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DEVELOPMENT OF TIRES FOR NEW FAMILY
OF MEDIUM TACTICAL TRUCK

L. S. Stokes
W. C. Macklem

United States Rubber Tire Company
Detroit 32, Michigan

Final Report
Phase III
December 1962

Detroit Procurement District, U. S. Army

Contract No. DA-20-018-ORD-20440

Department of the Army Project No. 215 and 219

Technical Supervision by
Research and Engineering Directorate
Army Tank Automotive Center
Detroit Arsenal, Center Line, Michigan

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ACKNOWLEDGEMENT

The authors wish to acknowledge assistance received in this endeavor from H. B. Hindin, R. A. Reichert, G. V. Constantiakis, L. R. Gill and Dr. J. M. Almand of the United States Rubber Tire Company in addition to the personnel of the U. S. D. A. National Tillage Machine Laboratory at Auburn, Alabama.

1. CONTRACT OBJECTIVE

The original contract objective was to conduct an engineering investigation to develop a tire based upon the most advanced concept of tire design and having optimum characteristics for its intended usage. Due to the excellent performance of the radial belted tire on laboratory and limited field testing the contract was modified to provide tires for a field endurance test.

2. SUMMARY

A relatively recent concept in tire design, the "radial belted tire", has been utilized to develop an optimum tire for the New Family of Medium Tactical Trucks. Experimentation has established the most desirable radial tire for tactical demands as one composed of a rigid steel breaker belt and a radial textile carcass. The use of synthetic stocks had no appreciable effect on tire performance.

This tire affords significant advantages in tire and vehicle performance. Tread wear, mobility, fuel economy, crown penetration resistance, durability, ride and handling, run flat maneuverability, climbing ability; and tire mechanics in terms of load distribution, and contact area are improved. Power consumption, running temperature and rolling resistance, are decreased.

Original radial constructions provided a weight savings; however, when it was deemed necessary to increase the strength of the radial tire to compete with the performance of the standard tire, the weight advantage was lost. However, future modified radial constructions may again alter the weight characteristics.

The above attributes when consolidated can be expressed as: increased ton miles per hour delivered, a possible universal inflation system, greater vehicle mobility and efficiency, increased combat time, reduced driver fatigue, and other economies in terms of gas consumption, tire economies, and vehicle maintenance and logistics.

3. CONCLUSIONS AND RECOMMENDATIONS

The experimental test results unquestionably show the feasibility of the radial ply belted tire concept for Military application. On the basis of the test results the following conclusions can be made:

1. 30% improvement in tread wear.
2. 60% improvement in drawbar pull in mud.
   25% improvement in drawbar pull in sand.
3. 15 to 19% improvement in fuel economy.
4. 21% improvement in power consumption at 22 mph.
5. Improved ride and handling, run flat maneuverability, and curb climbing ability.
6. More uniform tread pressure distribution.

The endurance level of the tires was slightly below the Military specifications but we believe this can be corrected.

We recommend that this study be continued with emphasis on increasing the endurance level of the 11:00 - 20 Radial Ply Belted Tactical tire. We further recommend that future studies be increased in scope to include tire sizes above and below the 11:00 - 20 size evaluated in this study.

4. DISCUSSION

4.1 Original Objective

The original contract objective was to conduct an engineering investigation to develop a tire based upon the most advanced concept of tire design and having optimum characteristics for its intended usage.

4.1.1 Initial Tire Design

In the conventional tire the tire body is composed of multiple layers of nylon or rayon cords laid diagonally across the tire from bead to bead. The direction of the cords is alternated in successive plies so that approximately an 80° angle is included between adjacent plies in the tire tread region.

A relatively recent concept in tires is the "radial ply belted tire" (See Figure 1). This tire utilizes a body of textile or metallic cords, laid so that they are transverse across the tire section. By laying the cords in a transverse direction the cords are used to maximum efficiency, therefore fewer plies are needed. The tire tread is supported by a belt formed of a series of textile or metallic cord layers intersecting with a small included angle at the circumferential tire centerline. The tire has an inherent track-like behavior inasmuch as the tread is attached to the flexible, inextensible belt which lies external to the tire body which serves primarily as an inflation chamber. If the radial tire is constructed with a metallic belt it offers great potential improvement in puncture resistance. It is this concept that was evaluated for Military application.

