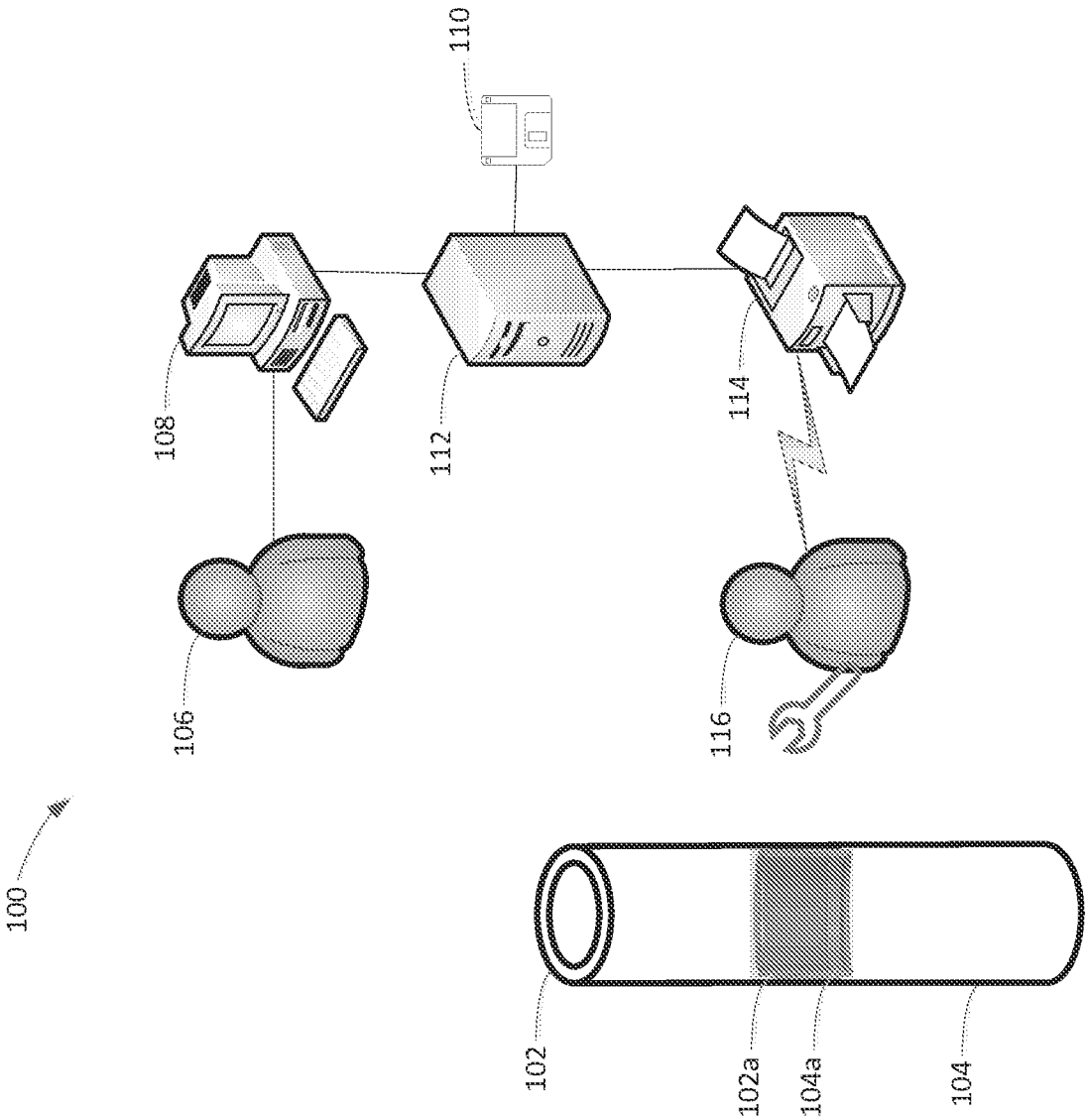

FIG. 1

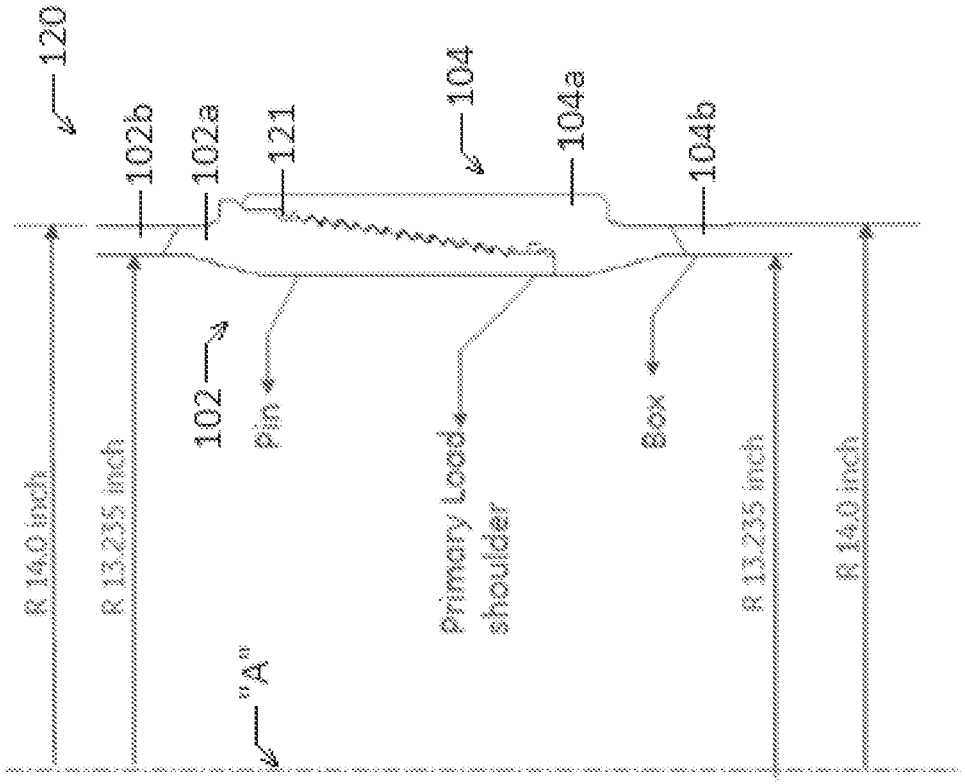

FIG. 2A

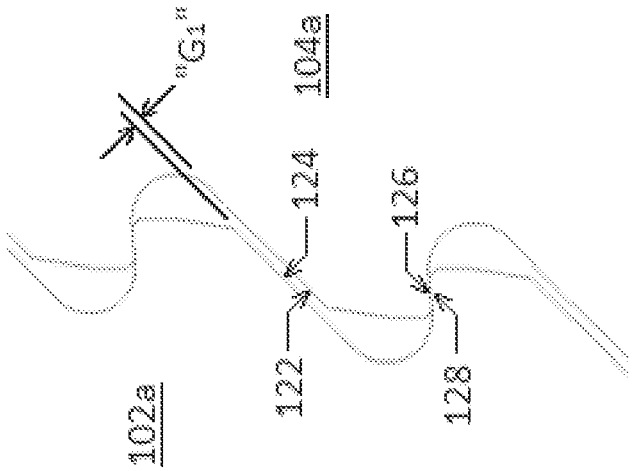

FIG. 2B

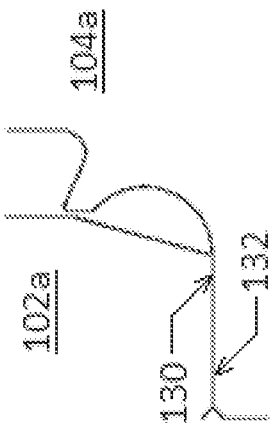

FIG. 2C

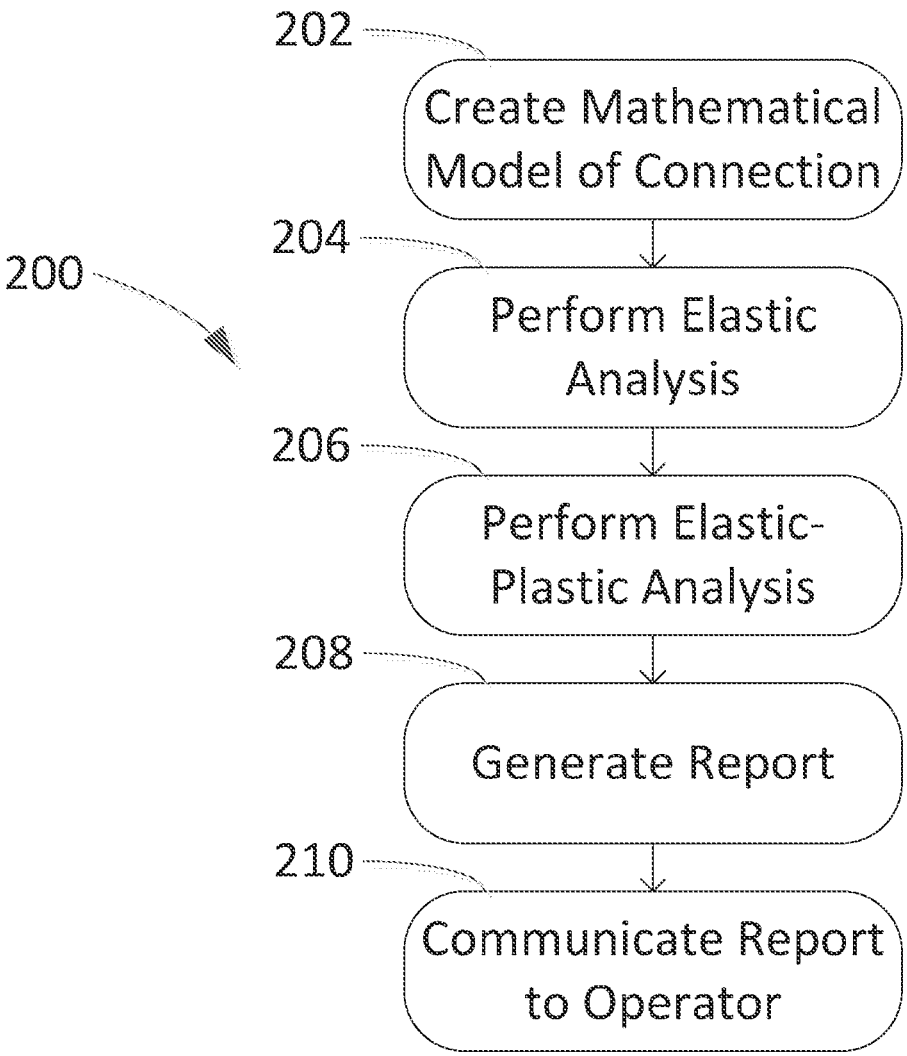
202
Create Mathematical Model of Connection
204
200
Perform Elastic Analysis
206
Perform Elastic-Plastic Analysis
208
Generate Report
210
Communicate Report to Operator

FIG. 3A

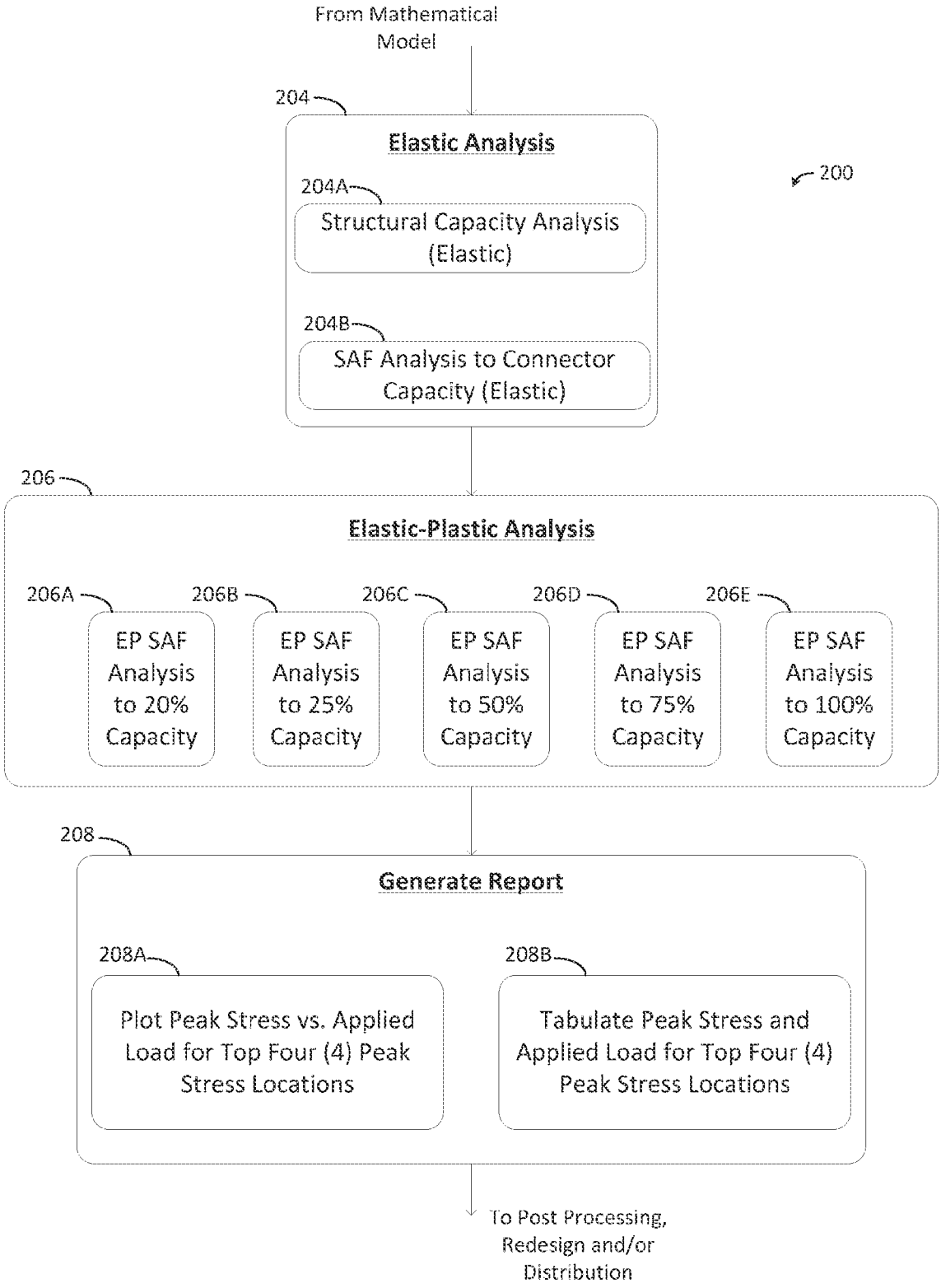
From Mathematical Model
204
Elastic Analysis
200
204A
Structural Capacity Analysis (Elastic)
204B
SAF Analysis to Connector Capacity (Elastic)
206
Elastic-Plastic Analysis
206A
EP SAF Analysis to 20% Capacity
206B
EP SAF Analysis to 25% Capacity
206C
EP SAF Analysis to 50% Capacity
206D
EP SAF Analysis to 75% Capacity
206E
EP SAF Analysis to 100% Capacity
208
Generate Report
208A
Plot Peak Stress vs. Applied Load for Top Four (4) Peak Stress Locations
208B
Tabulate Peak Stress and Applied Load for Top Four (4) Peak Stress Locations
To Post Processing, Redesign and/or Distribution

