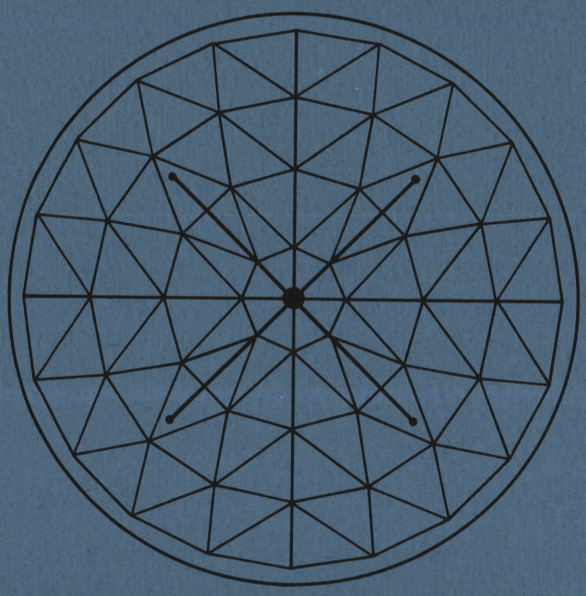

SECTION 2.0

NATIONAL RADIO ASTRONOMY OBSERVATORY
POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA 24944
TELEPHONE ARBOVALE 456-2011

PROJECT: 300 FT. DIA. HOMOLOGY TELESCOPE

SUBJECT: DYNAMIC ANALYSIS

2.0 ELEVATION BEARINGS

PREPARED BY O. R. Heine APPROVED BY _____ SUBMITTED BY S.D.L.

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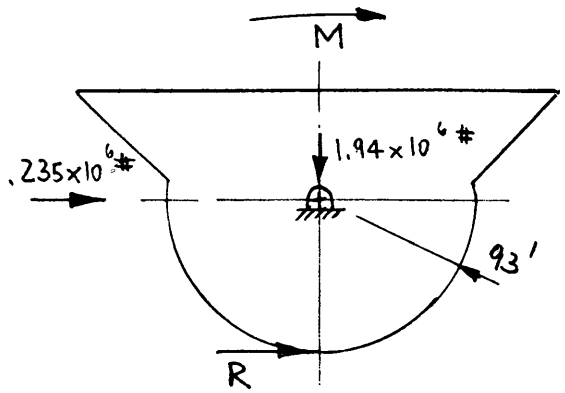
SUBJECT: ELEVATION BEARINGS

2.1 LOADS ON ELEVATION BEARINGS :

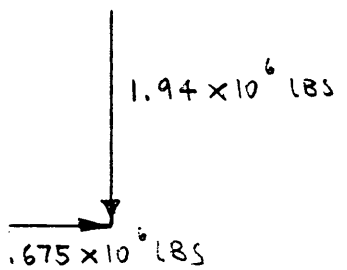
WEIGHT OF REFLECTOR ASSEMBLY	:	1280 TONS
SNOW LOAD	:	660 "
TOTAL DEAD LOAD ON BEARINGS	:	1940 TONS
WINDLOAD AT SURVIVAL CONDITION	:	235 TONS
MOMENT AT SURVIVAL CONDITION	:	81.5×10^6 FT-LBS

2.1.1 RADIAL LOAD ON BEARINGS :



$$R = \frac{81.5 \times 10^6}{2 \times 93} = .44 \times 10^6 \text{ LBS}$$

THUS MAXIMUM RADIAL LOAD ON EACH BEARING :



2.1.1 AXIAL LOAD ON BEARINGS : $.235 \times 10^6$ LBS

AND VERTICAL LOAD THEN (MAX. LOAD) : $1.94 \times 10^6 + \frac{81.5 \times 10^6}{200} = 2.35 \times 10^6$ LBS

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2.2. BEARINGS:

CONSIDER: TYPE: SPHERICAL ROLLER THRUST BEARING
MAKE: SKF, BEARING NO. 29576
B.S.L.R: 3,700,000 LBS = C_o
O.D. : 32.2835 IN
I.D. : 14.9606 "
H : 10.433 "
WEIGHT: 1816 LBS

MOUNTING ARRANGEMENT :

TWO BEARINGS OPPOSING EACH OTHER, AXIALLY PRELOADED, COINCIDING ORIGIN OF SPHERICAL CURVATURE.

