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Test Report T65-11-1

ROTOR CREEP TEST OF FUZE, MT, T366

by

W. E. CHANDLER

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MARCH 1965



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ROTOR CREEP TEST OF FUZE, MT, T366

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W. E. CHANDLER

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Research & Development Directorate

FRANKFORD ARSENAL

Philadelphia, Pa. 19137

March 1965

ABSTRACT

Tests were conducted to determine if the T366 fuze rotors(Fuze, MT, T366) could withstand storage temperatures under simulated loading conditions. Five 200-hour tests were conducted on these rotors which were subjected to loads of 8.25 lbs. and 16.5 lbs. at temperatures of -65° F, +70° F, +125° F and +165° F.

Overall results of the tests indicate that the rotors will withstand prolonged exposure to temperatures of -60° F and +165° F and still function satisfactorily.

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PROCEDURE

As required by FA Test Program Request (TPR) - FA-1610-566, (see Appendix A) four rotors (Figure 1) were tested under temperature conditions approximating those conditions present in actual storage and military applications. All four rotors are molded of a polycarbonate resin thermoplastic compound with a steel rotor pin and brass sleeves molded into the plastic. In the assembly of the T366 fuze, the rotor pin is subjected to a constant spring loading of 2.5 lbs. Excessive deflection of the rotor pin due to prolonged exposure to temperature extremes could result in a malfunction of the fuze. Therefore, the test program was designed to determine the amount of deflection (creep) of the rotor pin under given temperature conditions and also provide a basis for the prediction of T366 fuze shelf life relative to rotor function.

New rotors were used for each test conducted. Unlike the rotors used in the T366 fuze assembly, the rotors used in these tests have a longer unmachined rotor pin (see Figure 2). It was necessary to leave the pins long for these tests in order to have sufficient length to apply the simulated load and take deflection readings. It can readily be seen that a deflection reading taken at a specified point on this long rotor pin would be greater than a reading taken on the short pin used in the fuze assembly. Due to the many variables, such as the difference in the cross sectional areas of the different rotors tested, location of the rotor supports, location of the rotor pins relative to the rotor axis, etc., it was not possible to calculate a constant to determine the difference in the deflection readings (deflection differential) without an extensive study. Calculations were made of the bending moment of the long rotor pin (see Appendix B). The resulting deflections were considered insignificant. Three tests were also conducted to determine the magnitude of this deflection differential by actual measurement. Indicator readings were taken at the extreme end of the rotor pin and as close to the rotor as possible. The difference in these two readings is shown in Table I.

Table I. DEFLECTION DIFFERENTIAL TEST

<u>Rotor Dwg. No.</u>	<u>Temperature</u>	<u>Load (lbs)</u>	<u>Deflection Differential (ins)</u>
FD 21926	Ambient	16.5	.010
FD 21927	Ambient	16.5	.006
FD 21927	Ambient	8.25	.003



FD21881



FD21882



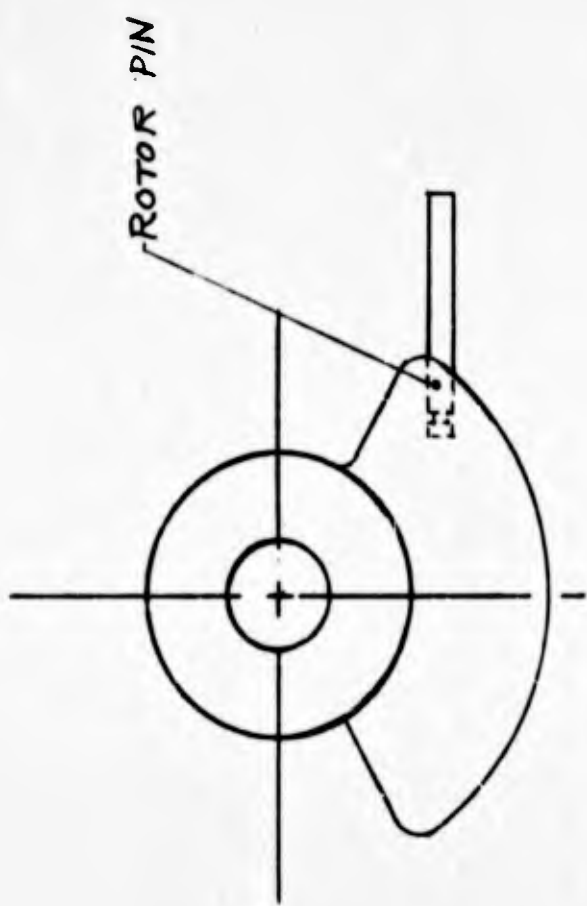
FD21926



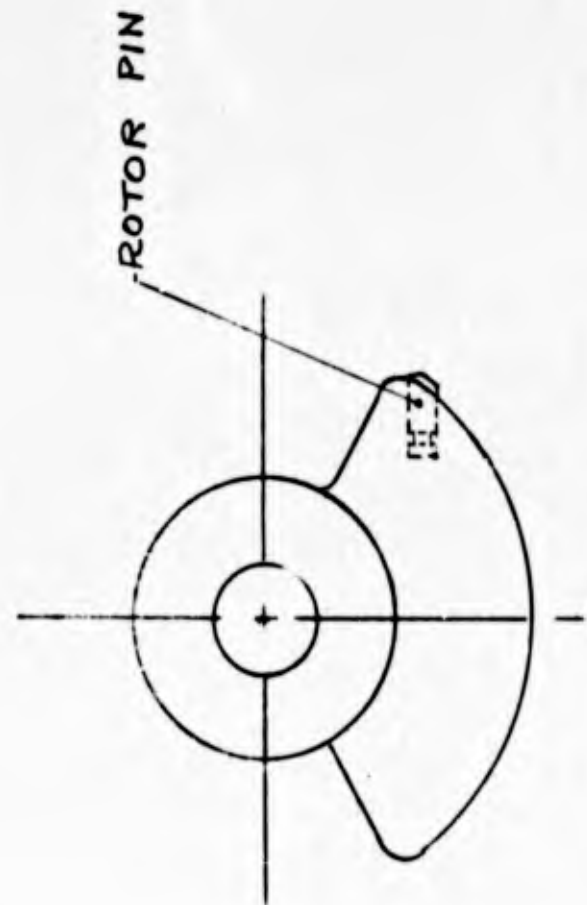
FD21927

Figure 1. Test Rotors for Fuze, MT, T366

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UNMACHINED ROTOR PIN
USED IN ROTOR CREEP TEST



MACHINED ROTOR PIN
USED IN T306 FUZE ASSEMBLY

Figure 2. Rotor Pin Comparison

Comparing the deflection differential with the deflection obtained during actual test, under comparable temperature and load conditions, it was found that approximately one-half of the rotor pin deflection was actually deflection differential. It is therefore estimated that all the deflection readings given in this report are 50% greater than the pin will experience in the T366 fuze assembly.

Voltage readings, representing the deflections, were taken hourly during the working day while tests were in process. The tabulation of voltage readings was converted to inches of deflection. Curves of time versus deflection were plotted for each rotor pin (see Appendix C). Curves were not plotted for the deflection readings taken of the rotor itself because the amount of deflection was too insignificant to plot. Bar charts were made for each different design of rotor tested showing a comparison in the amount of deflection at each temperature and load (see Appendix D).

The rate of creep, given in these tests, is that rate at which the rotor pin deflected during each 24-hour period following the first 24 hours of test.

TEST EQUIPMENT

One of the prime requirements of these tests was the precise measurement of deflection at test temperature conditions. A survey was made of dial indicator manufacturers in an effort to locate a dial indicator that would function accurately at the temperature extremes of -60°F and $+165^{\circ}\text{F}$. None of the commercially available dial indicators would meet these temperature requirements. A test setup was conceived employing a mechanical linkage system from the points of measurement on the rotors, located inside a temperature conditioning chamber, to dial indicators located outside of the chamber. Analysis of this proposed system proved that the accuracy of the indicator readings would be adversely affected by expansion and contraction of the linkages and the friction introduced at the pivot points. A search was therefore conducted for a means to measure the amount of deflection electronically. It was found that the functional characteristics, operational temperature range, and size of the linear variable differential transformer would meet the test requirements.

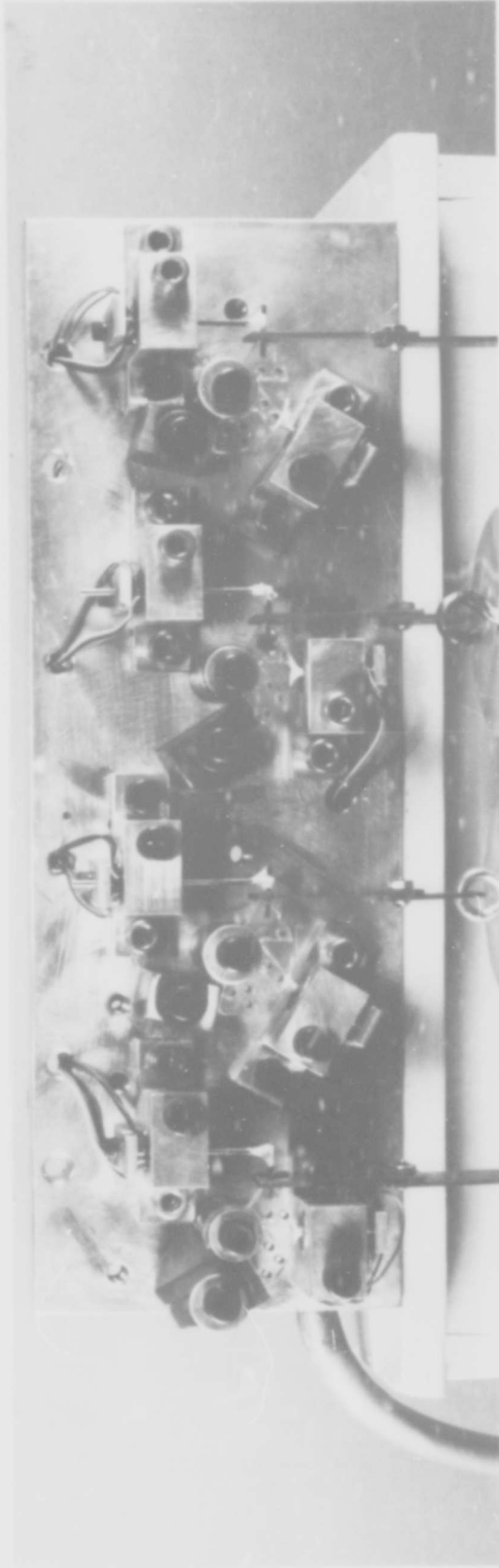
The linear variable differential transformer (LVDT) is an electro-mechanical transducer which produces an electrical voltage output proportional to the displacement of its movable core. It consists of three coils of wire equally spaced on a common cylinder with a magnetic core positioned axially within the coil assembly. The core provides a path for magnetic flux linking the coils. When the center or primary coil is energized with alternating current, voltages are induced in the two outer or secondary coils. If the secondary coils are connected in series opposition, the voltages in the secondary circuit are opposite in phase, thus the net output of the transformer is the difference of these voltages. At the null or central position the output voltage is zero.

When the core is moved from the null position, the voltage induced in the coil toward which the core is moved increases while the voltage induced in the opposite coil decreases. This produces the differential voltage output from the transformer which varies linearly with the change in the core position. Thus, a plot of voltage output versus core position produces a straight line through the null position within the range of the transformer.

All the transformers used in these tests were calibrated with a micrometer transformer calibration fixture. An input voltage of .34 volts at a frequency of 10,000 cps produced a transformer output voltage of two millivolts for each one thousandth of an inch displacement of the core. Calibration charts were plotted which illustrate the straight line linearity of the transformer output voltage and the linear motion of the core. Appendix E shows a typical chart of all eight LVDT's used in these tests.

In order to record the differential voltage output of the LVDT the following instrumentation was utilized: (see Figure 3 and Figure 4).

- | | |
|--------------------|---|
| Voltage Regulator: | Used to eliminate frequency variations of the audio-oscillator due to fluctuations in the line voltage. |
| Voltmeter: | Used to provide a constant check on line voltage. |
| Audio Oscillator: | Used to produce an input voltage of .34 volts at a frequency of 10,000 cps to the primary coil of the LVDT. |



