NATIONAL RADIO ASTRONOMY OBSERVATORY
P. O. Box O
Socorro, New Mexico

VLA Electronics Memorandum No. 200

ELECTRONIC/ELECTROMECHANICAL MOUSE FOR REMOTE SENSING OF 60mm WAVEGUIDE HELIX AND JOINT DEFECTS

W. E. Dumke
December 1980

1.0 INTRODUCTION

In the early days of waveguide testing with the "mechanical mouse" to measure waveguide curvature, damage was caused to the helix, particularly at waveguide joints. An "electronic mouse" was designed to detect this stripping of the helix using an amplitude measurement of the voltage of a tightly coupled self-excited oscillator.

Unfortunately it was later found that some waveguide was wound with bifilar wire, and in some cases only one of these wires would be stripped. This unifiliar stripping could not be detected by the "electronic" method.

Therefore, another design had to be incorporated to detect this problem which was dependent on a measurement of the mechanical roughness of the helix after stripping. This was done by sensing the vibration of an iron slug inside another coil form connected to the same oscillator.

For proper operation of both modes, the mouse should be pulled through the guide at NO MORE than 5 meters/minute speed.

Time does not permit further explanation, but notes are presented describing the completed combined unit, for possible future use.

2.0 NOTES

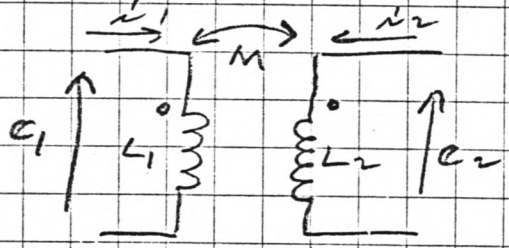
h, c, D, 9/9/77

19-Sept-77

FROM THE CHARTS DONE FROM 7/5/77 TO 9/7/77 AT DIFFERENT FREQUENCIES IT DOES NOT APPEAR HOPEFUL THAT A SINGLE STRIPPED WIRE CAN BE DIFFERENTIATED FROM THE NORMAL HELIX.

STEVE MAAS PRESENTED AN EXPLANATION OF THIS PHENOMENA SHOWN BELOW:

THE TWO COILS CAN BE SHOWN AS:



(P. 499 HAYT + KEMMERLY)

SINCE BOTH WIRES OF THE BIFILAR HELIX ARE WOUND IDENTICALLY, $L_1 = L_2$.

STEVE MAAS IDEA 19-Sept-77

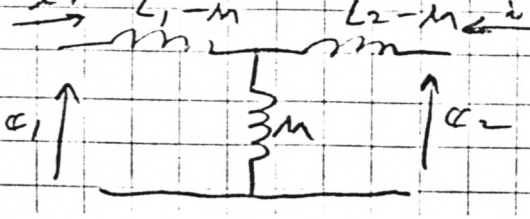
ALSO IT IS PROBABLE THAT $K=1$ THAT IS;

$$M = \sqrt{L_1 L_2}$$

BUT $L_1 = L_2 = L$

$$\therefore M = L$$

THE T EQUIVALENT OF THE TRANSFORMER IS: (P. 499 HAYT + KEMMERLY)



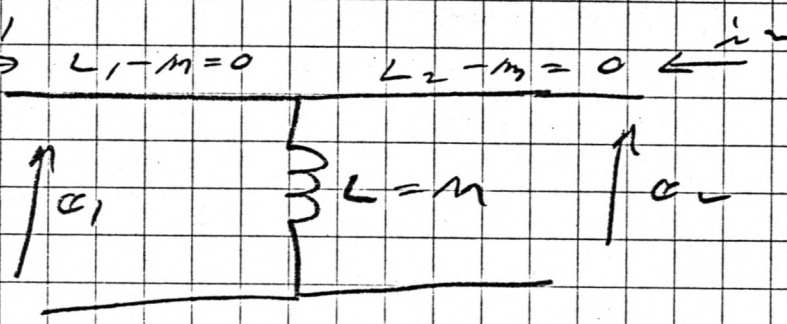
ELECTRONIC [illegible]

