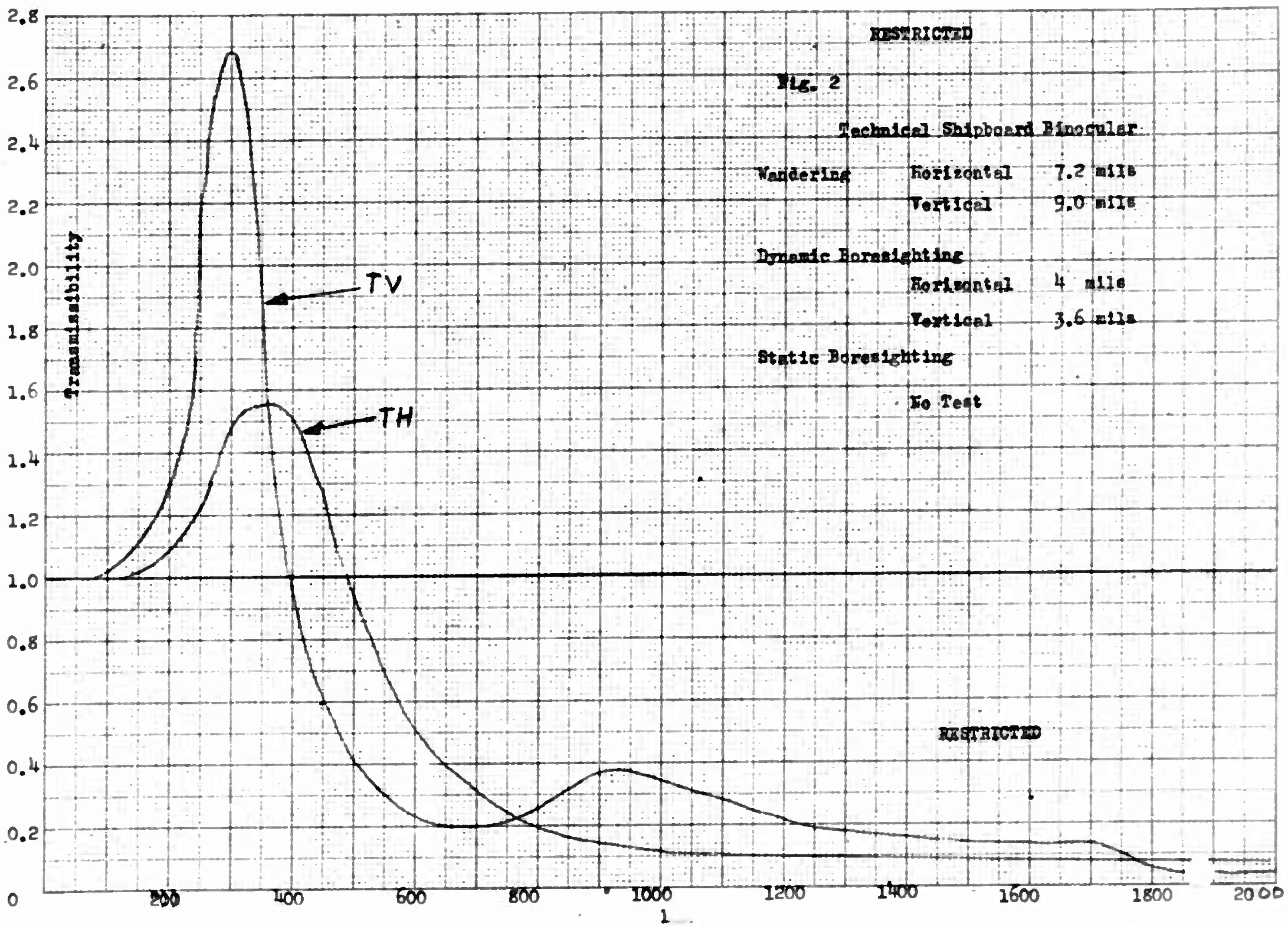
The tests were confined to the shipboard unit which was designed for pedestal mounting. The aircraft unit was designed for an overhead mounting, which would require a considerable modification of the shake table. The performance of the aircraft unit when mounted upside down on the shake table was so poor no quantitative tests were attempted.

