F5 Slide Show

6MV EN Tandem Column Decompression

GNS Sciences

Lower Hutt
New Zealand

Tandem Accelerator

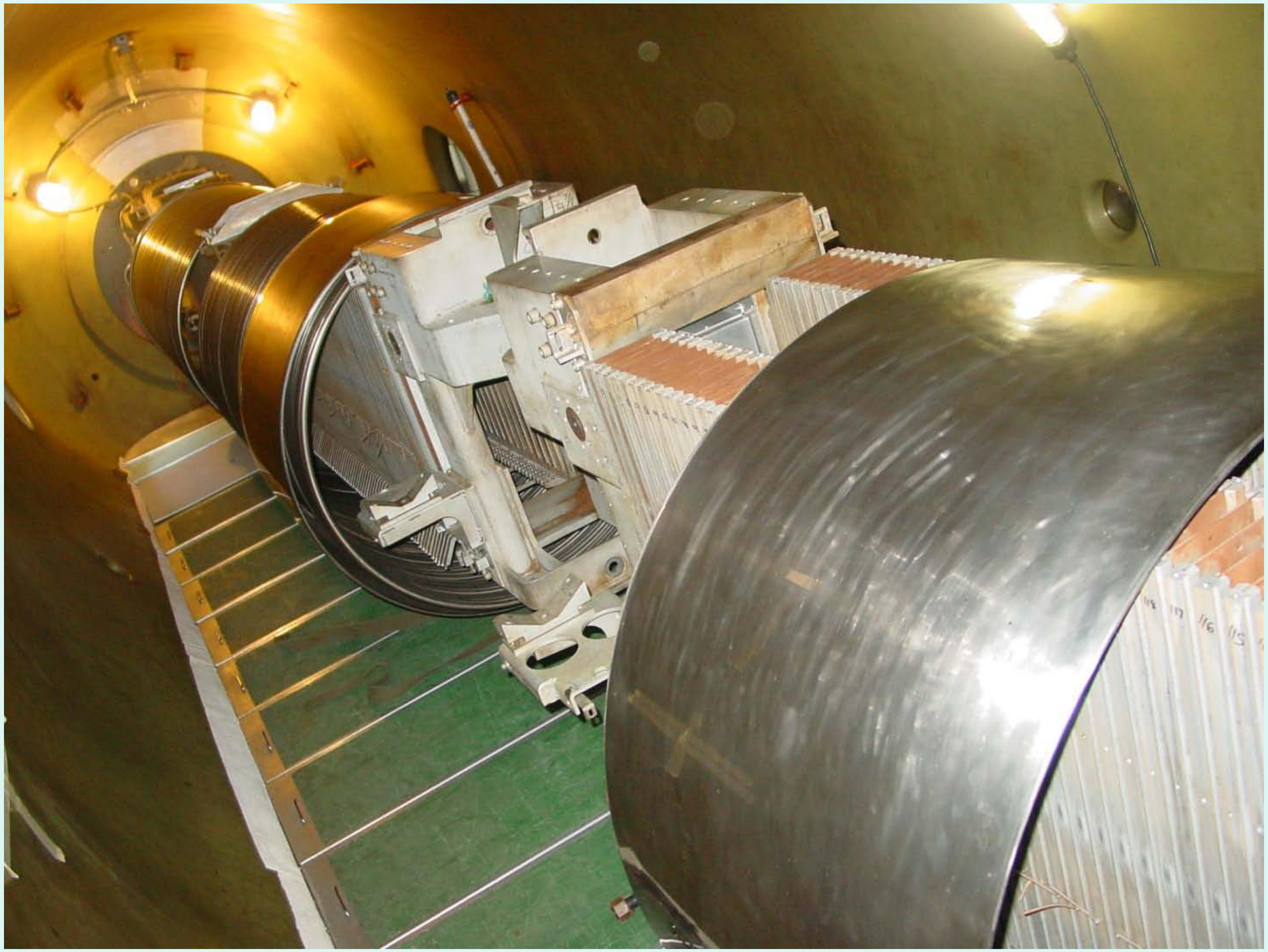
- The 6MV EN Tandem Accelerator (number EN 5) was purchased secondhand from ANU in 1980.
- It was built in 1959 and used very successfully at ANU for many years.
- A new building was build at Lower Hutt to house this machine in 1981-82
- An in-house (Chapman based) Cs sputter ion source was built at the same time.
- Finally the Tandem was re-commissioned as an AMS Radiocarbon dating machine in 1985.

EN 5 Tandem

- In 2009 after mounting maintenance costs GNS management decided to invest in a new 500kV Tandem CAMS machine from NEC.
- However, this was on the condition that the old machine be disposed off.
- For the decompression of the columns, it was decided to do this very carefully in case they needed to be recompressed at a different location in the future.
- Searching in the attic, some interesting pieces of equipment were found and after figuring out how to use these the process of decompression could be started.

- The procedure about to be described is after other components had been removed from inside the Tank including the Charging system, Column resistors, and Accelerator tubes.

Splitting the Terminal Spinning




ALT'R
4 7/8"
WHEN
PROPERLY
SEATED
V.A.C.
BELT


L.E. Terminal
Bottom


300 TO 600
L.E. Term
Left

Column support Rods

Rod Details For EN Tandem.doc [Compatibility Mode] - Microsoft Word

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Rod Details For EN Tandem

Length	Description	Thread
82”	H.E. Base end (Rt. side)	Left Hand
82”	H.E. Base end (Lt. side)	Left Hand
94.25”	L.E. Base end (Rt. side)	Left Hand
94.25”	L.E. Base end (Lt. side)	Left Hand
99”	H.E. Terminal (Rt. side)	Right Hand
99”	H.E. Terminal (Lt. side)	Right Hand
99”	L.E. Terminal (Rt. side)	Right Hand
99”	L.E. Terminal (Lt. side)	Right Hand

Page: 1 of 1 Words: 68 English (New Zealand) 130%

Start MyReminder.erfx - Effici... Chris Purcell - Inbox - IB... LOWER HUTT EN Decom... Rod Details For EN Ta... EN 5:28 p.m.