M. E. D. 9/D/7D

19-Sept-77

BUT $L_1 = L_2 = M = L$

THEREFORE $L_1 - M = 0$ AND $L_2 - M = 0$
AND $M = L$



STEVE MASS' IDEA

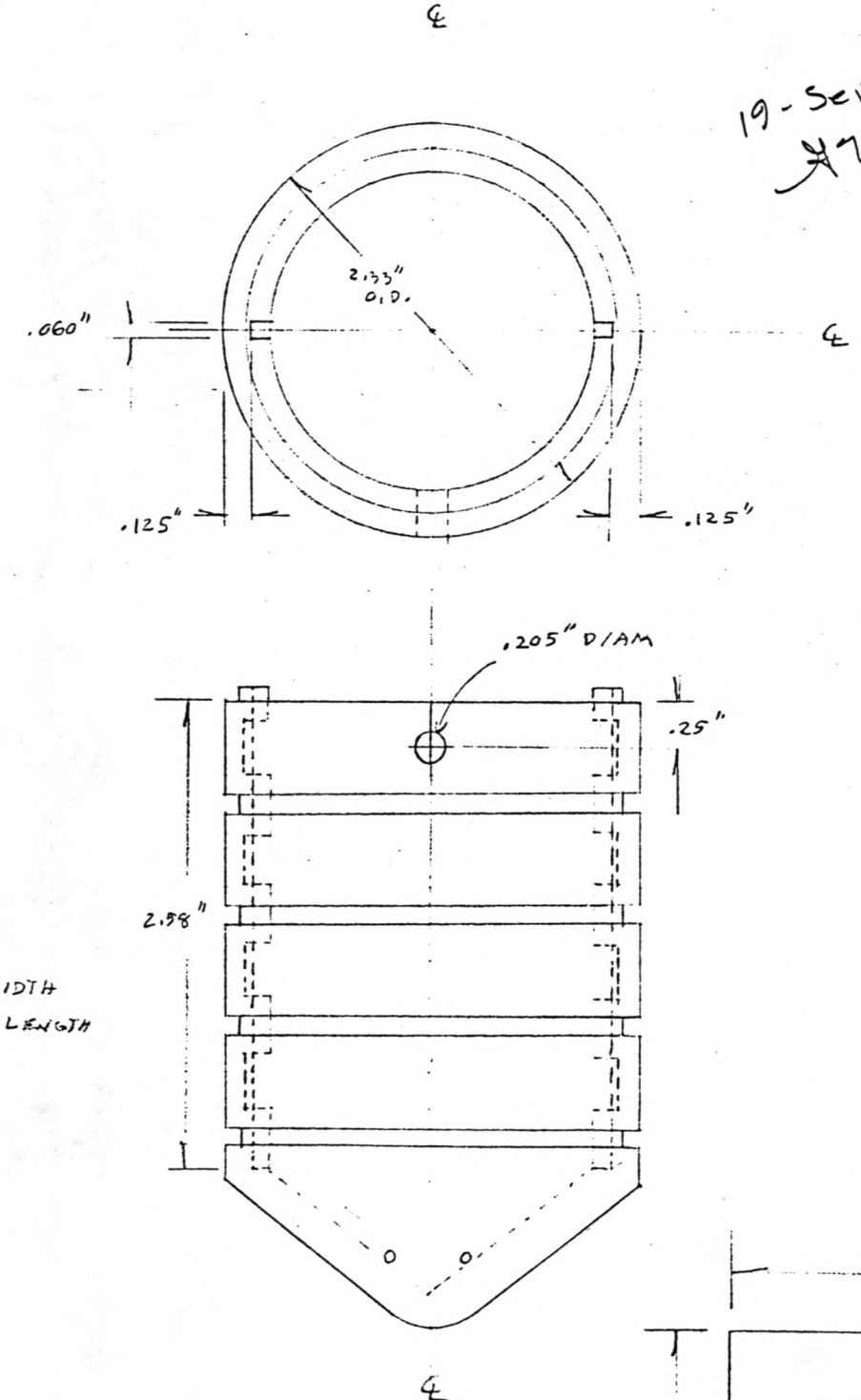
THEREFORE TWO UNIT COUPLED COIL (NORMAL WG) WILL NOT APPEAR ANY DIFFERENT FROM A SINGLE COIL (UNIFILAR STRIPPED WG) EXCEPT FOR PARASITIC ELEMENTS.