app. V



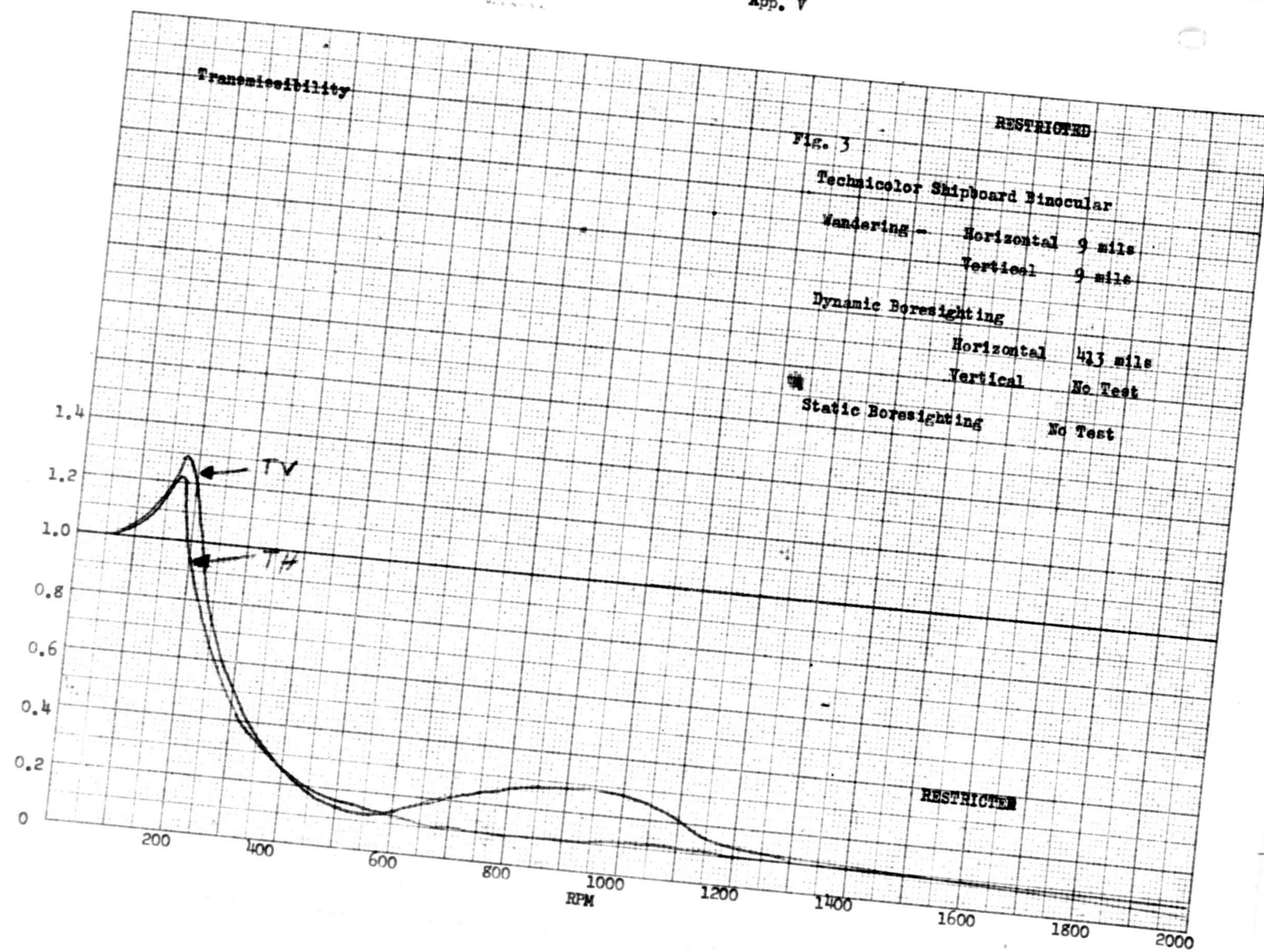
KEUFFEL & ESSER CO., N. Y. NO. 359-11
10 × 10 to the ½ inch, 5th lines accented
Engraving, 7 × 10 in.
MADE IN U. S. A.
Fig. 1.
RESTRICTED
Technicolor Shipboard Binocular
Wandering - Horizontal 1.5 mils
Vertical 16.2 mils
Dynamic Boresighting Horizontal 3.6 mils
Vertical 6.6 mils
Static Boresighting No Test
RESTRICTED
TV
TH
Transmissibility
RPM
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
100
200
400
600
800
1000
1200
1400
1600
1800
2000

App. 5


RESTRICTED
Fig. 2
Technical Shipboard Binocular
Wandering Horizontal 7.2 mils
Vertical 9.0 mils
Dynamic Boresighting
Horizontal 4 mils
Vertical 3.6 mils
Static Boresighting
No Test
RESTRICTED
Transmissibility
TV
TH
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
200
400
600
800
1000
1200
1400
1600
1800
2000

Shouldn't this have a TH TV mark?