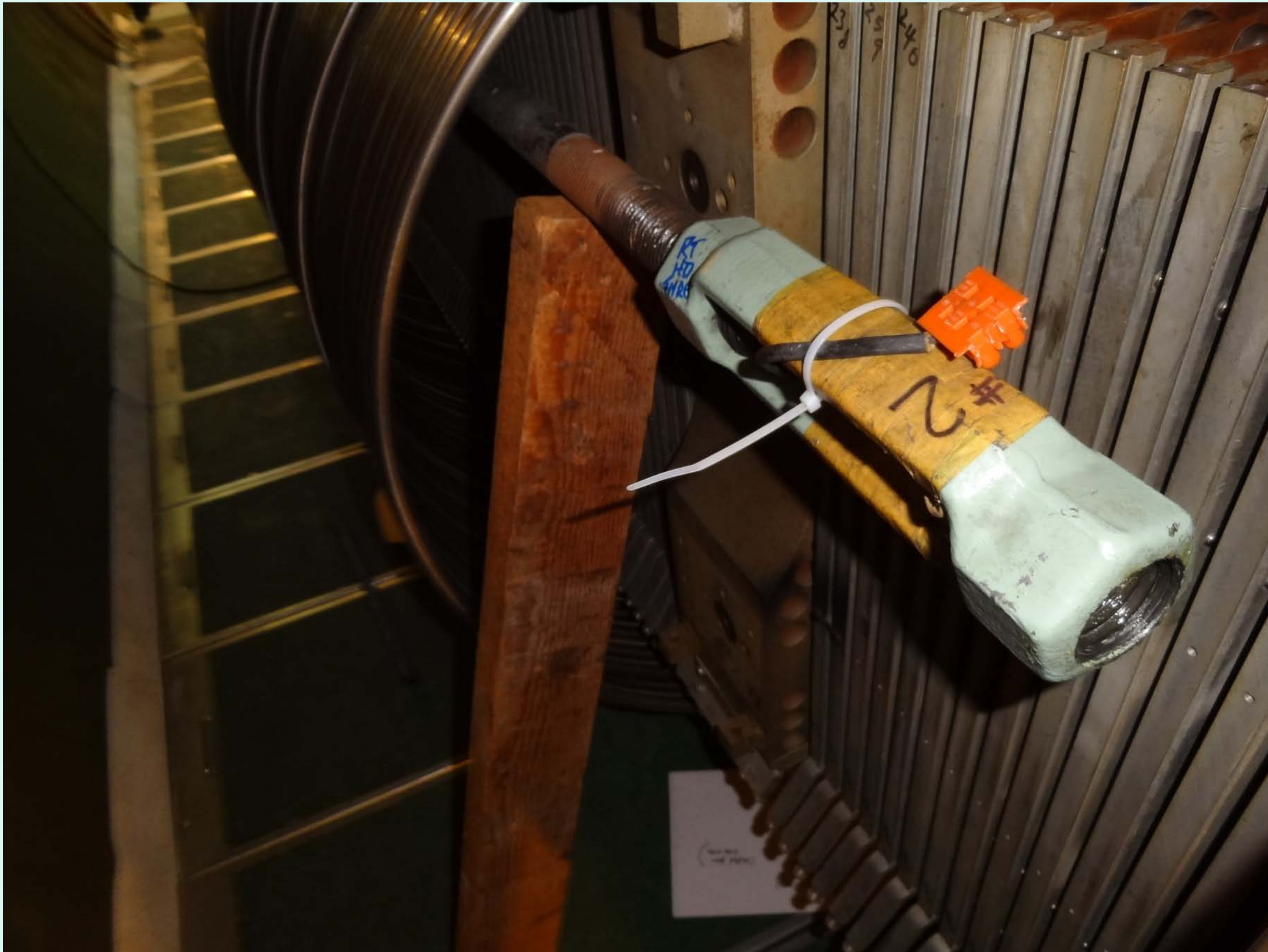
H.E. Rod Attachment is Inside The Tank


HE BASE
Right

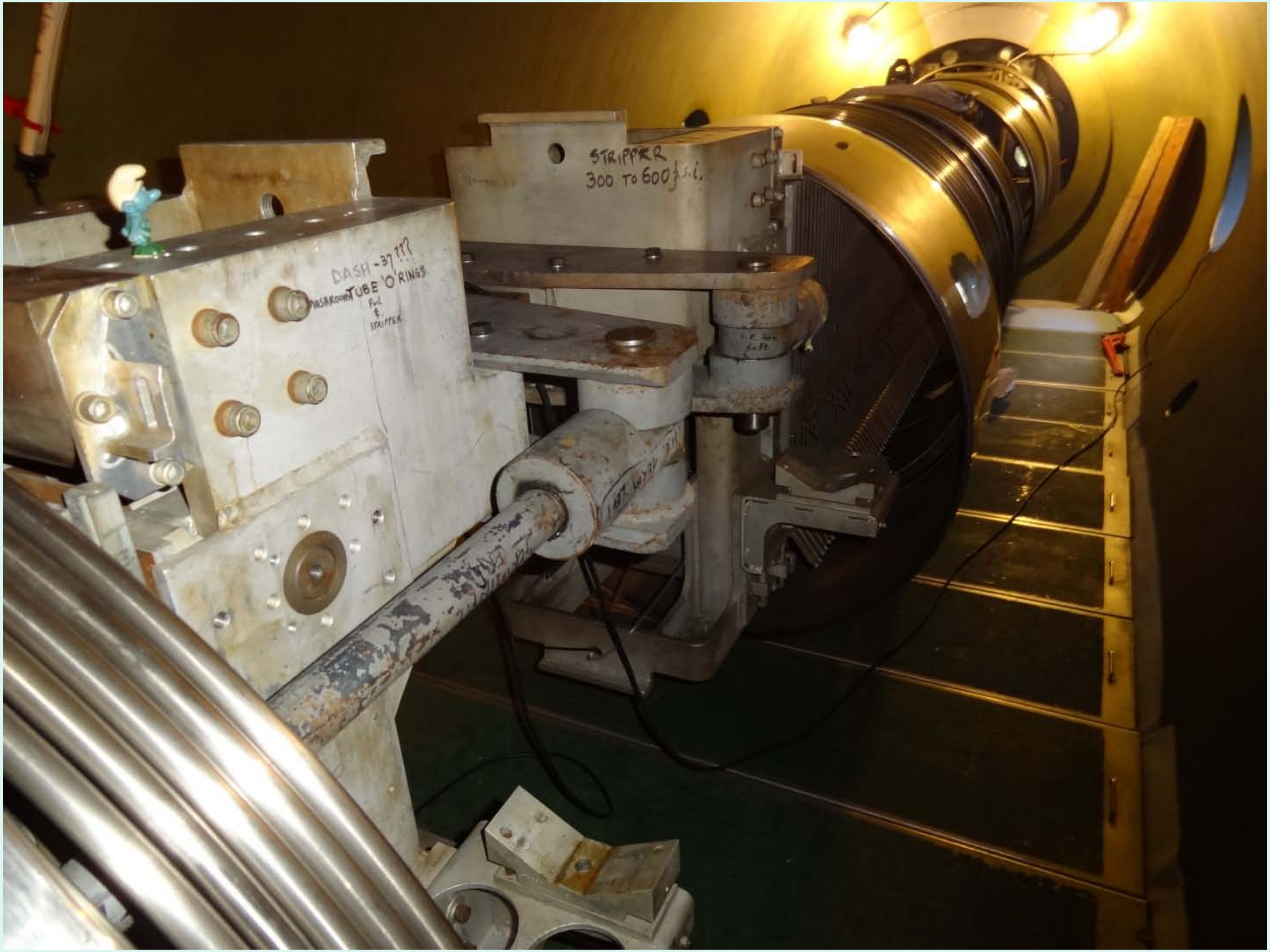
Fulcrum Blocks


HE

Strain Gauges cemented to the Turnbuckles