ELECTROMECHANICAL MOUSE

PROJ, NO, 13320

With G. Dunn 9/8/77

CUT 2-GROOVES AND 1-HOLE IN MOUSE CASING AS SHOWN



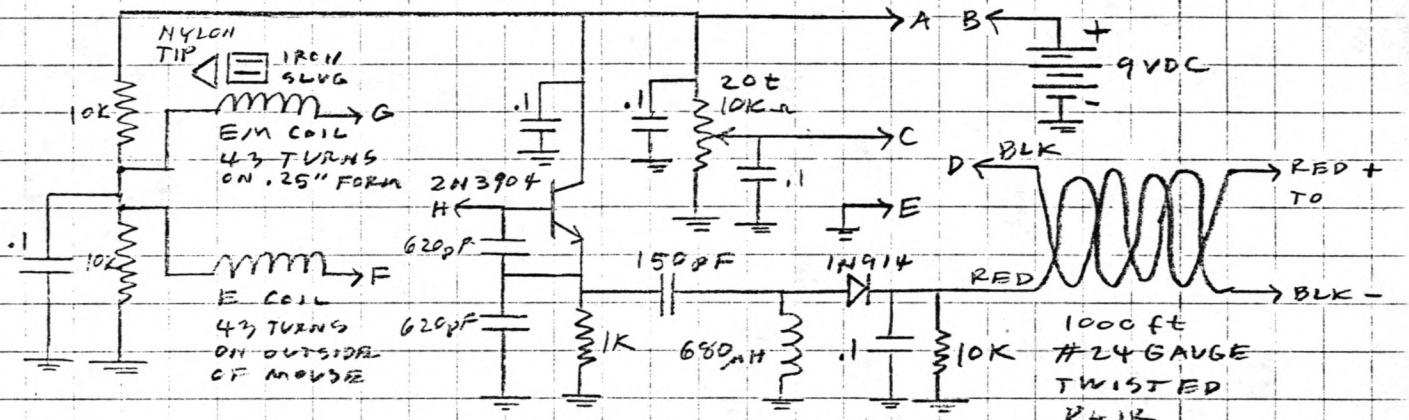
2.33"
.25
2.08"
.05"
2.03" P.C. BOARD WIDTH
2.50" P.C. BOARD LENGTH