FIG. 3B

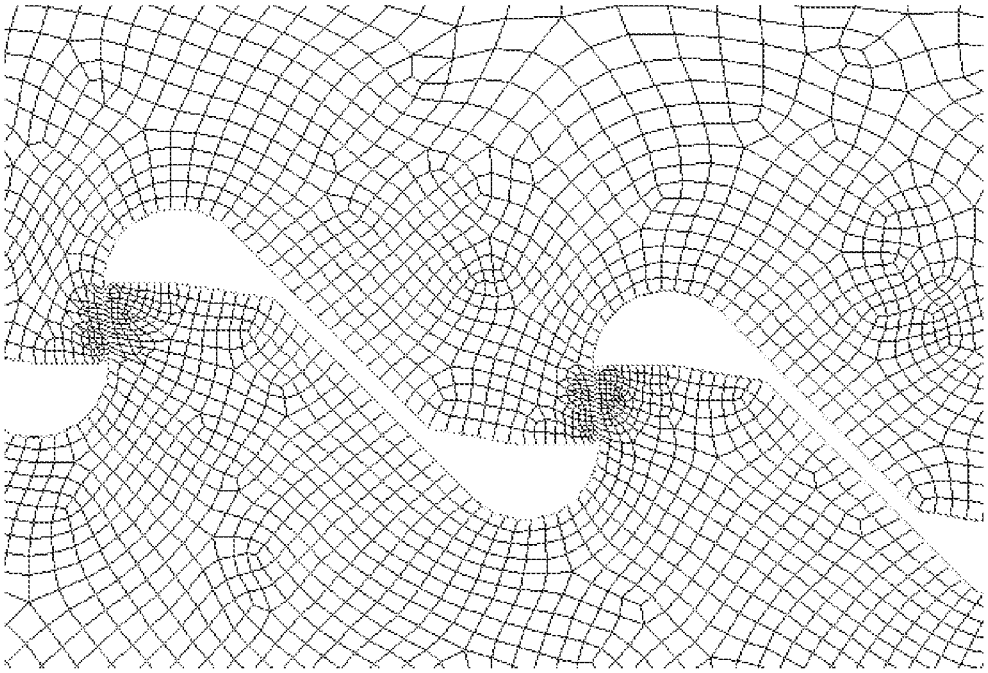

FIG. 4B

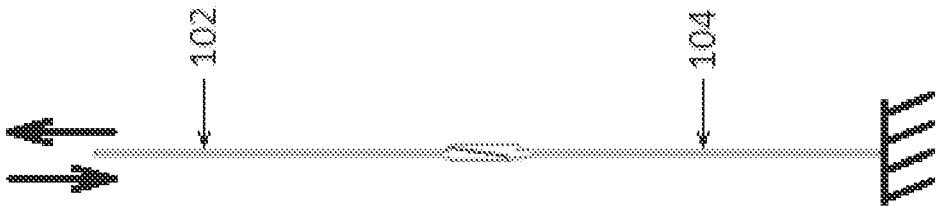

FIG. 4A

Load Step	*Description*
1	Preload
2	~0.0125*capacity
3	~0.0250*capacity
4	~0.050*capacity
5	~0.0625*capacity
6	0.125*capacity
7	0.25*capacity
8	0.5*capacity
9	1*capacity

FIG. 5A

Load step	Factor	Tension load, kips	Compression load, kips
1	0	0	0
2	0.0125	61	31
3	0.025	123	62
4	0.0625	306	155
5	0.125	613	309
6	0.25	1225	619
7	0.5	2450	1238
8	1	4900	2475

FIG. 5B

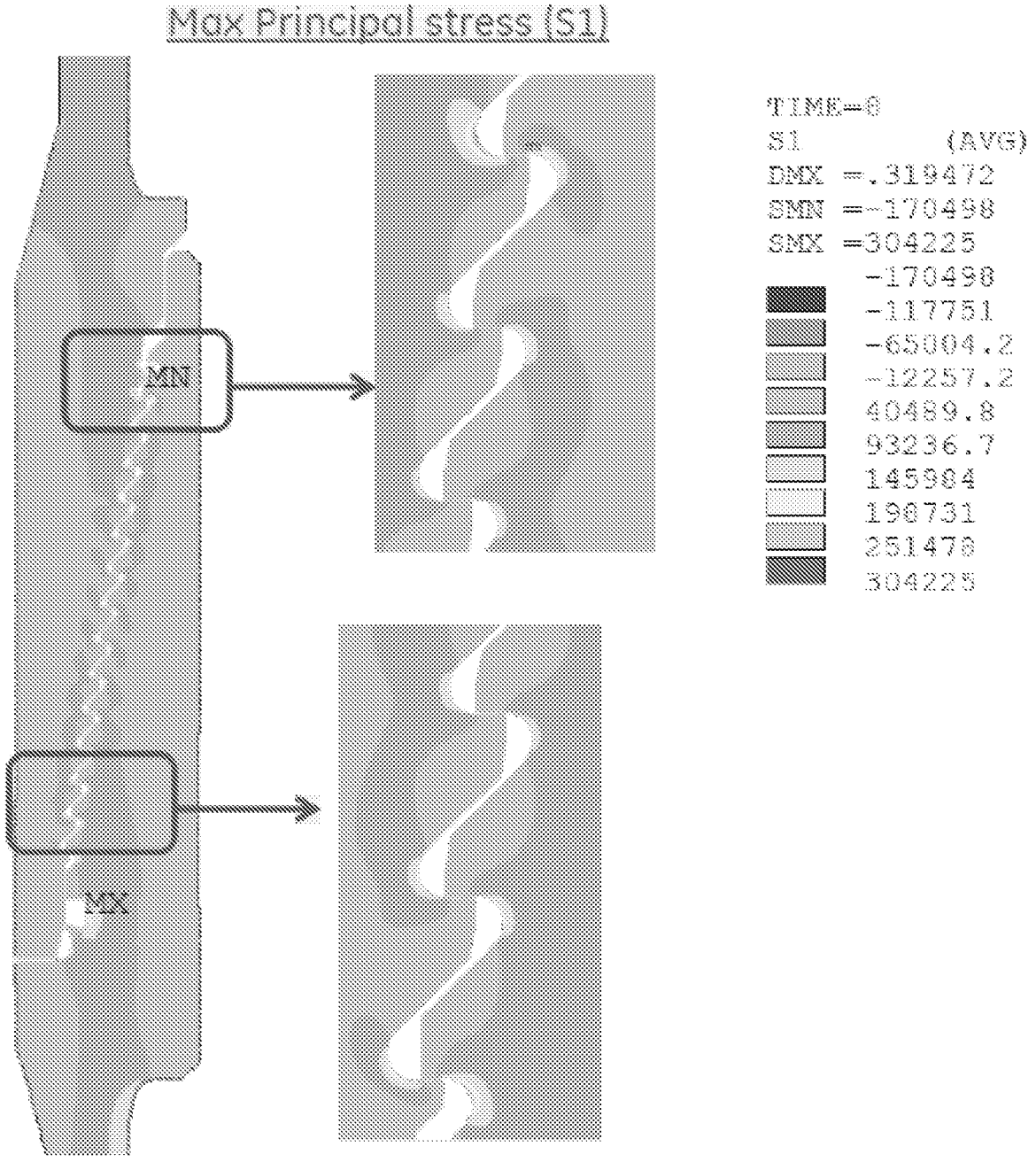
Max Principal stress (S1)
MN
MX
TIME=0
S1 (AVG)
DMX =.319472
SMN =-170498
SMX =304225
-170498
-117751
-65004.2
-12257.2
40489.8
93236.7
145984
198731
251478
304225

FIG. 6

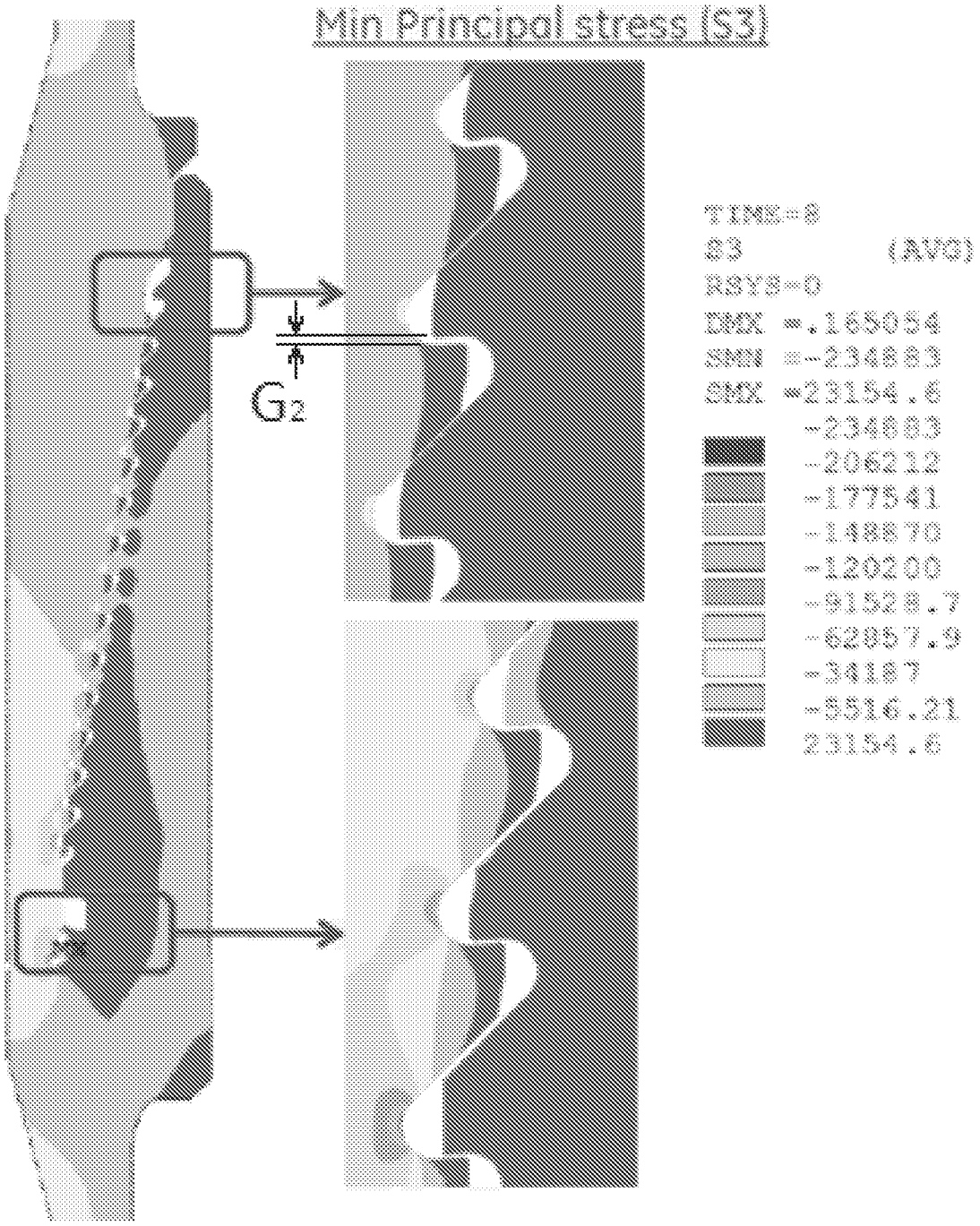
Min Principal stress (S3)
G2
TIME=8
S3 (AVG)
RSYS=0
DMX =.168054
SMN =-234883
SMX =23154.6
-234883
-206212
-177541
-148870
-120200
-91528.7
-62857.9
-34187
-5516.21
23154.6

FIG. 7

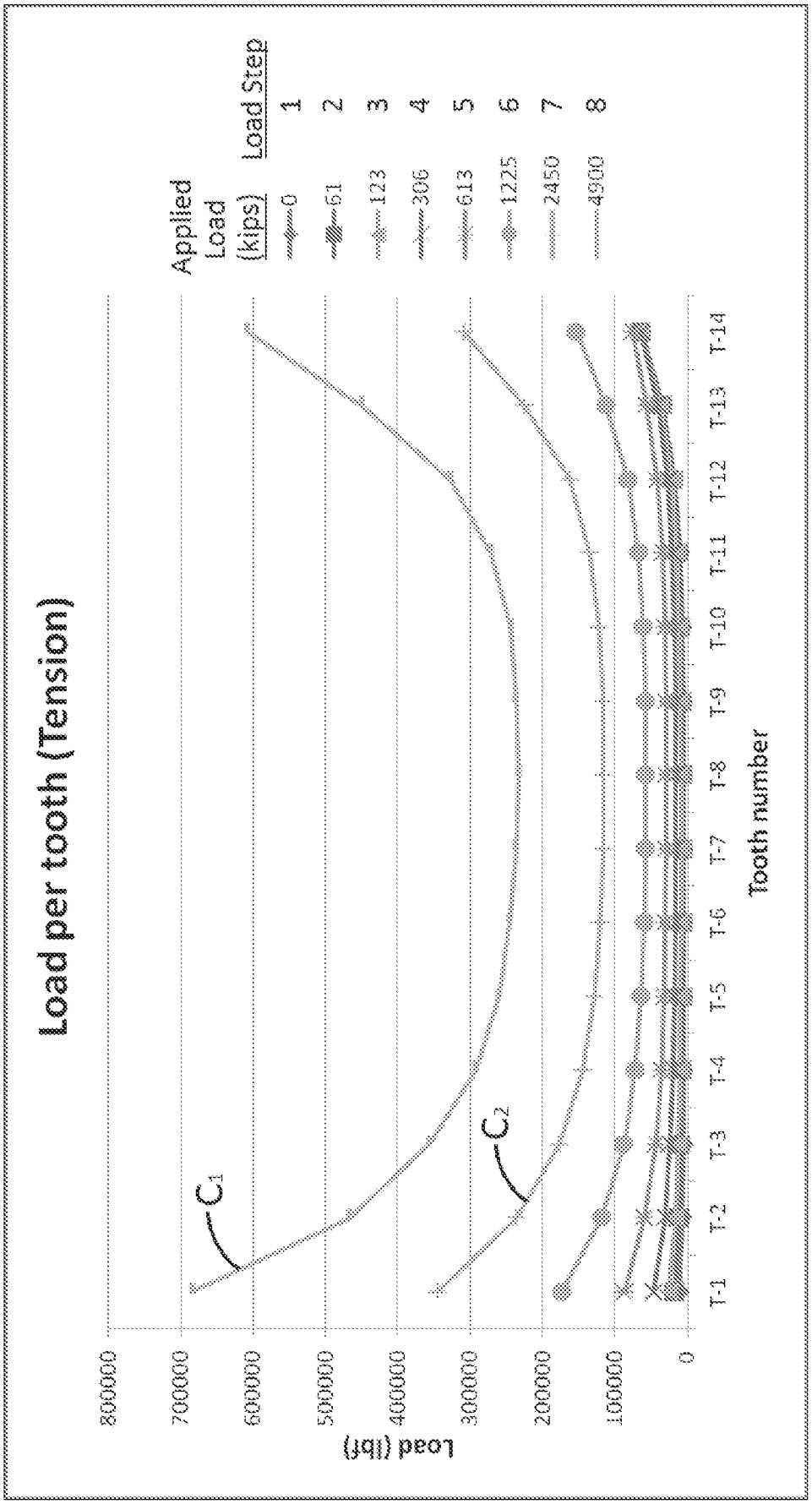
Load per tooth (Tension)
Load (lbf)
800000
700000
600000
500000
400000
300000
200000
100000
0
T-1
T-2
T-3
T-4
T-5
T-6
T-7
T-8
T-9
T-10
T-11
T-12
T-13
T-14
Tooth number
C1
C2
Applied Load (kips)
Load Step
0
1
61
2
123
3
306
4
613
5
1225
6
2450
7
4900
8