MINIMUM REQU'D AXIAL PRELOAD TO TAKE IMPOSED MAX. RADIAL LOAD F_R :

$$F_A = 1.8\ F_R$$

$$F_{R_1} = \tfrac{1}{2}\sqrt{(1.94\times10^6)^2+(.675\times10^6)^2} = \underline{1.06\times10^6\ \text{LBS}}$$

$$F_{R_2} = \tfrac{1}{2}\ 2.35\times10^6 = \underline{1.175\times10^6\ \text{LBS}}\ (\text{MAX.})$$

$$F_{A\,MIN} = 1.8\times1.175\times10^6 \cong \underline{2.12\times10^6\ \text{LBS}}$$

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EQUIVALENT LOAD, $P = 1.2 F_R + F_A$

$= 1.2 \times 1.175 \times 10^6 + 2.12 \times 10^6$

$P = \underline{3.53 \times 10^6 \text{ LBS}}$ V.S. 3.7×10^6 B.S.L.R. OK

BASIC DYNAMIC LOAD RATING, $C = \underline{1.61 \times 10^6 \text{ LBS}}$

$\frac{C}{P} = \frac{1.61 \times 10^6}{3.53 \times 10^6} = \underline{.457}$

SPEED : $6.3^\circ/\text{MIN} = \underline{1.05 \text{ RPH}}$

$\text{LIFE} = \left(\frac{C}{P}\right)^{3.33} \times 10^6 = .457^{3.33} \times 10^6 = \underline{.073 \times 10^6 \text{ REV.}}$

$L = \frac{.073 \times 10^6}{1.05} = \underline{70{,}000 \text{ HRS (OK)}}$

BEARINGS ARE ADEQUATELY SIZED!

MINIMUM AXIAL PRELOAD REQUIRED : 2.12×10^6 LBS

USE : $\underline{2.20 \times 10^6 \text{ LBS}}$

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DATE JUNE 1969

PROJECT: 300 FT. DIA. HOMOLOGY TELESCOPE

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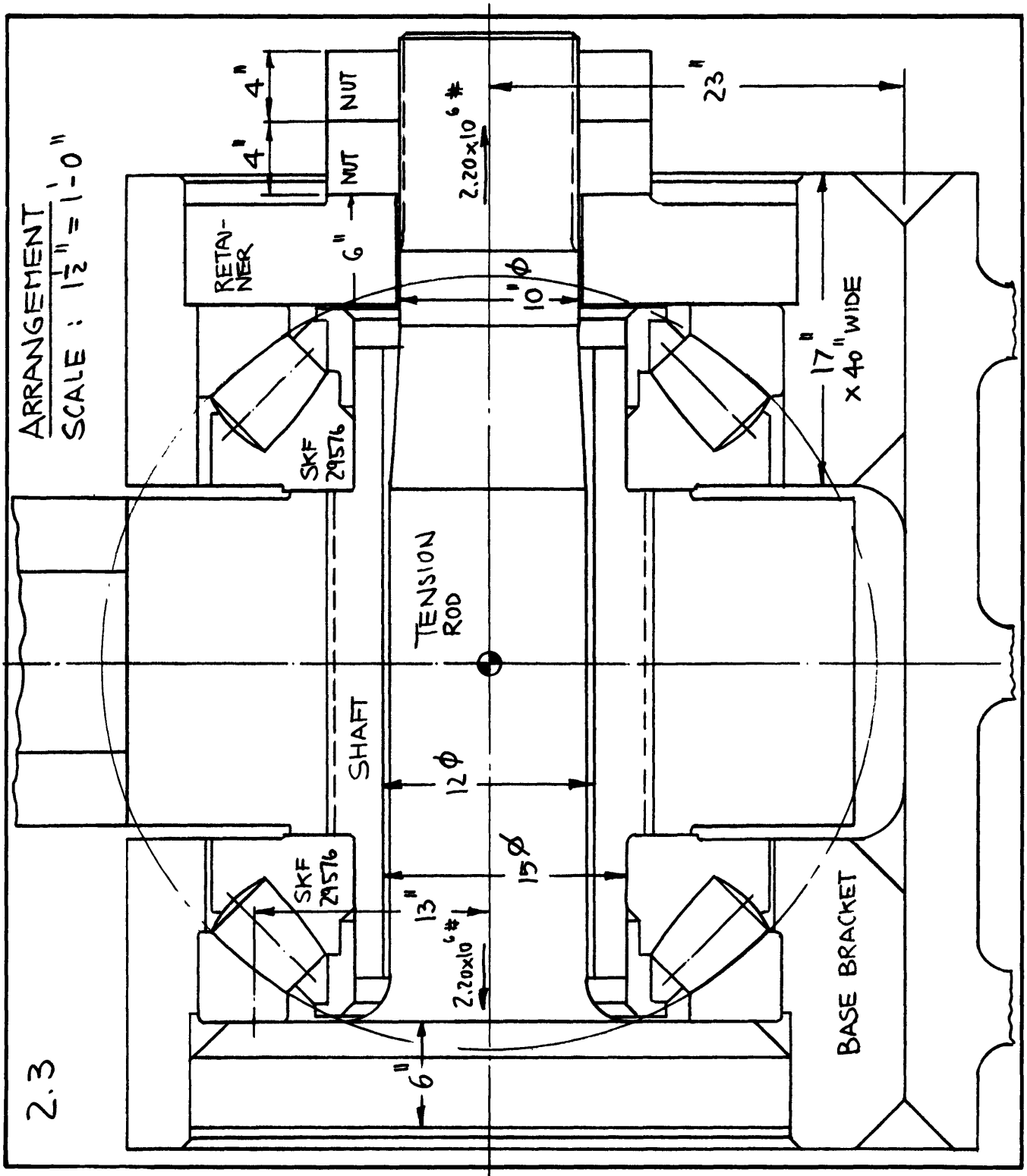

