G 210.51

Test Report No. 14801-1 No. of Pages 38

Rev 1

Report of Test on

SEISMIC VIBRATION TESTING
OF LIMITORQUE SMB-1/H3BC ACTUATORS
FOR LIMITORQUE CORPORATION
UNDER PURCHASE ORDER NO. TL516

ACTON ENVIRONMENTAL TESTING CORPORATION

Date June 11, 1979

	Prepared	Checked	Approved
By	B.Esposito	R.Gilfoy	M.L.Tolf
Signed	Bruce Esposito	R. Gilfoy	M.L.Tolf
Date	June 13, 1979	13 June 79	6/13/79

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SEISMIC TEST SMB-1-60/H3BC

TEST REPORT #B0048

SUBJECT: Project 678037 - Pre Seismic Torque Switch Calibration and Monitoring performed during Seismic Testing.

REFERENCE: Limitorque P/O 678037
Acton Report #14801-1

Unit Identification and Description

SMB-1-60, I.D. #678037-C mounted on an H3BC; I.D. #678037-C1.

Pre-Test Torque Switch Calibration

Procedure: Measured torque output of SMB-1-60/H3BC using 10,000'# torque stand.

Result: An actual torque of 5,740'# was obtained at a torque switch setting of 2 3/4.

Seismic Test Monitoring

Procedure: Both limit switch rotors and "open" torque switch were monitored for chatter by a 1 millisecond electronic chatter circuit.

The actuator was run from an open position (controlled by a limit switch), to a closed "torqued out" position (controlled by the torque switch) back to the open limit position during each of the seismic dwells and at the end of the seismic qualification.

Result and Conclusion

Refer to the general discussion of seismic testing for test reports B0047 and B0048 inserted in front of these reports.

Paul T. Young 1/20/79

Paul T. Young
Assistant Chief Test Engineer

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REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARAGRAPH NUMBER	CHANGES OR ADDITIONS	APPROVED BY
6/11/79	0	---------FIRST ISSUE----------			
7/25/79	1	1	4.0	Changed 1/17/79 to 4/9/79	Bruce Sponitz July 25, 1979
		4	3.0	"	
		6	3.2	Reworded sentence	
		9	3.3	Added word "Independently"	
		15	3.7	Changed seismic aging test to "Plant Vibration Aging Test" in 4 places	
		17	4.2	Added 6.0a Reworded last sentence	
		19	4.4	Changed seismic Aging Test to "Plant Vibration Aging Test" in 2 places	
		22	Figure 1	Removed OBE curve	

Report No. 14801-1

ENVIRONMENTAL TESTING CORPORATION
ACTON

Administrative Data

1.0 Purpose of Test: To subject actuators to seismic vibration testing.

2.0 Manufacturer: Limitorque Corporation
Lynchburg, Virginia

3.0 Manufacturer's Type or Model No: SMB-1/H3BC

4.0 Drawing, Specification or Exhibit: Limitorque Seismic Test of Limitorque SMB-3/H5BC and SMB-1/H3BC R&D Project 678037 dated April 9, 1979

5.0 Quantity of Items Tested: Two (2) units marked #3 and #4

6.0 Security Classification of Items: Unclassified

7.0 Date Test Completed: May 10, 1979

8.0 Test Conducted By: C.Pilotte
D.McLaughlin

9.0 Disposition of Specimens: Returned to Limitorque Corporation.

10.0 Abstract:

Refer to the results section herein.

ACTON ENVIRONMENTAL TESTING CORPORATION

1.0 TEST ITEMS

Two (2) Limitorque SMB-1/H3BC Actuators were submitted by Limitorque Corporation for seismic vibration testing at Acton Environmental Testing Corporation (AETC). The items were marked #3 and #4.

2.0 TEST REQUIREMENTS

The purpose of this test was to subject the actuators specified in section 1.0 above to the seismic vibration tests specified in section 3.0 below to determine their ability to withstand such vibration without evidence of mechanical damage, deterioration, loss of their ability to operate properly, or contact chatter in excess of one (1) millisecond where applicable.

3.0 TEST PROCEDURES

This test was performed under the direction of Mr. Paul Young of Limitorque Corporation in accordance with Limitorque Seismic Test of Limitorque SMB-3/H5BC and SMB-1/H3BC, Research and Development Project 678037 dated April 9, 1979.

210.51

3.1 Test Mounting

The actuator under test was bolted to a test fixture. The test fixture was then secured to the appropriate vibration table. Refer to the individual test descriptions for specifics.

3.2 Test Conditions

All tests were performed at room temperature and pressure.

During the resonance survey specified in section 3.4 below, the actuator under test was not operated.

During the qualification test specified in section 3.5, the actuator under test was cycled open and closed once/dwell.

During the multiple frequency test specified in section 3.6 below, the actuator under test was cycled open and closed once/run.

During the aging test specified in section 3.7 below, the actuator under test was cycled at the beginning of each test and then once every fifteen (15) minutes during the test.

The actuator under test was subjected to some tests with the seismic support bracket and some tests without the bracket. Refer to the individual test descriptions for specific details.

3.3 Test Monitoring

The actuator under test was visually monitored for any evidence of mechanical damage, deterioration or loss of its ability to operate properly where applicable.

The actuator under test was monitored with accelerometers by AETC personnel to determine its mechanical response. Data from these accelerometers through appropriate signal conditioning was recorded on visicorder recording paper included with this report for all tests except the multiple frequency tests during which data was recorded onto magnetic tape. During the multiple frequency tests, the output of the control accelerometer was also analyzed on-line and the X-Y plots of the test response spectra are included as part of this test report.

The accelerometers were located as follows:

ACCELEROMETER NO.	AXIS SENSING ORIENTATION*	LOCATION**
1	H_1	on H3BC Housing
2	H_2	
3	V	
4	H_1	on top of H3BC housing or on bracket when used
5	H_2	
6	V	
7	H_1	on SMB housing
8	H_2	
9	V	
10	H_1	on end cap of motor
11	H_2	
12	V	
13	H_1	on top of handwheel
14	H_2	
15	V	
16	H_1	on base of table
17	H_2	
18	V	Control is #18

For tests 1A-9A, 16A-18A, the triaxial group of accelerometers 16, 17 and 18 was reoriented as follows: (#18 remained the control accelerometer).

* *H_1 is the horizontal axis parallel to the motor axis*
H_2 is the horizontal axis perpendicular to the motor axis
V is the vertical axis.
***Refer to included photographs*

Report No. 14801-1

Test Monitoring (continued)

ACCELEROMETER NO.	AXIS SENSING ORIENTATION* H_1 TESTS	H_2 TESTS	V TESTS
16	V	V	H_1
17	H_2	H_1	H_2
18	H_1	H_2	V

During the tests specified in sections 3.5, 3.6, and 3.7 below, one (1) closed set of contacts of the limit switch and one (1) closed set of contacts of the torque switch were independently monitored for contact chatter in excess of one (1) millisecond.

* H_1 *is the horizontal axis parallel to the motor axis*
H_2 *is the horizontal axis perpendicular to the motor axis*
V *is the vertical axis.*

3.4 Resonance Survey

The resonance survey consisted of a sinusoidal input with peak horizontal or vertical accelerations of 0.75g at frequencies from 5 through 60 Hz and back to 5 Hz. The resonance survey was performed at a sweep rate of 1/2 octave/minute.

The resonance survey was performed both with and without the seismic support bracket using actuator #4. The input was applied using the AETC Ling A249 electrodynamic exciter as follows:

TEST NO.	AXIS OF EXCITATION*	SEISMIC SUPPORT BRACKET
1A	V	No
2A	V	Yes
3A	H_2	Yes
4A	H_2	No
5A	H_1	No
6A	H_1	Yes

Refer to the included photographs

H_1 is the horizontal axis parallel to the motor axis

H_2 is the horizontal axis perpendicular to the motor axis

V is the vertical axis

3.5 Qualification Test with Seismic Support Bracket

The qualification test with the seismic support bracket consisted of a continuous steady state sinusoidal dwell input with peak horizontal or vertical accelerations of 6.0g except where limited by AETC shaker table capabilities as specified below. The sinusoidal dwell test was performed at 1/3 octave intervals of frequency from 5.0 through 32 Hz (5.0, 6.3, 8.0, 10.0, 12.5, 16.0, 20.0, 25.0, 32.0) as well as at 35 Hz. Each dwell was for a duration of fifteen (15) seconds.