Exploded View of Rotor Test Fixture

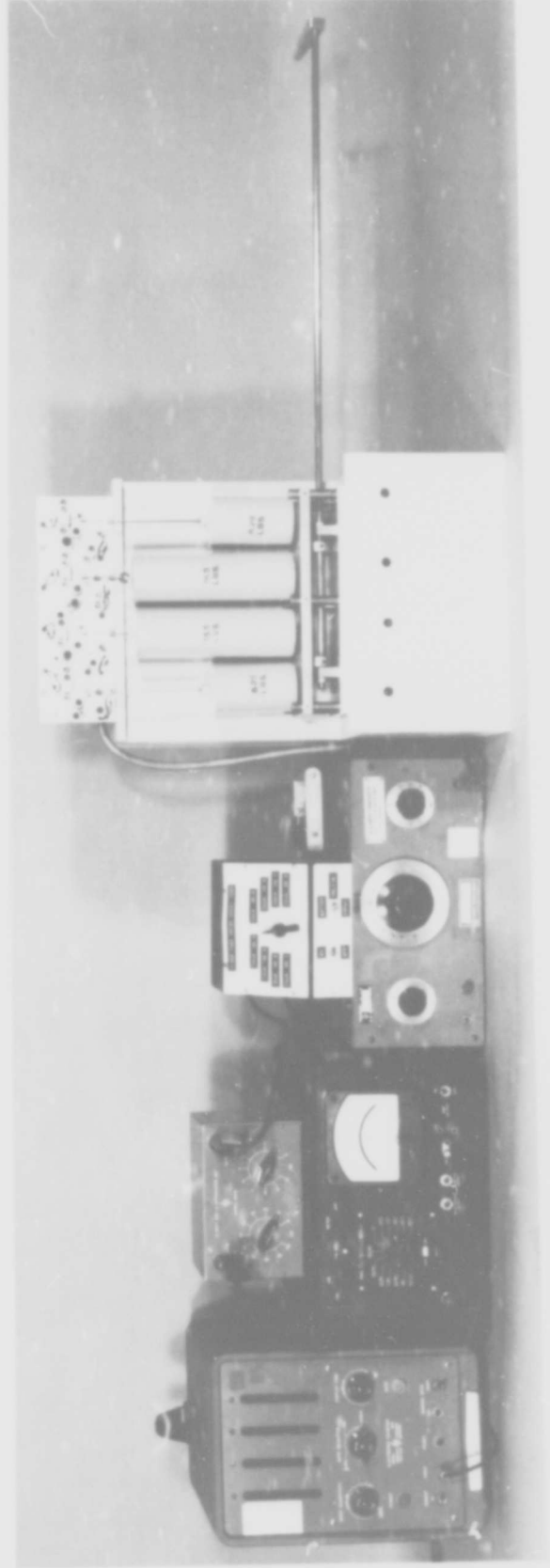


Figure 3. Rotor Creep Test Apparatus for Fuze, MT, T366

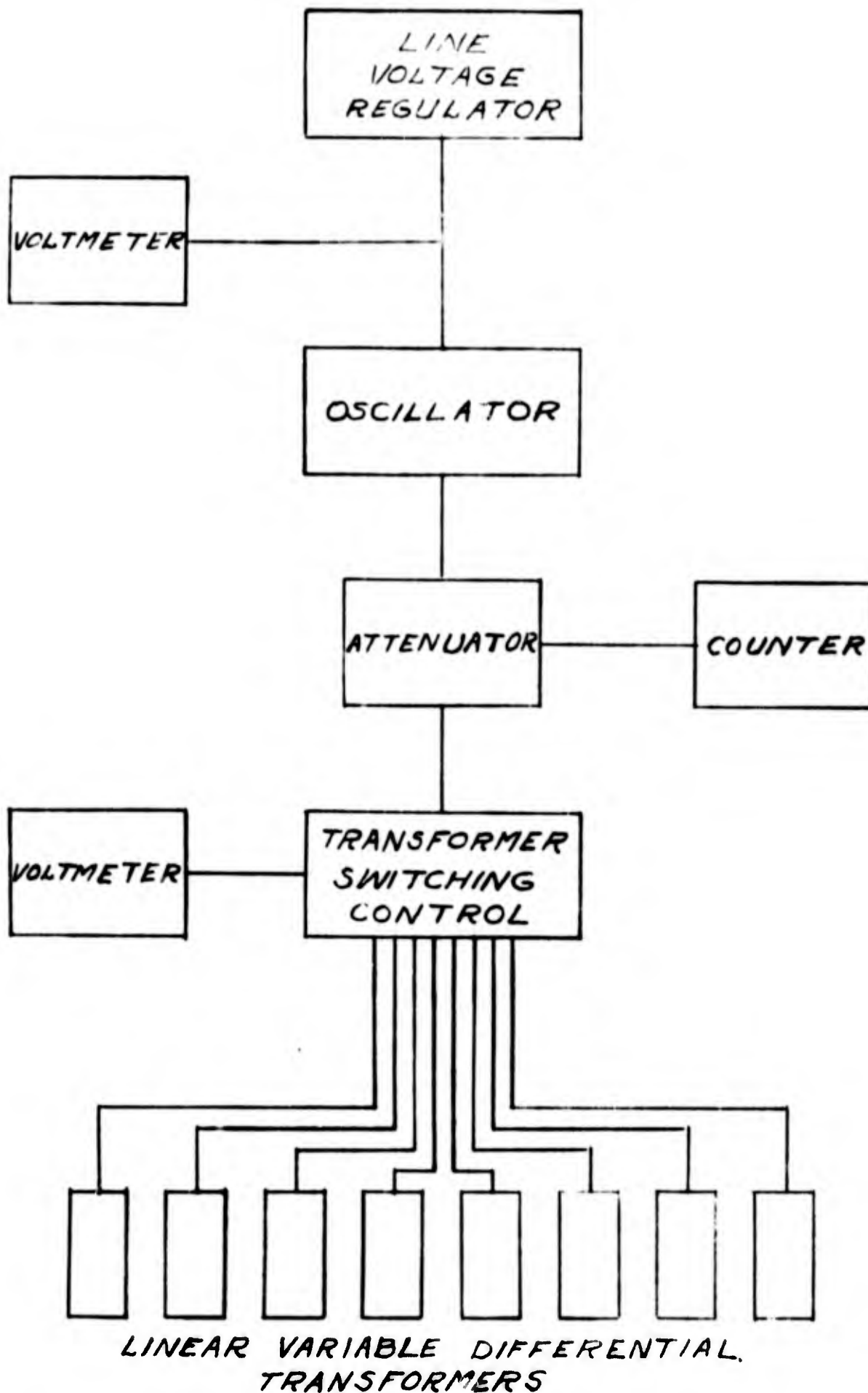


Figure 4. Block Diagram of Instrumentation

Counter:	Used to provide a constant check of the frequency output of the audio oscillator.
Attenuator:	Used to decrease the audio oscillator output voltage in order to operate it in a more accurate voltage range.
LVDT Switching Control:	Used to obtain the input and output voltage of each of the eight LVDT's.

TEST FIXTURE

The test fixture (see Figure 5) was designed to support the four different types of rotors and the LVDT's in accordance with the test setup and dimensional locations suggested in the test program request. Changes in the original test program necessitated modifications to the test fixtures. LVDT core rods were cemented directly to the rotors and rotor arms with dental cement. Eight terminal blocks were mounted on the back of the fixture to facilitate electrical connections from each LVDT to the switching control panel.

The necessity of having the test fixture inside a conditioning chamber required a means of applying the load to each of the rotors simultaneously from outside the chamber. A platform was designed that would support the weights in a raised position and when lowered would transfer the weights to the rotor arms simultaneously at the start of each test. This was accomplished by affixing two eccentrics qualified with each other on a common shaft which extended through the access port of the chamber. The shaft was mounted on a base plate and the eccentrics supported a movable top plate. Six guide pins fastened to the base plate and extending through the movable top plate insured parallelism of the top plate. When the handle of the eccentric shaft was vertical, the top plate was in a raised position. As the handle was rotated 90° in a clockwise direction, the point of contact between the top plate and the eccentrics moved to the position of minimum eccentricity, thus lowering the top plate. A wood test stand supported the test fixture and the weight platform while maintaining correct alignment with the chamber access port.

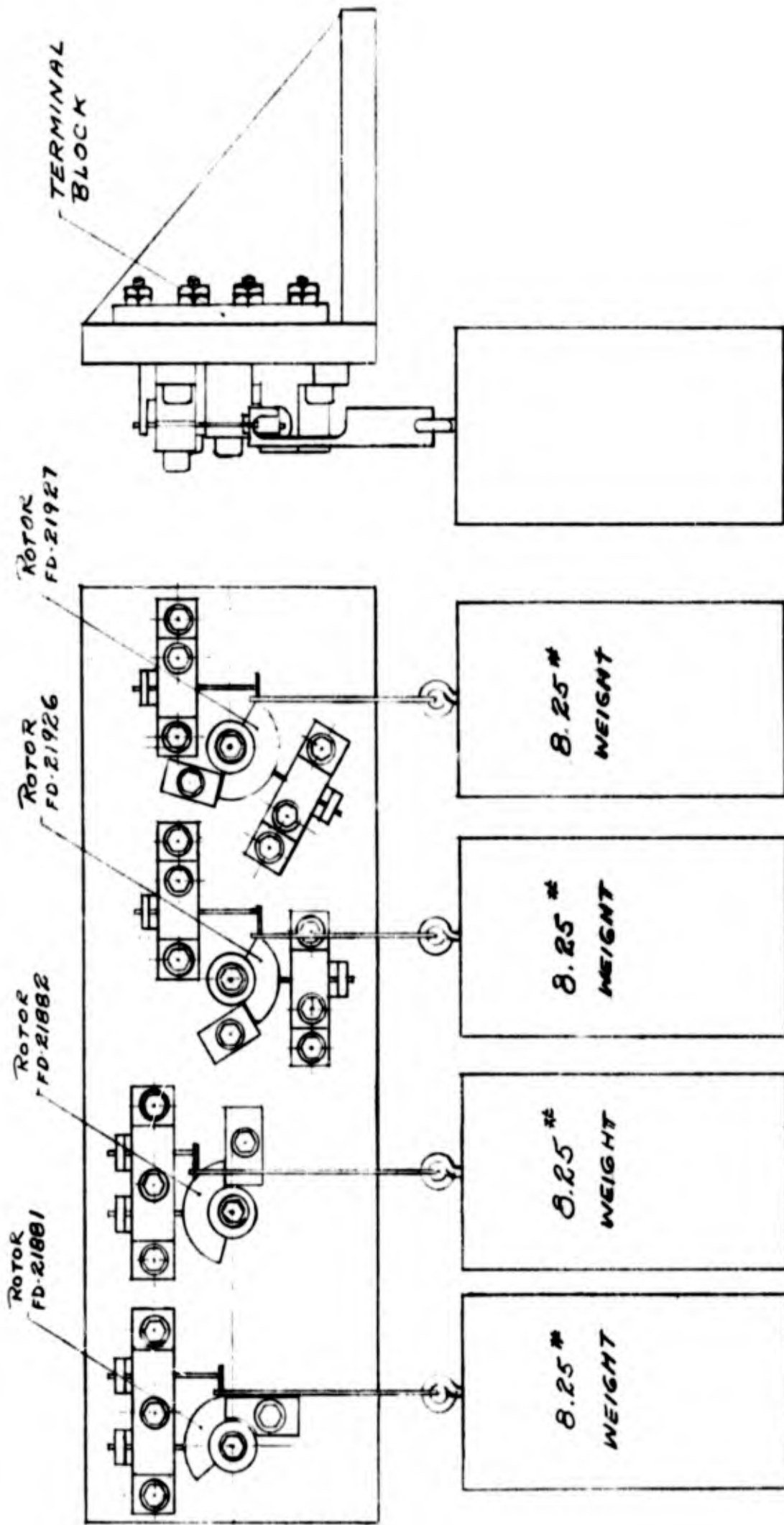


Figure 5. Assembly Sketch of Creep Test Fixture

TEST PROGRAM

It was agreed that the test program as outlined in Appendix A would be changed and the test conducted under the following conditions and in the following order.

Test I - Four rotors, FD-21881, FD-21882, FD-21926 and FD-21927, each subjected to a load of 8.25 lbs. for a period of 200 consecutive hours at a temperature of +70° F.

Test II - Four rotors, FD-21881, FD-21882, FD-21926 and FD-21927, each subjected to a load of 8.25 lbs. for a period of 200 consecutive hours at a temperature of +165° F.

Test III - Four rotors, FD-21881, FD-21882, FD-21926 and FD-21927, each subjected to a load of 8.25 lbs. for a period of 200 consecutive hours at a temperature of -60° F.

Test IV - Four rotors, FD-21881, FD-21882, FD-21926 and FD-21927, each subjected to a load of 8.25 lbs. for a period of 200 consecutive hours at a temperature of +125° F.

Note: This test to be cancelled if the amount of creep obtained in Test II is not excessive.

Test V - Two rotors, FD-21926 and FD-21927, subjected to a load of 8.25 lbs. and two rotors, FD-21926 and FD-21927, subjected to a load of 16.5 lbs for a period of 200 consecutive hours at a temperature of +165° F.

Text VI - Two rotors, FD-21926 and FD-21927, subjected to a load of 8.25 lbs. and two rotors, FD-21926 and FD-21927, subjected to a load of 16.5 lbs. for a period of 200 consecutive hours at a temperature of +125° F.

RESULTS

TEST I

Rotors FD 21881, FD 21882, FD 21926 and FD 21927 were mounted on the test fixture and temperature conditioned at +70° F for approximately two hours prior to start of the test (see Table II).

TEST II

Rotors FD 21881, FD 21882, FD 21926 and FD 21927 were mounted on the test fixture and temperature conditioned at +165° F for a period of 24 hours prior to start of the test (see Table III).

During the period between 75 and 96 hours of testing, which was after the normal working day, the thermostatic control of the temperature conditioning chamber malfunctioned. Temperatures in excess of 200° F were attained. A sharp increase in the amount of deflection occurred during this period. This abnormal increase in deflection is included in the final deflection readings tabulated in table III. The average rates of creep shown in table III are those obtained between 96 and 200 hours of testing at +165° F.

Remarks

A dotted line was plotted on each of the curves for this test to represent the curve that would have, in all probability, been generated if the chamber had not overheated.

Upon examination of the rotors at the completion of this test, it was discovered that cracks in the plastic had developed in rotors FD 21926 and FD 21927. The areas of the rotors where the cracks developed were photographed at approximately 15 magnifications (see Figures 6 and 7). The cracks were attributed to one or a combination of the following conditions:

1. The temperatures during the period of chamber malfunction may have reached a point close to the plasticity temperature of the polycarbonate resin plastic.
2. The rate of decrease in temperature, back to +165° F, immediately following the chamber malfunction was too rapid; thus strain cracks developed.

Table II. RESULTS OF TEST I

Rotor Dwg. No.	Load (lbs.)	Deflection After 5 Min. (ins)	Deflection After 24 Hrs. (ins)	Rate of Creep Per 24 Hrs. (ins)	Final Deflection After 200 Hrs. (ins)
FD 21881	8.25	.0034	.0035	.00006	.004
FD 21882	8.25	.0008	.0015	.00003	.0018
FD 21926	8.25	.0054	.0057	.00008	.0065
FD 21927	8.25	.0047	.005	.00006	.0057

Table III. TEST RESULTS OF TEST II

Rotor Dwg. No.	Load (lbs.)	Deflection After 5 Min. (ins)	Deflection After 24 Hrs. (ins)	Rate of Creep Per 24 Hrs. (ins)	Final Deflection After 200 Hrs. (ins)
FD 21881	8.25	.0038	.0053	.0001	.0072
FD 21882	8.25	.0022	.0024	.00005	.0027
FD 21926	8.25	.0090	.0168	.00017	.0275
FD 21927	8.25	.0077	.0130	.00015	.0212