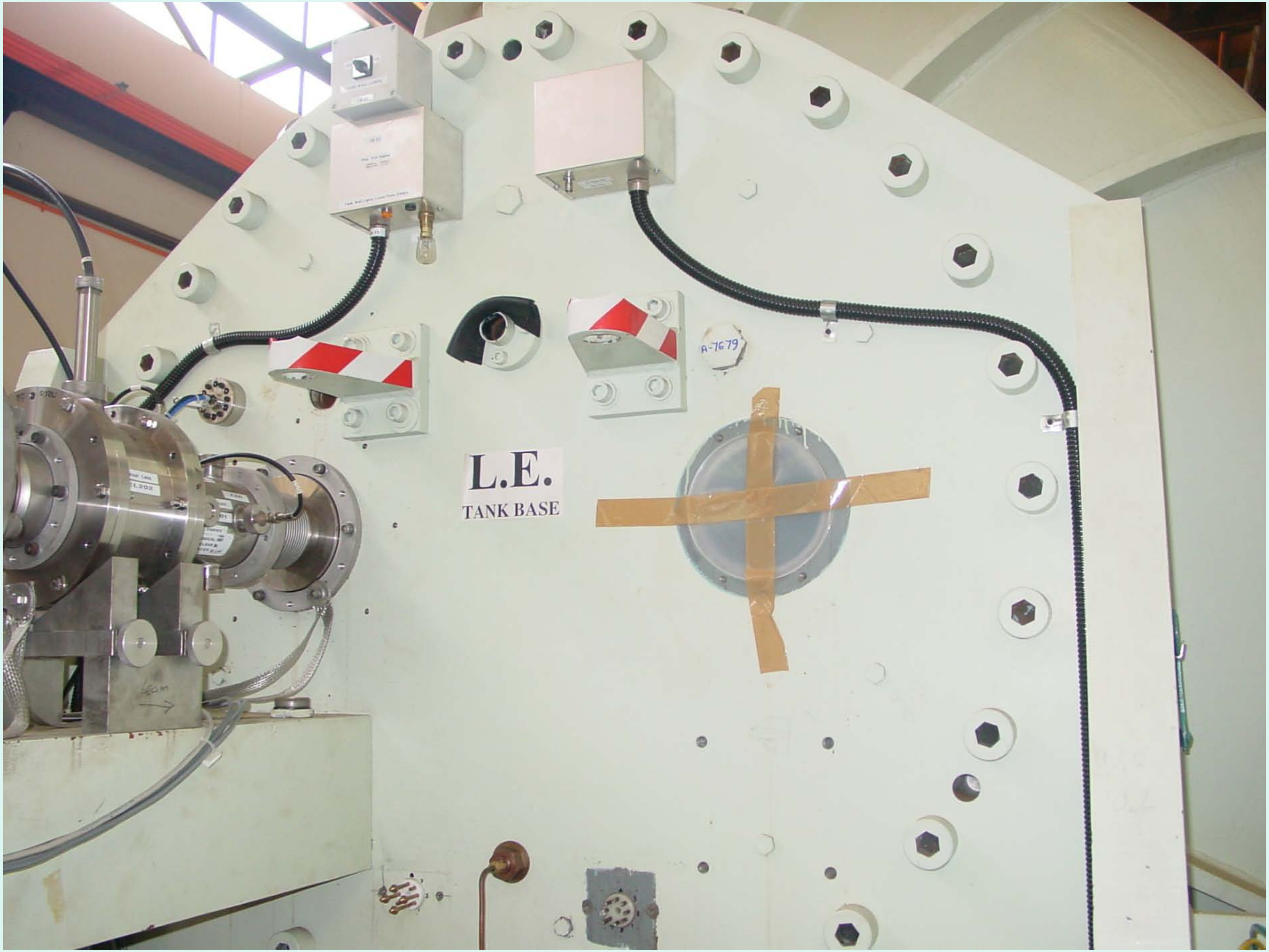


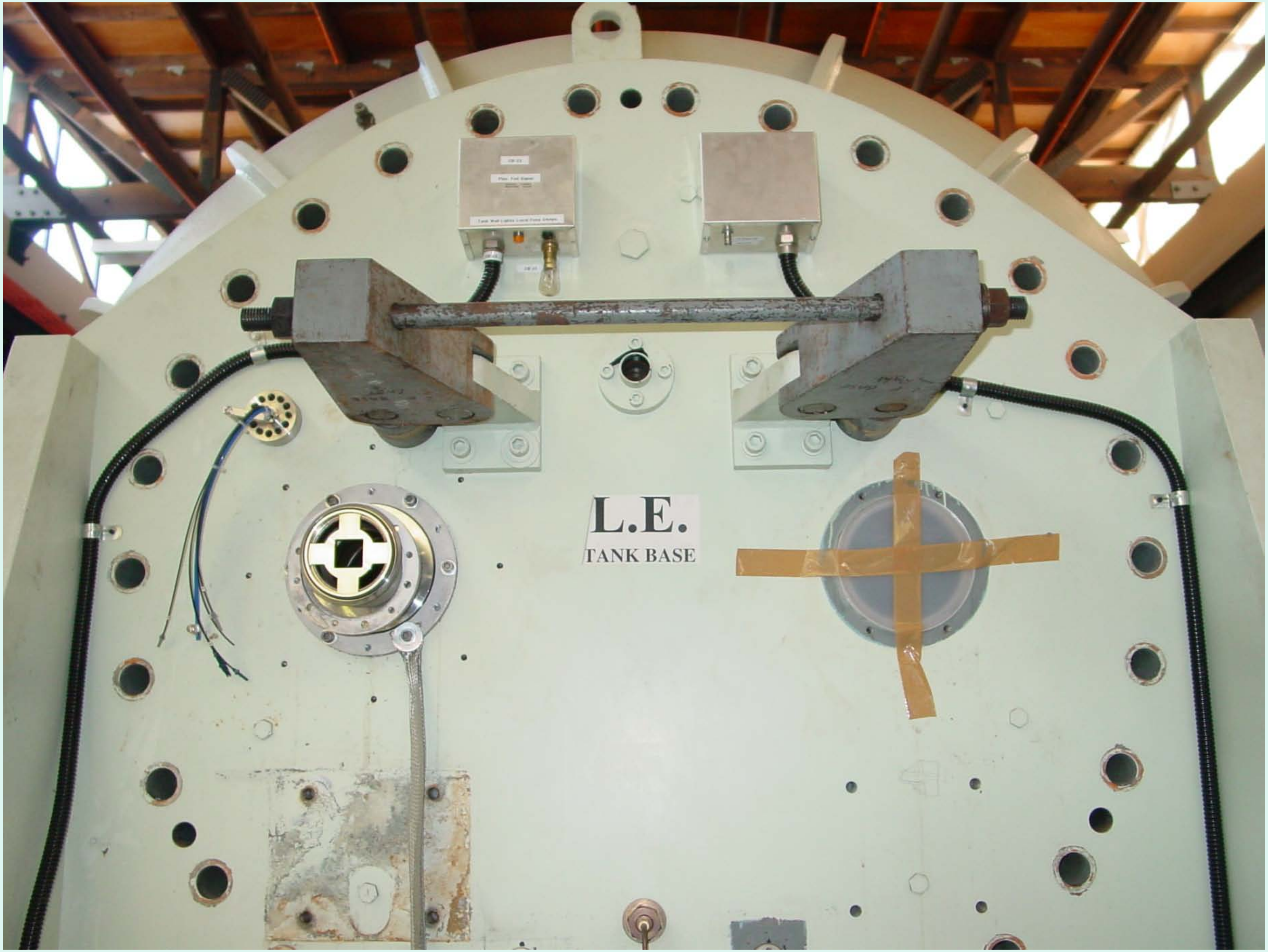

#2
Right

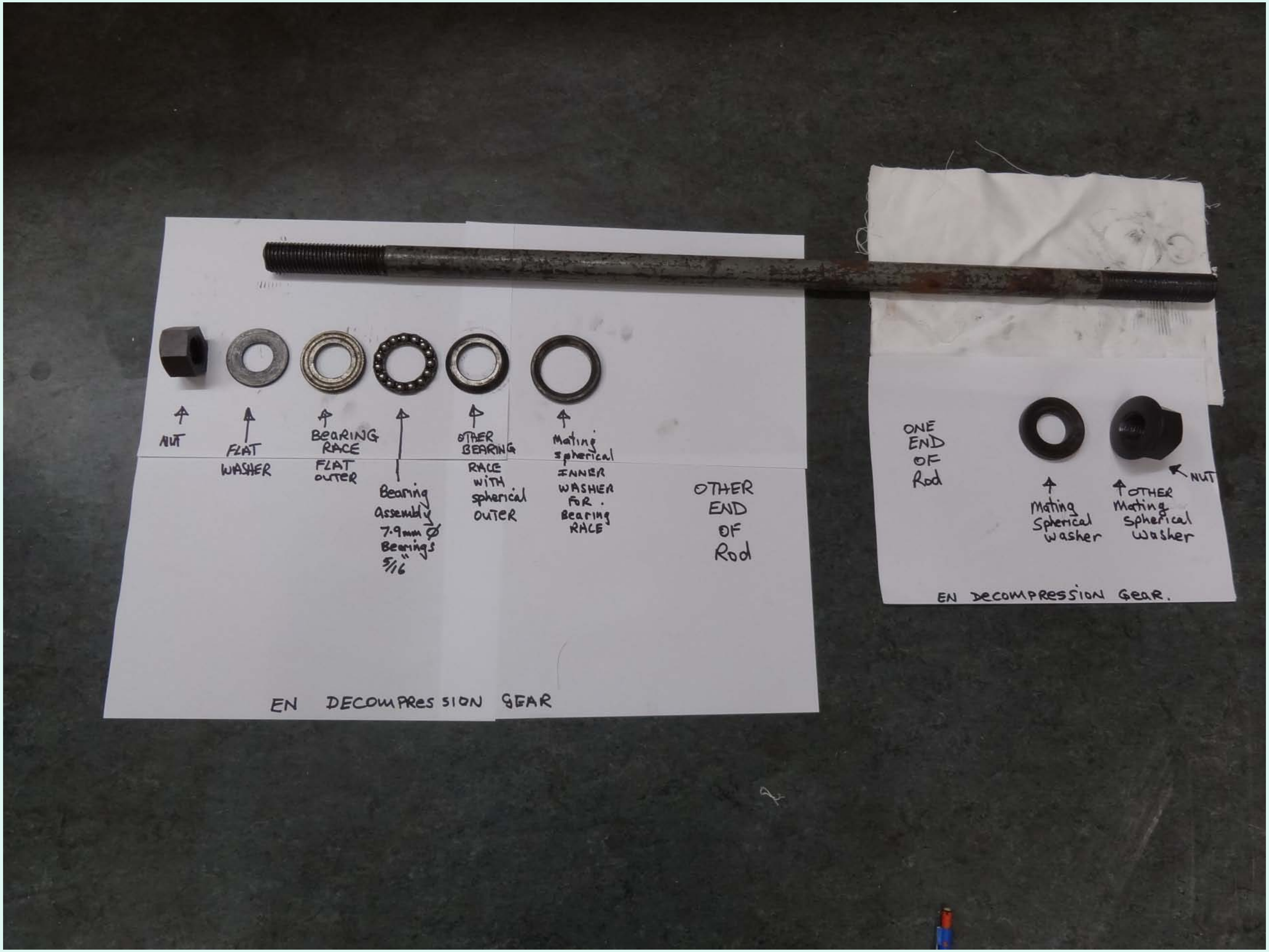

STRIPPER
300 TO 600 p.s.i.
DASH -37???
TUBE 'O' RINGS

Initial setting of The Rods