This qualification test was performed with the seismic support bracket using actuators #3 and #4.

The input was applied using the AETC Ling A249 electrodynamic exciter as follows:

TEST NO.	AXIS OF EXCITATION*	ACTUATOR NO.
7A	H_1	4
8A	H_2	3
9A	V	3

The level of input applied was as follows:

Refer to the included photographs

H_1 *is the horizontal axis parallel to the motor axis*

H_2 *is the horizontal axis perpendicular to the motor axis*

V *is the vertical axis*

Qualification Test with Seismic Support Bracket (continued)

FREQUENCY (Hz)	INPUT LEVEL (g)
5.0	1.0
6.3	1.5
8.0	3.0
10.0	5.0
12.5	5.5
16.0	6.0
20.0	6.0
25.0	6.0
32.0	6.0
35.0	6.0

Report No. 14801-1

3.6 Multiple Frequency Test

A biaxial multiple frequency excitation was applied. The test input was recorded on a 14-channel tape recorder, each track having discrete frequency sine beats recorded at a different frequency and delay between beats. All frequencies were recorded at maximum levels.

The input was played back through a 14-channel tape recorder. The outputs of the 14-channels were then combined in a 14-channel mixer which resulted in a multiple frequency output.

The individual mixer channels had gain controls so that the level of each output tape channel passing through the mixer could be controlled. In this manner, the required test spectrum was shaped by controlling the level of individual frequencies.

Qualification tests, consisting of biaxial periodic pseudo-random excitation were performed.

The test duration for each input was thirty (30) seconds.

The level was such that the Test Response Spectra (TRS) from the control accelerometer computed at Q=10 (5% damping) would envelop the SSE Required Response Spectra (RRS) shown in Figure 1.

The test response spectra were also analyzed at Q=20 (2.5% damping) and Q=50 (1.0% damping).

Multiple Frequency Test (continued)

The multiple frequency test was performed with the seismic support bracket using actuator #3. The input was applied using the AETC hydraulic seismic simulator as follows:

TEST NO.	BIAXIAL DIRECTION OF EXCITATION*
10A-11A**	$-H_1$ & V
12A	$-H_1$ & V
13A	$-H_2$ & V
14A	H_2 & V
15A	H_1 & V

*Refer to the included photographs
H_1 is the horizontal axis parallel to the motor axis
H_2 is the horizontal axis perpendicular to the motor axis
V is the vertical axis
**Shaker table equalization runs.

2.0.51

3.7 Plant Vibration Aging Test

The plant vibration aging test consisted of a sinusoidal input with peak horizontal or vertical acceleration of 0.75g at frequencies from 10 thru 100 Hz and back to 10 Hz. The plant vibration aging test was performed at a sweep rate of two (2) octaves/minute. The input was applied for 90 minutes/axis. The plant vibration aging test was performed with the seismic support bracket using actuator #3. The input was applied using the AETC Ling A249 electrodynamic exciter as follows:

TEST NO.	AXIS OF EXCITATION*
16A	H_1
17A	H_2
18A	V

Refer to the included photographs.

H_1 is the horizontal axis parallel to the motor axis

H_2 is the horizontal axis perpendicular to the motor axis

V is the vertical axis

4.0 TEST RESULTS

4.1 Resonance Survey Test Results

The following resonances were detected during the resonance survey specified in section 3.4 above:

TEST NO.	AXIS OF EXCITATION*	SEISMIC SUPPORT BRACKET	RESONANCES (Hz)
1A	V	No	None detected
2A	V	Yes	None detected
3A	H_2	Yes	49.0, 58.0
4A	H_2	No	41.0, 46.0, 58.0
5A	H_1	No	34.0, 41.0, 47.0
6A	H_1	Yes	56.0

Refer to the included photographs

H_1 is the horizontal parallel to the motor axis

H_2 is the horizontal axis perpendicular to the motor axis

V is the vertical axis

Report No. 14801-1

4.2 Qualification Test Results with Seismic Support Bracket

During the 35 Hz portion of test 7A, (6.0g), the interface gasket between the clutch housing and the main housing vibrated out and the three (3) 3/4" bolts of the seismic support bracket loosened up.

At this time, actuator #4 was replaced with actuator #3.

There was no evidence of mechanical damage, deterioration or contact chatter as a result of the qualification test specified in section 3.5 above other than that specified above.

4.3 Multiple Frequency Test Results

There was no evidence of mechanical damage, deterioration or contact chatter as a result of the multiple frequency test specified in section 3.6 above.

4.4 Plant Vibration Aging Test Results

There was no evidence of mechanical damage, deterioration, or contact chatter as a result of the plant vibration aging test specified in section 3.7 above.

5.0 TEST EQUIPMENT LIST

NAME	MFGR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL.FREQ.
Accelerometer	B&K	4343	472687	1-8000 Hz	±5%	AC307	3 months
"	"	"	472688	"	"	AC309	" "
"	"	8302	344778	1 Hz - 5 KHz	"	AC310	" "
"	"	"	344783	"	"	AC318	" "
"	"	"	344781	"	"	AC322	" "
"	"	"	450710	"	"	AC323	" "
"	"	"	472976	"	"	AC329	" "
"	"	"	472989	"	"	AC336	" "
"	"	"	473010	"	"	AC338	" "
"	PCB	302A	2834	"	"	AC367	" "
"	"	"	2843	"	"	AC371	" "
"	"	"	2844	"	"	AC374	" "
"	"	"	666	0.25 - 5 KHz	"	AC375	" "
"	"	"	667	"	"	AC376	" "
"	"	"	670	"	"	AC379	" "
"	"	"	671	"	"	AC380	" "
"	"	"	672	"	"	AC381	" "
"	"	"	673	"	"	AC382	" "
"	"	"	2845	1 Hz - 5 KHz	"	AC383	" "
"	"	"	694	0.25 Hz - 5 KHz	"	AC384	" "
"	"	"	2851	1 Hz - 5 KHz	"	AC392	" "
"	"	"	2853	"	"	AC395	" "
"	"	"	2854	"	"	AC396	" "
"	"	"	2855	"	"	AC410	" "

TEST EQUIPMENT LIST

NAME	MFGR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL.FREQ.
Accelerometer	PCB	302A	2856	1 Hz - 5 KHz	±5%	AC414	3 months
"	"	"	1772	"	"	AC415	" "
"	"	"	2057	"	"	AC444	" "
"	"	303A03	740	1 Hz - 70 KHz	"	AC464	" "
"	"	"	741	"	"	AC465	" "
"	"	"	743	"	"	AC467	" "
"	"	"	745	"	"	AC469	" "
Timer Seconds	SE	S60		0-60 seconds 1 rpm	±0.1sec	FM311	6 months
Scope,Storage	Tektronix	564-	11582	DC - 10 MHz	±3%	OS309	3 months
"	"	"	9027	"	"	OS311	" "
Filter-Dual	Ithaco	4302	35207	10 - 1 MHz	±3%	AM346	6 months
VTVM	Ballintine	310A	5580	10 Hz - 2 MHz, 0-100 volts 6 ranges	±5%	MV305	3 months
Sweep Oscillator	SDY	SD-104-5	21A	0.005 Hz - 50 KHz	±1%	SG315	6 months
Audio Generator	HEA	1G72		10 Hz - 100 KHz	±5%	SG327	" "
Visicorder	Honeywell	906B	8687	DC - 2 KHz 12 channel	±1db	RE301	3 months
"	"	906C2	99334	"	"	RE311	" "
Recorder Tape	Amp	FR1300	7430293	14 channel FM 1" Tape 0-2.5 KHz	±0.5%	RE331	" "
"	Honeywell	906C	99078	DC - 2 KHz 12 channel	±1db	RE335	" "
Recorder X-Y	MFE	715E	42167	Input: 1-10-100 MV 1-10V Both channels	±0.5%	RE340	" "
Visicorder	Honeywell	1508	15-1670	DC-2 KHz 12 channel 8" paper	±1db	RE344	" "

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Test No. RRS
Date MARCH 1999
Customer LIMITORQUE 14701
Test Item P/N
Test Item S/N
Type of Test RANDOM
Specification DRAFT B
Para. No. TBWS, EWS, EP-12
Conditions OPERATING
Temperature ROOM
Period of Test 30 SECONDS
Control Axis VERTICAL
Pickup No. CONTROL
Pick-up Axis VERTICAL
Operator BRUCE
Test Engr.
GRMS

REVISED RESPONSE SPECTRA (RRS)
(Q=10 (5% DAMPING)
TO BE ANALYZED @ Q=10, 25, 50

FIGURE

NO. 31,2BW. LOGARITHMIC: FOUR BY THREE 2½-INCH CYCLES.
codex GRAPH PAPER
IN STOCK DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. 02062
PRINTED IN U.S.A.