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CHECK BASIC DIMENSIONS: (ROUGH CHECK ONLY)

1. TENSION ROD: (TENSION)

$$S_{T\,MAX} = \frac{F_{A\,MAX}}{A_{MIN}} = \frac{2.2\times10^{6}}{\left(\frac{10^{2}\pi}{4}\right)} = \underline{28{,}000\ ^{LBS}/_{IN^2}\ (OK)}$$

2. NUTS: (SHEAR)

$$S_{S.} = \frac{2.2\times10^{6}}{10\pi\times4} = \underline{17{,}600\ ^{LBS}/_{IN^2}\ (OK)}$$

3. BASE BRACKET: (BENDING)

$$M_{B\,MAX} = 2.2\times10^{6}\times23 = \underline{50.5\times10^{6}\ IN\,LBS}$$

$$Z = \frac{bh^{2}}{6} = \frac{40\times17^{2}}{6} = \underline{1.93\times10^{3}\ IN^{3}}$$

$$S_{B\,MAX} = \frac{M_{B\,MAX}}{Z} = \frac{50.5\times10^{6}}{1.93\times10^{3}} = \underline{26{,}000\ ^{LBS}/_{IN^2}\ (OK)}$$

4. SHAFT: (SHEAR)

$$S_S = \frac{2.35\times10^{6}}{2\left(\frac{15^{2}\pi}{4} - \frac{12^{2}\pi}{4}\right)} = \frac{2.35\times10^{6}}{128} = \underline{17{,}400\ ^{LBS}/_{IN^2}\ (OK)}$$

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5. RETAINER :

$$S_{T MAX} = S_{R MAX} = -\frac{3\,FA}{2\pi m t^2}\left[\frac{1}{2}(m-1)+(m+1)\log\left[\frac{a}{R_0}\right]-(m-1)\frac{R_0^2}{2a^2}\right]$$

$$m = \frac{1}{\gamma} = \frac{1}{.25} = 4.0$$

$t = 6.0$ IN
$R_0 = 5.5$ IN
$a = 13.0$ IN

$$S_{T MAX} = \frac{-3\times 2.2\times 10^6}{2\pi 4\, 6^2}\left[\frac{1}{2}(4-1)+(4+1)\log\left(\frac{13}{5.5}\right)-(4-1)\frac{5.5^2}{2\times 13^2}\right]$$

$$= -7.3\times 10^3\left[1.5 + 5\log 2.37 - (3)\frac{30.2}{338}\right]$$

$$= -7.3\times 10^3\left[1.5 + 4.3 - .3\right]$$

$$= -7.3\times 10^3 \times 5.5 = -\frac{40{,}000\ \text{LBS/IN}^2}{(\text{OK})}$$

NOTE : HIGH STRENGTH MATERIAL REQUIRED THROUGHOUT.
BASE SHOULD PREFEABLY BE A STEEL-CASTING !

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2.4. WEIGHT ESTIMATE: (TAKE OFF FROM DRAWINGS)

ITEM DESCRIPTION	NO. REQ'D	UNIT WEIGHT (LBS)	TOTAL WEIGHT (LBS)
1. HOUSING	2	3,700	7,400
2. BRACKET	1	9,600	9,600
3. BASE	1	9,000	9,000
4. SHAFT / TENSION ROD	1	7,000	7,000
5. MISCALL		3,000	3,000

TOTAL WEIGHT OF BEARING ASSEMBLY EXCLUSIVE BEARINGS, EACH 36,000 LBS

2.5 COST ESTIMATE:

1. BEARING ASSEMBLY, MACHINED PARTS 36,000 LBS @ $1.- : $ 36,000.-
2. BEARINGS SKF 29576, 3632 LBS @ $4.- ≈ : 14,000.-

TOTAL COST PER UNIT $ 50,000.-

FOR TWO UNITS $ 100,000.-

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