FIG. 8A

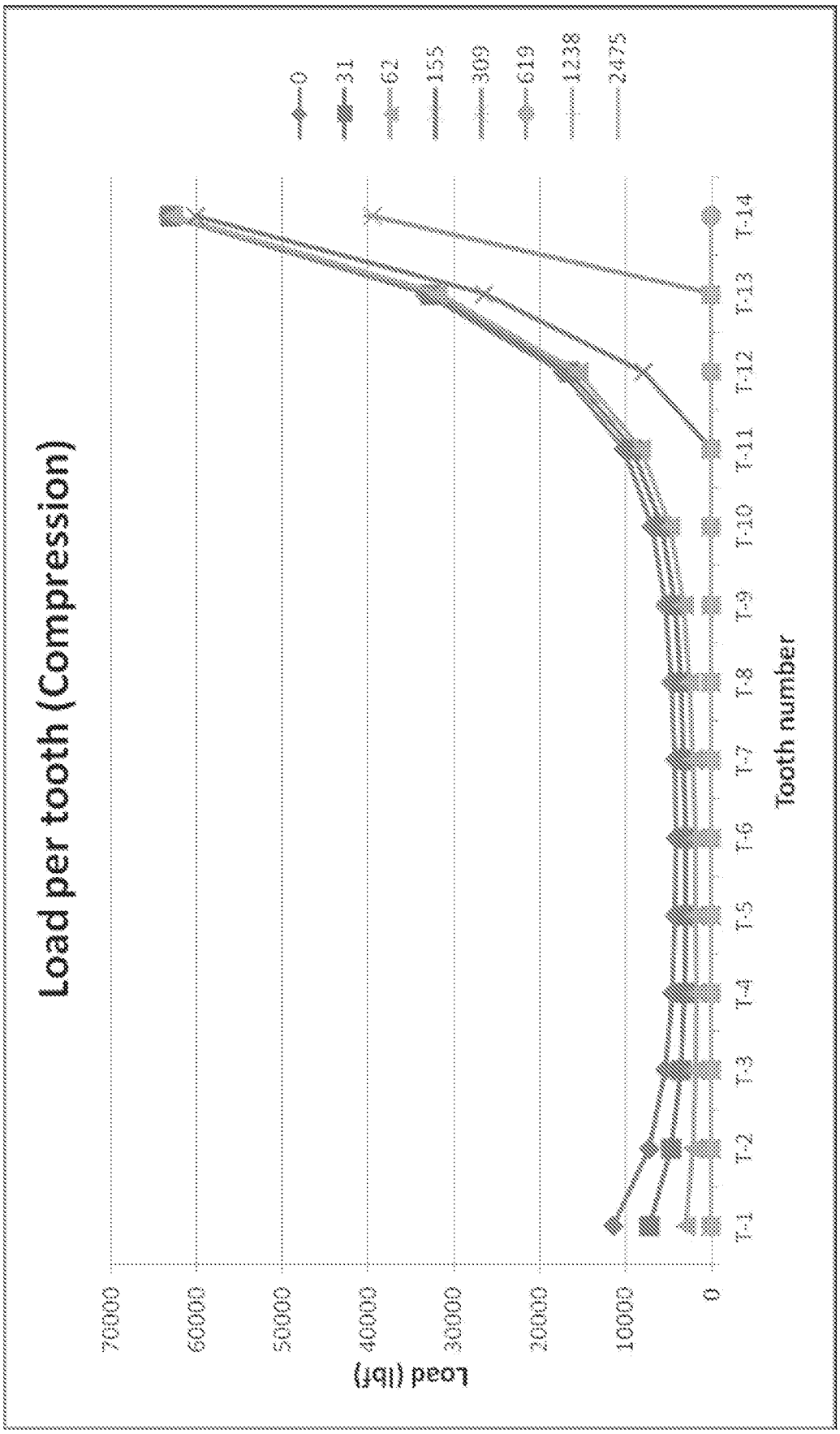
Load per tooth (Compression)
Load (lbf)
70000
60000
50000
40000
30000
20000
10000
0
T-1
T-2
T-3
T-4
T-5
T-6
T-7
T-8
T-9
T-10
T-11
T-12
T-13
T-14
Tooth number
0
31
62
155
309
619
1238
2475

FIG. 8B

	Load step	Load, kips	Peak stress (psi)- S1 in tension & S3 in compression	Connector alt stress,psi	Pipe alt stress, psi	SAF
compression	8	-2475	-47664	-23804	-18102	1.32
	7	-1237	-23859	-11923	-9051	
	6	-618	-11937	-5856	-4526	
	5	-309	-6081	-2892	-2263	
	4	-154	-3190	-2468	-1358	3.01
	3	-61	-806	-1527	-453	
	2	-30	-3	-1523	-453	
	1	0	-5	0	0	
tension	1	0	3363	0	0	
	2	61	6099	2959	896	
	3	123	8985	2962	896	
	4	306	17858	8954	2688	
	5	613	34100	16242	4480	3.72
	6	1225	68295	34195	8960	
	7	2450	136137	67842	17920	
	8	4900	269563	133426	35839	

FIG. 9

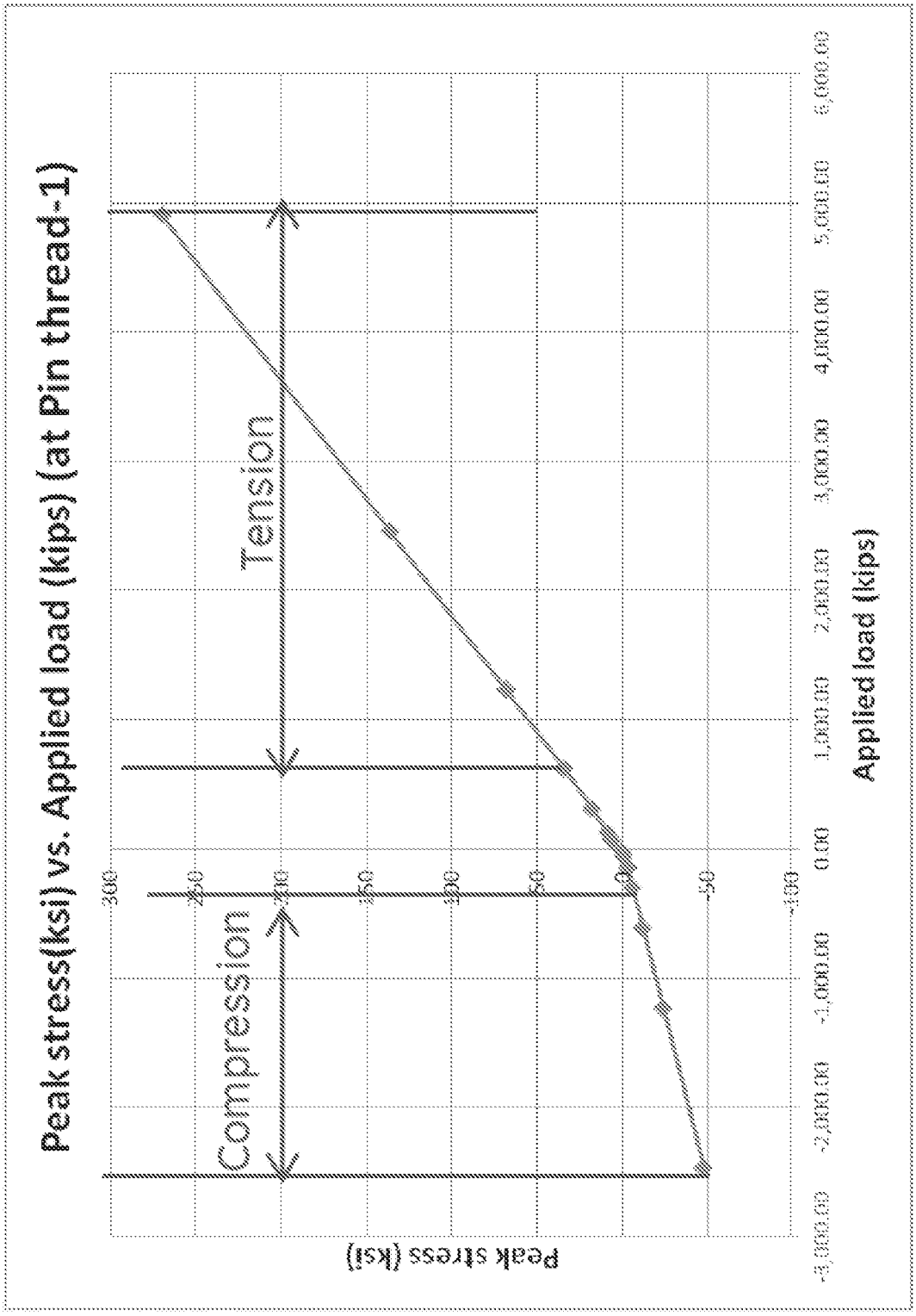
Peak stress(ksi) vs. Applied load (kips) (at Pin thread-1)
Tension
Compression
Peak stress (ksi)
Applied load (kips)
300
250
200
150
100
50
0
-50
-100
-3,000.00
-2,000.00
-1,000.00
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00

FIG. 10

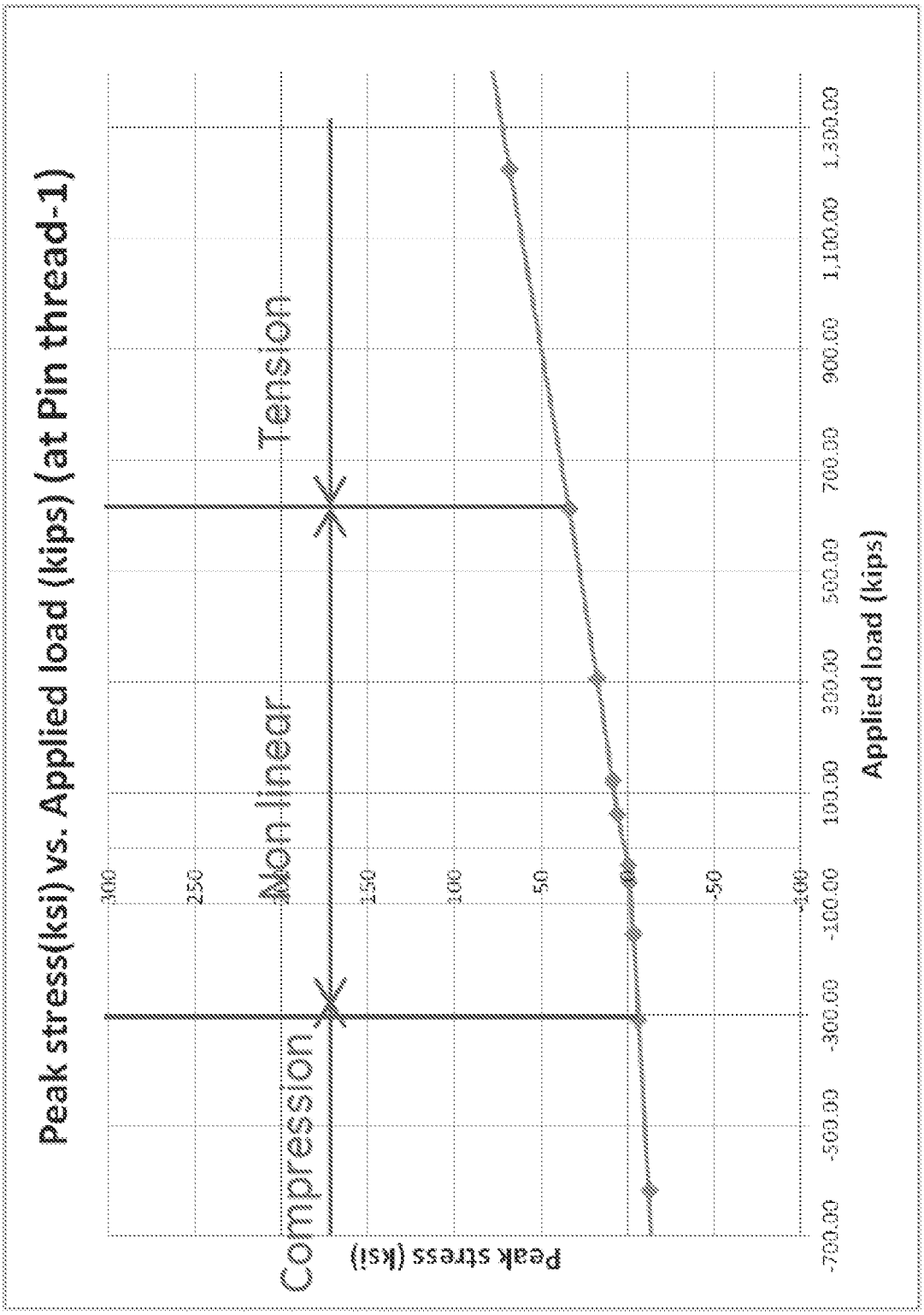
Peak stress(ksi) vs. Applied load (kips) (at Pin thread-1)
Tension
Mon linear
Compression
Peak stress (ksi)
300
250
150
100
50
-50
-100
-700.00
-500.00
-300.00
-100.00
100.00
300.00
500.00
700.00
900.00
1,100.00
1,300.00
Applied load (kips)

FIG. 11

Load step	Description
1	Pre load
2	Peak load
3	Un load
4	Peak load
5	Un load
6	Peak load
7	Un load
8	Load 1
9	Load 2
10	Load 3
11	Load 4
12	Load 5
13	Load 6
14	Peak load