WMC 7, D ~ 7/14/77

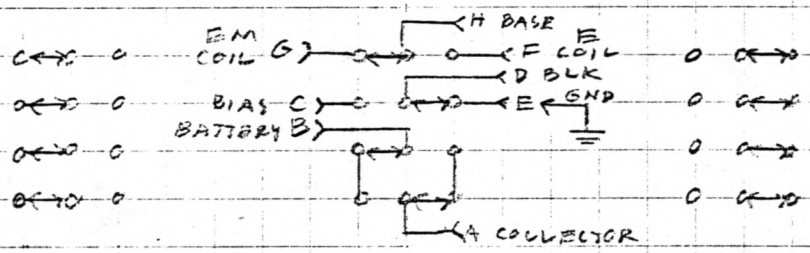
ELECTRONIC/ELECTROMECHANICAL MOUSE

SCHEMATIC DIAGRAM

19-Sept-77
JHAP



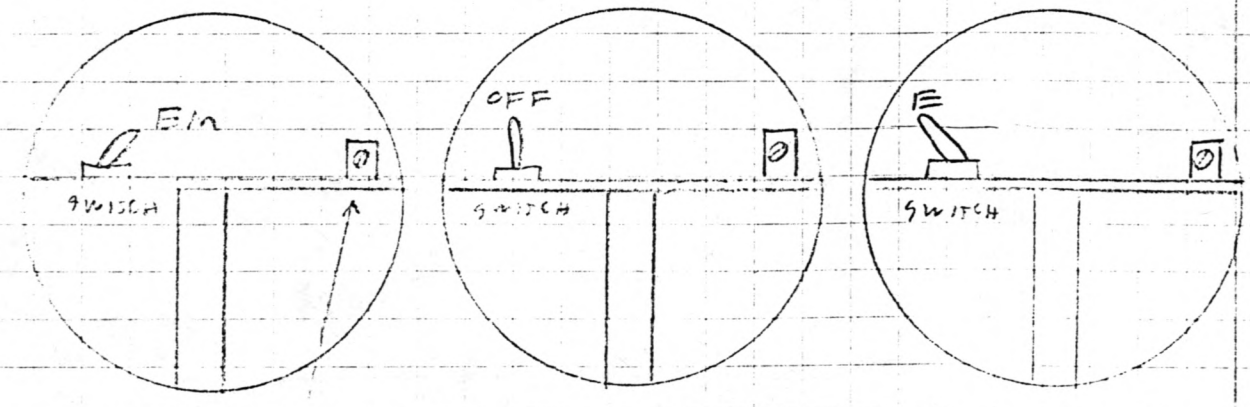
SWITCH CIRCUIT



ELECTROMECHANICAL POSITION

OFF POSITION

ELECTRONIC POSITION



SET POT FOR 0VDC WITH MOUSE IN NORMAL GUIDE

[.5 VOLTS RANGE
0 VDC CENTER SCALE
15cm/MINUTE SPEED

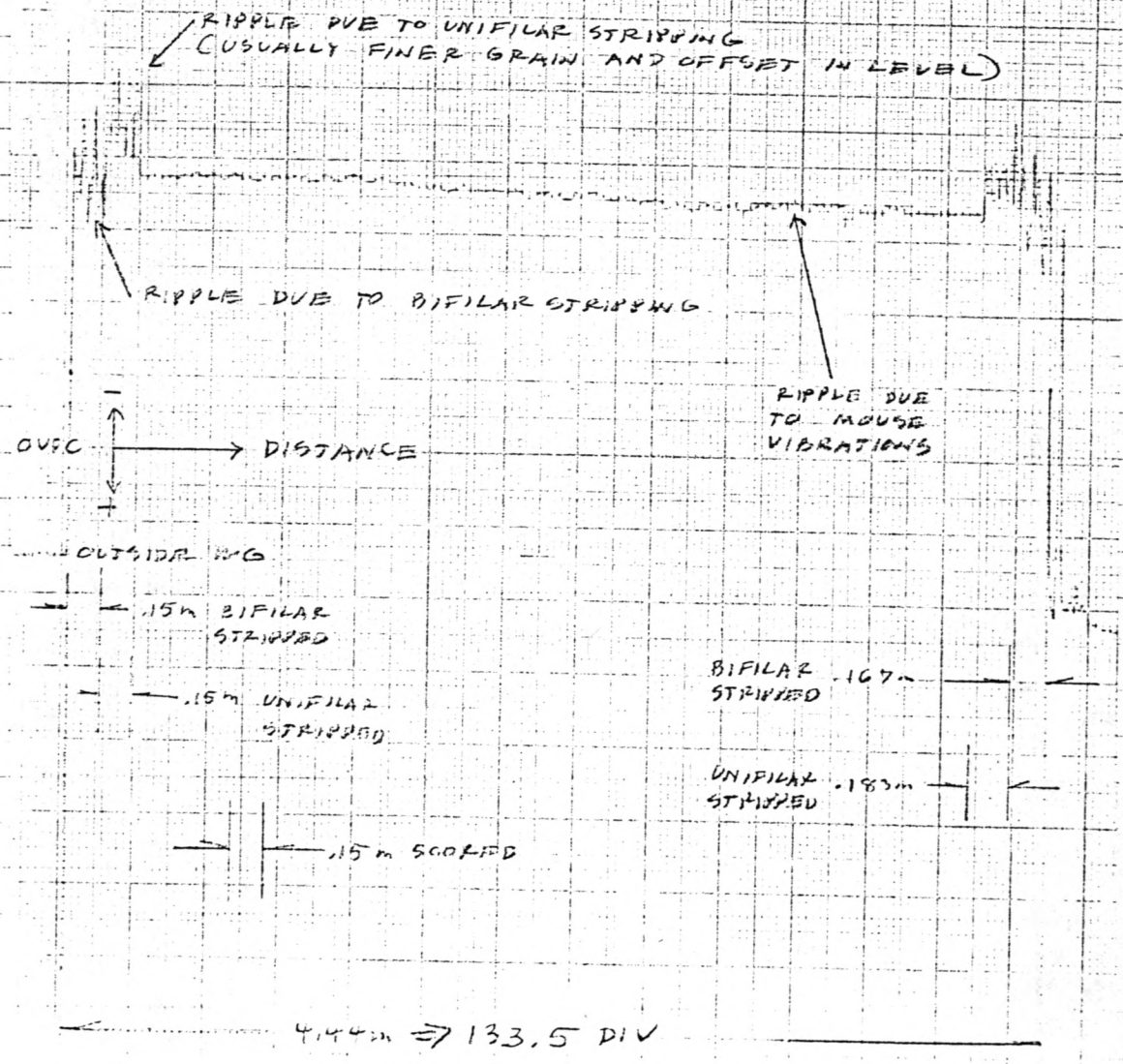
[10 VOLTS RANGE
0 VDC LEFT MARGIN
15 cm/MINUTE SPEED

9/14/77 – J Mike S.