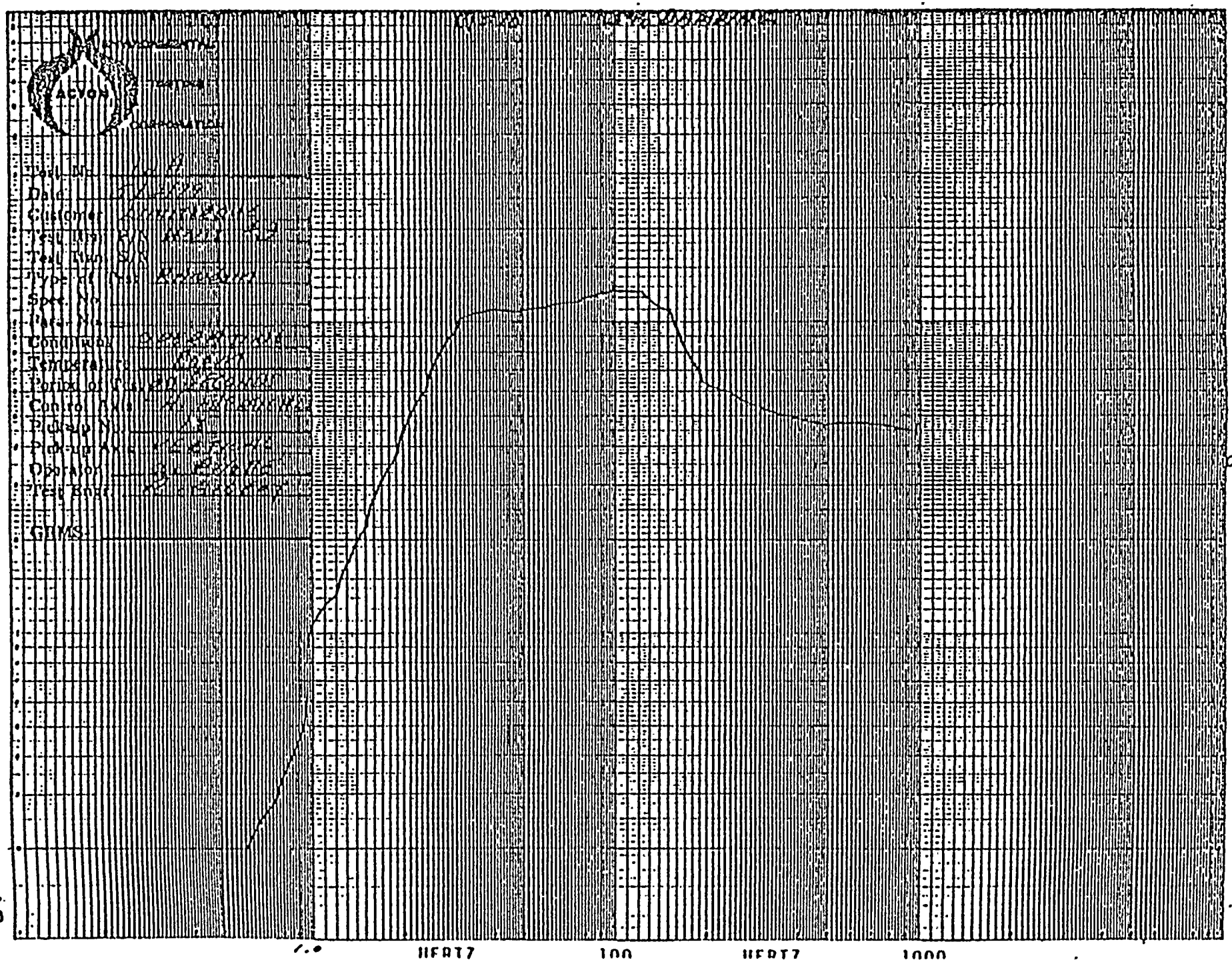

Fig. 51

NO. 31,288. LOGARITHMIC FOUR BY THREE 2½ INCH CYCLES.
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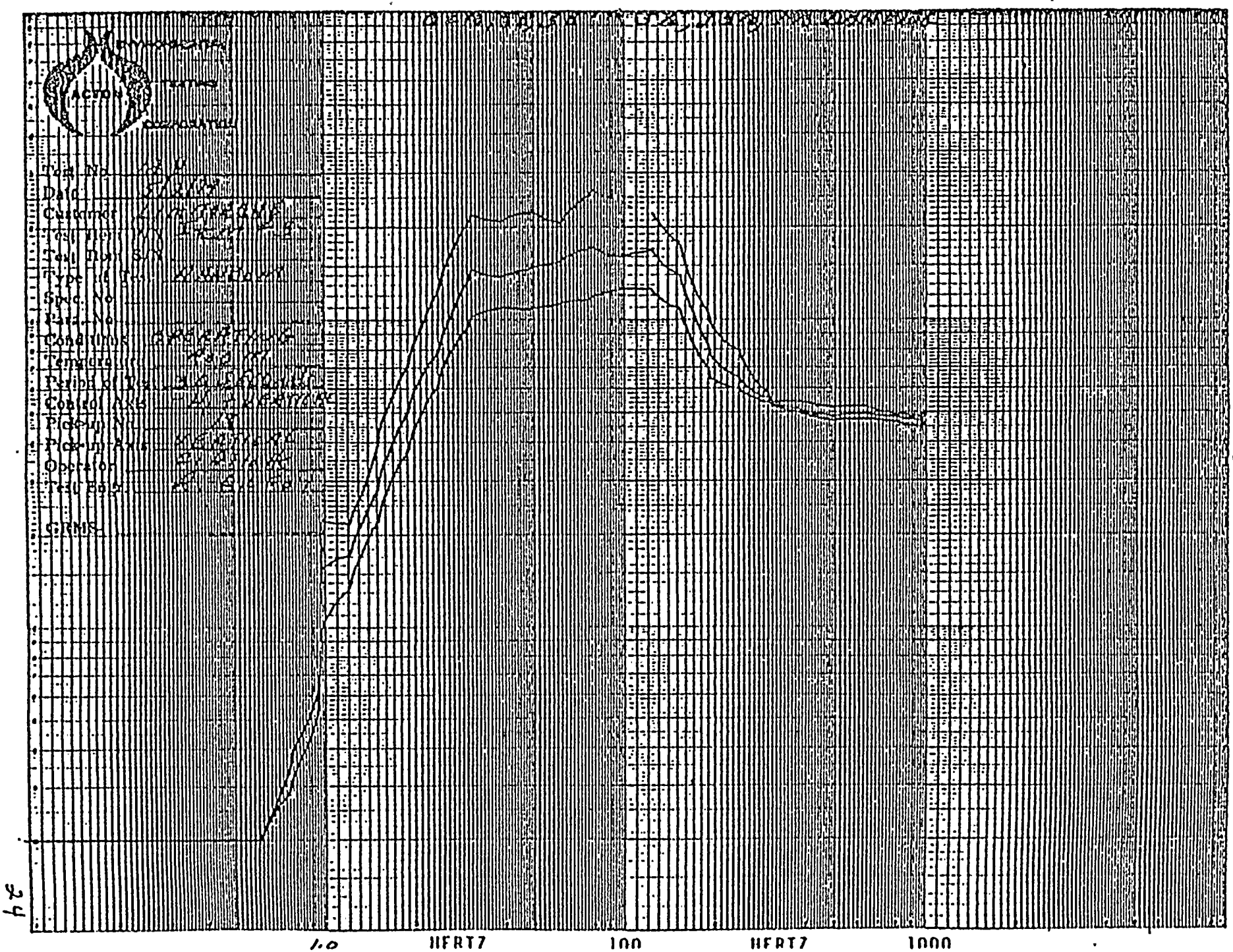