FIG. 12

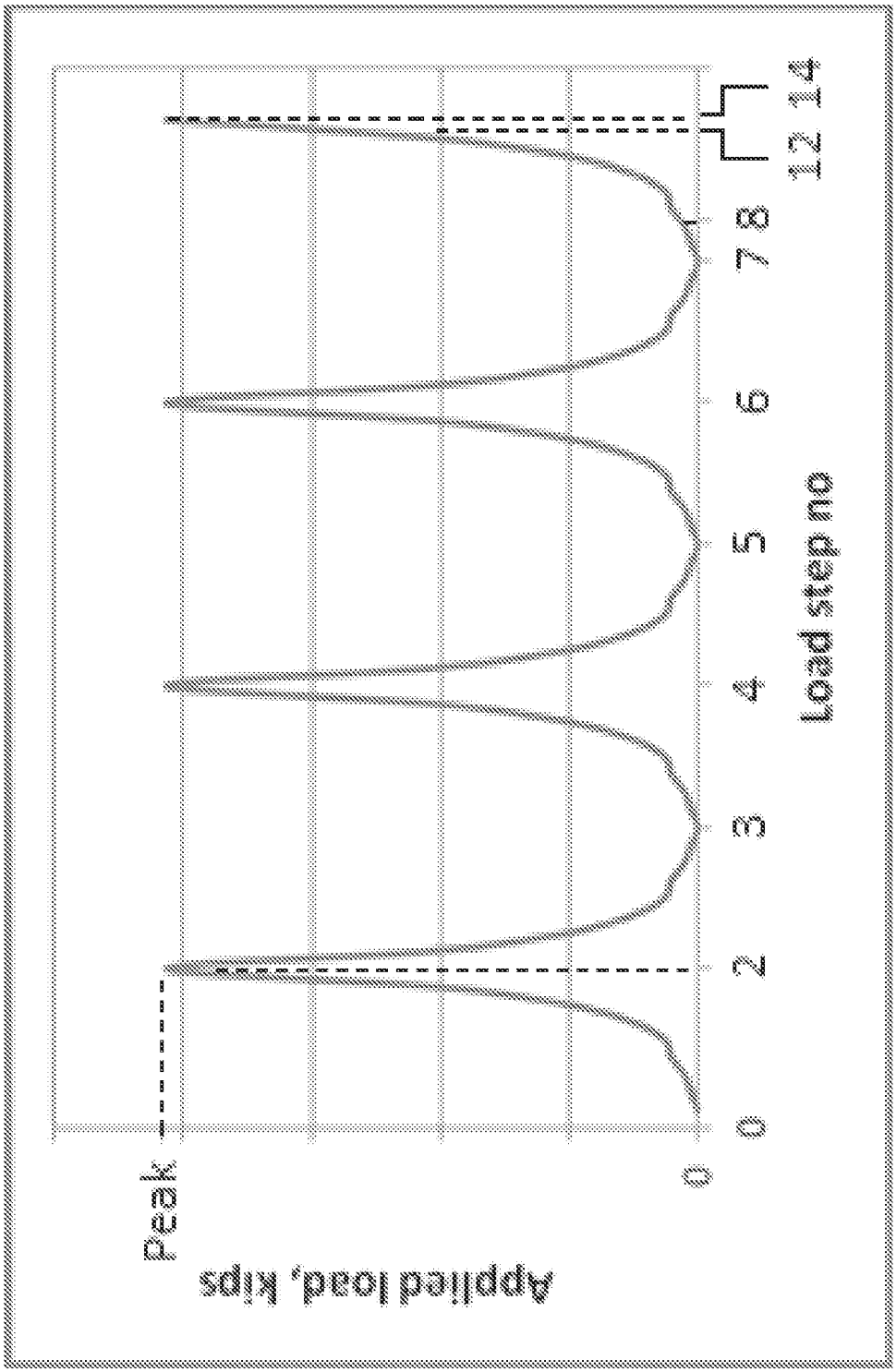

FIG. 13

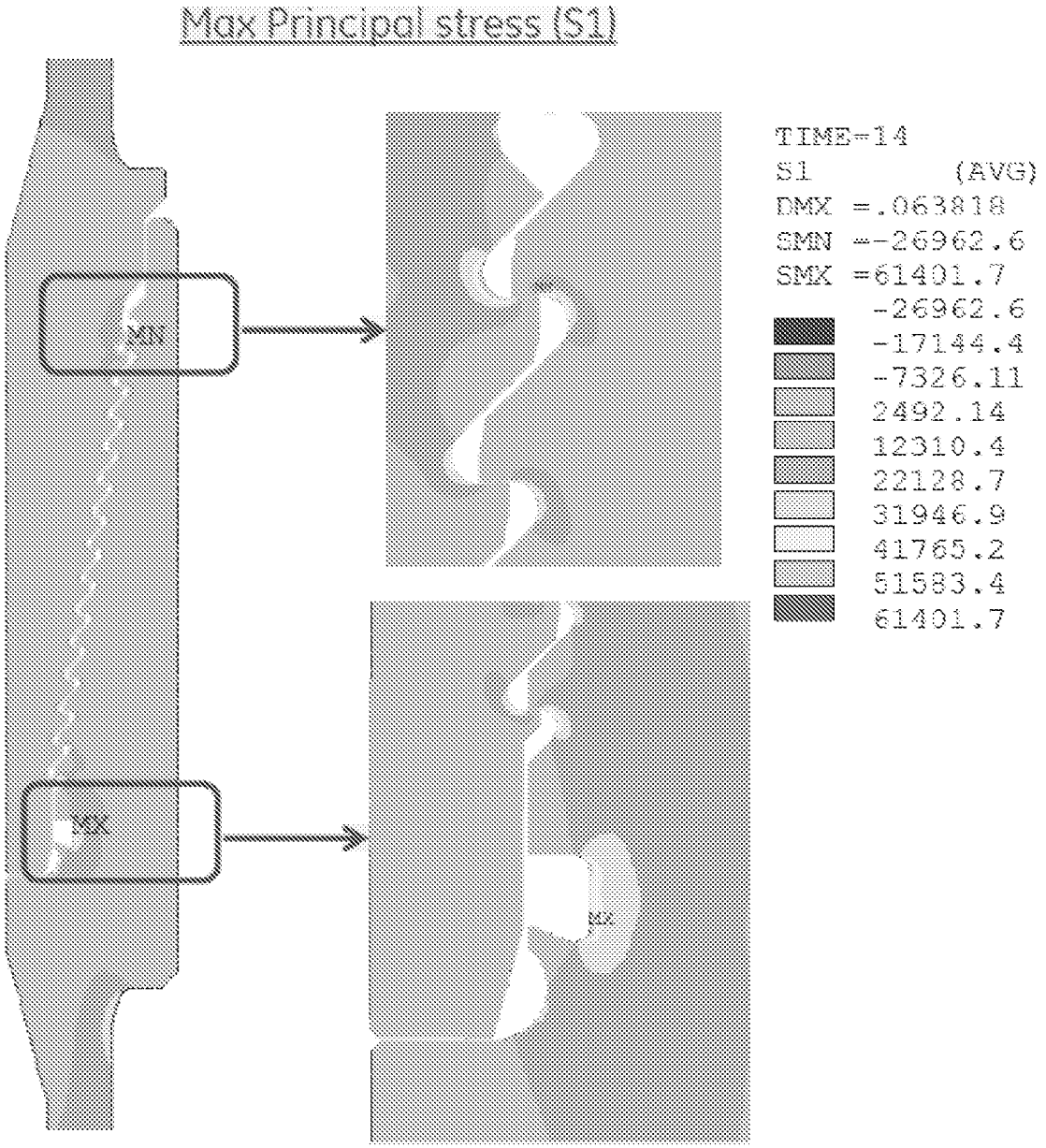
Max Principal stress (S1)
TIME=14
S1 (AVG)
DMX =.063818
SMN =-26962.6
SMX =61401.7
-26962.6
-17144.4
-7326.11
2492.14
12310.4
22128.7
31946.9
41765.2
51583.4
61401.7
MN
MX

FIG. 14

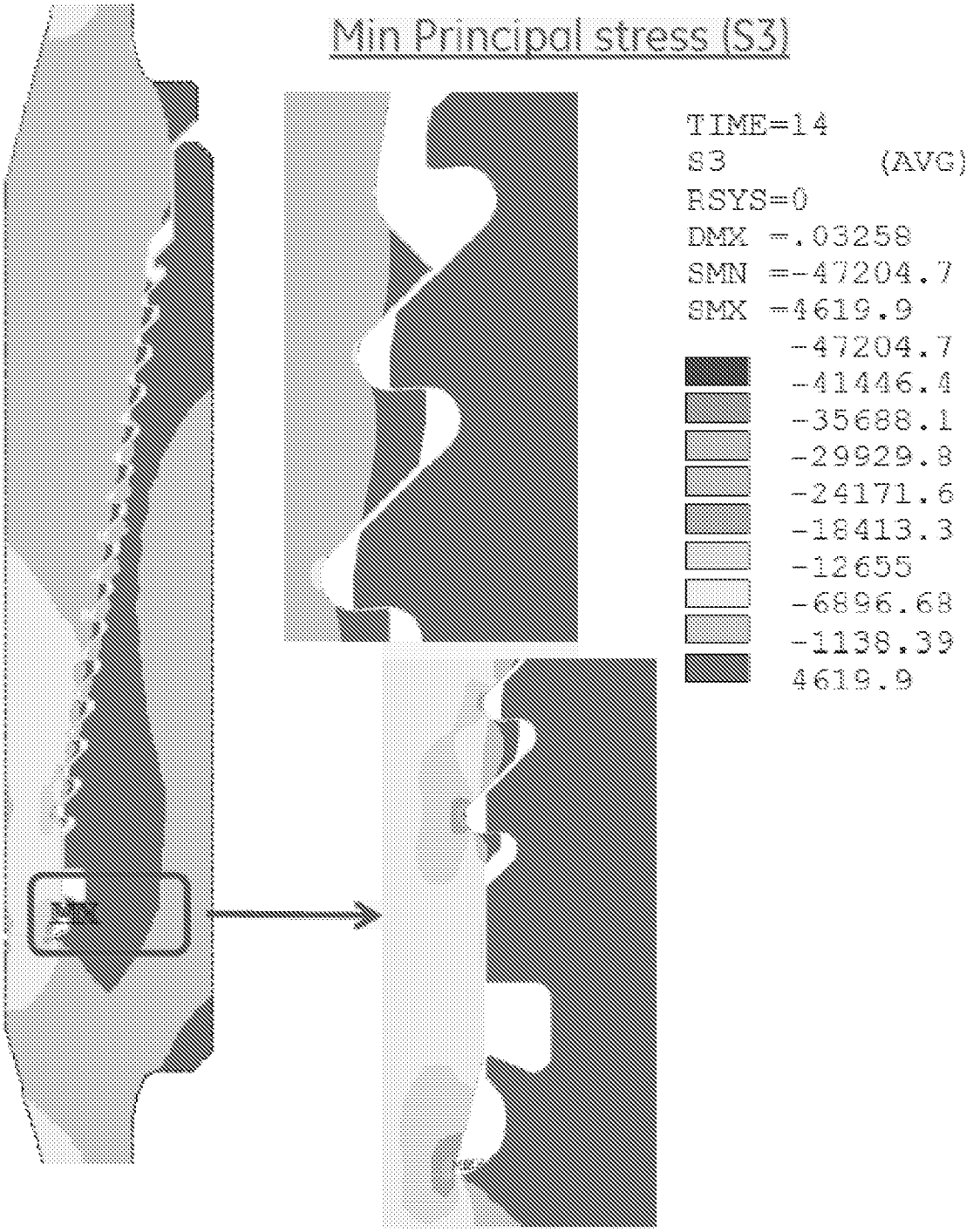
Min Principal stress (S3)
TIME=14
S3 (AVG)
RSYS=0
DMX =.03258
SMN =-47204.7
SMX =4619.9
-47204.7
-41446.4
-35688.1
-29929.8
-24171.6
-18413.3
-12655
-6896.68
-1138.39
4619.9

FIG. 15

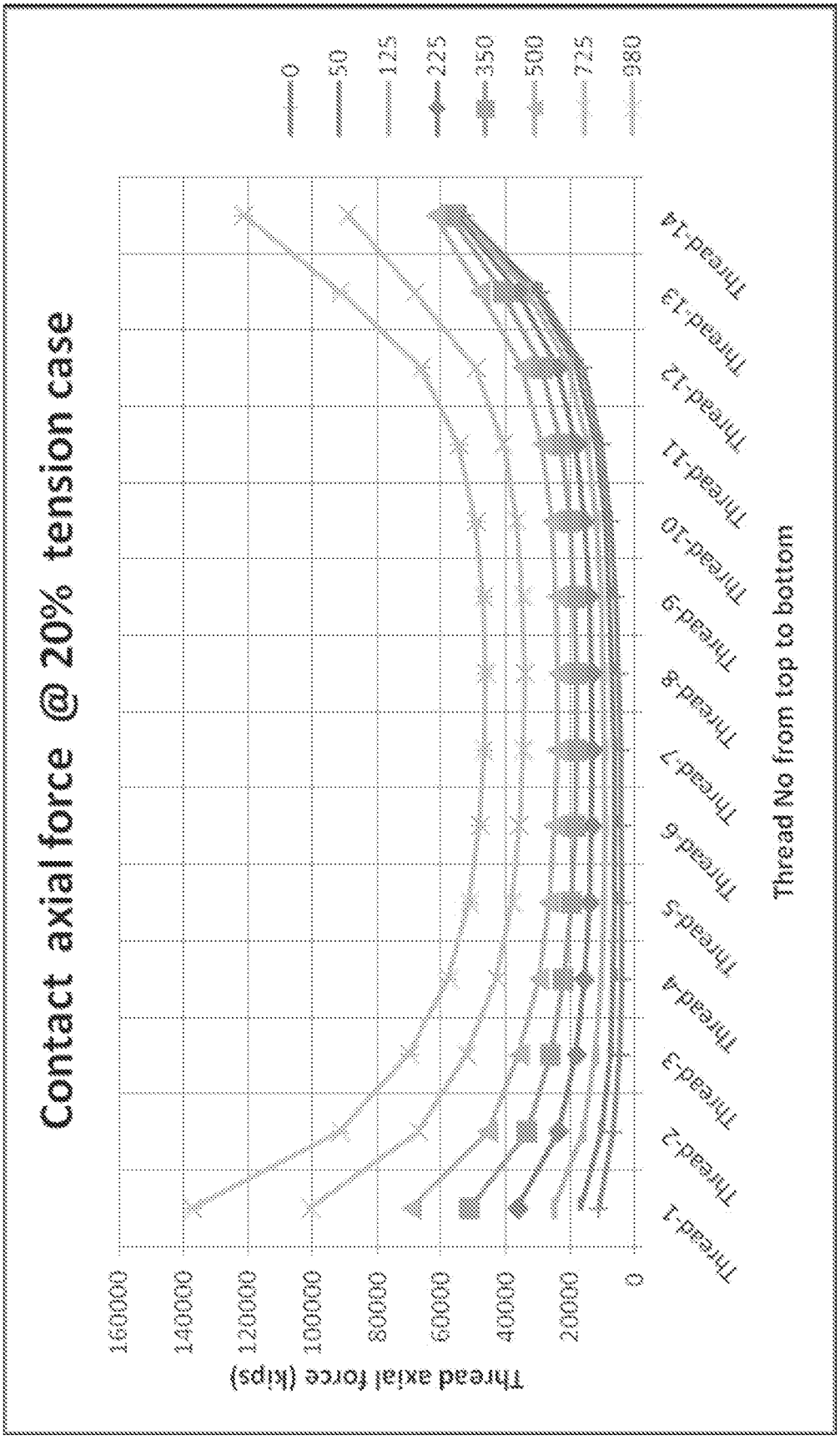
Contact axial force @ 20% tension case
Thread axial force (kips)
160000
140000
120000
100000
80000
60000
40000
20000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
50
125
225
350
500
725
980