ELECTROMECHANICAL RESPONSE .5V RANGE 15cm/min SPEED

IF 4.44m ⇒ 133.5 DIV, THEN
.15 m ⇒ 4.5 DIV
.167 m ⇒ 5.0 DIV
.183m ⇒ 5.5 DIV
.75m ⇒ 22.6 DIV
.90m ⇒ 27.1 DIV

19-Sept-77



ELECTRONIC/ELECTROMECHANICAL MOUSE

9/14/77-2 with 9 Dr

0VDC → DISTANCE

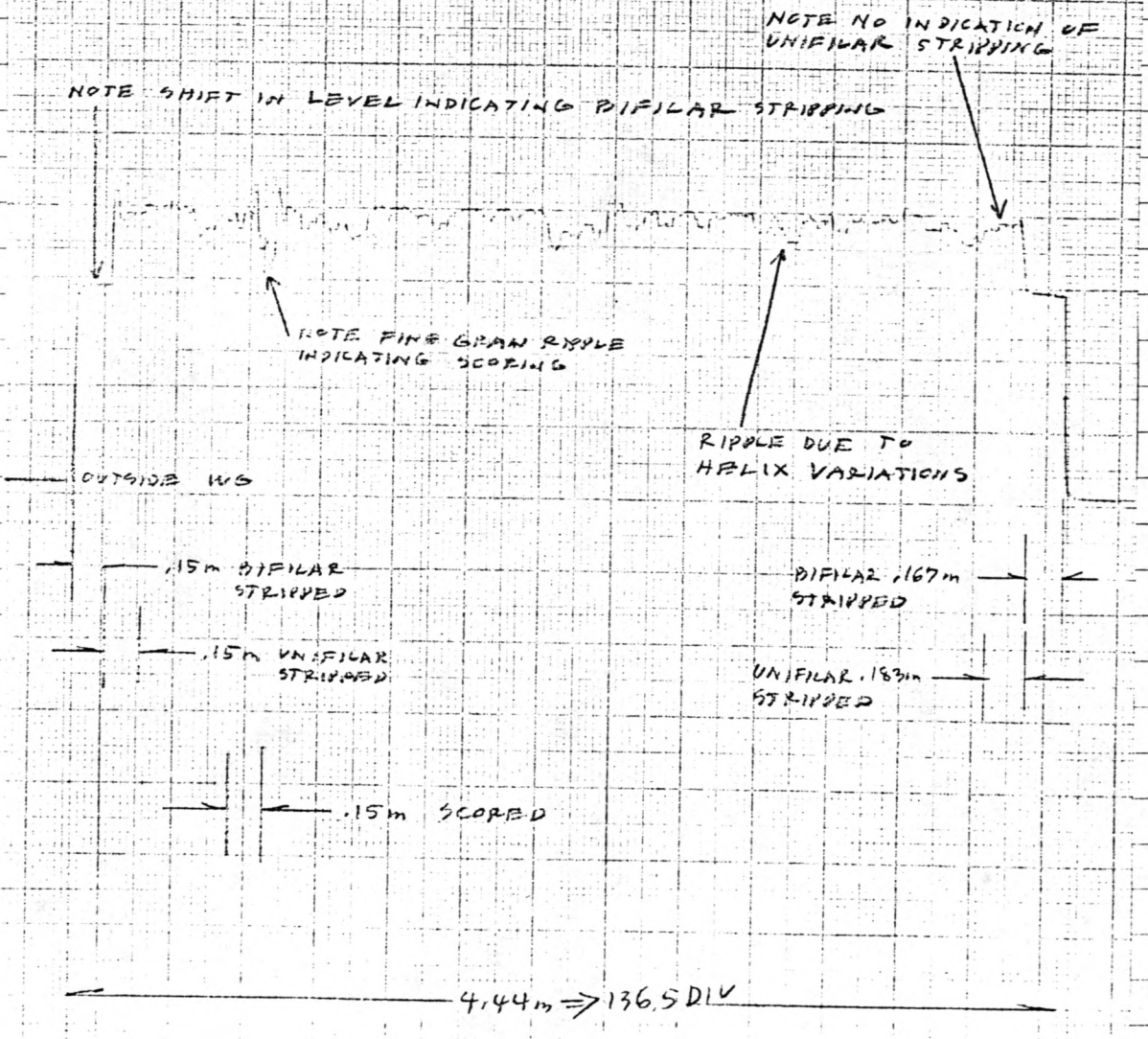
AMPLITUDE ↓

ELECTRONIC RESPONSE 10 V RANGE
15cm/min SPEED

IF 4.44m ⇒ 135.6 DIV → THEN

.15m ⇒ 4.6 DIV
.167m ⇒ 5.1 DIV
.183m ⇒ 5.6 DIV
.75 in ⇒ 22.9 DIV
.90 in ⇒ 27.5 DIV