34

2105

NO. 31,288. LOGARITHMIC: FOUR BY THREE 2½ INCH CYCLES.
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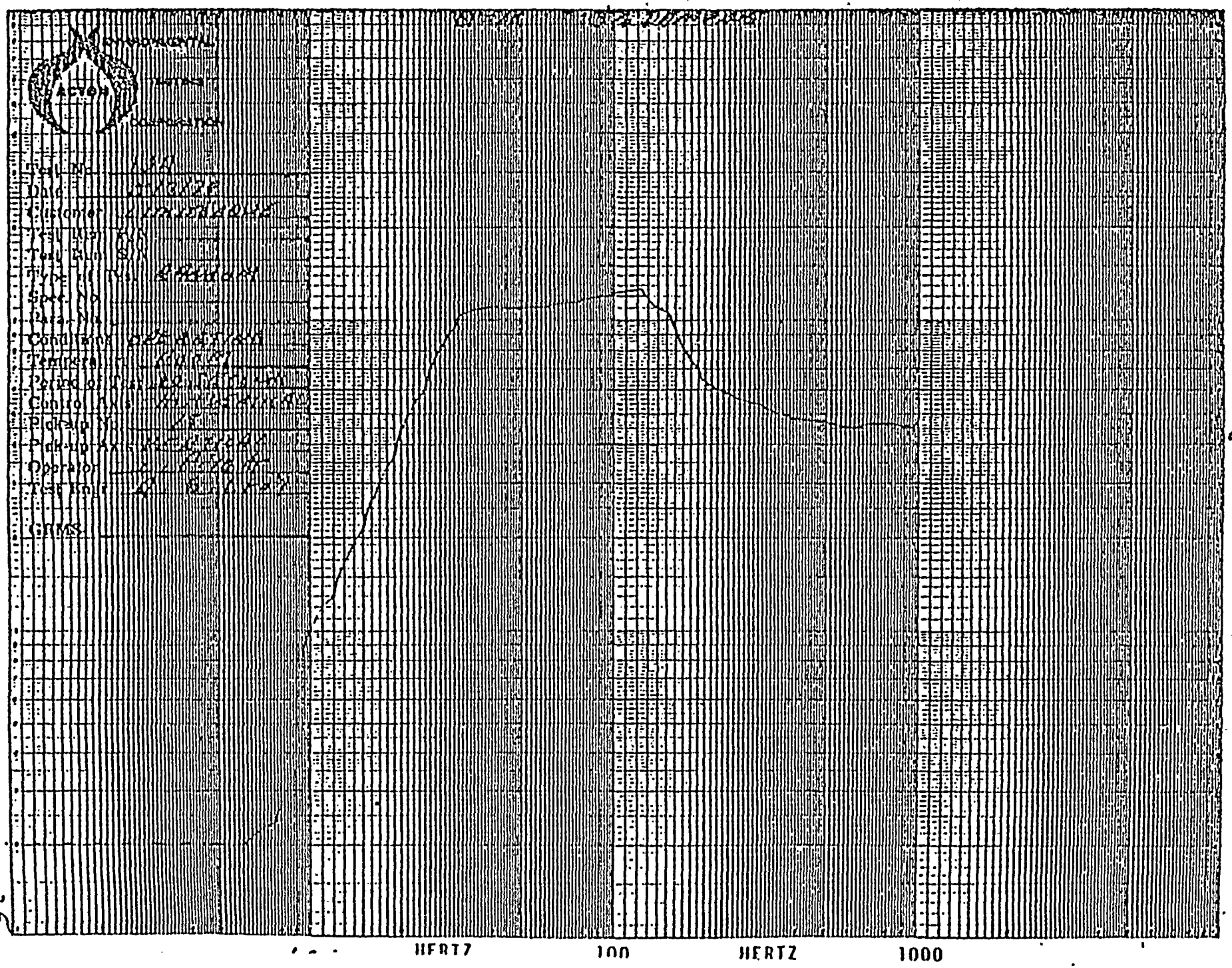

NO. 31,209 QUANTIMICE FOUR BY THREE 2½ INCH CYCLES.
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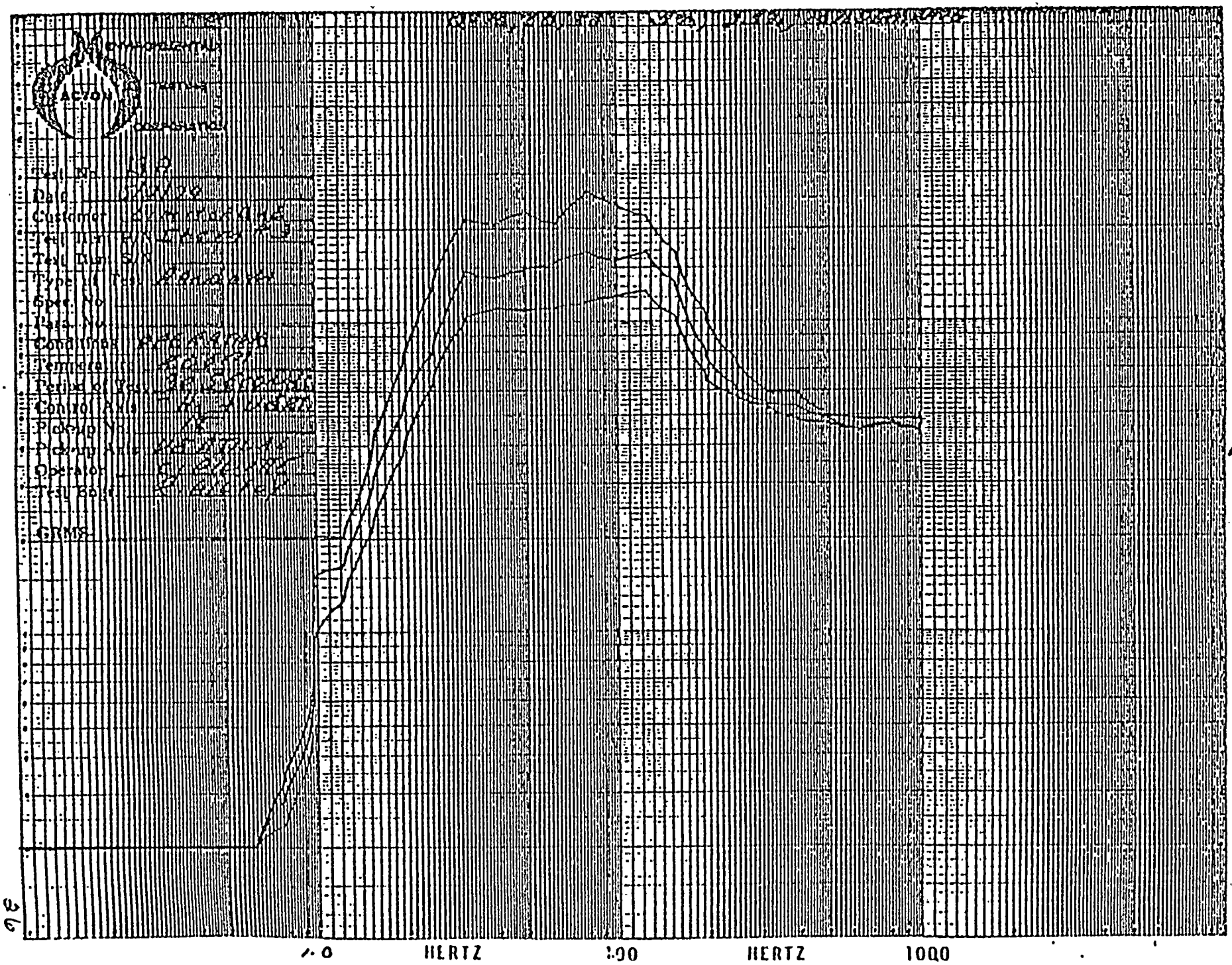