FIG. 16A

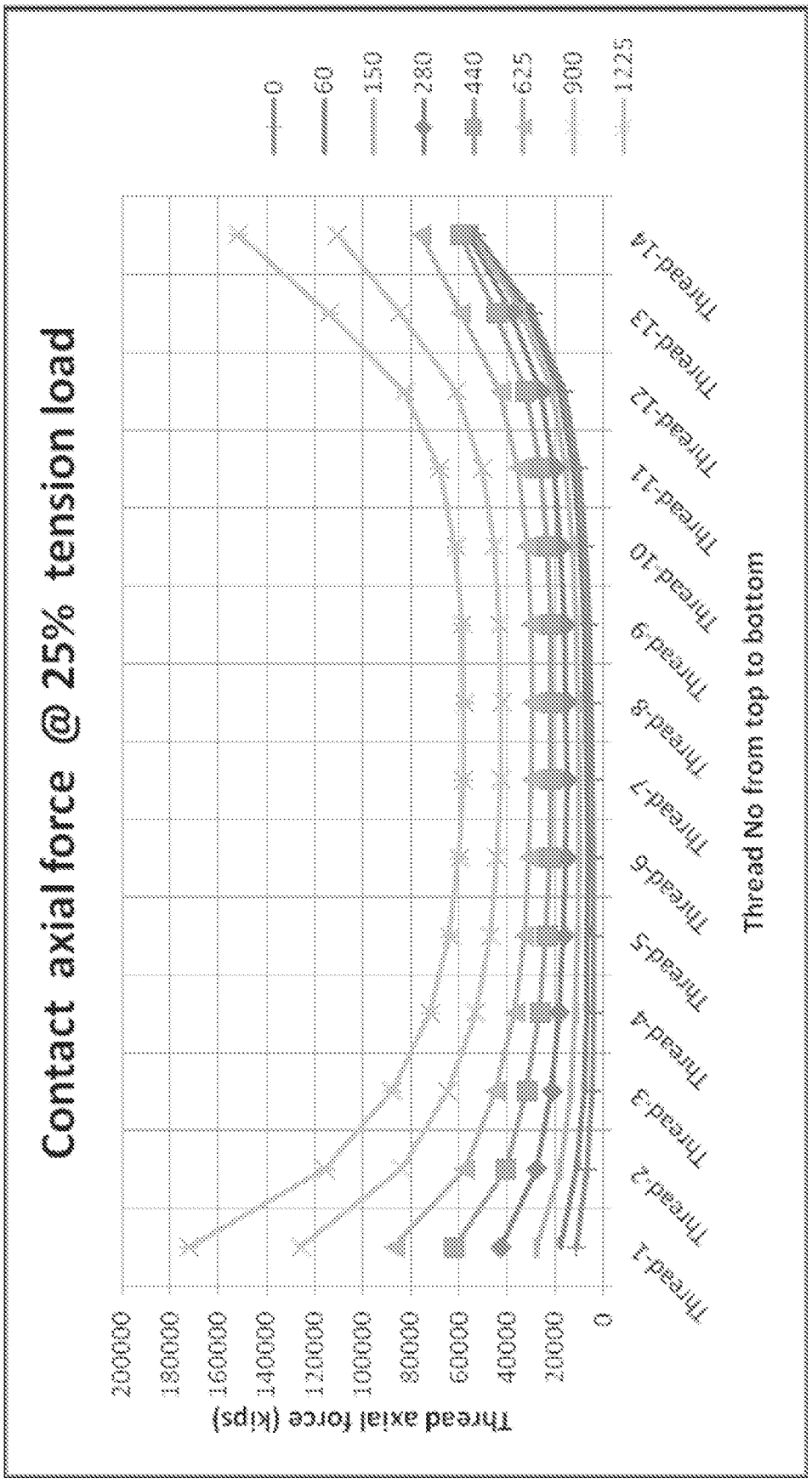
Contact axial force @ 25% tension load
Thread axial force (kips)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
60
150
280
440
625
900
1225

FIG. 16B

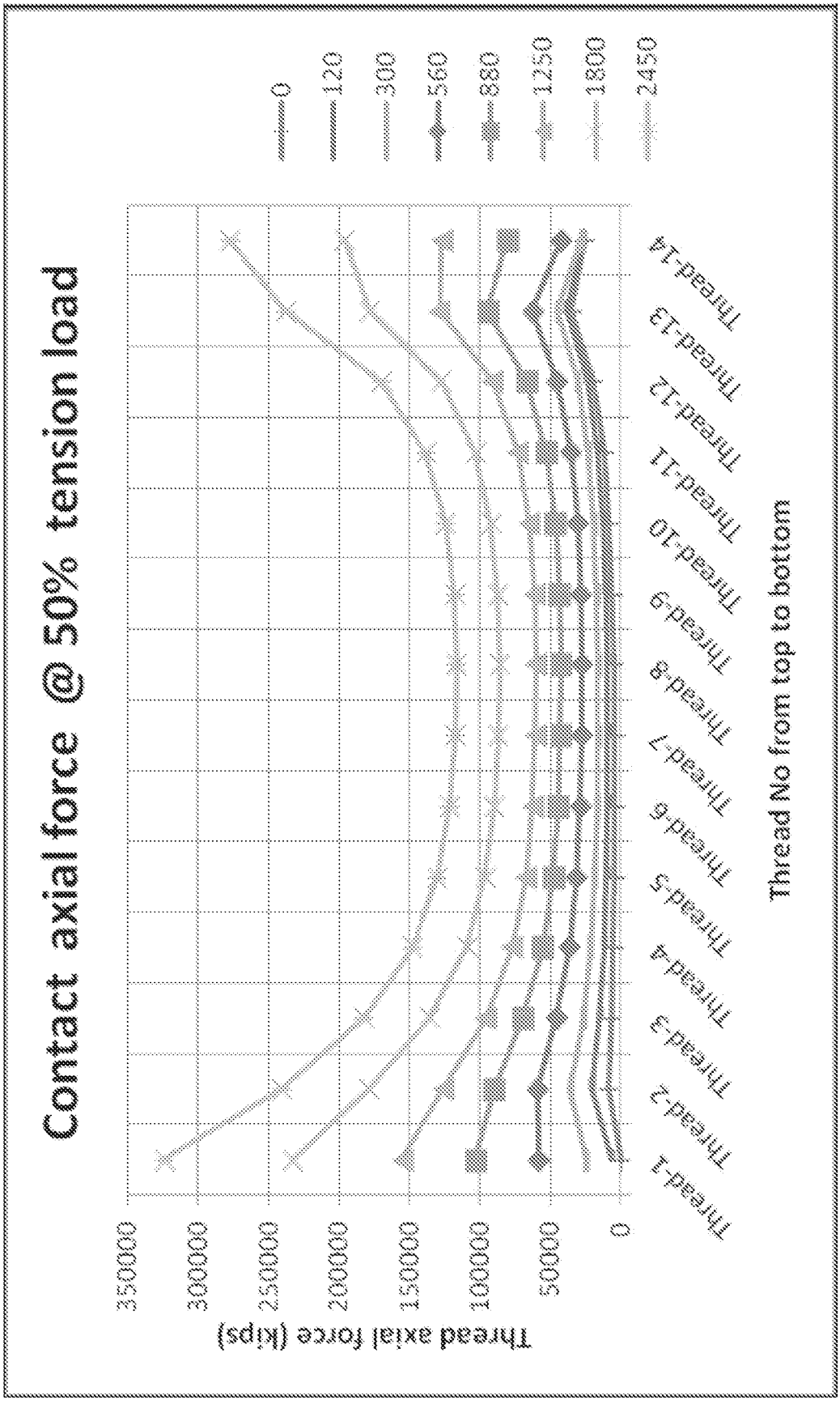
Contact axial force @ 50% tension load
Thread axial force (kips)
350000
300000
250000
200000
150000
100000
50000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
120
300
560
880
1250
1800
2450

FIG. 16C

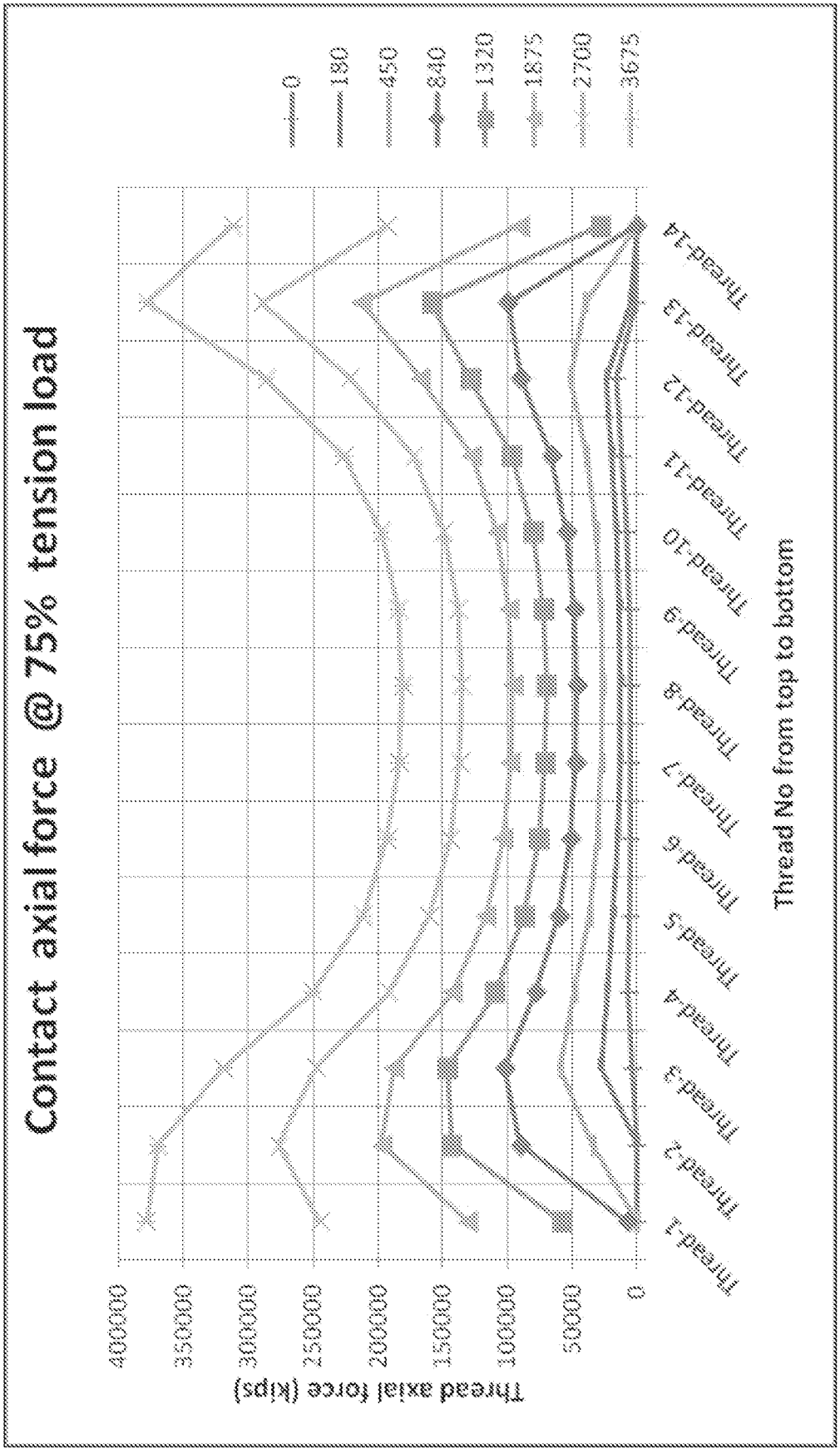
Contact axial force @ 75% tension load
Thread axial force (kips)
400000
350000
300000
250000
200000
150000
100000
50000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
180
450
840
1320
1875
2700
3675

FIG. 16D

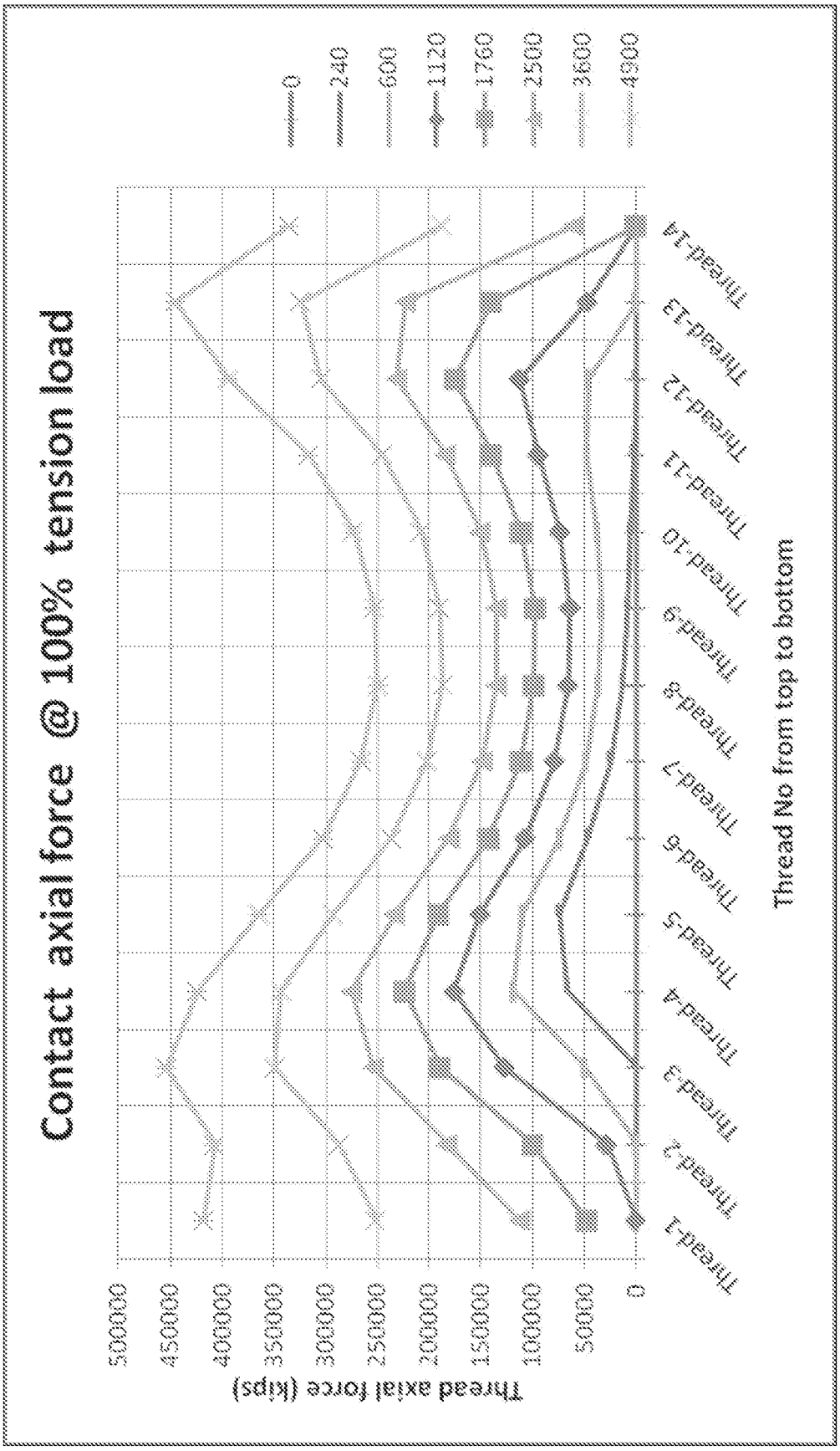
Contact axial force @ 100% tension load
Thread axial force (kips)
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
240
600
1120
1760
2500
3600
4600