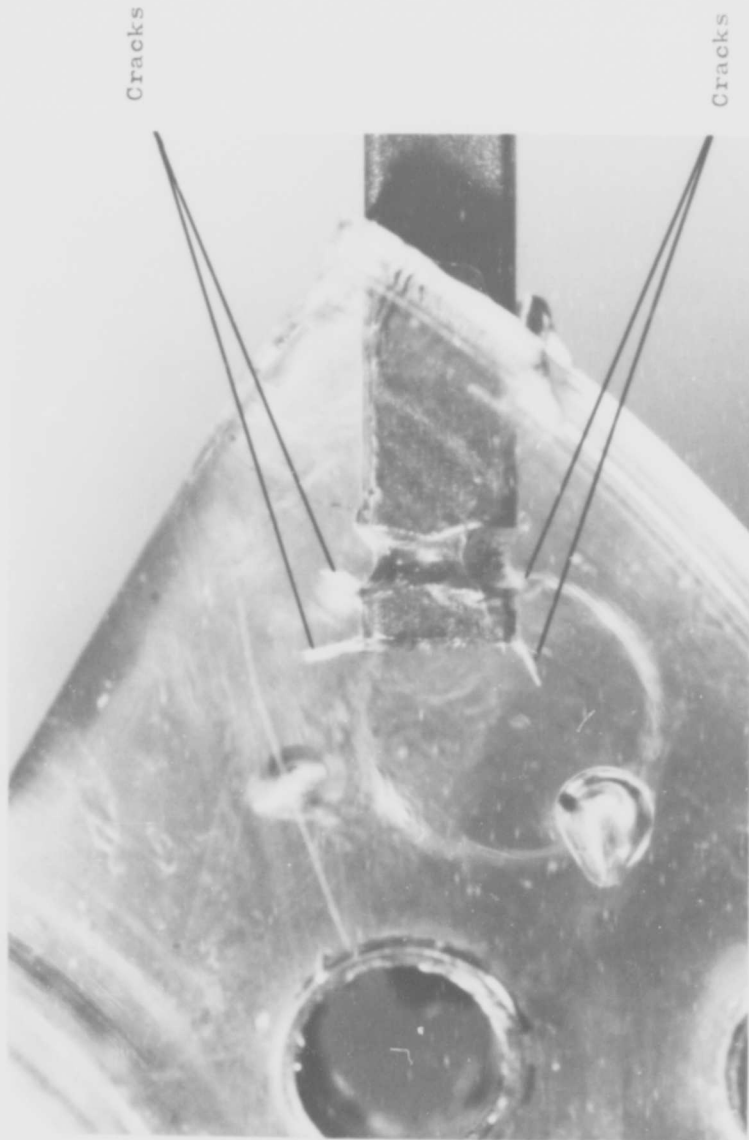
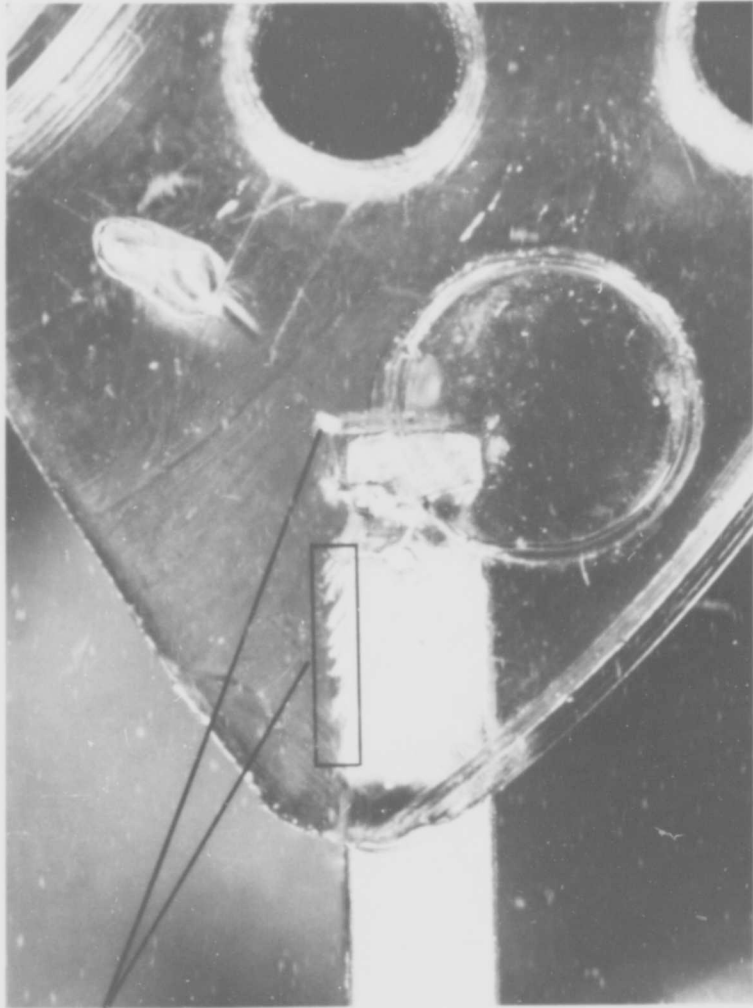


Figure 6. Cracks in Rotor FD 21926



Cracks

Figure 7. Cracks in Rotor FD 21927

3. The comparatively sharp corners on the rotor pins caused stress points and subsequent cracks.

TEST III

Rotors FD 21881, FD 21882, FD 21926 and FD 21927 were mounted on the test fixture and temperature conditioned at -60° F for a period of 16-1/2 hours prior to start of the test (see Table IV).

After 146 hours of test the circulating fan stopped functioning. The chamber was shut down and the test fixture was removed from the chamber. Upon completion of repairs to the chamber the test was continued for an additional 60 hours (see Table V).

Remarks

Some amount of permanent set was evident at the start of the 60 additional hours of test which affected both the rate of creep and the final deflection. Time versus deflection curves were plotted for both the 146 hours and 60 additional hours of test and were included on the same chart.

Each of the rotors was examined at the end of the test. No cracks developed in any of the rotors around the area of the rotor pin. However, strain cracks developed in the plastic in a radial pattern surrounding the brass sleeves on rotors FD 21926 and FD 21927.

TEST IV

Test IV was cancelled. Upon consideration of the results of Test II and the results of Test VI which partially duplicates this test, it was decided that no appreciable information would be gained by conducting this test.

TEST V

Two rotors, FD 21926 and two rotors, FD 21927 were mounted on the test fixture and temperature conditioned at $+165^{\circ}$ F for a period of 18 hours prior to start of the test (see Table VI).

Table IV. RESULTS OF TEST III (146 Hours)

<u>Rotor Dwg. No.</u>	<u>Load (lbs.)</u>	<u>Deflection After 5 Min. (ins)</u>	<u>Deflection After 24 Hrs. (ins)</u>	<u>Rate of Creep Per 24 Hrs. (ins)</u>	<u>Final Deflection After 146 Hrs. (ins)</u>
FD 21881	8.25	.0029	.0029	-	.0029
FD 21882	8.25	.0015	.0016	-	.0016
FD 21926	8.25	.0049	.0058	.00012	.0063
FD 21927	8.25	.0093	.0094	.00001	.0095

Table V. RESULTS OF TEST III (60 Hours)

<u>Rotor Dwg. No.</u>	<u>Load (lbs.)</u>	<u>Deflection After 5 Min. (ins)</u>	<u>Deflection After 24 Hrs. (ins)</u>	<u>Rate of Creep Per 24 Hrs. (ins)</u>	<u>Final Deflection After 60 Hrs. (ins)</u>
FD 21881	8.25	.0022	.0023	.00004	.0024
FD 21882	8.25	.0009	.0010	.00004	.0011
FD 21926	8.25	.0031	.0033	.00004	.0034
FD 21927	8.25	.0045	.0041	.00004	.0042

Table VI. RESULTS OF TEST V

<u>Rotor Dwg. No.</u>	<u>Load (lbs.)</u>	<u>Deflection After 5 Min. (ins)</u>	<u>Deflection After 24 Hrs. (ins)</u>	<u>Rate of Creep Per 24 Hrs. (ins)</u>	<u>Final Deflection After 200 Hrs. (ins)</u>
FD 21926	8.25	.0132	.0193	.0004	.0226
FD 21927	8.25	.0126	.0147	.0004	.0177
FD 21926	16.5	.0347	.0411	.0011	.0500
FD 21927	16.5	.0477	.0588	.0008	.0645

Table VII. RESULTS OF TEST VI

<u>Rotor Dwg. No.</u>	<u>Load (lbs.)</u>	<u>Deflection After 5 Min. (ins)</u>	<u>Deflection After 24 Hrs. (ins)</u>	<u>Rate of Creep Per 24 Hrs. (ins)</u>	<u>Final Deflection After 200 Hrs. (ins)</u>
FD 21926	8.25	.0104	.0118	.00018	.0131
FD 21927	8.25	.0070	.0079	.00011	.0087
FD 21926	16.5	.0190	.0239	.00051	.0275
FD 21927	16.5	.0152	.0185	.00035	.0210

Remarks:

Each of the rotors was examined at the end of the test. No cracks developed in the area of the rotor pin. Strain cracks developed in a radial pattern surrounding the brass sleeves on all four rotors tested. The cracks were more severe on the rotors subjected to the 16.5 lbs. load. In addition to these cracks, minute strain cracks were evident throughout the plastic in each of the rotors. Again, they were more severe on the rotors subjected to the 16.5 lb load.

TEST VI

Two rotors, FD 21926 and two rotors, FD 21927 were mounted on the test fixture and temperature conditioned at +125° F for a period of 67 hours prior to start of the test (see Table VII).

Remarks:

Each of the rotors was examined at the end of the test. No cracks developed in the area of the rotor pin. Strain cracks developed in the plastic in a radial pattern surrounding the brass sleeves and surface strain cracks appeared in the areas of stress concentrations. However, none of the cracks in these rotors were as severe as those developed in Test V.

CONCLUSIONS

The tests conducted indicate that any one of the four rotors tested will withstand prolonged exposure to temperature extremes of -60° F to +165° F and still function satisfactorily. Overall results show that the following factors or conditions have the most significant effects on the proper operation of the T366 fuze rotors after storage at varying temperature conditions.

1. High temperatures (+165° F) most drastically affects the stability of the polycarbonate resin plastic in the rotors.

2. Low temperatures (-60° F) seem to increase the stability of the plastic.

3. Sharp corners on the steel rotor pins are conducive to local cracking of the plastic.

The ability of the four different designs of rotors tested to resist deflection, creep, and cracking are listed below in the order of their effectiveness:

- a. FD 21882
- b. FD 21881
- c. FD 21927
- d. FD 21926

RECOMMENDATIONS

It is recommended that the following additional tests be conducted to obtain additional information that may contribute to T366 fuze reliability:

1. A long term creep and durability test of approximately 9000 hours duration at elevated temperatures. This test would determine how aging will affect the stability of the plastic.

2. A -60° F to 165° F temperature shock test. This test would determine the rotors' ability to withstand severe thermal changes.

3. A high temperature destruction test using selected loads and increasing the temperature until rotor failure. These tests would determine safe maximum storage temperatures.

APPENDIX A

Frankford Arsenal
Research & Development Group
Artillery Ammunition Components Division
Mechanical Time Fuze Branch-1610
Philadelphia, Pennsylvania 19137

Test Program Request
JFBaker/eh/21230
30 September 1963
TPR-FA-1610-566

1. Material for Test:

Supplied by RAD Eng. Electro Mech. Time Fuze Br. 1610:-

- a. Four Large Rotors for "B" switch, Dwg. FD 21927.
- b. Four Small Rotors for "B" switch, Dwg. FD 21926.
- c. Four Large Rotors for "A" switch, Dwg. FD 21882.
- d. Four Small Rotors for "A" switch, Dwg. FD 21881.

2. Project:

Fuze, MT, T366, DEP 370.

3. Classification:

Unclassified

4. Expenditure Order:

43621-05

5. Previous Tests:

None

6. Precautions in Handling and Testing:

Normal care to prevent damage to the items to be tested.

7. Object of Tests:

To test the ability of these rotors to withstand the storage temperatures while under the influence of the spring loads.

8. Test Program:

a. The rotors will be set up in the environmental chamber as shown in appendix A in groups of four rotors. Each group shall consist of one rotor of each type as noted in appendix A except small rotor FD 21881 and large rotor FD 21882 of which there will be two in each group. One large and one small rotor shall have the 8 1/4 lbs loading while the second pair shall have the 16 1/2 lb loading.

b. Exposure temperatures shall be as follows:

Group A+165° F
Group B+125° F
Group C+70° F
Group D-60° F

c. Exposure times at the respective temperatures shall be up to and including 200 hours or until failure occurs.

d. Deflection readings shall be taken at the following times:

1) Two minutes after start of test.

2) Two hours after start.

3) Twenty hours after start and at one hundred and two hundred hours after start of test.

4) All deflection readings shall be recorded as per temperature, total time lapse, and total deflection.

e. It is suggested that these tests be accomplished in alphabetical order and in as short a time as possible.

PREPARED BY:

/s/JOHN F. BAKER

REVIEWED BY:

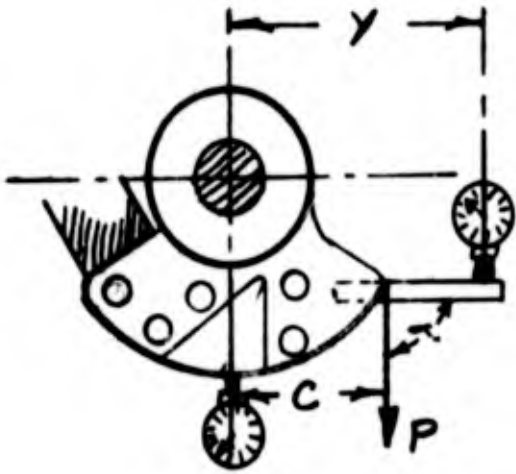
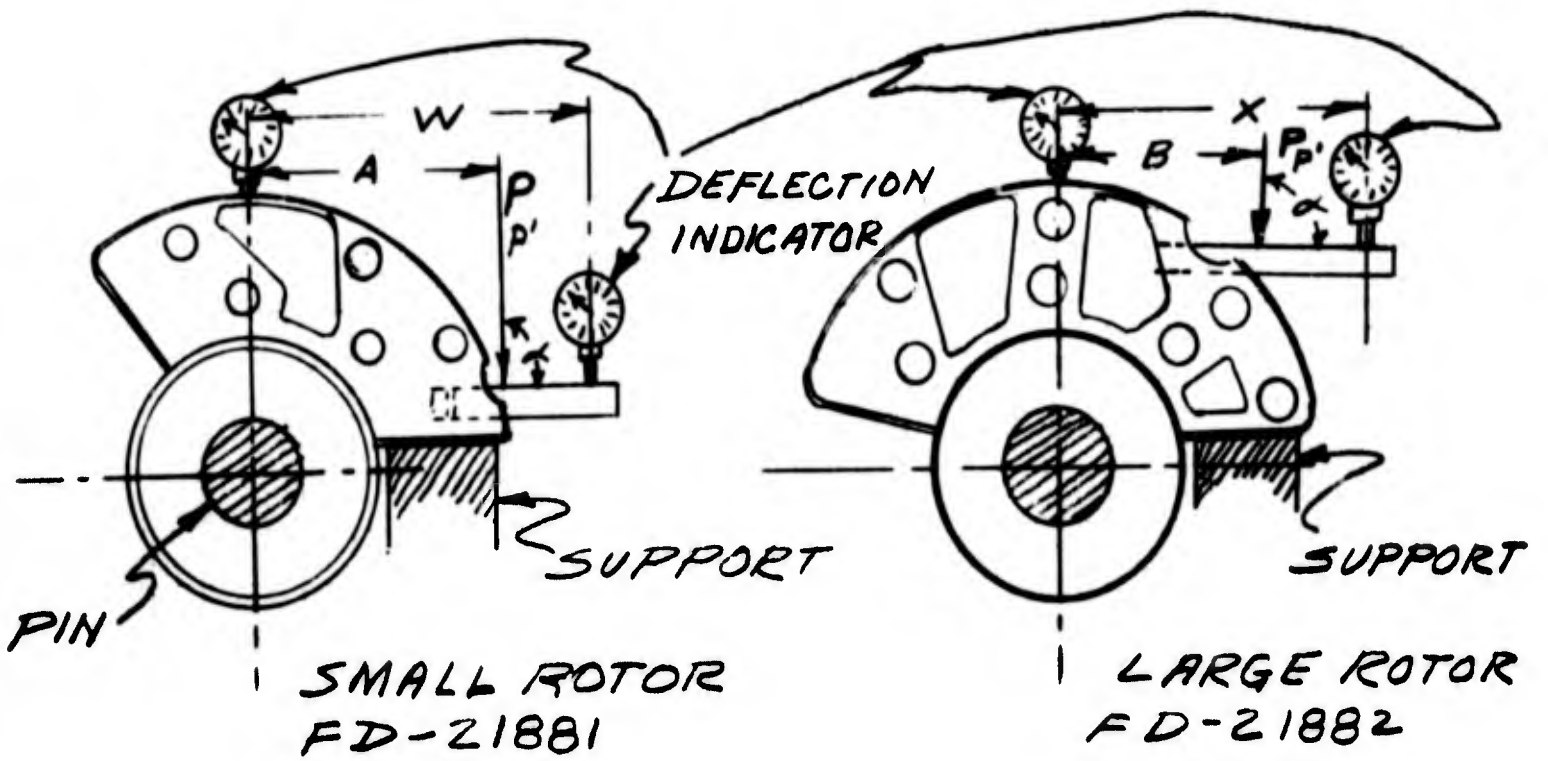
/s/D. R. LENTON