It was agreed to conduct the majority of the contract tests using natural rubber stocks as opposed to synthetic. This was requested by the Contractor because the majority of the Contractors previous proprietary testing had been conducted with radial tires featuring natural rubber compounds. Therefore the Contractor believed that an engineering investigation of the radial tire design could be conducted at minimum cost if the natural rubber compounds were used in the majority of

4. DISCUSSION (cont'd)

4.1.1 Initial Tire Design (cont'd)

the test tires. However the Contractor tested a sufficient number of tires of high synthetic content to determine the effect of synthetic compounds on the tire characteristics.

The following three types of radial ply tires were built and tested:

1. Rayon carcass - Rayon belt
2. Rayon carcass - Wire belt
3. Wire carcass - Wire belt

The tires were designed to carry 3500# load at 30 psi inflation for highway operation. Rayon was selected as a carcass material to avoid growth problems.

To determine the effect of synthetic compounds on the performance of the tires, one group of radial tires was constructed with synthetic tread and sidewall compounds. The tires were compared to two groups of conventional tactical tires, one featuring synthetic compounds and the other using NR compounds.

4.1.2 Tire Mold and Equipment

The basic tire mold was an 11:00-20 mold owned by the Contractor and used extensively in his radial ply tire development program. To facilitate the procurement of tires a tread ring with a tactical design was ordered for this mold. In keeping with the belted radial tire design the tread pattern was stopped at the tread shoulder.

Several shaping bags to fit a proprietary horizontal shaping machine were built and used during the length of the contract.

4.1.3 Testing

A Summary of the Contractor testing is shown in the following bar charts. Figures 2, 3, 4 and 5.