FIG. 16E

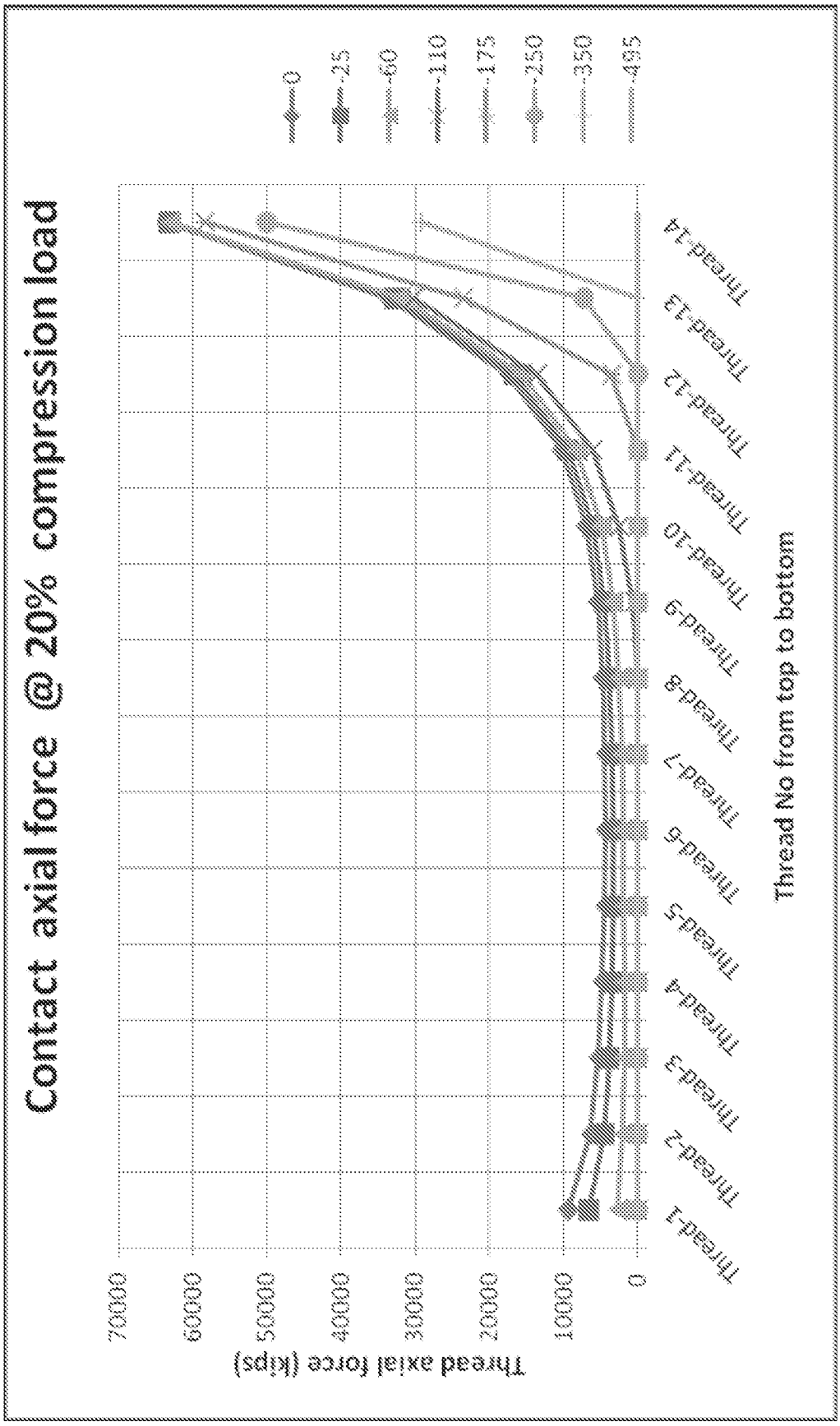
Contact axial force @ 20% compression load
Thread axial force (kips)
70000
60000
50000
40000
30000
20000
10000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
-25
-60
-110
-175
-250
-350
-495

FIG. 17A

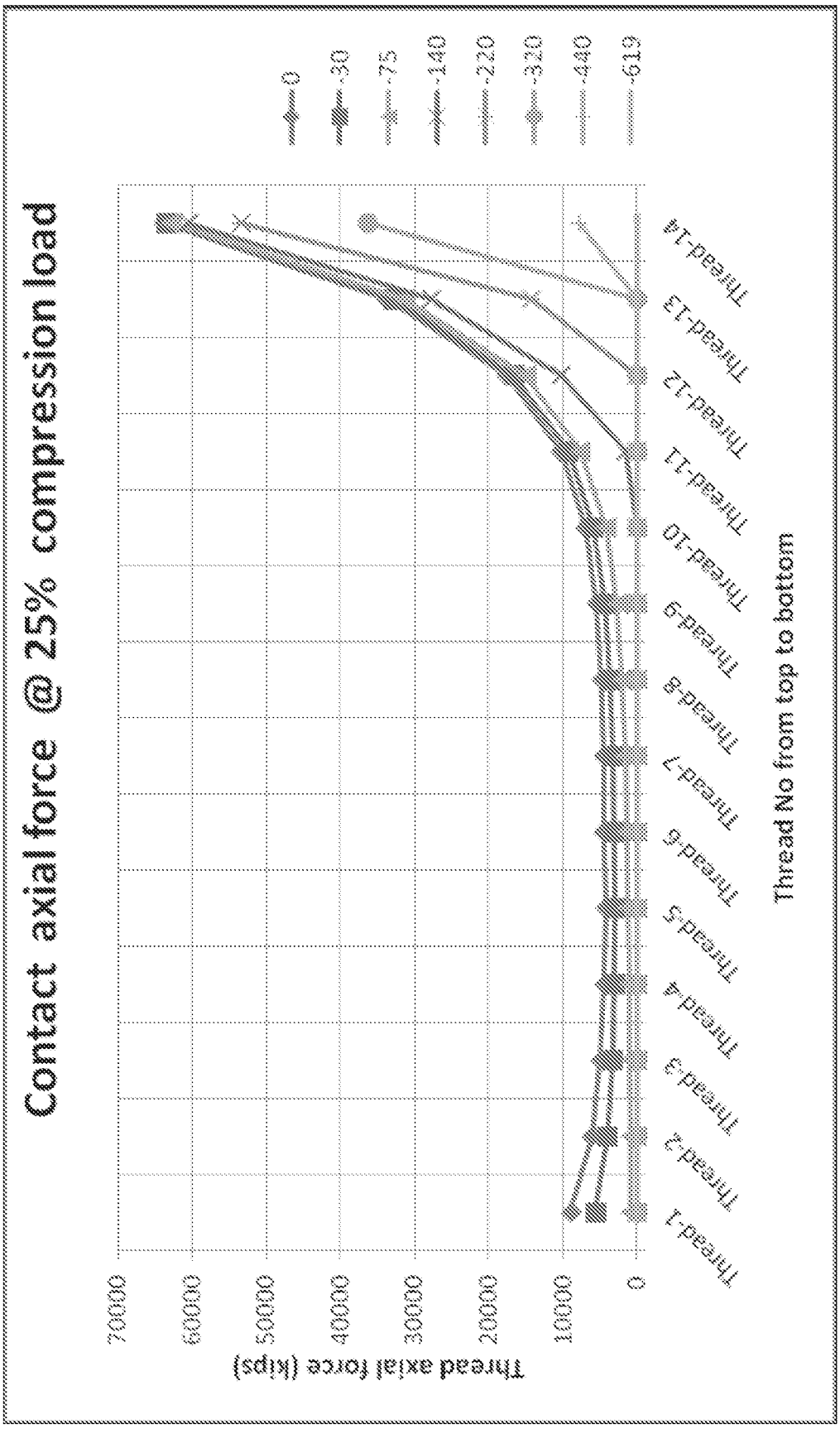
Contact axial force @ 25% compression load
Thread axial force (kips)
70000
60000
50000
40000
30000
20000
10000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
-30
-75
-140
-220
-320
-440
-619

FIG. 17B

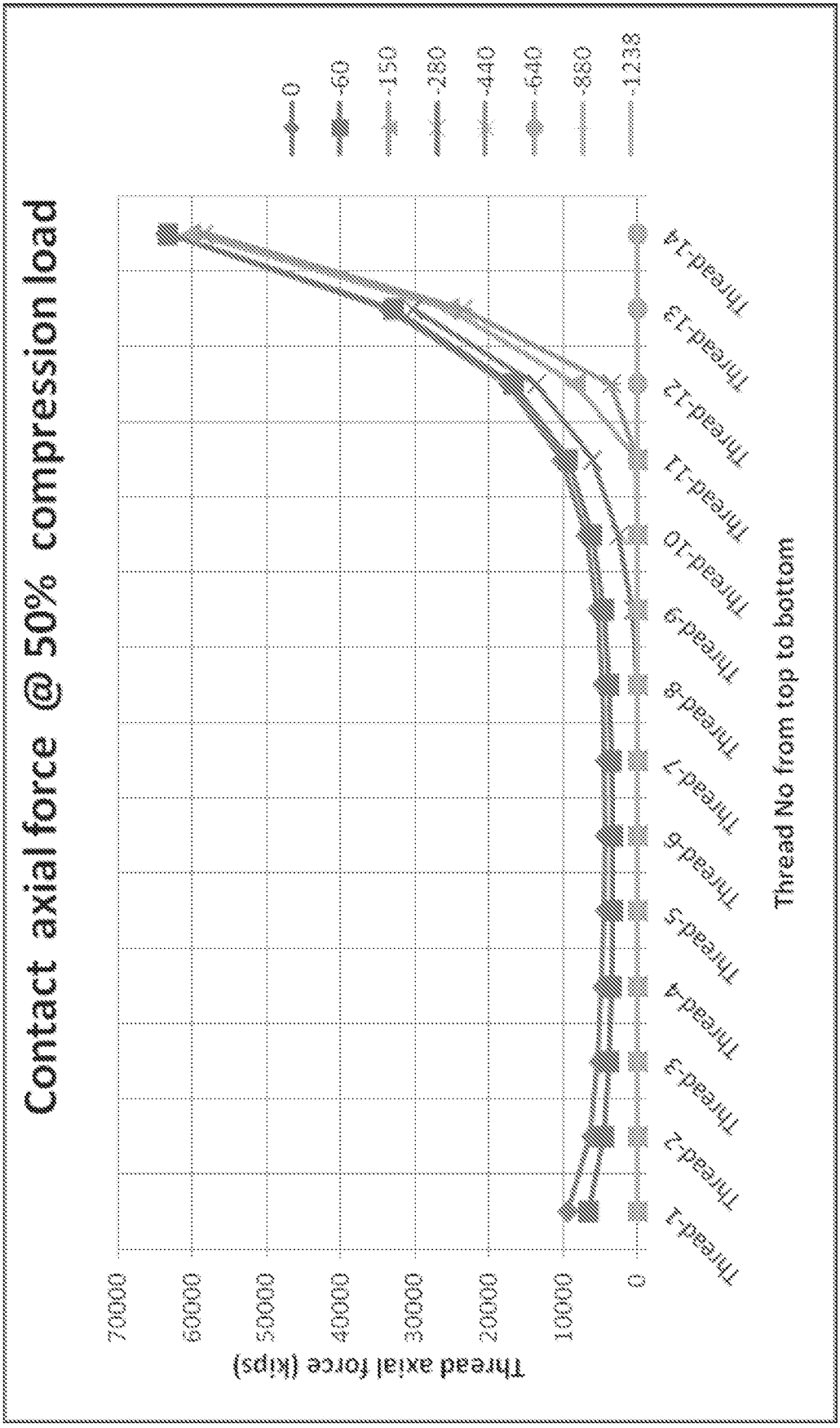
Contact axial force @ 50% compression load
Thread axial force (kips)
70000
60000
50000
40000
30000
20000
10000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
-60
-150
-280
-440
-640
-860
-1238

FIG. 17C

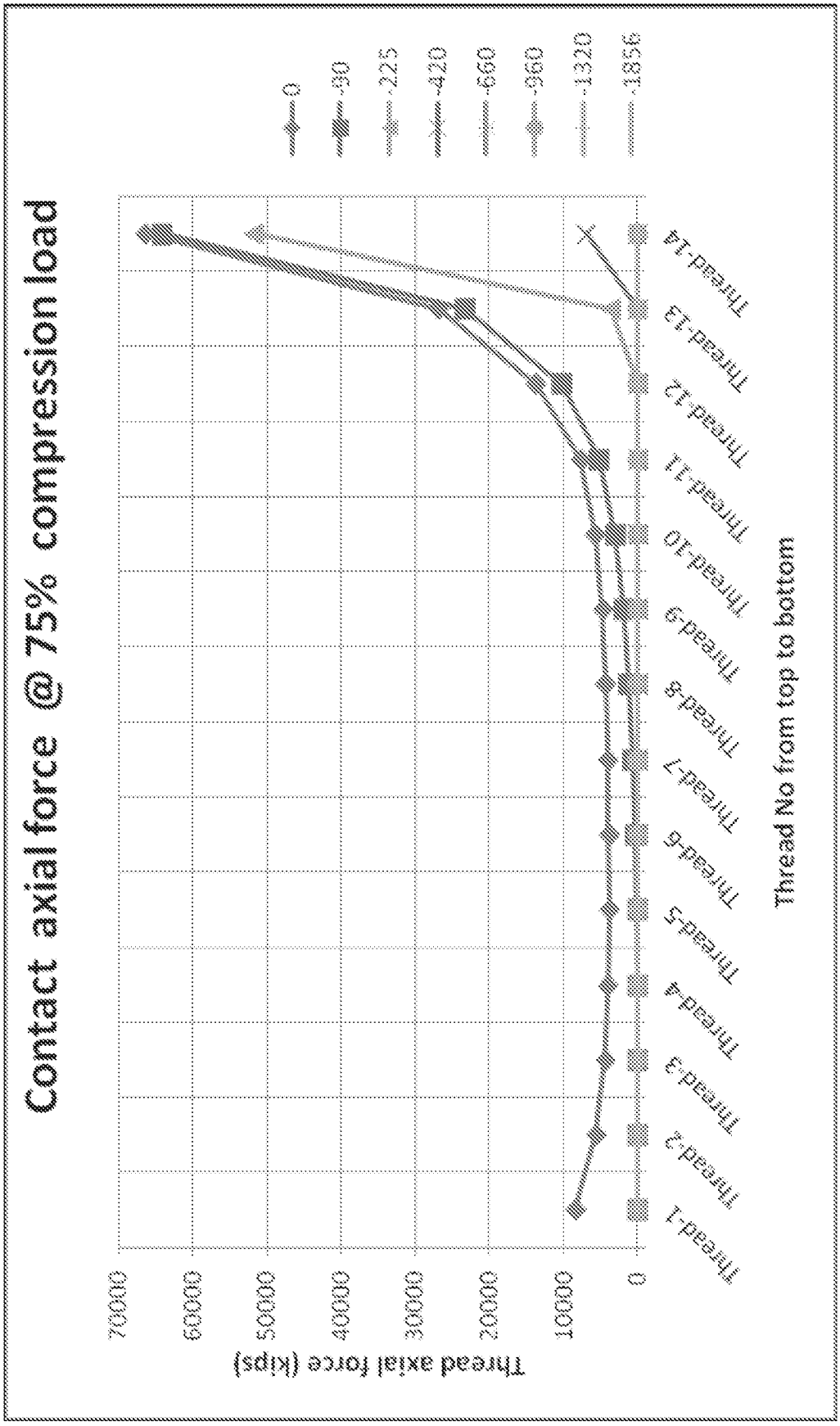
Contact axial force @ 75% compression load
Thread axial force (kips)
70000
60000
50000
40000
30000
20000
10000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
-90
-225
-420
-660
-960
-1320
-1856