APPROVED BY:

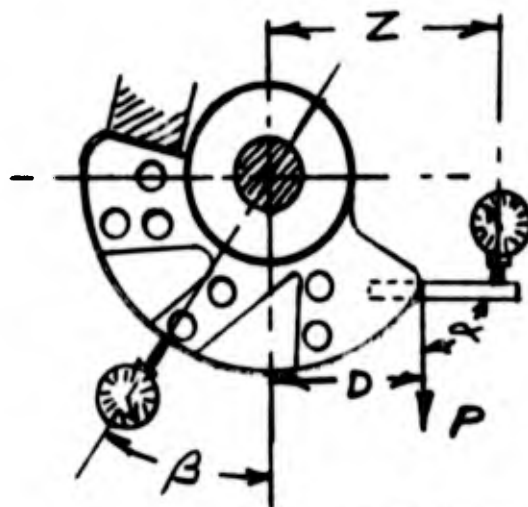
/s/B. D. NABRESKI

APPENDIX A

TEST SETUP (SUGGESTED)



SMALL ROTOR
FD-21926

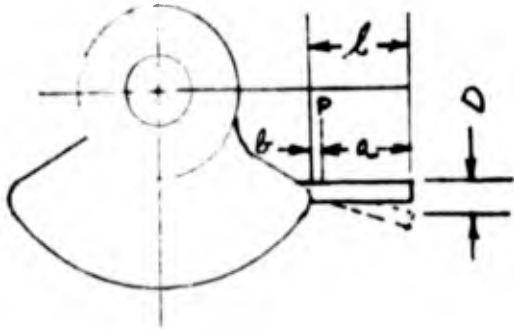


LARGE ROTOR
FD-21927

A	.688	W	.938	α	90°
B	.531	X	.781	β	30°
C	.562	Y	.875	P	8.25#
D	.562	Z	.750	P'	16.50#
PIN DIA.		.249 ⁰⁰⁰			

APPENDIX B

BENDING MOMENT CALCULATIONS OF ROTOR PIN



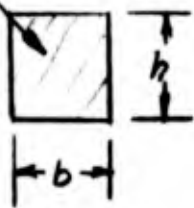
D = DEFLECTION (INCHES)

P = LOAD (LBS)

E = MODULUS OF ELASTICITY

I = MOMENT OF INERTIA

CROSS SECTION OF ROTOR PIN



$$h = .062$$

$$b = .062$$

$$I = \frac{1}{12} b h^3$$

$$I = \frac{1}{12} .062 \times (.062)^3$$

$$I = \frac{1}{12} (.062)^4$$

$$I = .000001$$

ROTOR - FD 21881 AND FD 21882

$$P = 16.5 \text{ lbs.} \quad l = .031" \quad L = .250$$

$$D = \frac{P l^2}{6EI} (3L - l)$$

$$D = \frac{16.5 (.031)^2}{6EI} (.75 - .031)$$

$$D = \frac{16.5 \times .001 \times .719}{6 \times 30,000,000 \times .000001}$$

$$D = \frac{.0165 \times .719}{180}$$

$$D = .00006$$

ROTOR - FD21881 AND FD21882.

$$\underline{P = 8.25 \text{ lbs.}} \quad \underline{b = .031} \quad \underline{l = .250}$$

$$D = \frac{P b^2}{6EI} (3l - b)$$

$$D = \frac{8.25 (.031)^2}{6EI} (.75 - .031)$$

$$D = \frac{8.25 \times .001 \times .719}{6 \times 30,000,000 \times .000001}$$

$$D = \frac{.0082 \times .719}{180}$$

$$D = .00003$$

ROTOR - FD21926

$$\underline{P = 16.5 \text{ lbs.}} \quad \underline{b = .031} \quad \underline{l = .313}$$

$$D = \frac{P b^2}{6EI} (3l - b)$$

$$D = \frac{16.5 (.031)^2}{6EI} (.939 - .031)$$

$$D = \frac{16.5 \times .001 \times .908}{180}$$

$$D = \frac{.0165 \times .908}{180}$$

$$D = .00008$$

ROTOR-FD 21926

$$P = 8.25 \text{ lbs.} \quad b = .031 \quad l = .319$$

$$D = \frac{P b^2}{6EI} (3l - b)$$

$$D = \frac{8.25 (.031)^2}{6EI} (.939 - .031)$$

$$D = \frac{8.25 \times .001 \times .908}{180}$$

$$D = \frac{.0082 \times .908}{180}$$

$$D = .00004$$

ROTOR-FD 21927

$$P = 16.5 \quad b = .031 \quad l = .188$$

$$D = \frac{P b^2}{6EI} (3l - b)$$

$$D = \frac{16.5 (.031)^2}{6EI} (.564 - .031)$$

$$D = \frac{16.5 \times .001 \times .533}{180}$$

$$D = \frac{.0165 \times .533}{180}$$

$$D = .00004$$

ROTOR - FD 21927

$$P = 8.25 \quad b = .031 \quad l = .188$$

$$D = \frac{P b^2}{6EI} (3l - b)$$

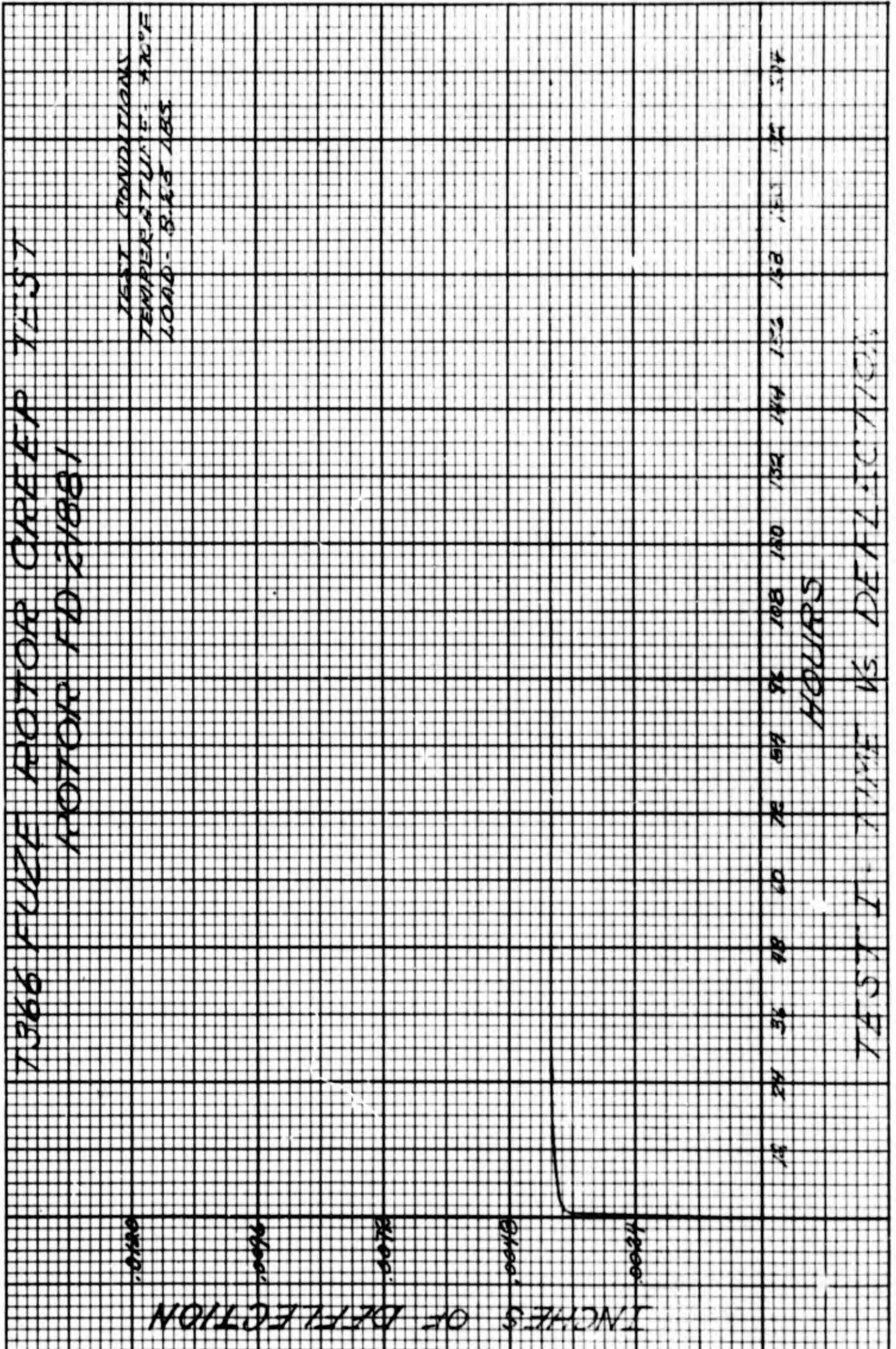
$$D = \frac{8.25 (.031)^2}{6EI} (.564 - .031)$$