App. V

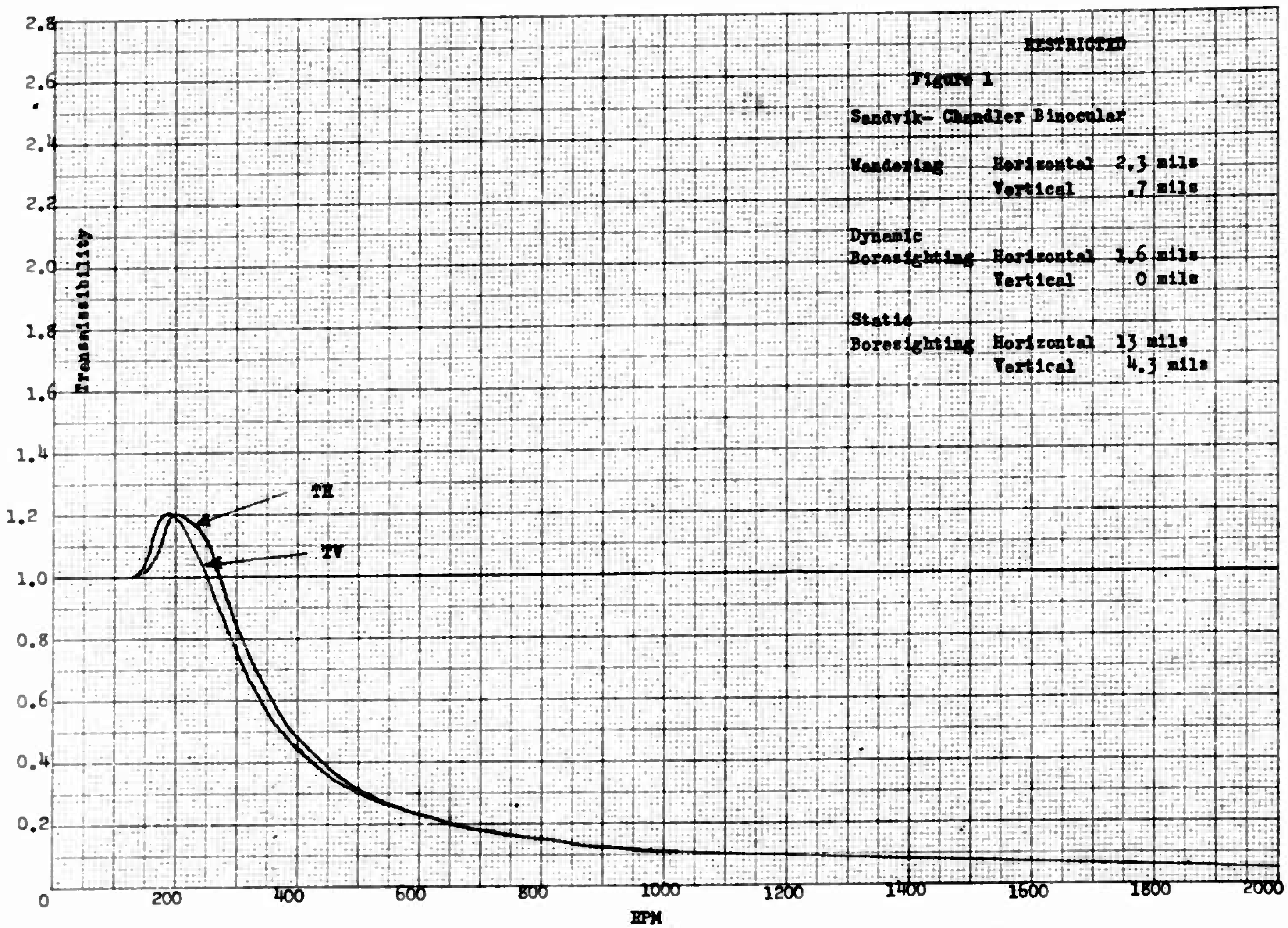


The Sandvik - Chandler Mount

The binocular mounting designed by Sandvik and Chandler at Kodak Park was similar in principle to the Technicolor mounts, but differed in details of restoring torque and damping. One of these units was submitted for shake table tests by Dr. Chandler. The performance curves are shown in Figure 1. While the transmissibility in the range from about 1200 to 1800 is acceptable, at low frequencies it is noticeably poorer than that of the gimbal type. The system is heavily damped, and has a high natural frequency, about 200 rpm. At the request of Dr. Chandler, who observed the test, no measurements were made above 1800 rpm, where the accelerations in the shake table exceed gravity.

This mounting employs frictional damping, hence static boresighting tests were not applicable. The dynamic boresighting errors were within tolerance, but the wandering about the horizontal axis was greater than the acceptable maximum.

App. VI


RESTRICTED
Figure 1
Sandvik- Chandler Binocular
Wandering Horizontal 2.3 mils
Vertical .7 mils
Dynamic
Boresighting Horizontal 1.6 mils
Vertical 0 mils
Static
Boresighting Horizontal 13 mils
Vertical 4.3 mils
TH
TV
Transmissibility
RPM
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8

The Kollsman Mount