L.E. Rod Passes through End Tank Wall and the process is repeated


L.E.
TANK BASE
A-7679


L.E.
TANK BASE

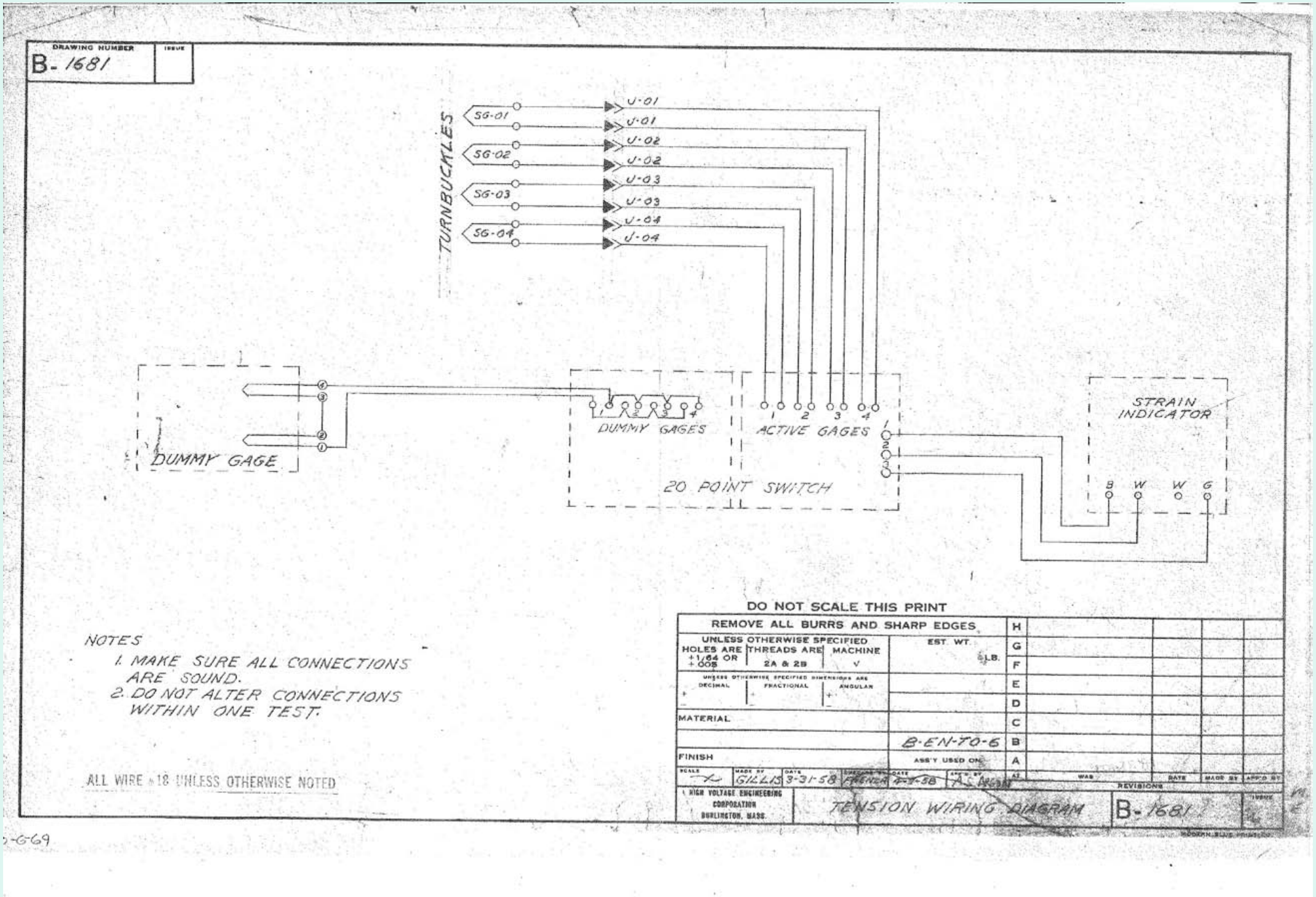

NUT
FLAT WASHER
BEARING RACE FLAT OUTER
Bearing assembly 7.9mm Ø Bearings 5/16"
OTHER BEARING RACE WITH spherical OUTER
Mating spherical INNER WASHER FOR Bearing RACE
OTHER END OF Rod
EN DECOMPRESSION GEAR
ONE END OF Rod
Mating Spherical washer
OTHER Mating Spherical washer
NUT
EN DECOMPRESSION GEAR.