$$D = \frac{8.25 \times .001 \times .533}{180}$$

$$D = \frac{.0082 \times .533}{180}$$

$$D = .00002$$

APPENDIX C

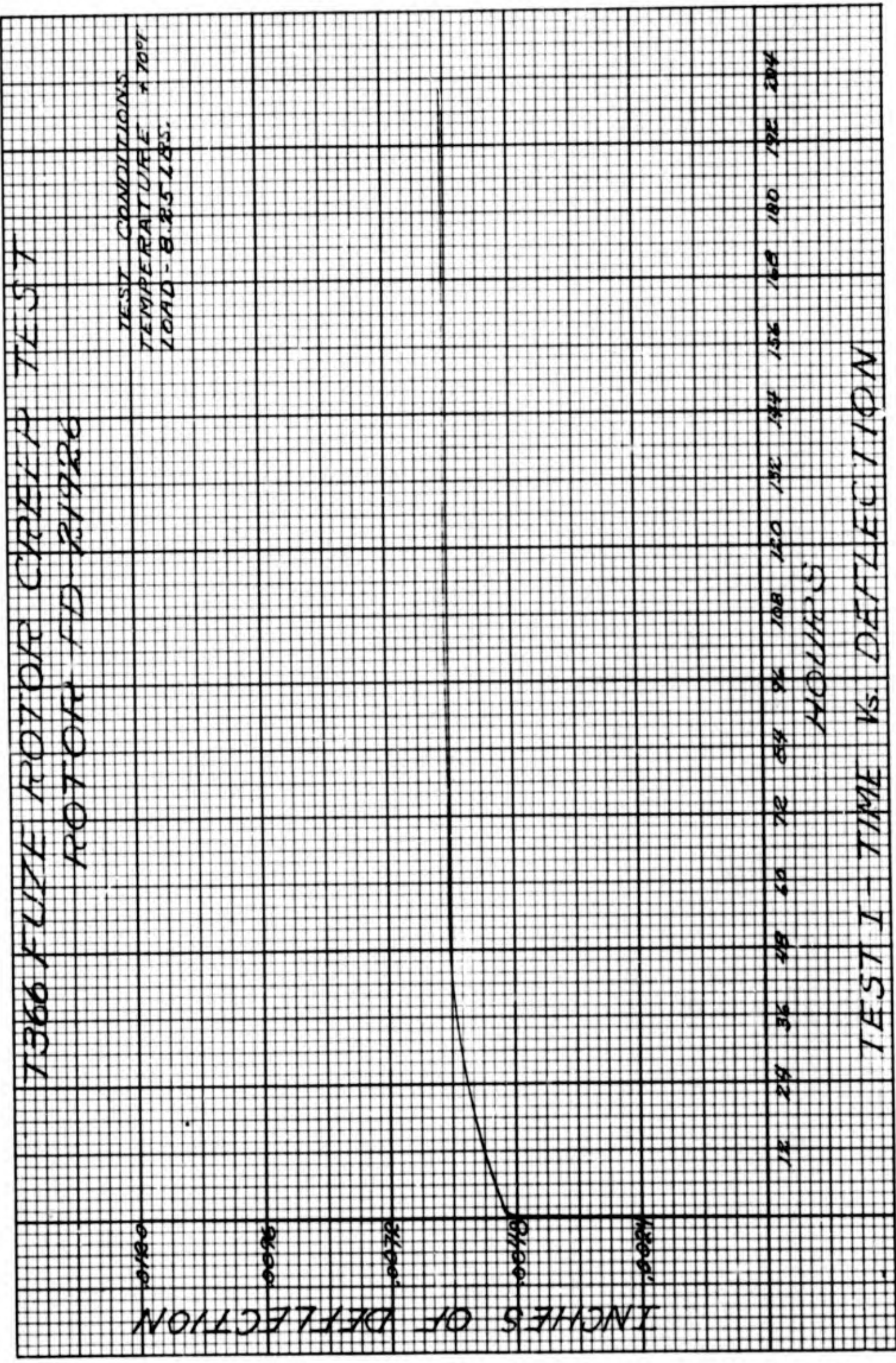


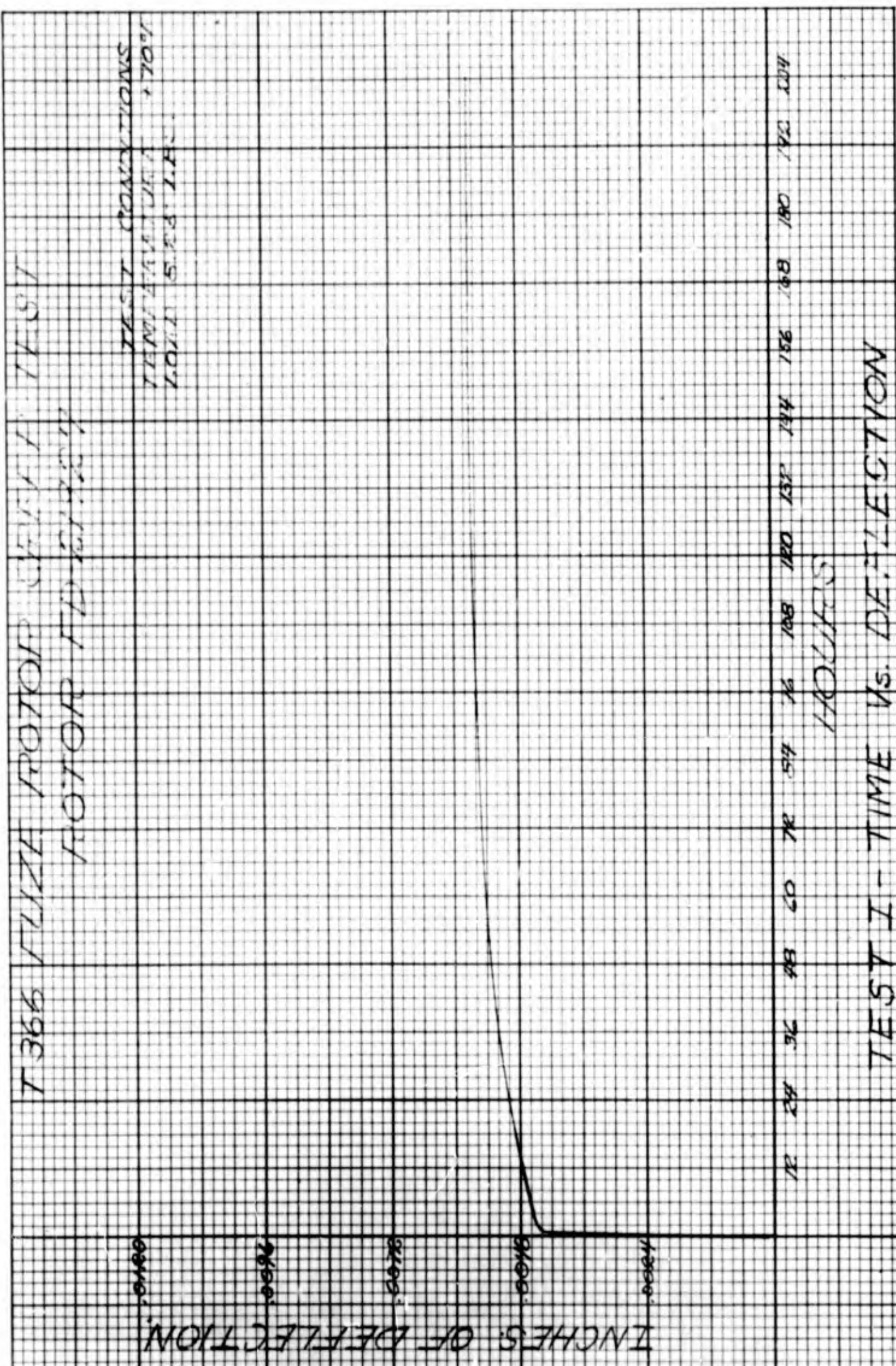
T366 FUZZ ROTOR CREEP TEST
 ROTOR FD 21882

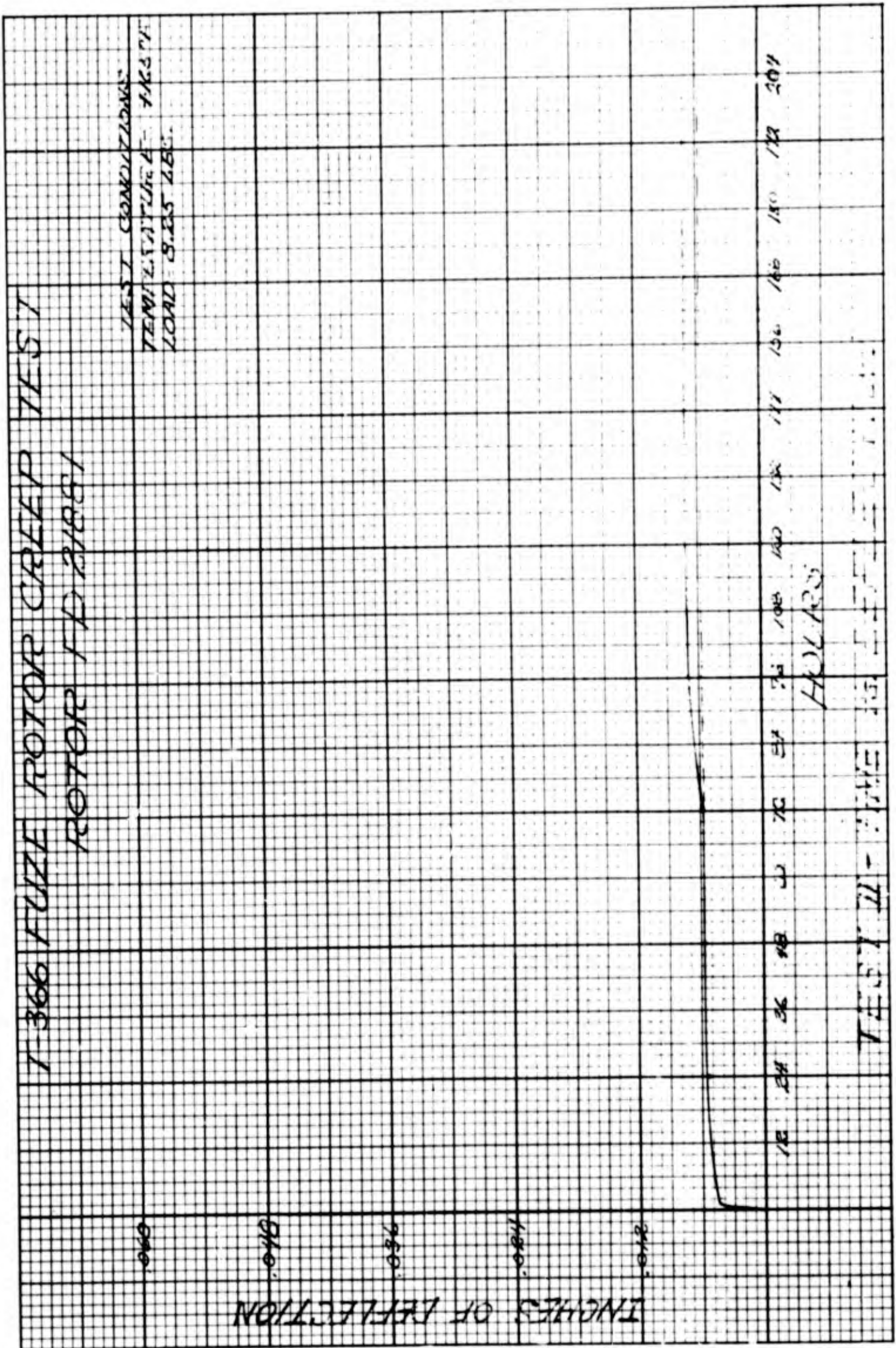
TEST CONDITIONS
 TEMPERATURE +70°F
 LOAD - 8.25 LBS.