FIG. 17D

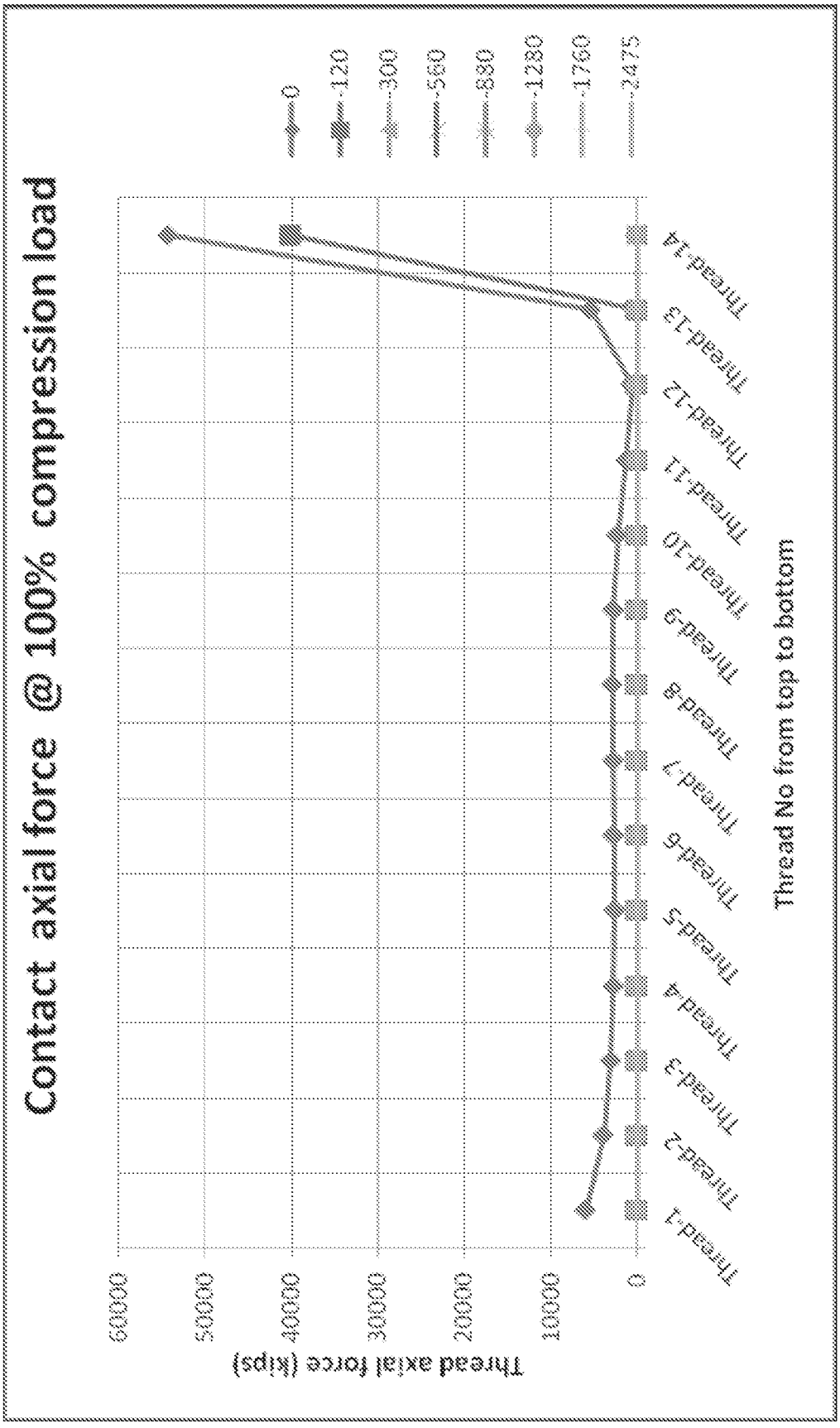
Contact axial force @ 100% compression load
Thread axial force (kips)
60000
50000
40000
30000
20000
10000
0
Thread-1
Thread-2
Thread-3
Thread-4
Thread-5
Thread-6
Thread-7
Thread-8
Thread-9
Thread-10
Thread-11
Thread-12
Thread-13
Thread-14
Thread No from top to bottom
0
-120
-300
-560
-880
-1280
-1760
-2475

FIG. 17E

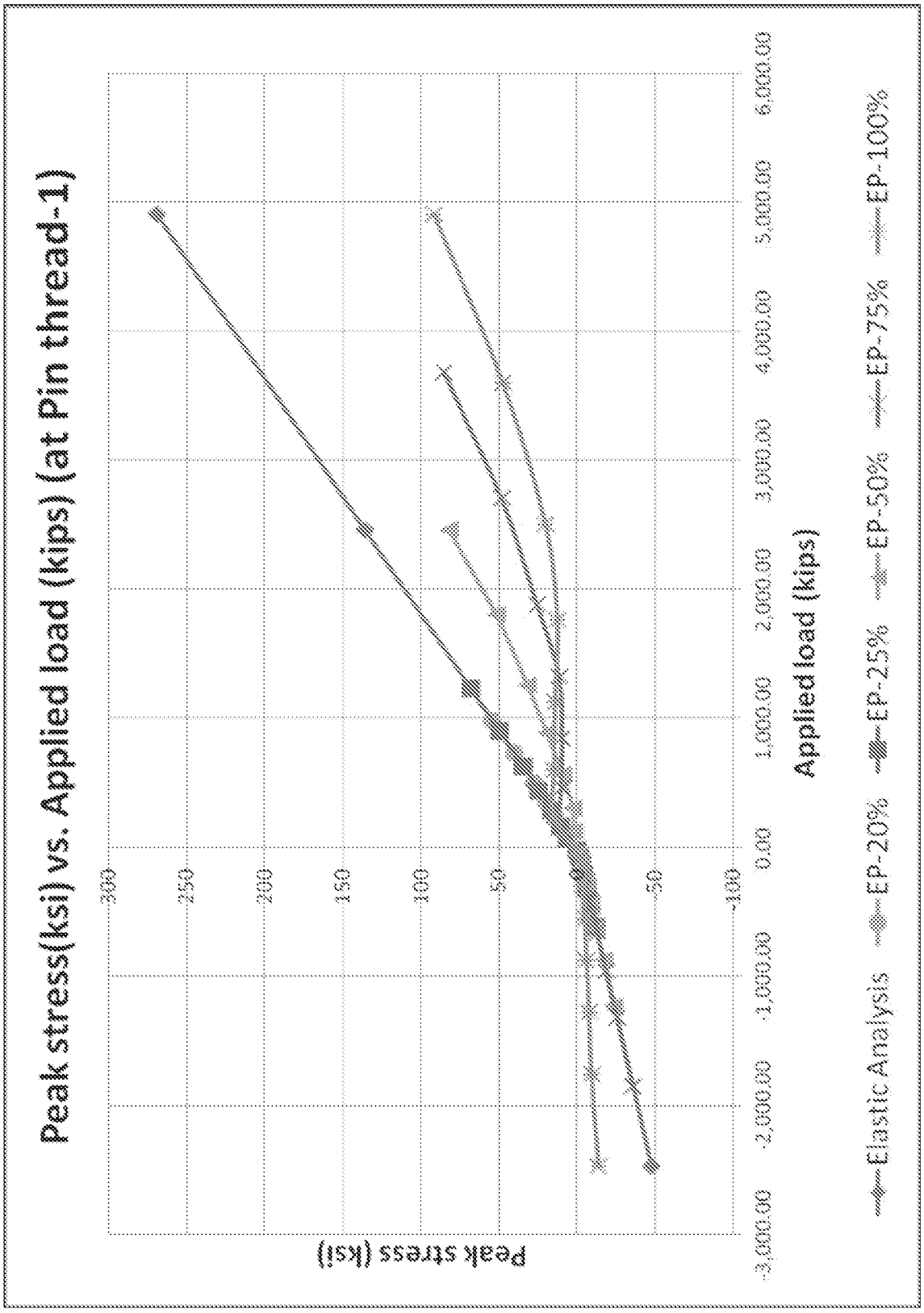
Peak stress(ksi) vs. Applied load (kips) (at Pin thread-1)
Peak stress (ksi)
300
250
200
150
100
50
0
-50
-100
-3,000.00
-2,000.00
-1,000.00
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
Applied load (kips)
Elastic Analysis
EP-20%
EP-25%
EP-50%
EP-75%
EP-100%

FIG. 18A

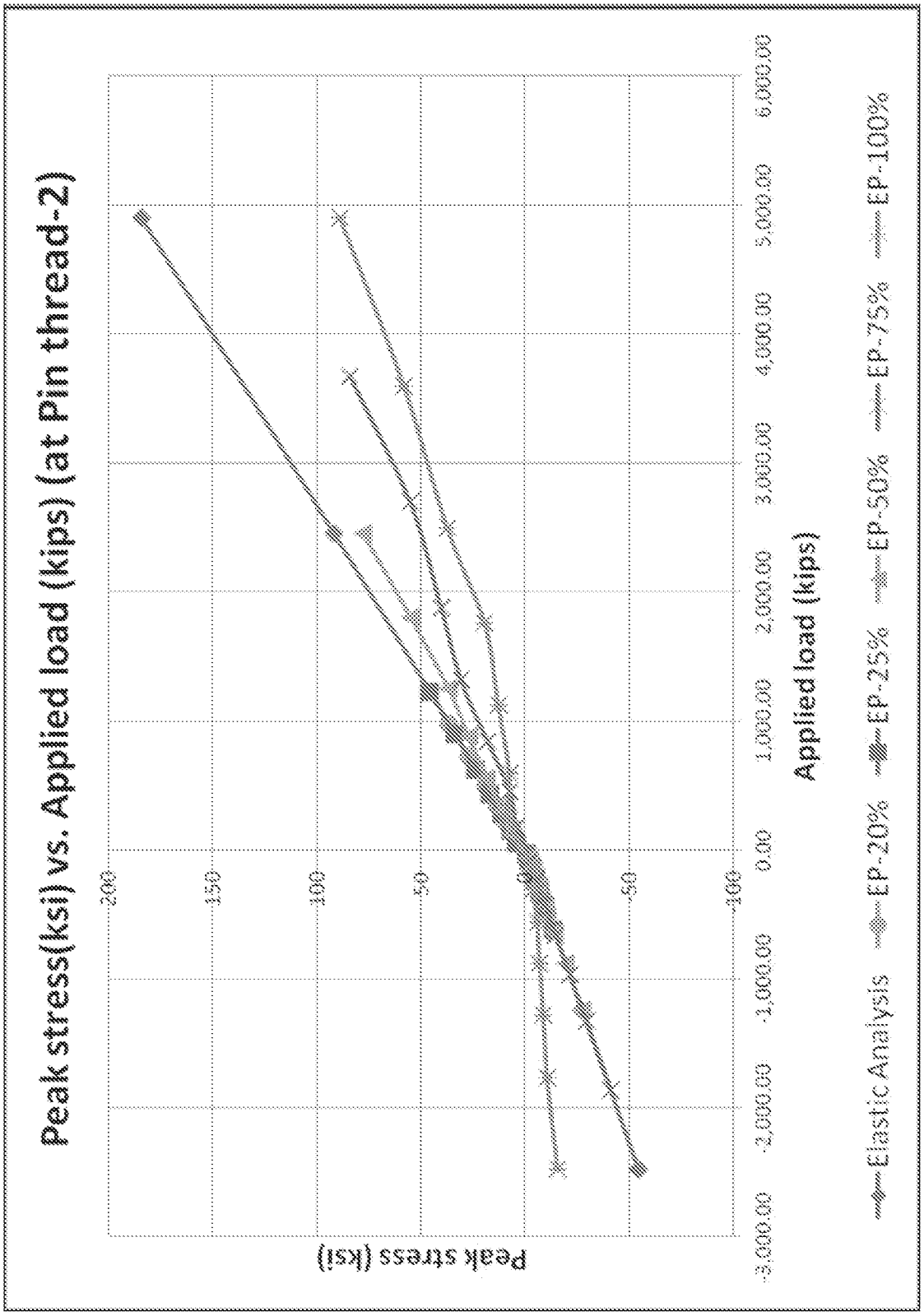
Peak stress(ksi) vs. Applied load (kips) (at Pin thread-2)
Peak stress (ksi)
200
150
100
50
0
-50
-100
-3,000.00
-2,000.00
-1,000.00
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
Applied load (kips)
Elastic Analysis
EP-20%
EP-25%
EP-50%
EP-75%
EP-100%