- Long cables are connected to the four strain gauges attached to column rod turnbuckles and these cables are taken outside the Tank.
- These are then individually wired up to the <u>20 Point Switch Box.</u>
- As well, the compensating dummy gauge is attached to this Switch Box on the opposite side.
- Then the <u>Strain Indicator</u> is connected to the Switch Box .

Strain Gauge Switching Box

Strain Indicator

Wiring up Strain Gauges

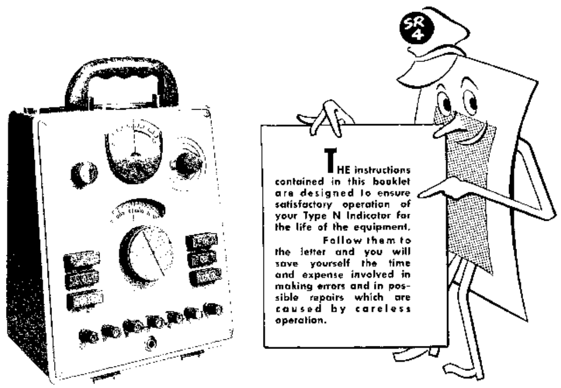


BALDWIN
INSTRUCTION BOOK

P 7507

SR-4®

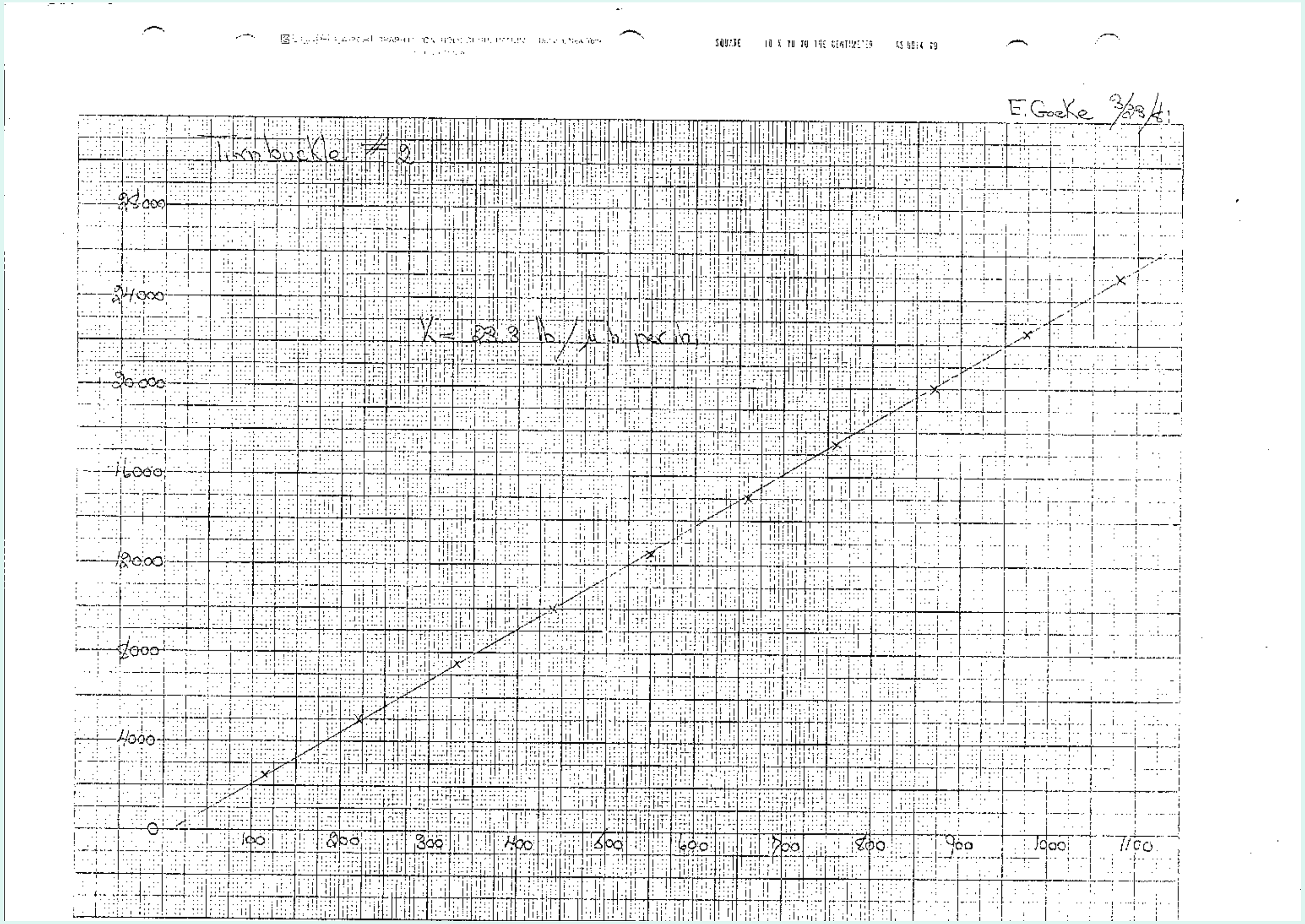
TYPE N PORTABLE STRAIN INDICATOR



BALDWIN-LIMA-HAMILTON

- The Strain Indicator measures microinches per inch. This has to be converted into pounds force.
- Each Turnbuckle strain gauge has its own calibration graph to convert the strain indicator reading.