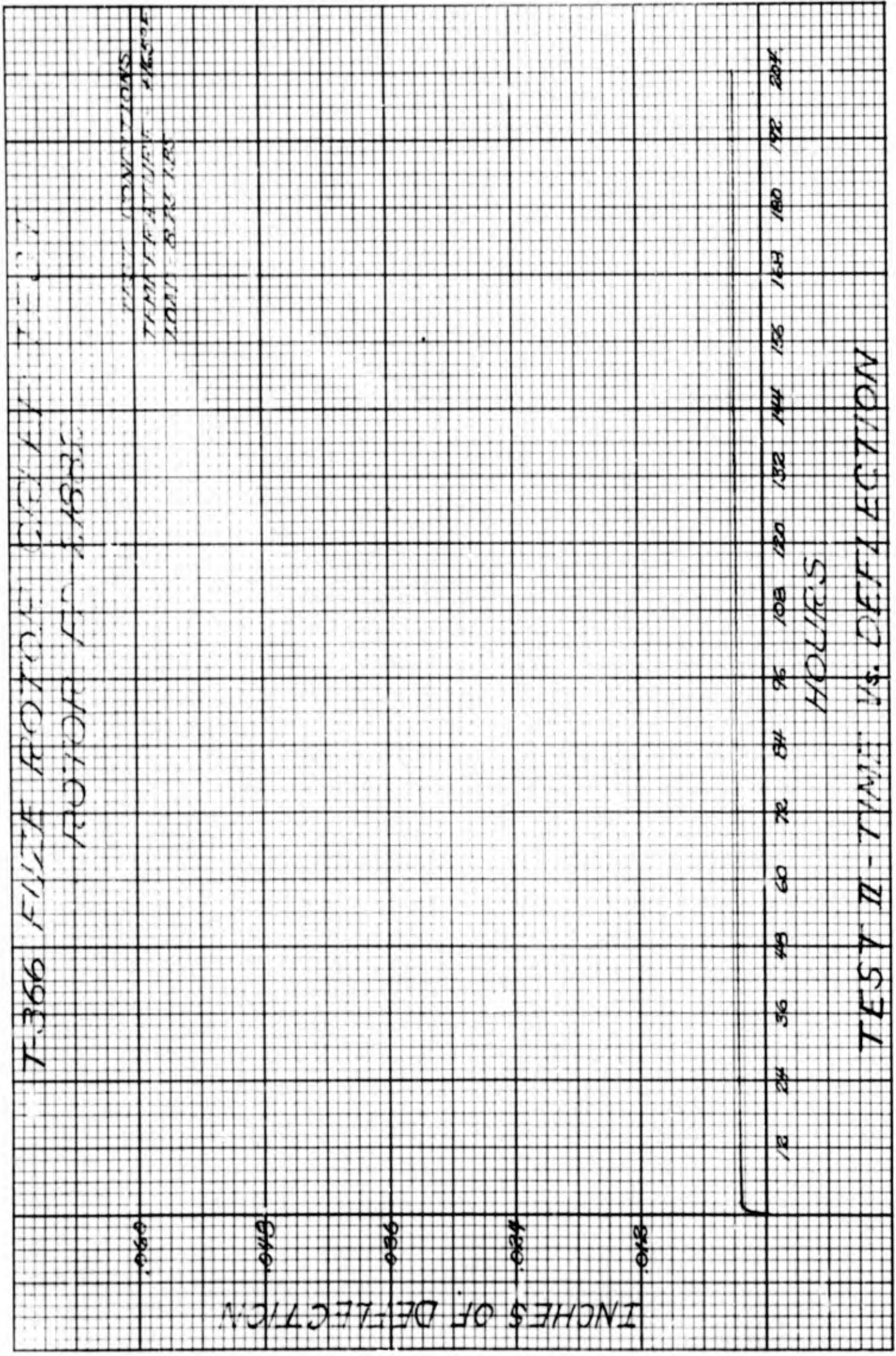
INCHES OF DEFLECTION

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223H 224L 225R 226D 227E 228H 229L 230R 231D 232E 233H 234L 235R 236D 237E 238H 239L 240R 241D 242E 243H 244L 245R 246D 247E 248H 249L 250R 251D 252E 253H 254L 255R 256D 257E 258H 259L 260R 261D 262E 263H 264L 265R 266D 267E 268H 269L 270R 271D 272E 273H 274L 275R 276D 277E 278H 279L 280R 281D 282E 283H 284L 285R 286D 287E 288H 289L 290R 291D 292E 293H 294L 295R 296D 297E 298H 299L 300R 301D 302E 303H 304L 305R 306D 307E 308H 309L 310R 311D 312E 313H 314L 315R 316D 317E 318H 319L 320R 321D 322E 323H 324L 325R 326D 327E 328H 329L 330R 331D 332E 333H 334L 335R 336D 337E 338H 339L 340R 341D 342E 343H 344L 345R 346D 347E 348H 349L 350R 351D 352E 353H 354L 355R 356D 357E 358H 359L 360R 361D 362E 363H 364L 365R 366D 367E 368H 369L 370R 371D 372E 373H 374L 375R 376D 377E 378H 379L 380R 381D 382E 383H 384L 385R 386D 387E 388H 389L 390R 391D 392E 393H 394L 395R 396D 397E 398H 399L 400R 401D 402E 403H 404L 405R 406D 407E 408H 409L 410R 411D 412E 413H 414L 415R 416D 417E 418H 419L 420R 421D 422E 423H 424L 425R 426D 427E 428H 429L 430R 431D 432E 433H 434L 435R 436D 437E 438H 439L 440R 441D 442E 443H 444L 445R 446D 447E 448H 449L 450R 451D 452E 453H 454L 455R 456D 457E 458H 459L 460R 461D 462E 463H 464L 465R 466D 467E 468H 469L 470R 471D 472E 473H 474L 475R 476D 477E 478H 479L 480R 481D 482E 483H 484L 485R 486D 487E 488H 489L 490R 491D 492E 493H 494L 495R 496D 497E 498H 499L 500R 501D 502E 503H 504L 505R 506D 507E 508H 509L 510R 511D 512E 513H 514L 515R 516D 517E 518H 519L 520R 521D 522E 523H 524L 525R 526D 527E 528H 529L 530R 531D 532E 533H 534L 535R 536D 537E 538H 539L 540R 541D 542E 543H 544L 545R 546D 547E 548H 549L 550R 551D 552E 553H 554L 555R 556D 557E 558H 559L 560R 561D 562E 563H 564L 565R 566D 567E 568H 569L 570R 571D 572E 573H 574L 575R 576D 577E 578H 579L 580R 581D 582E 583H 584L 585R 586D 587E 588H 589L 590R 591D 592E 593H 594L 595R 596D 597E 598H 599L 600R 601D 602E 603H 604L 605R 606D 607E 608H 609L 610R 611D 612E 613H 614L 615R 616D 617E 618H 619L 620R 621D 622E 623H 624L 625R 626D 627E 628H 629L 630R 631D 632E 633H 634L 635R 636D 637E 638H 639L 640R 641D 642E 643H 644L 645R 646D 647E 648H 649L 650R 651D 652E 653H 654L 655R 656D 657E 658H 659L 660R 661D 662E 663H 664L 665R 666D 667E 668H 669L 670R 671D 672E 673H 674L 675R 676D 677E 678H 679L 680R 681D 682E 683H 684L 685R 686D 687E 688H 689L 690R 691D 692E 693H 694L 695R 696D 697E 698H 699L 700R 701D 702E 703H 704L 705R 706D 707E 708H 709L 710R 711D 712E 713H 714L 715R 716D 717E 718H 719L 720R 721D 722E 723H 724L 725R 726D 727E 728H 729L 730R 731D 732E 733H 734L 735R 736D 737E 738H 739L 740R 741D 742E 743H 744L 745R 746D 747E 748H 749L 750R 751D 752E 753H 754L 755R 756D 757E 758H 759L 760R 761D 762E 763H 764L 765R 766D 767E 768H 769L 770R 771D 772E 773H 774L 775R 776D 777E 778H 779L 780R 781D 782E 783H 784L 785R 786D 787E 788H 789L 790R 791D 792E 793H 794L 795R 796D 797E 798H 799L 800R 801D 802E 803H 804L 805R 806D 807E 808H 809L 810R 811D 812E 813H 814L 815R 816D 817E 818H 819L 820R 821D 822E 823H 824L 825R 826D 827E 828H 829L 830R 831D 832E 833H 834L 835R 836D 837E 838H 839L 840R 841D 842E 843H 844L 845R 846D 847E 848H 849L 850R 851D 852E 853H 854L 855R 856D 857E 858H 859L 860R 861D 862E 863H 864L 865R 866D 867E 868H 869L 870R 871D 872E 873H 874L 875R 876D 877E 878H 879L 880R 881D 882E 883H 884L 885R 886D 887E 888H 889L 890R 891D 892E 893H 894L 895R 896D 897E 898H 899L 900R 901D 902E 903H 904L 905R 906D 907E 908H 909L 910R 911D 912E 913H 914L 915R 916D 917E 918H 919L 920R 921D 922E 923H 924L 925R 926D 927E 928H 929L 930R 931D 932E 933H 934L 935R 936D 937E 938H 939L 940R 941D 942E 943H 944L 945R 946D 947E 948H 949L 950R 951D 952E 953H 954L 955R 956D 957E 958H 959L 960R 961D 962E 963H 964L 965R 966D 967E 968H 969L 970R 971D 972E 973H 974L 975R 976D 977E 978H 979L 980R 981D 982E 983H 984L 985R 986D 987E 988H 989L 990R 991D 992E 993H 994L 995R 996D 997E 998H 999L 1000R 1001D 1002E 1003H 1004L 1005R 1006D 1007E 1008H 1009L 1010R 1011D 1012E 1013H 1014L 1015R 1016D 1017E 1018H 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1517E 1518H 1519L 1520R 1521D 1522E 1523H 1524L 1525R 1526D 1527E 1528H 1529L 1530R 1531D 1532E 1533H 1534L 1535R 1536D 1537E 1538H 1539L 1540R 1541D 1542E 1543H 1544L 1545R 1546D 1547E 1548H 1549L 1550R 1551D 1552E 1553H 1554L 1555R 1556D 1557E 1558H 1559L 1560R 1561D 1562E 1563H 1564L 1565R 1566D 1567E 1568H 1569L 1570R 1571D 1572E 1573H 1574L 1575R 1576D 1577E 1578H 1579L 1580R 1581D 1582E 1583H 1584L 1585R 1586D 1587E 1588H 1589L 1590R 1591D 1592E 1593H 1594L 1595R 1596D 1597E 1598H 1599L 1600R 1601D 1602E 1603H 1604L 1605R 1606D 1607E 1608H 1609L 1610R 1611D 1612E 1613H 1614L 1615R 1616D 1617E 1618H 1619L 1620R 1621D 1622E 1623H 1624L 1625R 1626D 1627E 1628H 1629L 1630R 1631D 1632E 1633H 1634L 1635R 1636D 1637E 1638H 1639L 1640R 1641D 1642E 1643H 1644L 1645R 1646D 1647E 1648H 1649L 1650R 1651D 1652E 1653H 1654L 1655R 1656D 1657E 1658H 1659L 1660R 1661D 1662E 1663H 1664L 1665R 1666D 1667E 1668H 1669L 1670R 1671D 1672E 1673H 1674L 1675R 1676D 1677E 1678H 1679L 1680R 1681D 1682E 1683H 1684L 1685R 1686D 1687E 1688H 1689L 1690R 1691D 1692E 1693H 1694L 1695R 1696D 1697E 1698H 1699L 1700R 1701D 1702E 1703H 1704L 1705R 1706D 1707E 1708H 1709L 1710R 1711D 1712E 1713H 1714L 1715R 1716D 1717E 1718H 1719L 1720R 1721D 1722E 1723H 1724L 1725R 1726D 1727E 1728H 1729L 1730R 1731D 1732E 1733H 1734L 1735R 1736D 1737E 1738H 1739L 1740R 1741D 1742E 1743H 1744L 1745R 1746D 1747E 1748H 1749L 1750R 1751D 1752E 1753H 1754L 1755R 1756D 1757E 1758H 1759L 1760R 1761D 1762E 1763H 1764L 1765R 1766D 1767E 1768H 1769L 1770R 1771D 1772E 1773H 1774L 1775R 1776D 1777E 1778H 1779L 1780R 1781D 1782E 1783H 1784L 1785R 1786D 1787E 1788H 1789L 1790R 1791D 1792E 1793H 1794L 1795R 1796D 1797E 1798H 1799L 1800R 1801D 1802E 1803H 1804L 1805R 1806D 1807E 1808H 1809L 1810R 1811D 1812E 1813H 1814L 1815R 1816D 1817E 1818H 1819L 1820R 1821D 1822E 1823H 1824L 1825R 1826D 1827E 1828H 1829L 1830R 1831D 1832E 1833H 1834L 1835R 1836D 1837E 1838H 1839L 1840R 1841D 1842E 1843H 1844L 1845R 1846D 1847E 1848H 1849L 1850R 1851D 1852E 1853H 1854L 1855R 1856D 1857E 1858H 1859L 1860R 1861D 1862E 1863H 1864L 1865R 1866D 1867E 1868H 1869L 1870R 1871D 1872E 1873H 1874L 1875R 1876D 1877E 1878H 1879L 1880R 1881D 1882E 1883H 1884L 1885R 1886D 1887E 1888H 1889L 1890R 1891D 1892E 1893H 1894L 1895R 1896D 1897E 1898H 1899L 1900R 1901D 1902E 1903H 1904L 1905R 1906D 1907E 1908H 1909L 1910R 1911D 1912E 1913H 1914L 1915R 1916D 1917E 1918H 1919L 1920R 1921D 1922E 1923H 1924L 1925R 1926D 1927E 1928H 1929L 1930R 1931D 1932E 1933H 1934L 1935R 1936D 1937E 1938H 1939L 1940R 1941D 1942E 1943H 1944L 1945R 1946D 1947E 1948H 1949L 1950R 1951D 1952E 1953H 1954L 1955R 1956D 1957E 1958H 1959L 1960R 1961D 1962E 1963H 1964L 1965R 1966D 1967E 1968H 1969L 1970R 1971D 1972E 1973H 1974L 1975R 1976D 1977E 1978H 1979L 1980R 1981D 1982E 1983H 1984L 1985R 1986D 1987E 1988H 1989L 1990R 1991D 1992E 1993H 1994L 1995R 1996D 1997E 1998H 1999L 2000R 2001D 2002E 2003H 2004L 2005R 2006D 2007E 2008H 2009L 2010R 2011D 2012E 2013H 2014L 2015R 2016D 2017E 2018H 2019L 2020R 2021D 2022E 2023H 2024L 2025R 2026D 2027E 2028H 2029L 2030R 2031D 2032E 2033H 2034L 2035R 2036D 2037E 2038H 2039L 2040R 2041D 2042E 2043H 2044L 2045R 2046D 2047E 2048H 2049L 2050R 2051D 2052E 2053H 2054L 2055R 2056D 2057E 2058H 2059L 2060R 2061D 2062E 2063H 2064L 2065R 2066D 2067E 2068H 2069L 2070R 2071D 2072E 2073H 2074L 2075R 2076D 2077E 2078H 2079L 2080R 2081D 2082E 2083H 2084L 2085R 2086D 2087E 2088H 2089L 2090R 2091D 2092E 2093H 2094L 2095R 2096D 2097E 2098H 2099L 2100R 2101D 2102E 2103H 2104L 2105R 2106D 2107E 2108H 2109L 2110R 2111D 2112E 2113H 2114L 2115R 2116D 2117E 2118H 2119L 2120R 2121D 2122E 2123H 2124L 2125R 2126D 2127E 2128H 2129L 2130R 2131D 2132E 2133H 2134L 2135R 2136D 2137E 2138H 2139L 2140R 2141D 2142E 2143H 2144L 2145R 2146D 2147E 2148H 2149L 2150R 2151D 2152E 2153H 2154L 2155R 2156D 2157E 2158H 2159L 2160R 2161D 2162E 2163H 2164L 2165R 2166D 2167E 2168H 2169L 2170R 2171D 2172E 2173H 2174L 2175R 2176D 2177E 2178H 2179L 2180R 2181D 2182E 2183H 2184L 2185R 2186D 2187E 2188H 2189L 2190R 2191D 2192E 2193H 2194L 2195R 2196D 2197E 2198H 2199L 2200R 2201D 2202E 2203H 2204L 2205R 2206D 2207E 2208H 2209L 2210R 2211D 2212E 2213H 2214L 2215R 2216D 2

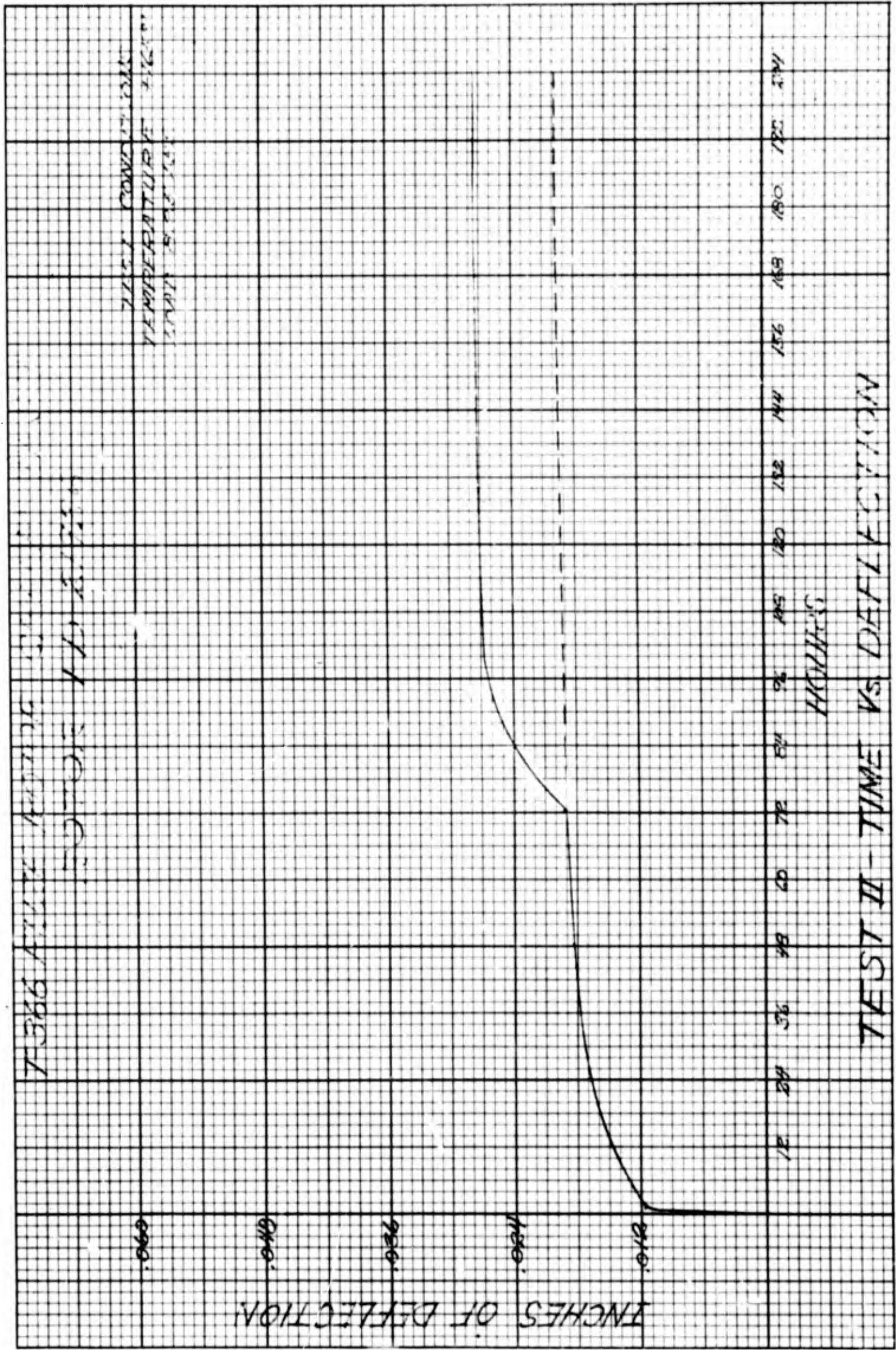








DEFLECTIONS
TIME - TIME VS. DEFLECTION
1011 - 8721.RS



T-366 FUZE ROTOR CREEP TEST
 ROTOR FD 21927

TEST CONDITIONS
 TEMPERATURE 1/65°F
 LOAD - 8.85 LBS.

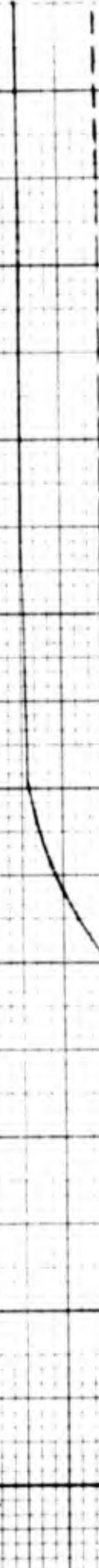
INCHES OF DEFLECTION

0.00
 0.40
 0.80
 1.20
 1.60

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204

HOURS

TEST II - TIME VS DEFLECTION



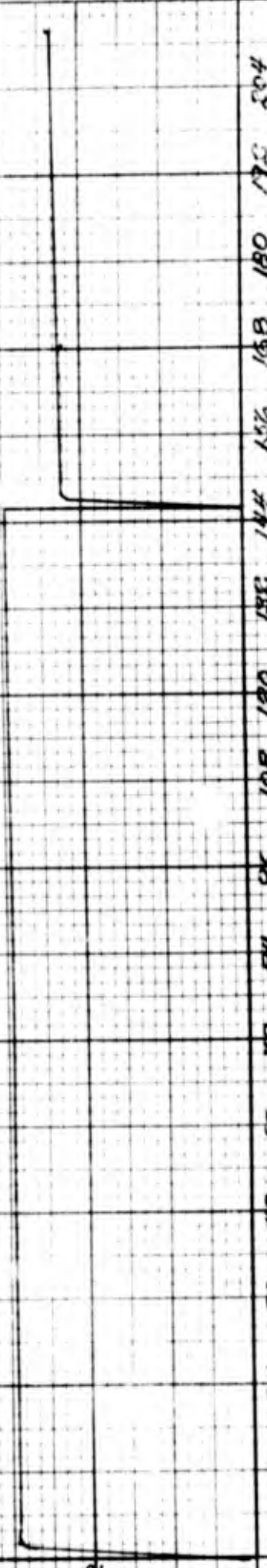
T-366 FUZE ROTOR CREEP TEST
 ROTOR FD-21881

TEST CONDITIONS
 TEMPERATURE -60°F
 LOAD 8.25 LBS.