NO. 31,298. LOGARITHMIC FOUR BY THREE 2½ INCH CYCLES.
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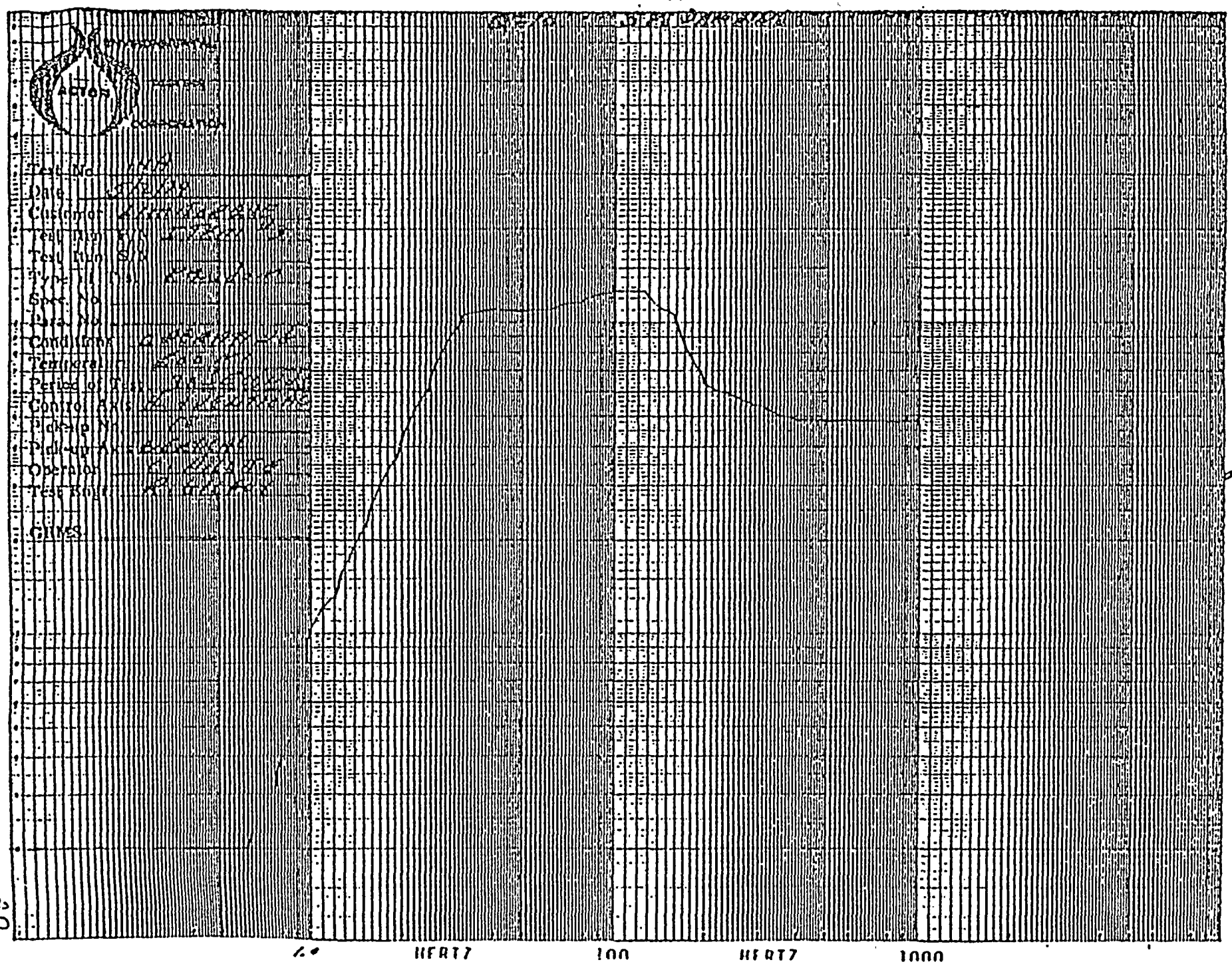

NO. 31,259. LOGARITHMIC FOUR BY THREE 2½ INCH CYCLES.
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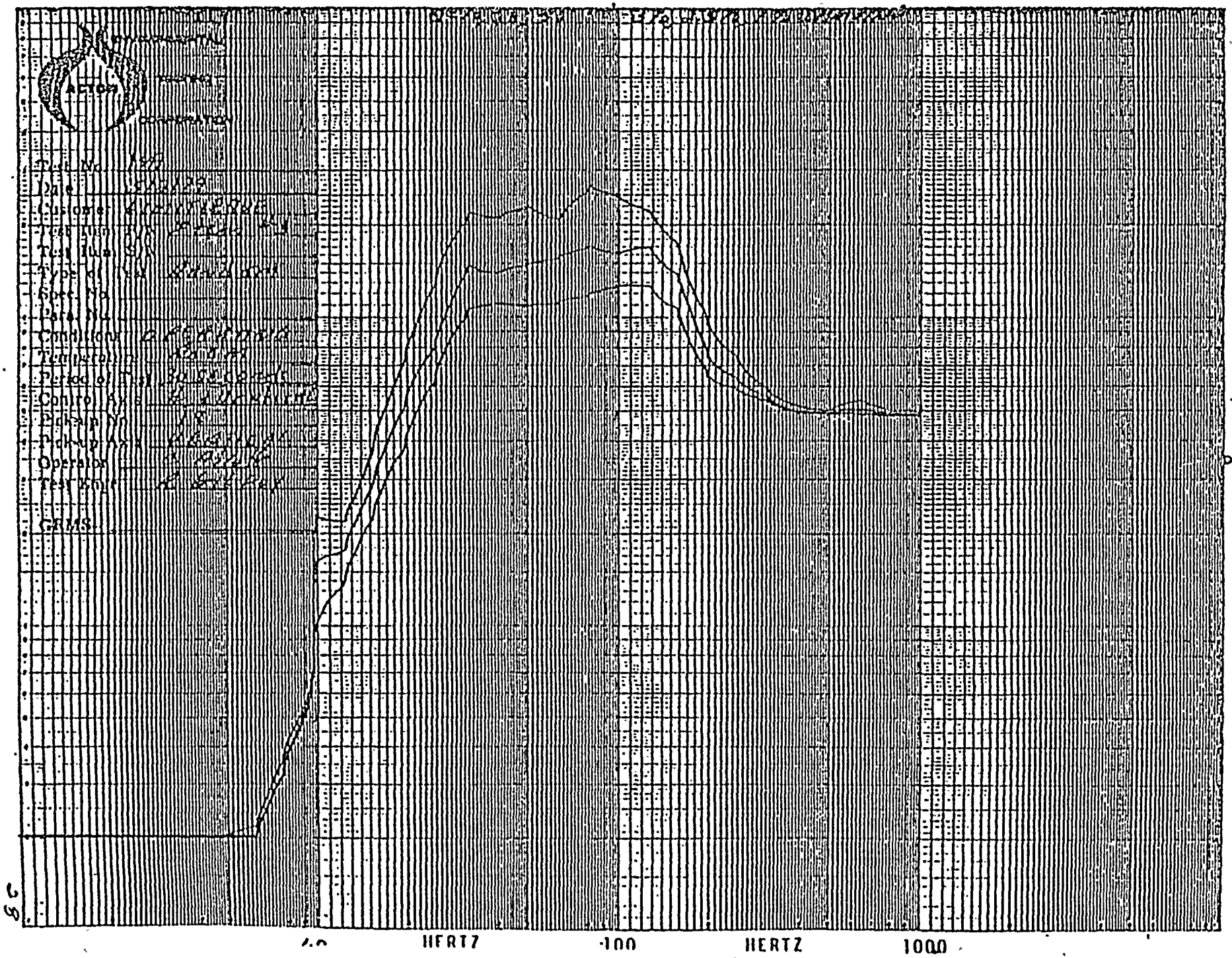