Each Strain Gauge has its own calibration graph



- We used the slope given for each calibration graph into our own Excel spreadsheet.
- The slope k for our four strain gauges are:
- 1) For #11,   k = 24.25 µinches per inch
- 2) For #09,   k = 23.90 µinches per inch
- 3) For #01,   k = 23.90 µinches per inch
- 4) For #02,   k = 23.30 µinches per inch

Strain Gauge Formula

- Strain is in µinches per inch
- Strain = X + (T2 – T1)*1,000 + (D2 – D1)
- X = Extender range
- T2 = Final Thousands step number
- T1 = Initial Thousands step number
- D2 = Final Dial Number
- D1 = Initial Dial Number


RANGE
THOUSANDS
RENEW BATTERIES
GAGE FACTOR
MICROINCHES PER INCH
RANGE EXTENDER
+20
0
-20
POWER
ON
OFF
CHECK
LIMA HAMILTON

- The Load across the whole Tank/Column is 38,000lb before the decompression procedure
- The end goal is that each rolled out Tank Column has 38,000lbs applied across the added support rods.
- Since there is one rod on each side of each column structure, therefore the final load on each individual rod turnbuckle is 19,000lbs

- Procedure:
- Measure the strain gauge with no load. These are then the reference readings
- The Tank HE Spring reads 222 turns which represents the 38,000lbs of compression on the complete column structure
- So the idea is to reduce this 38,000lbs by ~10% (from 222 turns to ~ 201 turns)
- Then increase the Rods tension by 10% so each strain gauge reads ~10% of 19,000lbs

- The spreadsheet is used to determine what strain to apply
- Then adjust the L.E. Rod Nut until the Right hand Strain indicator reads this value. Then check the strain gauge reading on the opposite left side to check the force is being applied evenly on both sides of the L.E. end.
- Repeat this with the H.E. end Rod nut and Strain gauges.

Strain Gauge Measuring

- Now this whole procedure is repeated by reducing the Tank compression by another 10% and then increasing the Tension on the Rods by 10%
- This process is continued in 10% steps till the Tank compression is zero
- Hence the total Tension across the two Rods on each Column will then be 38,000Lbs (hence each Column is still under a compression of 38,000Lbs)

Tensioning H.E. End

Tensioning L.E. end

Releasing Column Spring

Column Tension Counter

Strain Calculation Turnbuckle #11

Slope K=24.25 Lb/microinch per inch

Using HE Spring adjuster to Reduce Column Pressure EN Tank counter	Therefore required increase in each side Rod's Pressure LB's Load to apply to each Strain Gauge		µinch/inch strain required	Calculated D2 required	Reading You Set range	thousands	dial	X	(T2-T1) * 1000	D2-D1	strain	Set Load lbs	% of full
222					0	14	45.00						
200	1,900		78.35	**123.35**	0	14	123.35	0	0	78.35	78.35	**1,900**	10%
178	3,800		156.70	**201.70**	0	14	201.70	0	0	156.70	156.70	**3,800**	20%
155	5,700		235.05	**280.05**	0	14	280.05	0	0	235.05	235.05	**5,700**	30%
133	7,600		313.40	**358.40**	0	14	358.40	0	0	313.40	313.40	**7,600**	40%
111	9,500		391.75	**436.75**	0	14	436.75	0	0	391.75	391.75	**9,500**	50%
89	11,400		470.10	**515.10**	0	14	515.10	0	0	470.10	470.10	**11,400**	60%
67	13,300		548.45	**593.45**	0	14	593.45	0	0	548.45	548.45	**13,300**	70%
44	15,200		626.80	**671.80**	0	14	671.80	0	0	626.80	626.80	**15,200**	80%
22	17,100		705.15	**750.15**	0	14	750.15	0	0	705.15	705.15	**17,100**	90%
0	19,000		783.51	**828.51**	0	14	828.51	0	0	783.51	783.51	**19,000**	100%

Procedure:

D1 = 45 microinches/inch Initial (off set)

For this L.E. Turnbuckle, "Adjust L.E. Rod Nut" so that Strain Indictor Dial (column H) reads calculated D2 figure in column E

Strain is in microinches/inch

Strain = X + (T2 - T1)*1000 + (D2 - D1

T = Thousands Switch. - Each step shifts the reference point of the balancing Dial by 2000 microinch per inch. T1 is initial and T2 is final.

D = Balancing Dial. - Use the Dial to bring the Meter pointer to zero. D1 is initial Dial reading and D2 is final REQUIRED Dial reading (col E)

In this case, **D2 = (Strain required) + (D1)**

(because Strain = D2 - D1)

Strain Gauge: Resistance wire strain gauge with intial resistance of 120 ohms

Col B / 24.25 = Col D

Col D + D1 = Col E

LE_right_ No1 Turnbuckle #11 | LE left No2 Turnbuckle #9 | HE left No3 Turnbuckle #1 | HE right No4 Turnbuckle #2

Strain Calculation Turnbuckle #9

Slope K=23.9 Lb/microinch per inch

Using HE Spring adjuster to Reduce Column Pressure	Therefore required increase in each side Rod's Pressure		µinch/inch		Reading ACTUALLY Measured						Actual D2 - D1	Actual	
EN Tank counter	LB's Load to apply to each Strain Gauge		strain required	D2 required	range	thousands	dial	X	(T2-T1) * 1000	D2-D1	strain	Load lbs	% of full
222					0	12	1005						
200	1,900		79	1084	0	12	1090	0	0	85	85	2,032	11%
178	3,800		159	1164	0	12	1163	0	0	158	158	3,776	20%
155	5,700		238	1243	0	12	1245	0	0	240	240	5,736	30%
133	7,600		318	1323	0	12	1320	0	0	315	315	7,529	40%
111	9,500		397	1402	0	12	1390	0	0	385	385	9,202	48%
89	11,400		477	1482	0	12	1461	0	0	456	456	10,898	57%
67	13,300		556	1561	0	12	1540	0	0	535	535	12,787	67%
44	15,200		636	1641	0	12	1630	0	0	625	625	14,938	79%
22	17,100		715	1720	0	12	1715	0	0	710	710	16,969	89%
0	19,000		795	1800	0	12	1790	0	0	785	785	18,762	99%

D1 = 1005 microinches/inch Initial (off set)

For this L.E. Turnbuckle, just read off what Stain Indicator reads and fill in Column H. This is a check that rods are not binding.