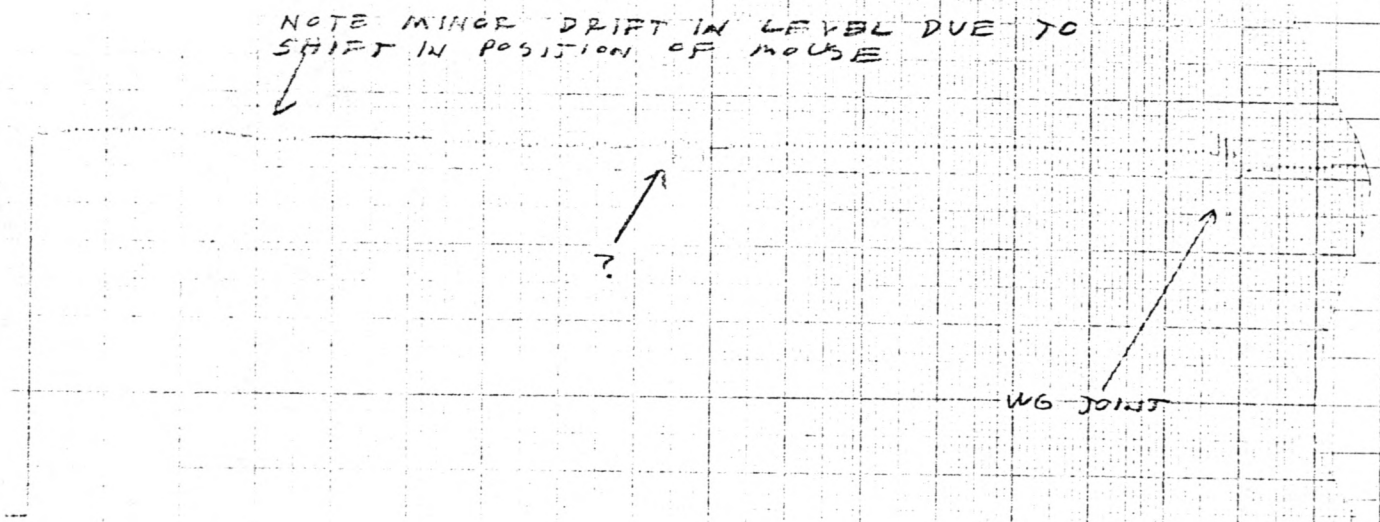
19-Sept-77
JEKP



9/14/77-3 (LEFT) Walter G. Soper

ELECTROMECHANICAL RESPONSE IN NORMAL WG SECTIONS

19-Sept-77
SMAP



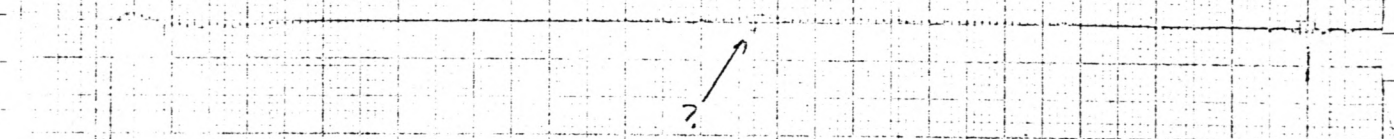
9/14/77 - 3 (RIGHT)

19-Sept-77

9/14/77-4 (LEFT) William G. Fogle

ELECTROMECHANICAL RESPONSE IN
NORMAL WG SECTIONS
(SAME AS 9/14/77-3)

19-Sept-77



177-4 (RIGHT)

19-Sept-77

9/14/77-5 (LEFT)