INCHES OF DEFLECTION

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204
 HOURS

TEST III - TIME VS DEFLECTION



13665 FLUXE ROTOR CREEP TEST
 ROTOR ID 21882

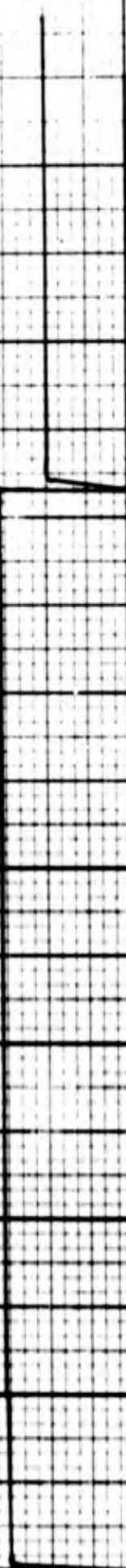
TEST CONDITIONS
 TEMPERATURE -60°F
 LOAD 8.25 LBS.

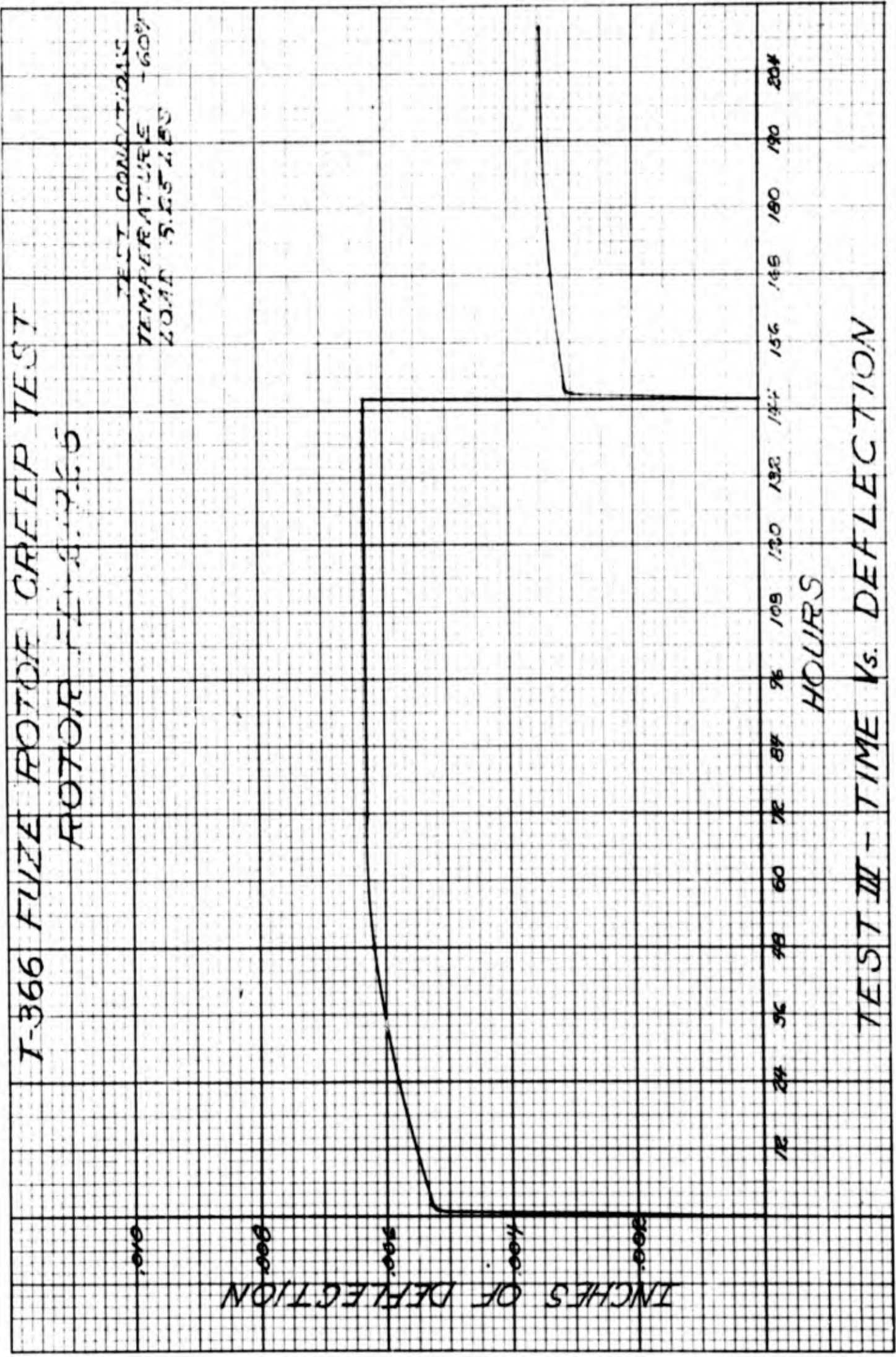
INCHES OF DEFLECTION

HOURS

TEST III - TIME VS DEFLECTION

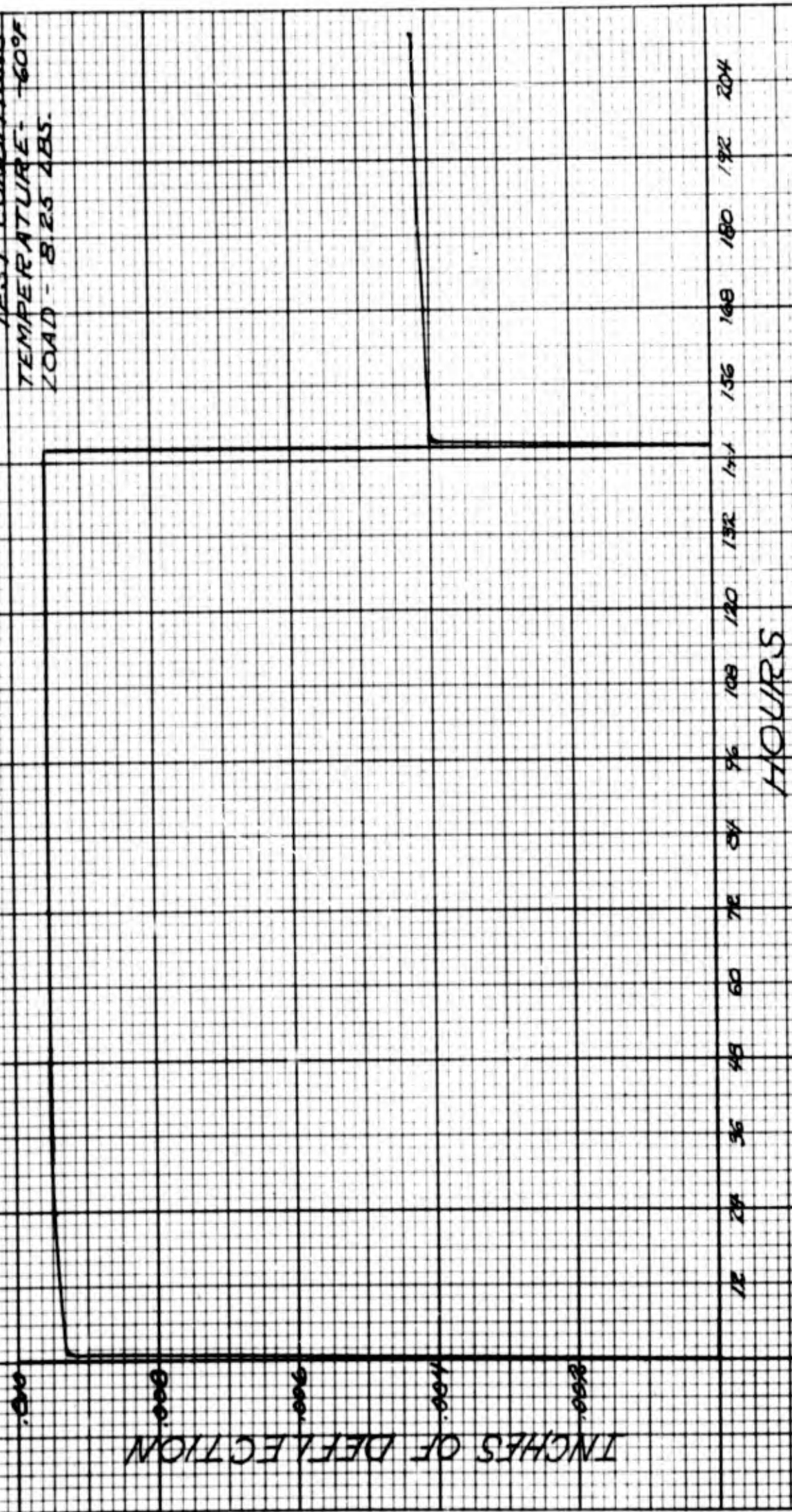
12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204





T-366 FUZE ROTOR CREEP TEST
 ROTOR FD-21927

TEST CONDITIONS
 TEMPERATURE - 60°F
 LOAD - 8.25 LBS.



TEST III - TIME Vs. DEFLECTION

T-366 FUZZ ROTOR CREEP
 ROTOR FD-21926

TEST

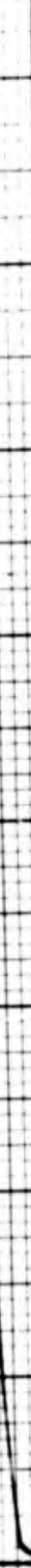
TEST CONDITIONS
 TEMPERATURE +165°F
 LOAD: 8.25 LBS.

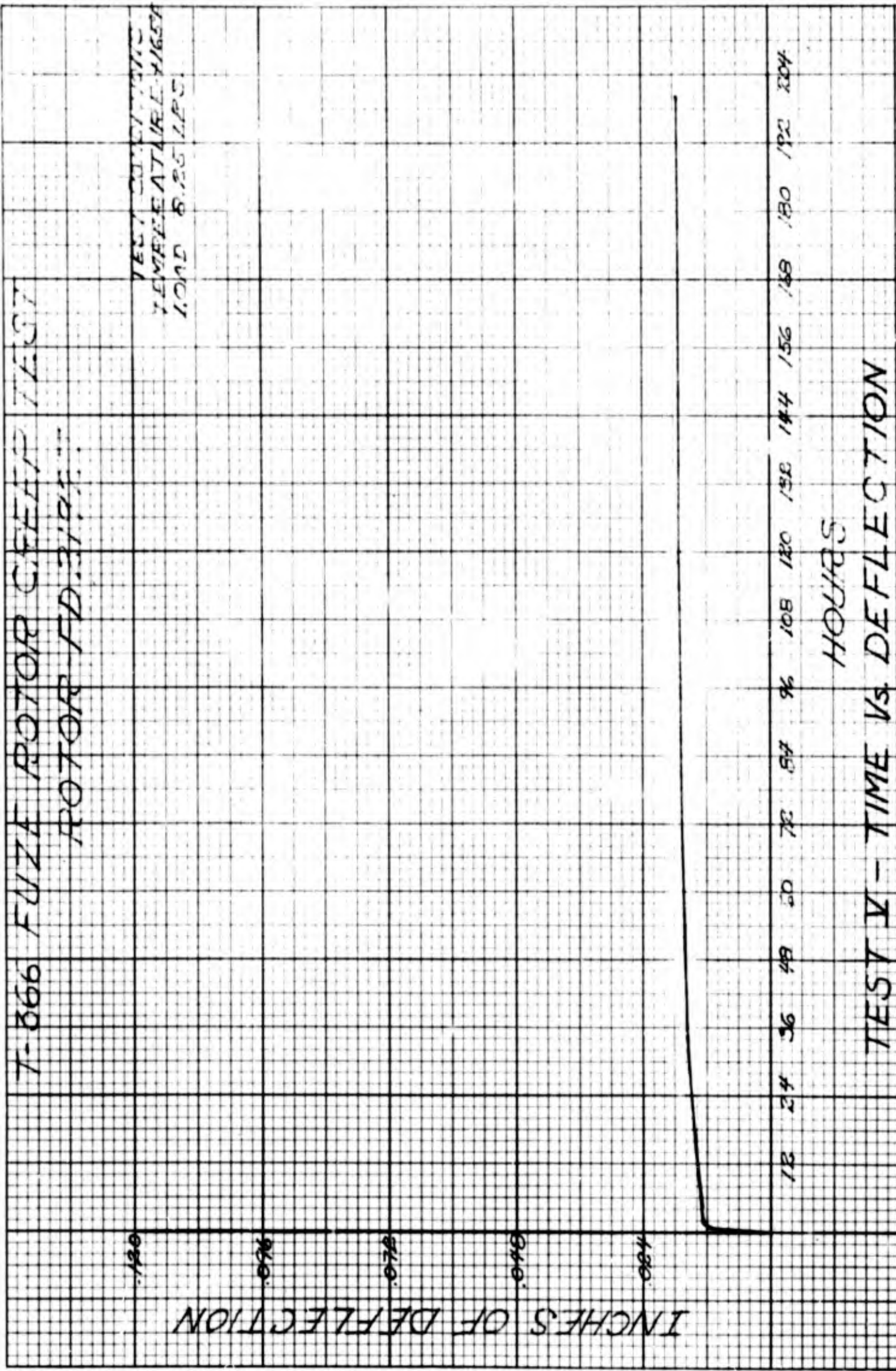
INCHES OF DEFLECTION

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204

HOURS

TEST II - TIME vs. DEFLECTION





T-366 FUZE ROTOR CREEP TEST
 ROTOR FD21926

TEST CONDITIONS
 TEMPERATURE 165°F
 LOAD 16.5 LBS.