NO. 31,258. LOGARITHMIC FOUR BY THREE 2½ INCH CYCLES.
Keuffel & Esser GRAPH PAPER
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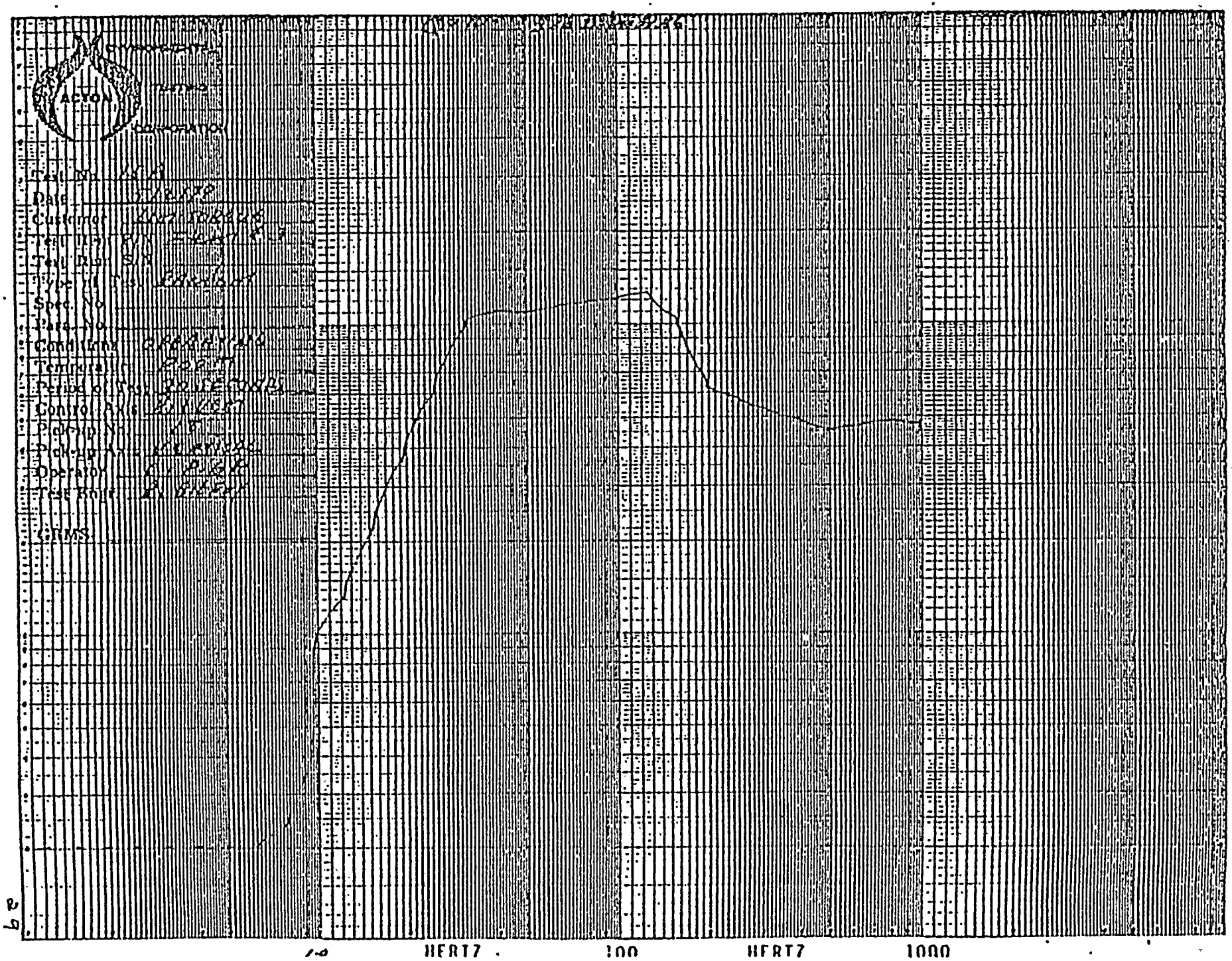

Figure 1

NO. 31,289. LOGARITHMIC FOUR BY THREE 2½ INCH CYCLES.
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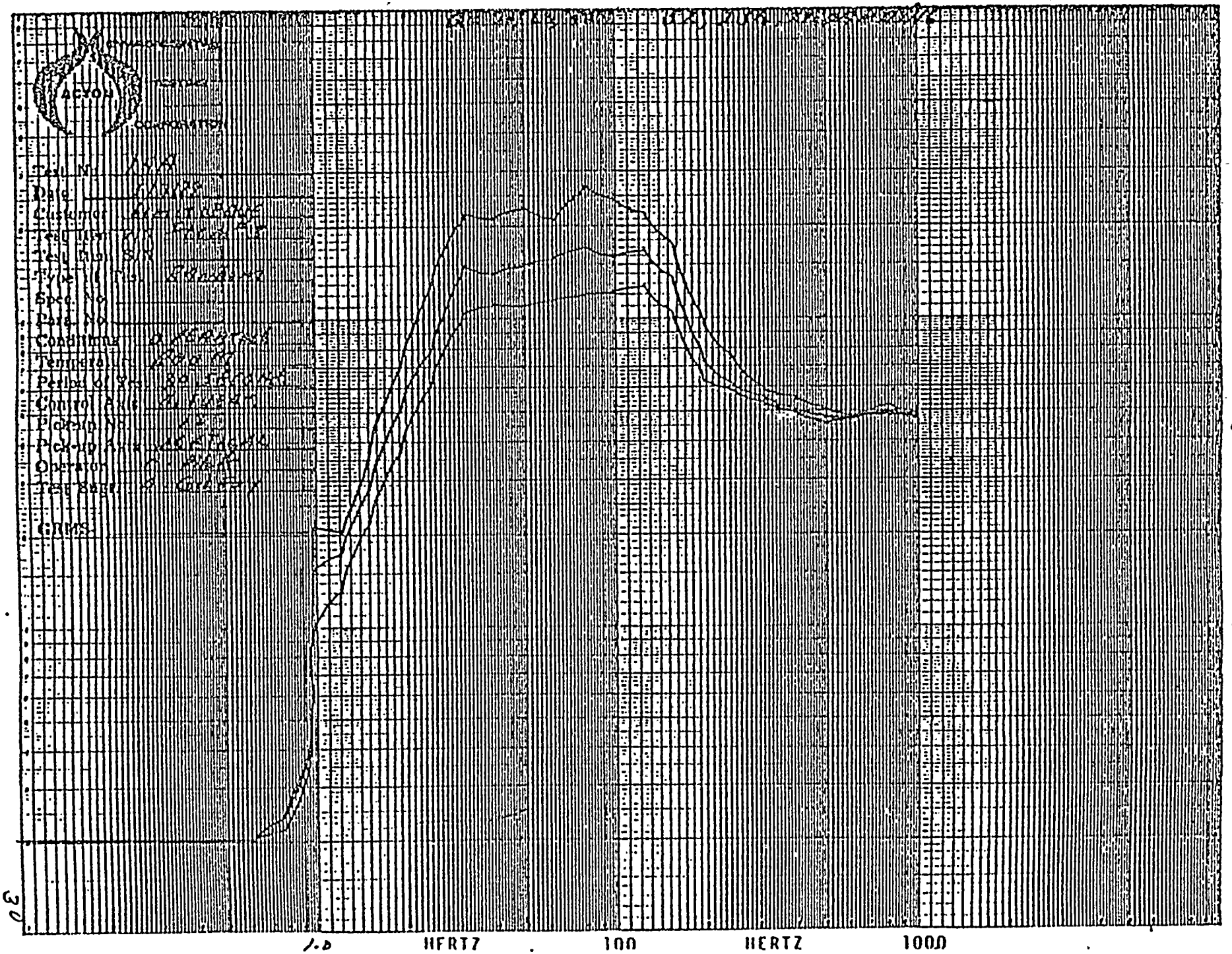
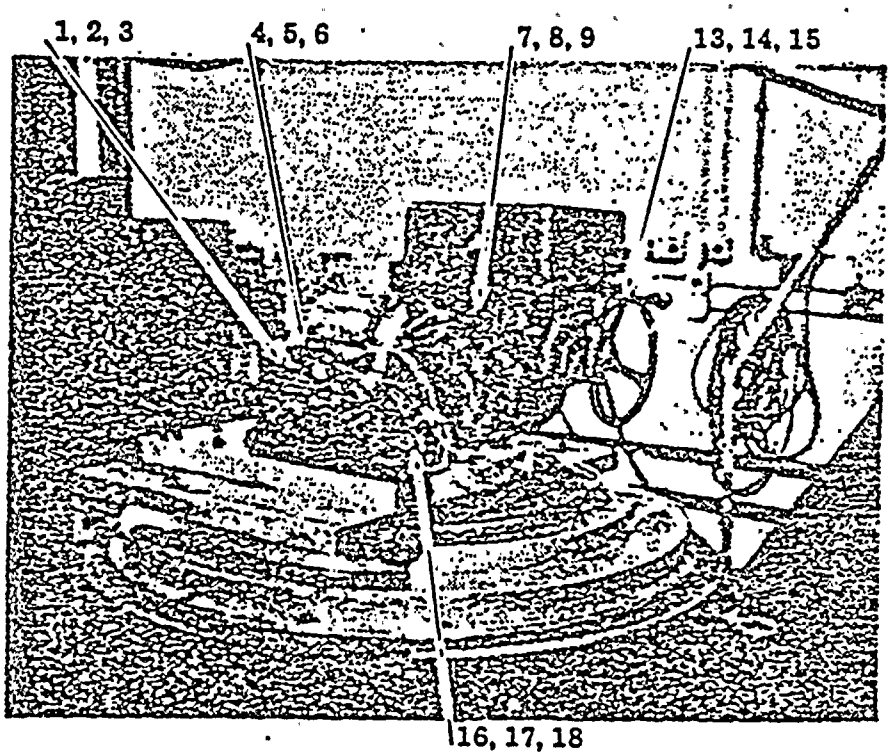