FIG. 18B

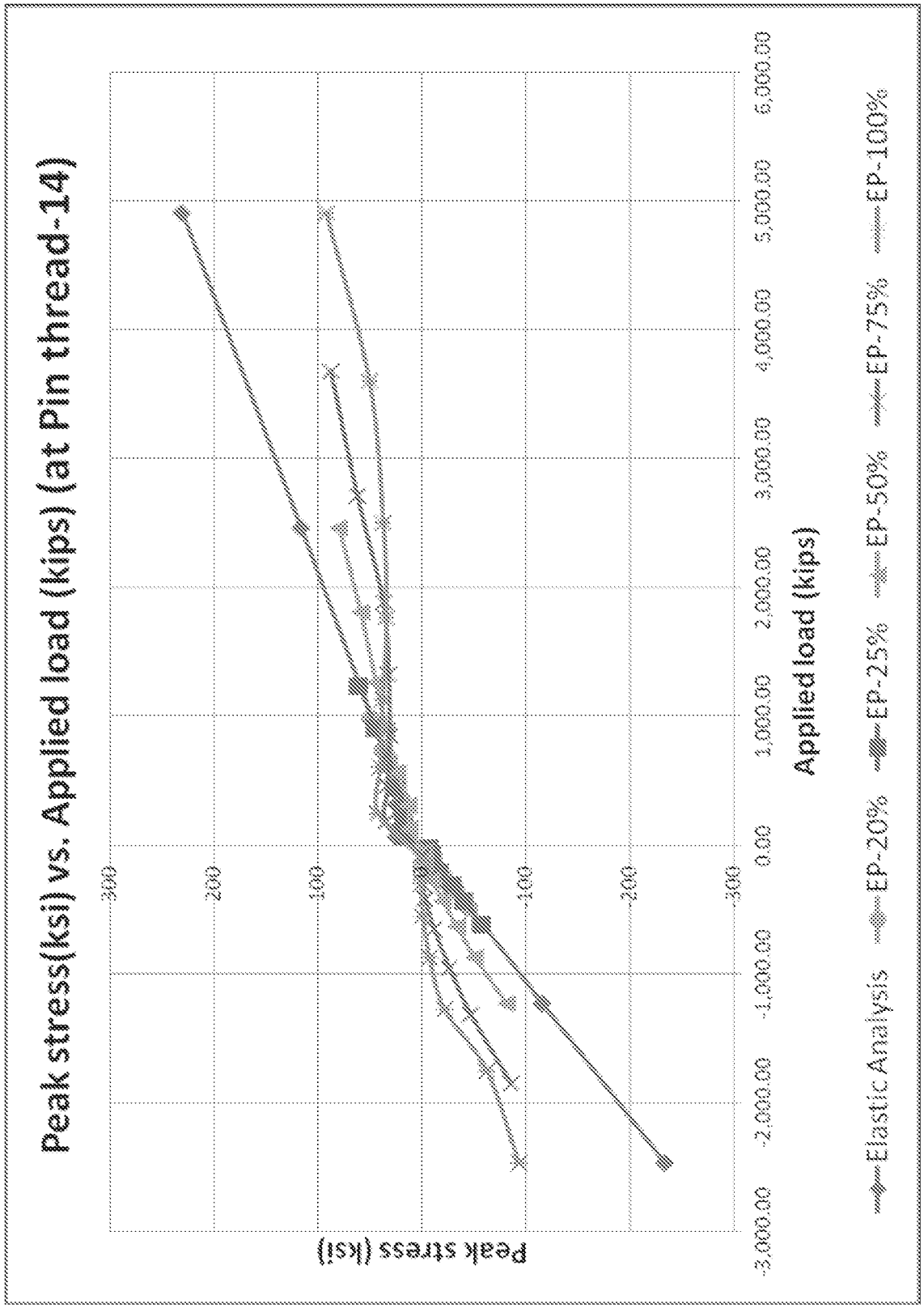
Peak stress(ksi) vs. Applied load (kips) (at Pin thread-14)
Peak stress (ksi)
300
200
100
-100
-200
-300
-3,000.00
-2,000.00
-1,000.00
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
Applied load (kips)
Elastic Analysis
EP-20%
EP-25%
EP-50%
EP-75%
EP-100%

FIG. 18C

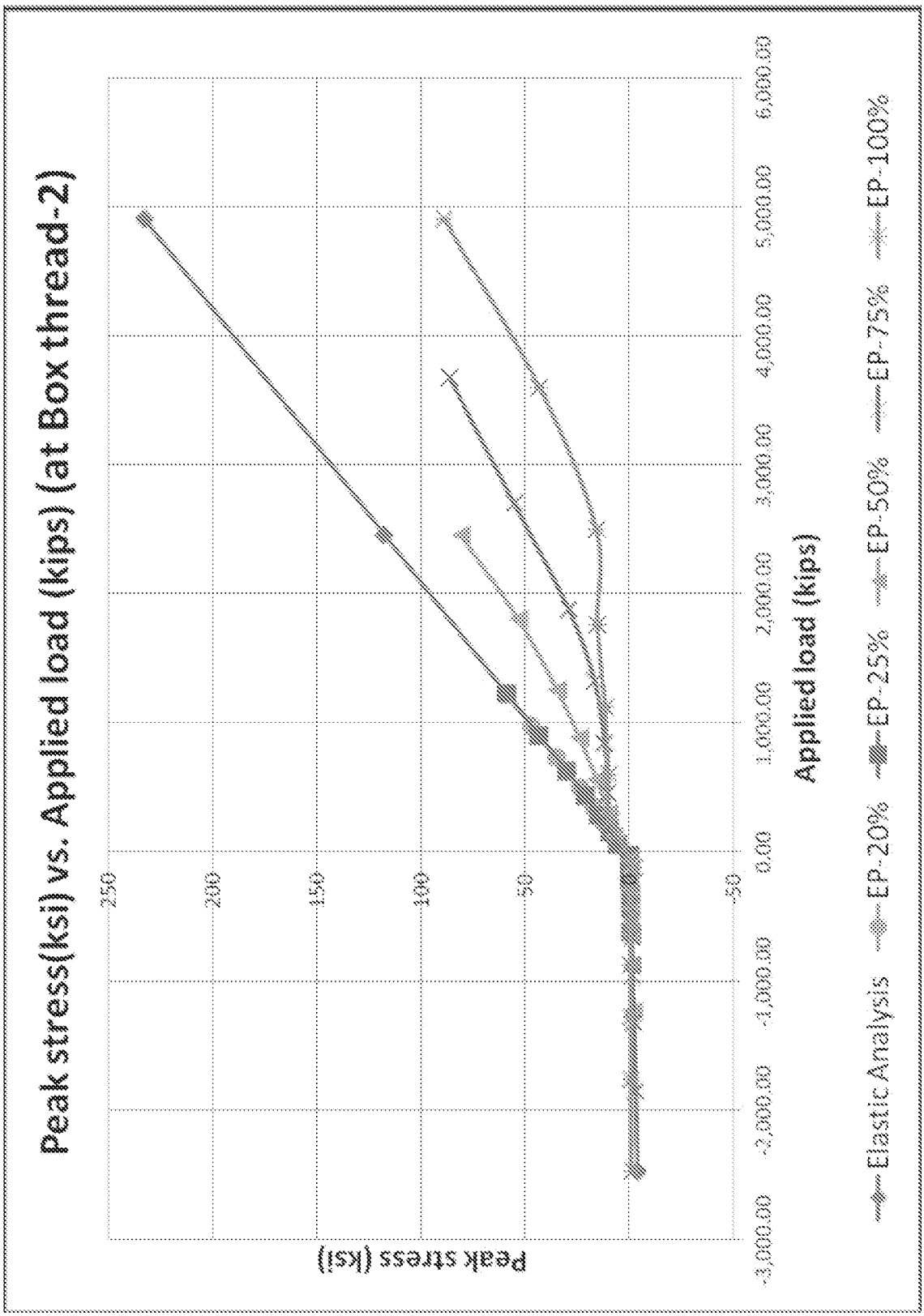
Peak stress(ksi) vs. Applied load (kips) (at Box thread-2)
Peak stress (ksi)
250
200
150
100
50
-50
-3,000.00
-2,000.00
-1,000.00
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
Applied load (kips)
Elastic Analysis
EP-20%
EP-25%
EP-50%
EP-75%
EP-100%

FIG. 18D

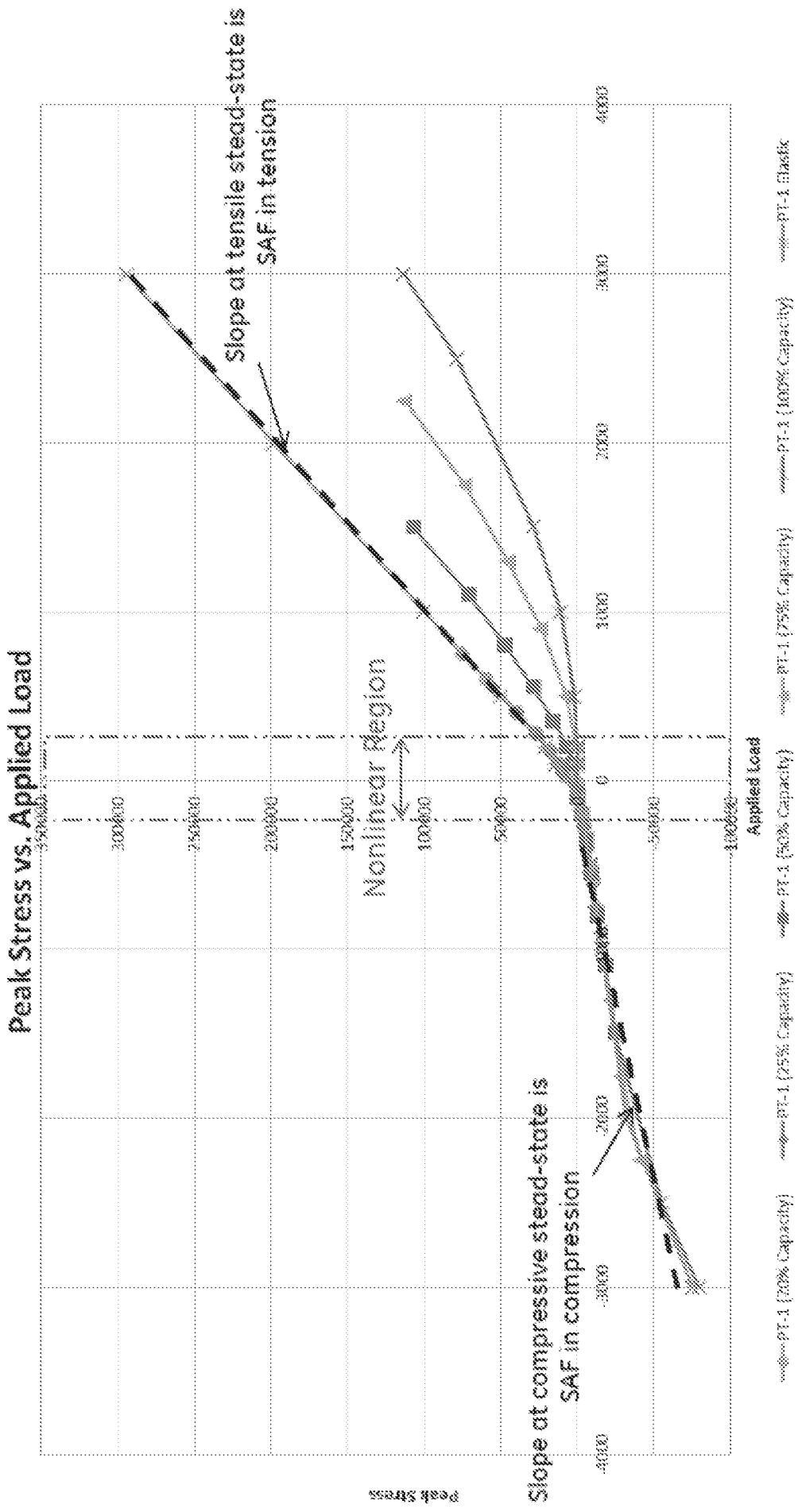
Peak Stress vs. Applied Load
Slope at tensile stead-state is SAF in tension
Nonlinear Region
Slope at compressive stead-state is SAF in compression
Peak Stress
Applied Load
PT-1 (20% Capacity)
PT-1 (25% Capacity)
PT-1 (50% Capacity)
PT-1 (75% Capacity)
PT-1 (100% Capacity)
PT-1 Elastic

FIG. 19

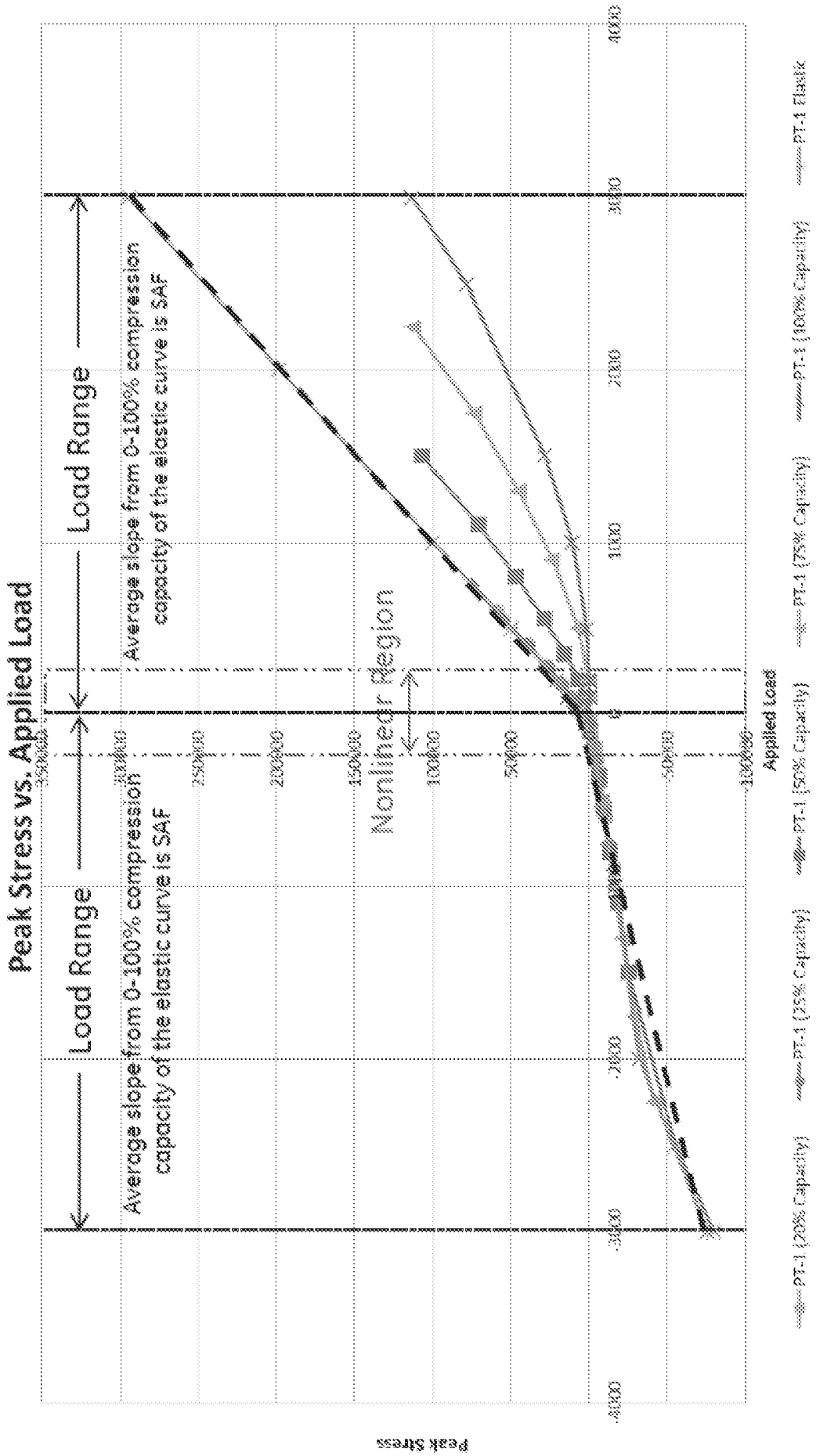
Peak Stress vs. Applied Load
Load Range
Load Range
Average slope from 0-100% compression capacity of the elastic curve is SAF
Average slope from 0-100% compression capacity of the elastic curve is SAF
Nonlinear Region
Peak Stress
Applied Load
PT-1 (25% Capacity)
PT-1 (50% Capacity)
PT-1 (75% Capacity)
PT-1 (100% Capacity)
PT-1 Elastic

FIG. 20