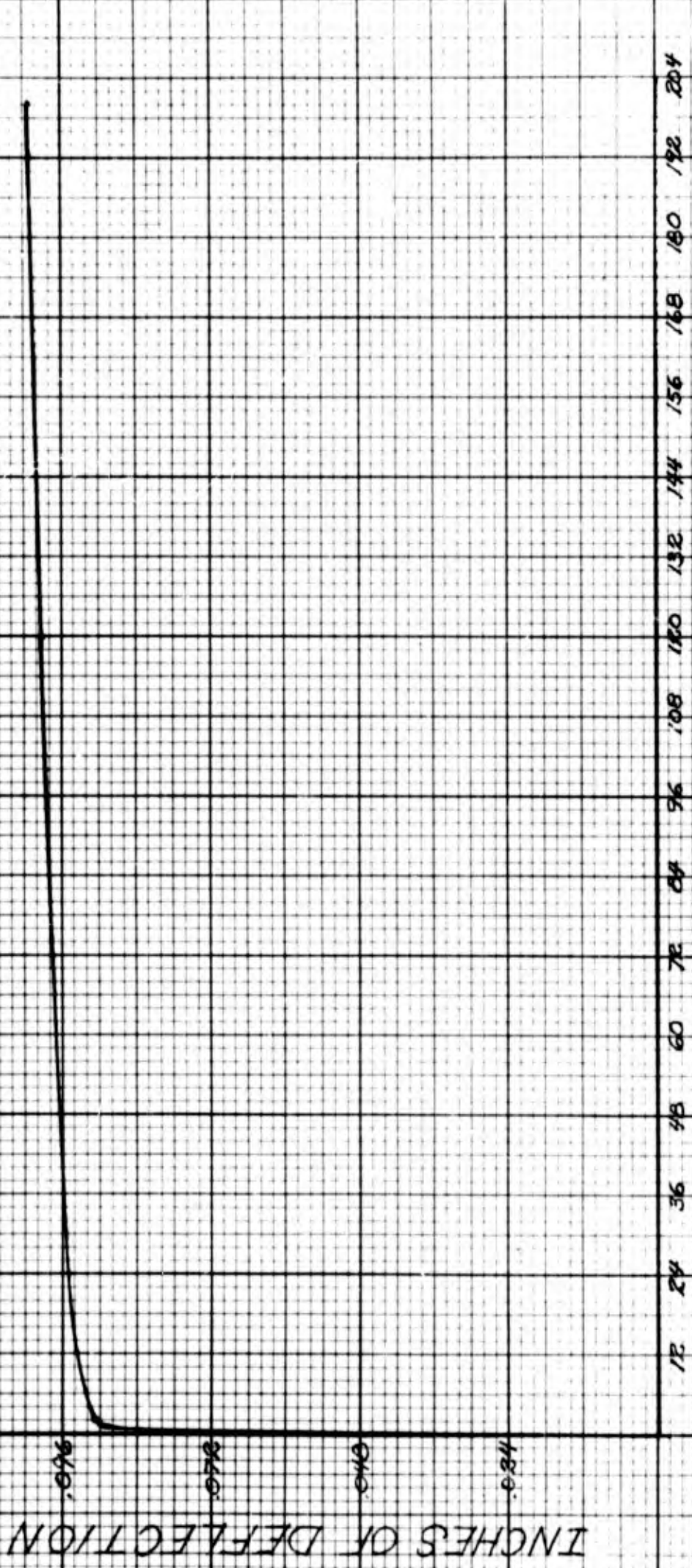
INCHES OF DEFLECTION

1R 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204
 HOURS

TEST V - TIME vs. DEFLECTION

T-366 FUZE ROTOR CREEP TEST
 ROTOR: FD 21927

TEST CONDITIONS:
 TEMPERATURE: +165°F
 LOAD: 16.5 LBS.



HOURS
 TEST IV - TIME VS. DEFLECTION

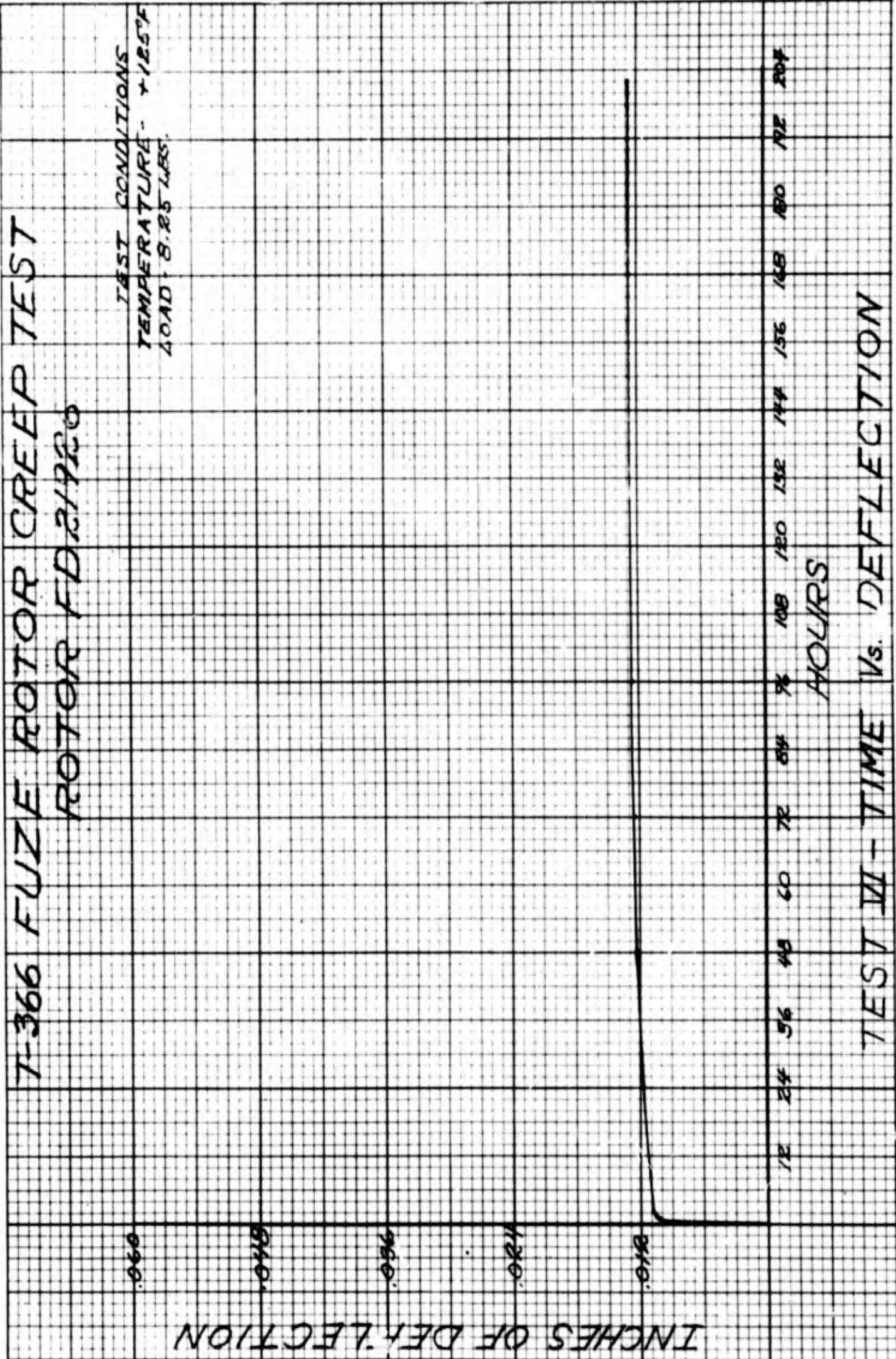
T-366 FUZE ROTOR CREEP TEST
 ROTOR FD21920

TEST CONDITIONS
 TEMPERATURE - +125°F
 LOAD - 8.25 LBS.

INCHES OF DEFLECTION

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204
 HOURS

TEST III - TIME Vs. DEFLECTION



T366 FUZE ROTOR CREEP TEST
 ROTOR FD 21927

TEST CONDITIONS
 TEMPERATURE: 765°F
 LOAD: 8.25 LBS

INCHES OF DEFLECTION

12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204

HOURS

TEST VI - TIME vs. DEFLECTION



T.366 FUZE ROTOR CREEP TEST
 ROTOR FD 21926

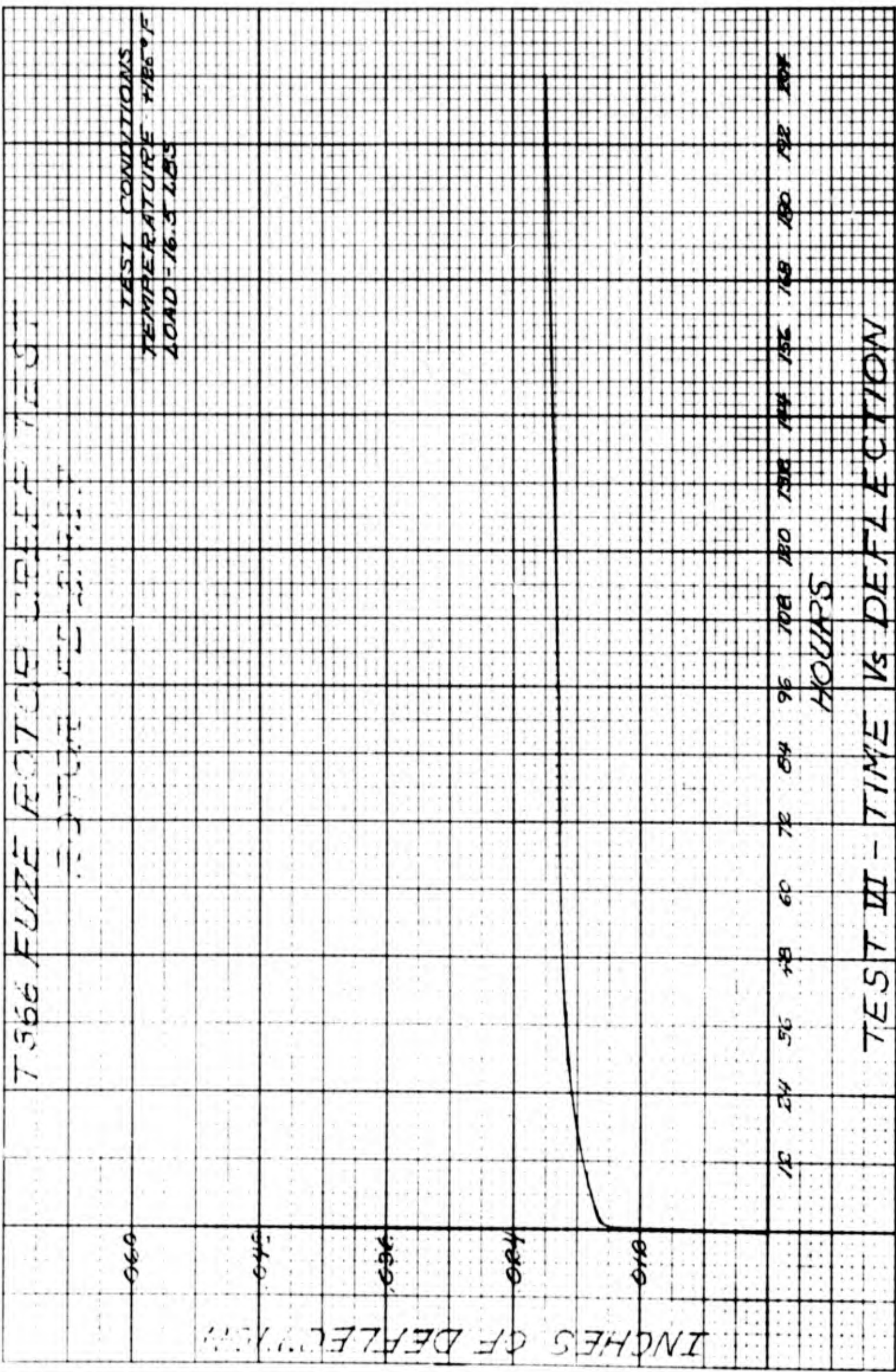
TEST CONDITIONS
 TEMPERATURE - $+185^{\circ}$
 LOAD - 16.5 LBS.

INCHES OF DEFLECTION

18 24 30 36 42 48 54 60 72 84 96 108 120 132 144 156 168 180 192 204

HOURS




TEST III - TIME VS. DEFLECTION



APPENDIX D

ROTOR - FD 21882

LEGEND

-  DEFLECTION AFTER 5 MINUTES OF TEST
-  DEFLECTION AFTER 24 HOURS OF TEST
-  CREEP FOR BALANCE OF 200 HOUR TEST

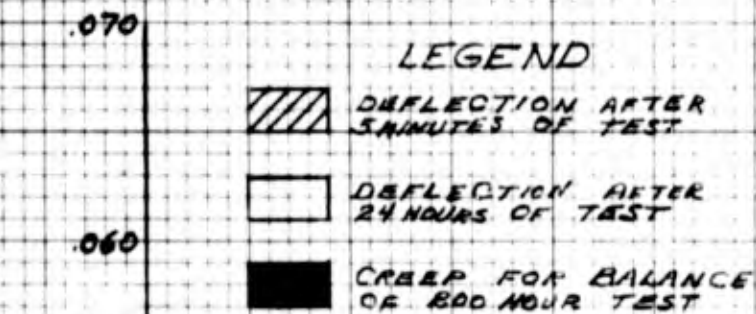
DEFLECTION - INCHES

.070
 .060
 .050
 .040
 .030
 .020
 0/0

LOAD - LBS.	8.25	8.25		8.25
TEMP - °F	-60°	+70°	+125°	+165°

BAR CHART OF TEST RESULTS

ROTOR - FD 21927



DEFLECTION - INCHES

.070
.060
.050
.040
.030
.020
.010




LOAD - LBS.
TEMP. °F

8.25	8.25	8.25	16.5	8.25	16.5
-60°	+70°	+125°	+125°	+165°	+165°

BAR CHART OF TEST RESULTS

ROTOR-FD 21926

LEGEND

-  DEFLECTION AFTER 5 MINUTES OF TEST
-  DEFLECTION AFTER 24 HOURS OF TEST
-  CREEP FOR BALANCE OF 90 HOUR TEST

DEFLECTION - INCHES

.070
.060
.050
.040
.030
.020
.010

LOAD - LBS
TEMP °F

8.25 -60°	8.25 +70°	8.25 16.5 +125°	8.25 16.5 +165°
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BAR CHART OF TEST RESULTS

ROTOR - FD 21881

LEGEND

- DEFLECTION AFTER 3 MINUTES OF TEST
- DEFLECTION AFTER 24 HOURS OF TEST
- CREEP FOR BALANCE OF 200 HOUR TEST

DEFLECTION - INCHES

.070
 .060
 .050
 .040
 .030
 .020
 .010

LOAD - LBS	8.25	8.25	8.25
TEMP °F	-60°	+70°	+165°

BAR CHART OF TEST RESULTS

APPENDIX E