Fig. 31

30

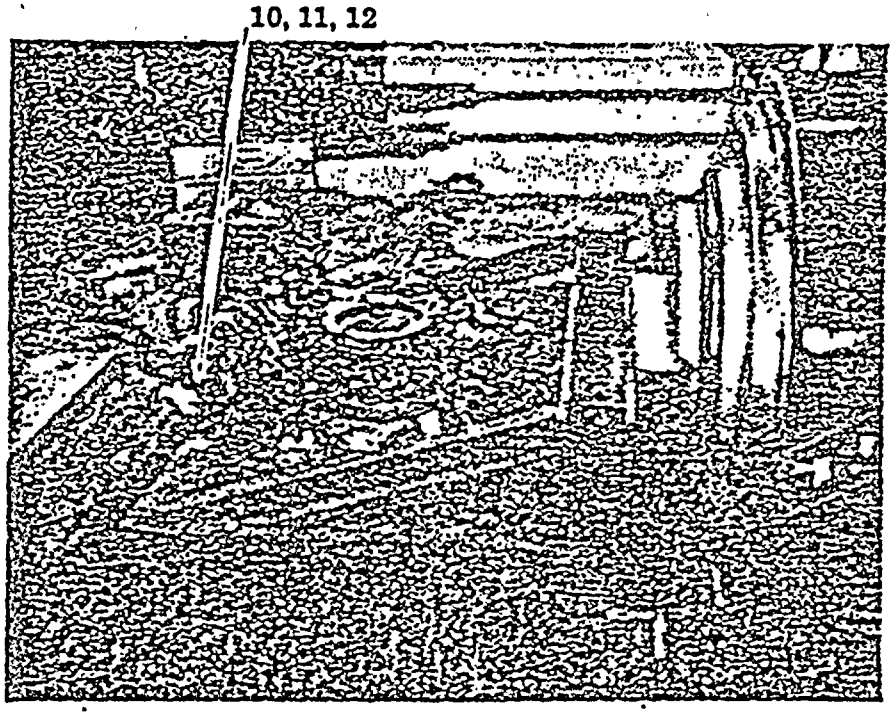
2(0.5)