ELECTRONIC RESPONSE IN NORMAL WG

19-Sept-77

WG JOINT

NO REACTION AS IS SHOWN ON ELECTROMECHANICAL RESPONSE

No. 9270-1037

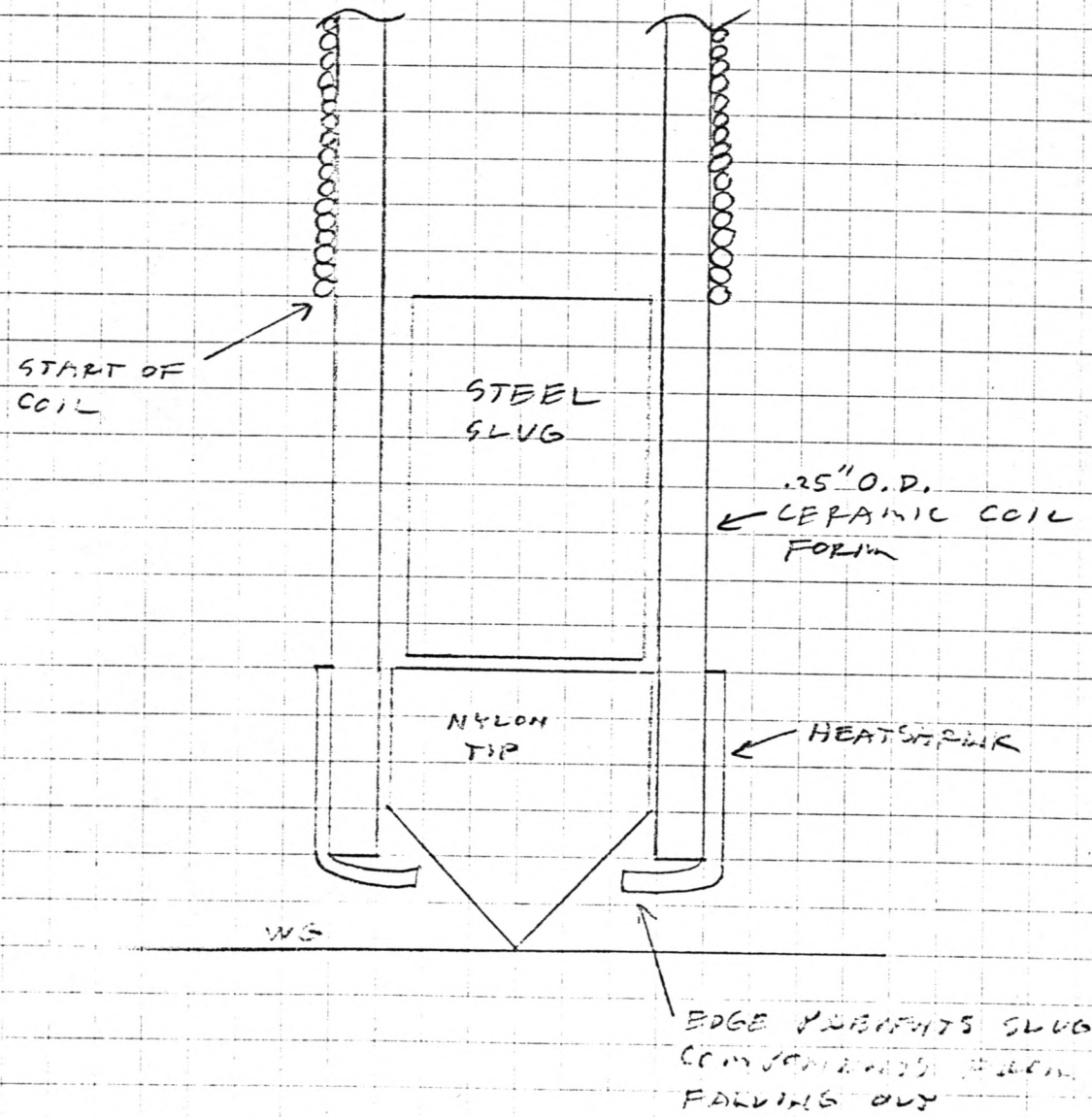
9-5 (RIGHT)

19-Sept-77

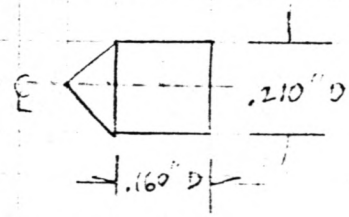
Wm. T. Dent 9/15/77

SLUG ARRANGEMENT USED IN TESTS OF 9/14/77

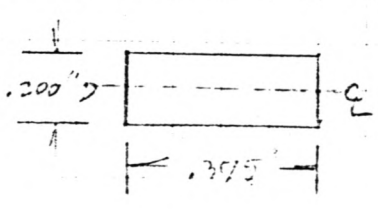
19-Sept-77



NYLON TIP



STEEL SLUG



ELECTRONIC/[illegible]