4.1.3.1 Indoor Tests

4.1.3.1.1 Endurance Testing

Figures 7 and 8 summarize our simulated field endurance

Tactical Tires

MOBILITY

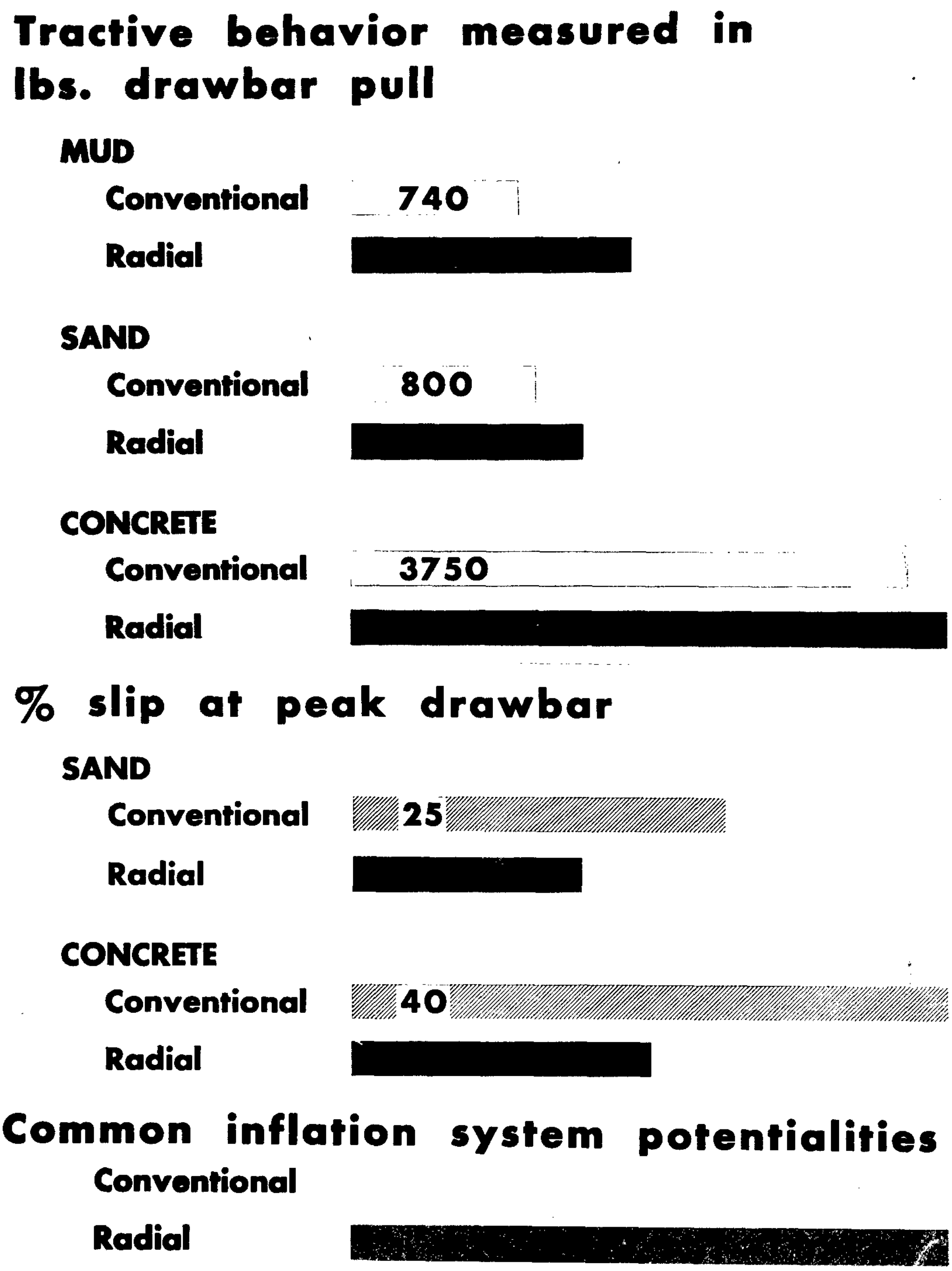


FIG 2

6

Tactical Tires

MOBILITY (CONTINUED)