Should be similar Load in Lbs to other L.E. Turnbuckle that you set with Nut

Strain is in microinches/inch

Strain = X + (T2 - T1)*1000 + (D2 - D1)

In this case **Strain = D2 - D1**

Col B / 23.9 = Col D

Col D + D1 = Col E

LE right No1 Turnbuckle #11 | LE_left No2 Turnbuckle #9 | HE left No3 Turnbuckle #1 | HE right No4 Turnbuckle #2

Strain Calculation Turnbuckle #1

Slope K=23.9 Lb/microinch per inch

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Using HE Spring adjuster to	Therefore required												
Reduce Column Pressure	increase in each side Rod's Pressure		µinch/inch	Calculated	Reading You Set							Set	
EN Tank counter	LB's Load to apply to each Strain Gauge		strain required	D2 required	range	thousands	dial	X	(T2-T1) * 1000	D2-D1	strain	Load lbs	% of full
222					0	14	548.00						
200	1900		79.50	627.50	0	14	627.50	0	0	79.50	79.50	1900	10%
178	3800		159.00	707.00	0	14	707.00	0	0	159.00	159.00	3800	20%
155	5700		238.49	786.49	0	14	786.49	0	0	238.49	238.49	5700	30%
133	7600		317.99	865.99	0	14	865.99	0	0	317.99	317.99	7600	40%
111	9500		397.49	945.49	0	14	945.49	0	0	397.49	397.49	9500	50%
89	11400		476.99	1024.99	0	14	1024.99	0	0	476.99	476.99	11400	60%
67	13300		556.49	1104.49	0	14	1104.49	0	0	556.49	556.49	13300	70%
44	15200		635.98	1183.98	0	14	1183.98	0	0	635.98	635.98	15200	80%
22	17100		715.48	1263.48	0	14	1263.48	0	0	715.48	715.48	17100	90%
0	19000		794.98	1342.98	0	14	1342.98	0	0	794.98	794.98	19000	100%

Procedure:

D1 = 548 microinches/inch Initial (off set)

For this H.E. Turnbuckle, "Adjust H.E. Rod Nut" so that Strain Indictor Dial (column H) reads calculated figure in column E

Strain is in microinches/inch

Strain = X + (T2 - T1)*1000 + (D2 - D1)

LE right No1 Turnbuckle #11 | LE left No2 Turnbuckle #9 | HE_left No3 Turnbuckle #1 | HE right No4 Turnbuckle #2

Strain Calculation Turnbuckle #2

Slope K=23.3 Lb/microinch per inch

Using HE Spring adjuster to Reduce Column Pressure	Therefore required increase in each side Rod's Pressure		µinch/inch		Reading ACTUALLY Measured							Actual	
EN Tank counter	LB's Load to apply to each Strain Gauge		strain required	D2 required	range	thousands	dial	X	(T2-T1) * 1000	D2-D1	strain	Load lbs	% of full
222					0	12	1850						
200	1900		82	1932	0	12	1930	0	0	80	80	1864	10%
178	3800		163	13	0	14	17	0	2000	-1833	167	3891	20%
155	5700		245	95	0	14	100	0	2000	-1750	250	5825	31%
133	7600		326	176	0	14	185	0	2000	-1665	335	7806	41%
111	9500		408	258	0	14	260	0	2000	-1590	410	9553	50%
89	11400		489	339	0	14	350	0	2000	-1500	500	11650	61%
67	13300		571	421	0	14	430	0	2000	-1420	580	13514	71%
44	15200		652	502	0	14	500	0	2000	-1350	650	15145	80%
22	17100		734	584	0	14	610	0	2000	-1240	760	17708	93%
0	19000		815	665	0	14	700	0	2000	-1150	850	19805	104%

D1 = 1850 microinches/inch Initial (off set)

For this H.E. Turnbuckle, just read off what Stain Indicator reads and fill in Column H. This is a check that rods not binding.

Should similar Load in Lbs to other H.E. Turnbuckle that you set with Nut

Strain is in microinches/inch

Strain = X + (T2 - T1)*1000 + (D2 - D1)

In this case, Strain = D2 - D1

LE right No1 Turnbuckle #11 | LE left No2 Turnbuckle #9 | HE left No3 Turnbuckle #1 | HE_right No4 Turnbuckle #2

- Next remove the Tank base bolts at both the L.E. and H.E. ends
- Then place a jack in the terminal to assist with splitting the columns a couple of millimeters and catch the metal compression block as it falls out.
- Use the ratchet on the High Energy Carriage wheels to roll the H.E. end out.

Undoing Very Tight End Bolts

The Column Compression Block in the centre of the Terminal

A little Persuasion to split the Columns Apart

And the compression block becomes free

Time to clear the Mortar out of the Rail Tracks

Rollin, Rollin, Rollin

Fully Out

Then
Safety
Supports
added

That’s It.

Ready for next stage

Issues experienced.

- After all the Tank bolts were removed and we tried to roll H.E. carriage/column structure out of the Tank, its wheels just spun around and we could not move it out.
- We then discovered that the carriage wheels were not quite siting on its rails (a few millimetres gap)
- So we concluded that originally after the installation of the Tandem was completed, the Tank must have been raised slightly on its pedestals during the beamline alignment procedure.
- Hence with the Tank bolts now removed we had the H.E. carriage suspended on the 3 Tank dowel pins

- We then very loosely reinstalled 3 Tank bolts for safety and attempted to adjust the carriage height so the wheels were in contact with the rail.
- However, these three safety bolts lead to further problems as they would bind too easily.
- By removing them and aligning a couple of bolt holes by eye, we could properly adjust the carriage height
- Then finally we could roll the carriage out easily as the dowel pins were tapered.

Acknowledgement

I wish to thank my GNS colleague, John West for assisting me in carrying out this operation.

Thank You for your attention