An Anti-Oscillation mounted binocular, manufactured by the Kollsman Instrument Division was submitted by the Bureau of Aeronautics for shake table tests at the Institute of Optics. This mounting used the gimbal principle but departed widely from the design of the Institute of Optics, Type II-b and the Eastman Kodak 6 x 42 Night Binocular. Figure 1 shows the performance of this mounting. A copy of the report submitted to the Bureau of Aeronautics is also included.

SHAKE TABLE TEST OF KOLLSMAN AOM BINOCULAR

An anti-oscillation mounted binocular, manufactured by Kollsman Instrument Division, has been submitted by the Bureau of Aeronautics, Navy Department, to the Institute of Optics, University of Rochester, for testing in accordance with specifications submitted by the Institute of Optics. This test has been carried out, with the following results:

1. The vertical and horizontal components of transmissibility of this mounting, as measured on the shake table, are plotted on the accompanying graph, together with the Acceptable Performance Curve given in the specificat ons.

2. According to the specifications, the transmissibility as measured on the shake table shall be less than or equal to that of the Acceptable Performance Curve over the frequency range from 0 to 2000 rpm. The graph shows wide departure from this specification.

3. Visual observation through the binoculars, during the shake table test, shows very poor performance over practically the entire range of frequencies.

4. This shake table test indicates, in our opinion, that the mounting is unsatisfactory for use in aircraft.

An inspection of the design and construction of this mounting leads to the following conclusions:

1. No suitable damping of the system has been provided.

2. The inner systems are not properly balanced, and no adequate provisions have been made for doing so.

3. The restoring torque is too great, resulting in too high a natural frequency.

4. The bearings are not pre-loaded to prevent end-play.

5. The construction is not sufficiently rigid and free from play.

App VII

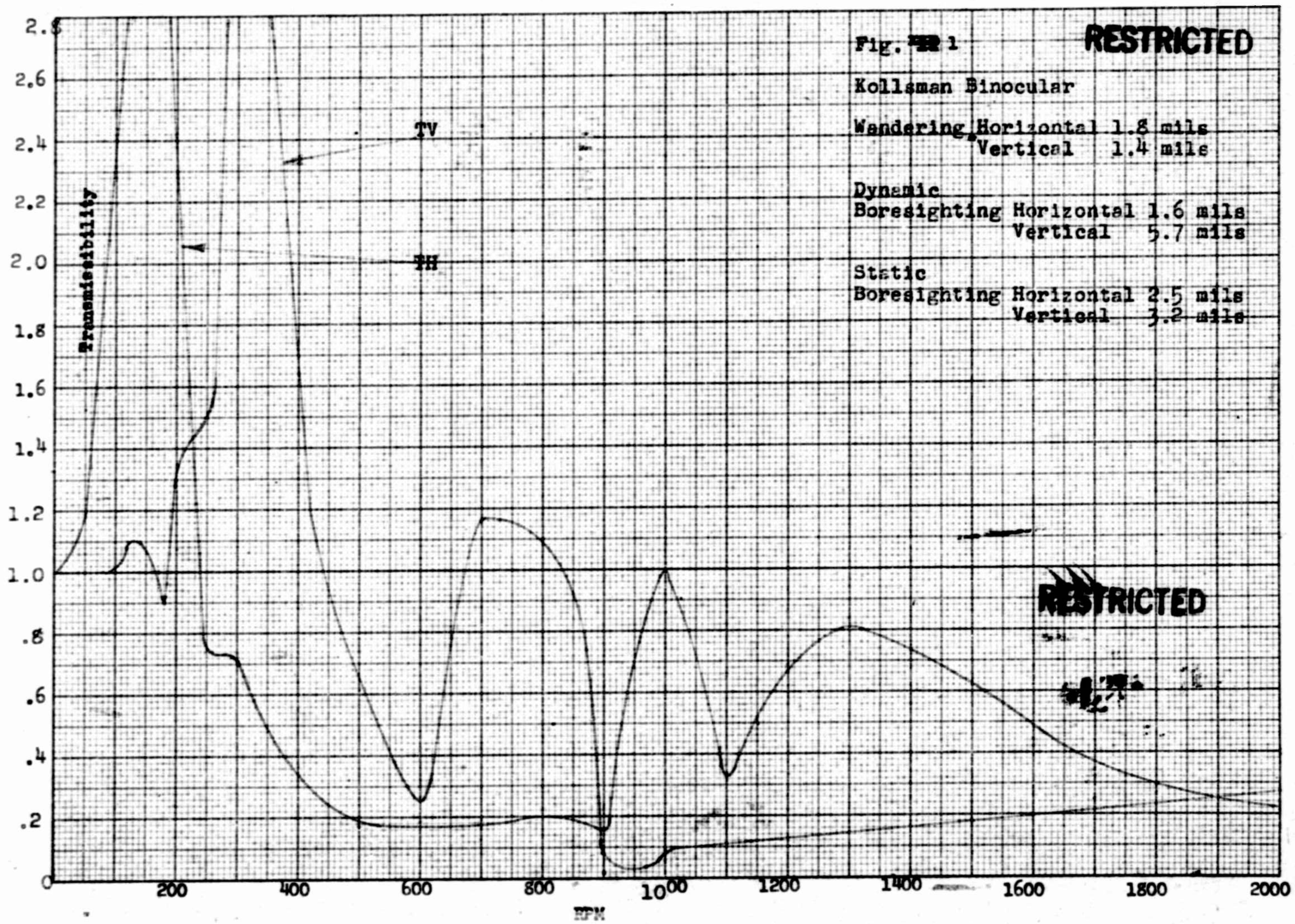


Fig. 1
RESTRICTED
Kollsman Binocular
Wandering Horizontal 1.8 mils
Vertical 1.4 mils
Dynamic
Boresighting Horizontal 1.6 mils
Vertical 5.7 mils
Static
Boresighting Horizontal 2.5 mils
Vertical 3.2 mils
TV
TH
Transmissibility
RPM
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
RESTRICTED

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9908

RESTRICTED

TITLE: Anti-Oscillation Mount Tests

AUTHOR(S): (Not Known)
ORIGINATING AGENCY: Office of Scientific Research and Development, Washington, D. C.
PUBLISHED BY: (Same)

ATI- 9908
REVISION (None)
ORIG. AGENCY NO. (None)
PUBLISHING AGENCY NO. OSRD 6034

DATE	DOC. CLASS.	COUNTRY	LANGUAGE	PAGES	ILLUSTRATIONS
Oct '45	Restr.	U.S.	Eng.	13	photos, tables, graphs

ABSTRACT:

Tests conducted by the University of Rochester on antioscillation mounts for binoculars are described. Appendixes give the design of testing equipment, testing procedure, and acceptable performance specifications, and discuss the mounts that were tested. The gimbal mount, developed by the University of Rochester and redesigned for production, by the Eastman Kodak Company gives the best over-all performance, but is complex and expensive. The simpler mounts, developed by Eastman and Technicolor, require further development.

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DIVISION: Ordnance and Armament (22)
SECTION: Fire Control (4)

ATI SHEET NO.: R-22-4-43

SUBJECT HEADINGS: Binoculars - Airplane mounting (16154); Mounts - Vibration (65260)