WILL S. Smith 9/19/77 19-Sept-77 JHD

ELECTRONIC MOUSE CHARACTERISTICS

- DETECTS BIFILAR STRIPING OF HELIX WIRE
- NOT ABLE TO DIFFERENTIATE BETWEEN UNIFILAR STRIPING AND NORMAL WAVEGUID.
- DETECTS SCORING AND CAN DIFFERENTIATE BETWEEN OPEN AND SHORTED TURNS.
- NOT ABLE TO DETECT DIRT IN WAVEGUID.
- ABLE TO PRODUCE QUANTITATIVE DATA ON SEPERATION AT WAVEGUIDE JOIN.
- DETECTS AS YET UNKNOWN ELECTRICA OR MECHANICAL VARIAJIONS IN THE HELI STRUCTURE
- AVERAGES EFFECTS AROUND THE CIRCUMFERENCE OF THE MOUSE. THERE ROTATION OF THE WAVEGUIDE WILL NOT AFFECT RESULTS.
- NO REGULAR MAINTAINANCE REQUIRE EXCEPT FOR BATTERY REPLACEMEN
- RESPONSE MOSTLY INDEPENDENT OF SPE

ELECTRONIC/MECHANICAL MOUSE CHARACTERISTI

- DETECTS BOTH UNIFILAR AND BIFILAR STRIPING OF HELIX WIRE (VIBRAJION PERIOD GREATER FOR BIFILAR STRIPING)
- WILL NOT DETECT SCORING UNLESS TH MECHANICAL DEFECT LIES IN THE PATH OF THE PROBE.
- PROBE ONLY SENSES MAJOR MECHANICAL DEFECTS ALONG A SINGLE LONGITUDINA LINE THROUGH THE WAVEGUIDE. [illegible] ROTATION OF THE WAVEGU MAY AFFECT RESULTS IN SOME INSTANCES.
- THE PROBE VIBRATION IS NOT CONTROLL WELL ENOUGH TO OBTAIN CONSISTENT QUANTITATIVE DATA ON JOINT SEPARATION.
- NOT ABLE TO DETECT DIRT IN THE WAVEGUIDE UNLESS DIRT PARTICLES LIE IN THE PATH OF THE PROBE.
- PROBE TIP MAY DETERIORATE WITH TIME AN [illegible]

Wilbur S. Dupree 9/19/77 19-Sept-77 JLWP.

SINCE BOTH TYPES OF SENSING YIELD USEFUL INFORMATION THEY WERE COMBINED INTO ONE UNIT. (SEE p. 14

ELECTRONIC/ELECTROMECHANICAL MOUSE CHARACTERISTICS

- TEFLON "PIG" HOUSING IS UNLIKELY TO CAUSE DAMAGE TO WAVEGUIDE BECAUS OF FLEXIBILITY AND SMOOTH SURFACE OF TEFLON, AS WELL AS "PIG'S" SHORT LENGTH WHICH PERMITS EASY PASSAGE THROUGH OFFSET JO

- BATTERY REQUIRES PERIODIC REPLACEMENT (CURRENT DRAIN ≈ 5mA

- NORMAL OPERATING SPEED IS 5 METER MINUTE.

- AT PRESENT (DUE TO LACK OF SUITABLE 4 CONDUCTOR CABLE) ONLY ONE OF THE TWO SYSTEMS MAY BE OPERATED AT ONE TIME. ASSUMING THAT ANY INTERACTION PROBLEMS ARE SOLVABLE, BOTH COULD BE OPERATED SIMULTANEOUSLY WITH 4-CONDUCTOR CABLE.

42-Sept 77

Wm. E. Dunn
8/31/77

ELECTRONIC MOUSE

NORMALIZED PEAK AMPLITUDE VS. COUPLING SLEEVE GAP

(REFER TO CHART 8/31/77-1)

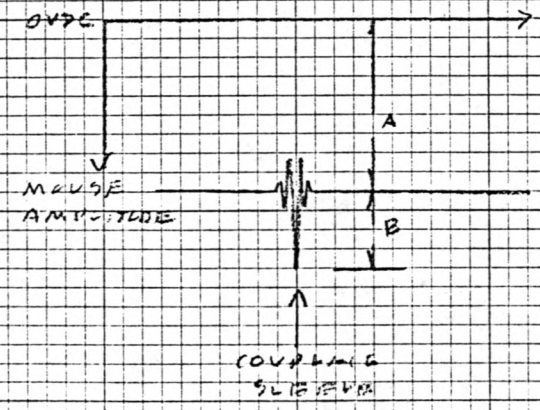
NORMALIZED PEAK AMPLITUDE →

.28 .27 .26 .25 .24 .23 .22 .21 .20 .19 .18 .17 .16 .15 .14 .13 .12 .11 .10 .09 .08

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

COUPLING SLEEVE GAP IN # OF TURNS →

← NORMAL COUPLING SLEEVE



NORMALIZED PEAK AMPLITUDE = $\frac{B}{A}$

460700