ACCELEROMETER LOCATIONS
VERTICAL AXIS
ACTUATOR #4
TESTS 1A & 2A
ACTUATOR #3 SIMILAR FOR TESTS 9A & 18A

Report No. 14801-1

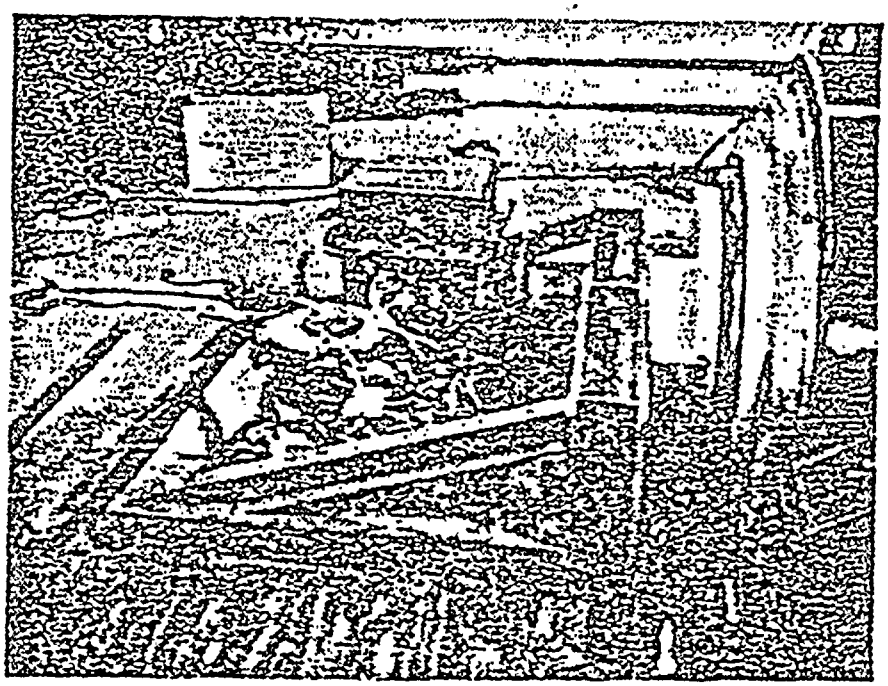
210.51



ACCELEROMETER LOCATIONS
H_2 AXIS
ACTUATOR #4
TESTS 3A & 4A

Report No. 14801-1

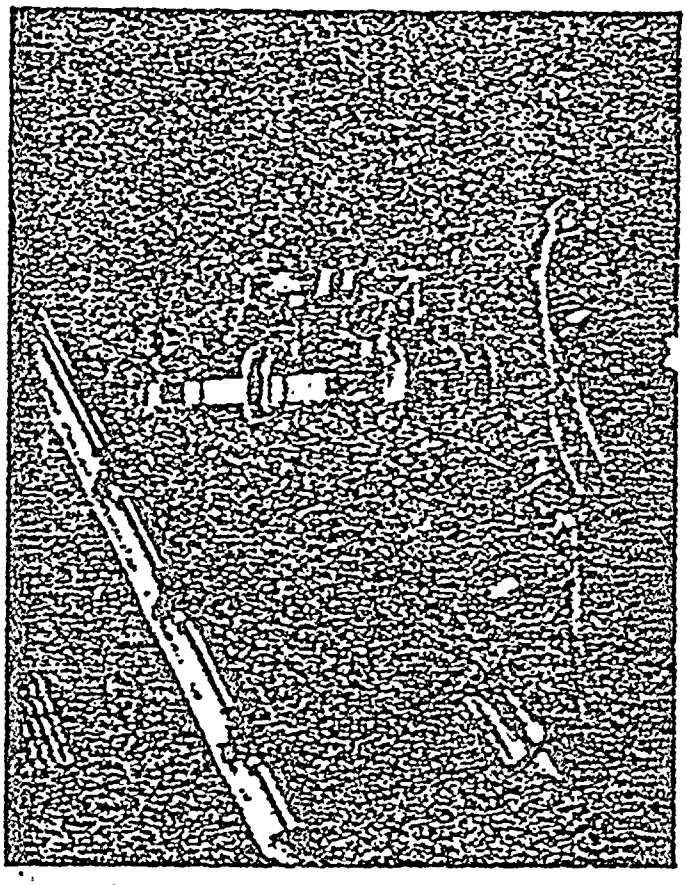
210.51



H_1 AXIS
ACTUATOR #4
TESTS 5A, 6A, 7A
(ACTUATOR #3 SIMILAR FOR TEST 16A)

Report No. 14801-1

210.11



-H_1 & V
BIAXIAL DIRECTION OF EXCITATION
ACTUATOR #3
TESTS 10A-12A

Report No. 14801-1

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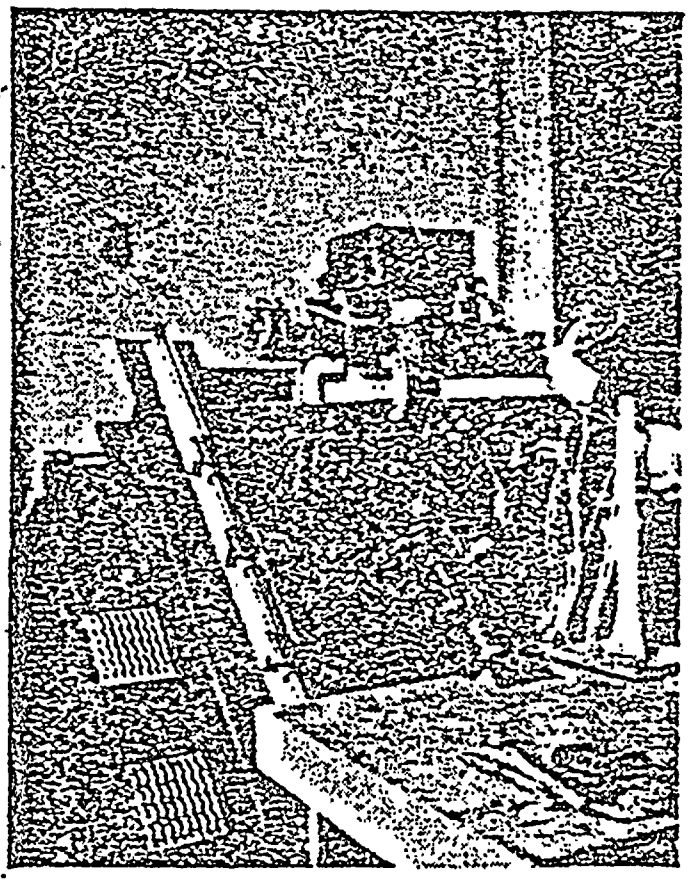


-H_2 & VERTICAL
BIAXIAL DIRECTION OF EXCITATION
ACTUATOR #3
TEST 13A

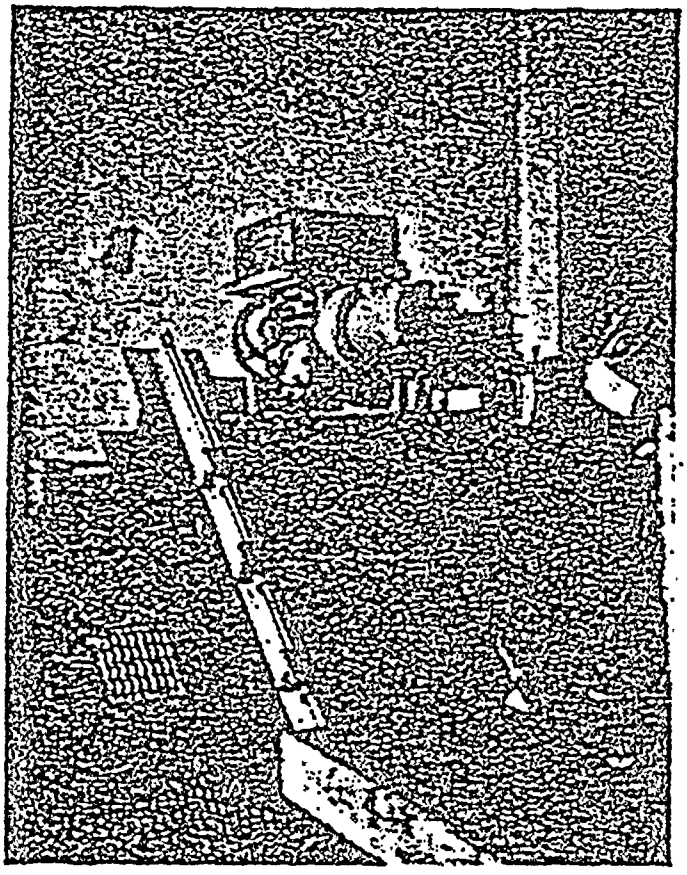
Report No. 14801-1

210, J/

H_2 & V
BIAXIAL DIRECTION OF EXCITATION
ACTUATOR #3
TEST 14A

Report No. 14801-1

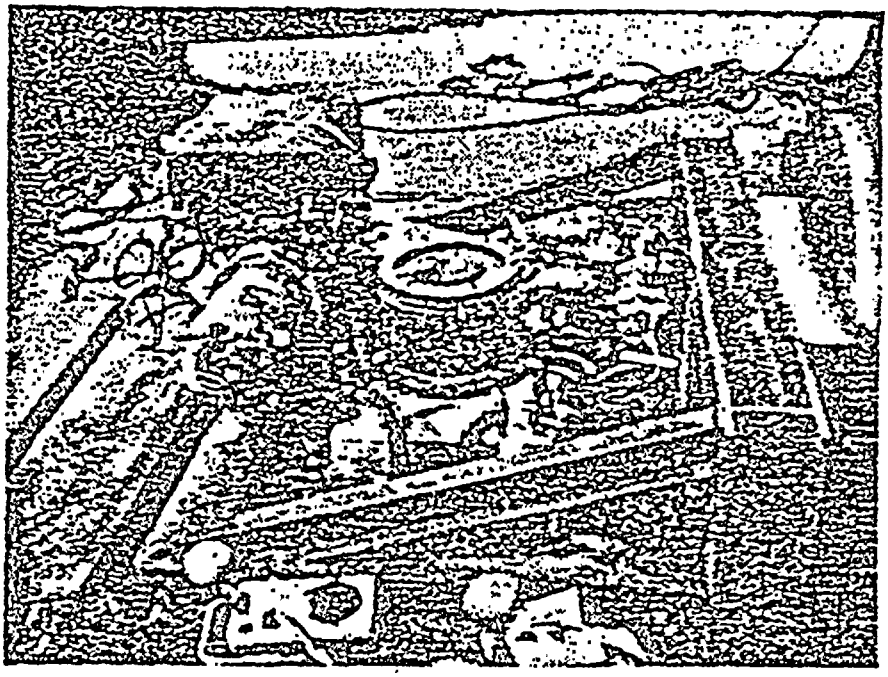
210.51



H_1 & V
BIAXIAL DIRECTION OF EXCITATION
ACTUATOR #3
TEST 15A

Report No. 14801-1

210.5/



H_2 AXIS
ACTUATOR #3
TESTS 8A & 17A

Report No. 14801-1