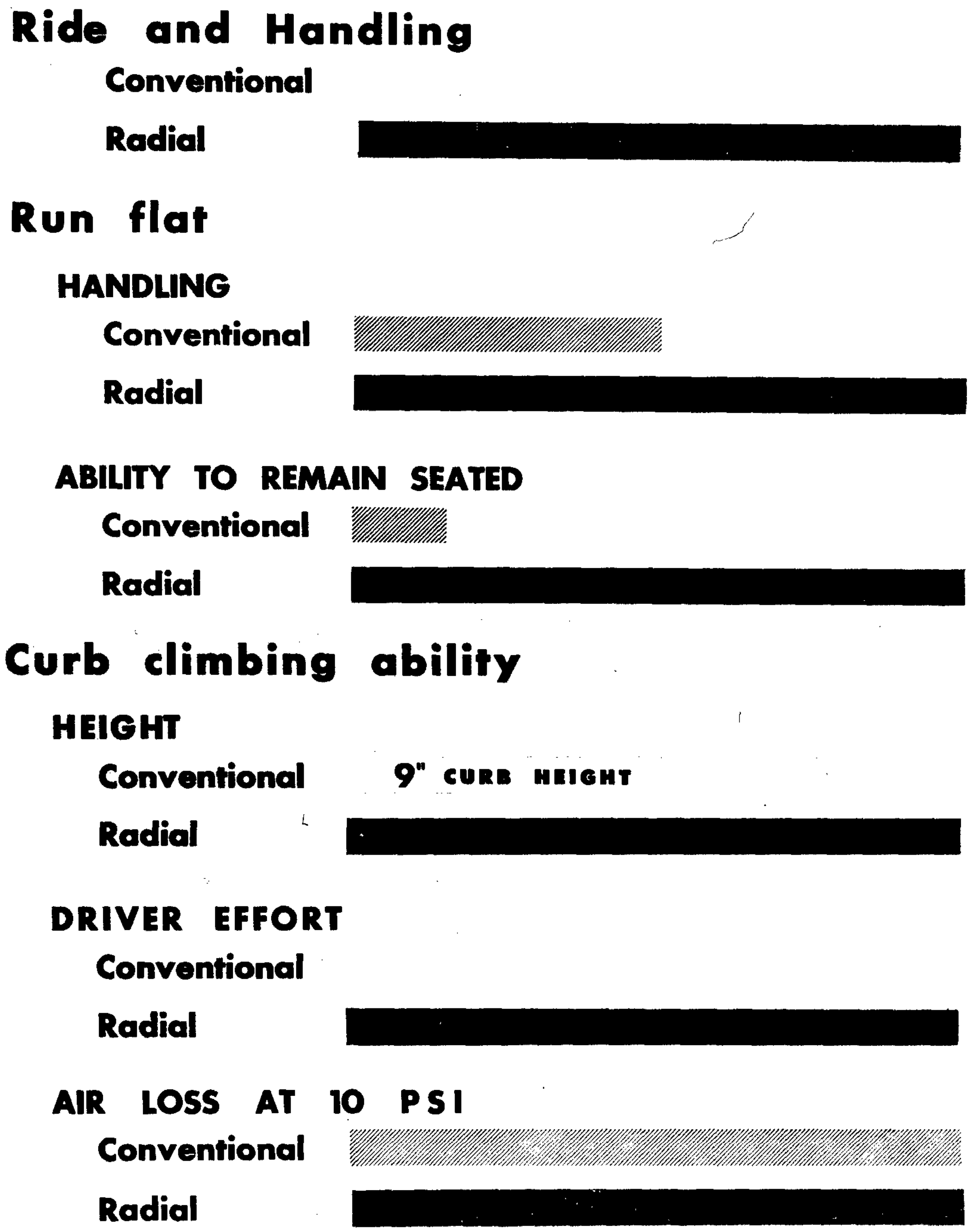


FIG. 3

7

Tactical Tires

FUEL ECONOMY

MILES PER GALLON

Conventional	6.24
Radial	[redacted]

POWER CONSUMPTION PER TIRE AT 22 MPH

Conventional	4.78
Radial	[redacted]

RUPTURE AND PENETRATION RESISTANCE IN CROWN

AVERAGE ENERGY VALUE

Conventional	21635
Radial	[redacted]

DURABILITY - LABORATORY 30 MPH

TEST WHEEL HOURS

Conventional	94.0
Radial	[redacted]

HEAT BUILD - UP

Conventional	330° F
Radial	[redacted]

FIG. 4
8

Tactical Tires

TIRE MECHANICS

LOAD DISTRIBUTION

Conventional

Radial

LOADING FOR EQUAL DEFLECTION

Conventional

Radial

SPRING RATE

Conventional

Radial

Contact Area

NET TO GROSS

Conventional

Radial

GROSS

Conventional

Radial

WEIGHT AT COMPARATIVE RUPTURE LEVEL

Conventional 117 lb.

Radial

FIG. 5

9

4. DISCUSSION (cont'd)

4.1.3.1.1 Endurance Testing (cont'd)

testing on laboratory test wheels. Test conditions were as follows: Load - 3500#; speed - 30 mph; inflation - 50, 40, 30, 20, 10 psi for 24 hours each on a smooth wheel.

All tires except the all wire tire failed shortly after entering the 10 psi phase. The standard tires failed of ply separations, the all textile of breaker separations and the wire-textile of fabric fatigue in the shoulder area. It should be emphasized that the sharp tread shoulder, at the low test inflation, bridges in the buttress area and undoubtedly contributes to the textile failures. A photograph of one of the all wire tires running at 10 psi is shown in Figure 6 (Note the bridging effect.)

The all wire tires were removed very close to completion of the 10 psi phase. Tires were removed due to cracking in the sidewall where the tread ring mold modification had been made. Proper molds would alleviate this deficiency.

An inspection of the thermal curves of Figure 7 reveals that the belted tire runs from 20-70° cooler in the shoulder region than does the regular tire - up to 48 hours. After 48 hours the difference is even more pronounced. The all wire tire runs the coolest, 70° less; the wire-textile, 50° less; the all textile, 20° less. It is interesting to note that the temperature of the wire tire at 10 psi is comparable to the regular tire at 40-50 psi. The thermal advantage of the belted construction is manifested in both lower power consumption and rolling resistance.

An inspection of the thermal curves of Figure 8 reveals the effect of synthetic compounds on the performance of conventional and radial ply tires. The use of synthetic tread and sidewall compounds does not materially effect the thermal performance of the radial tire. However, the use of NR compound in the conventional tactical tire improves its thermal performance considerably. Comparing the thermal performance of the NR conventional tire to the radial tires shows the characteristics of both tires to be approximately the same until the 48 hour point and then the radial tire gains its thermal advantage. Data on the thermal performance of the tires are shown on Table I and II.

FIG. 6

11

THERMAL GRAPH
SHOULDER TEMP. VS. HOURS OF RUN

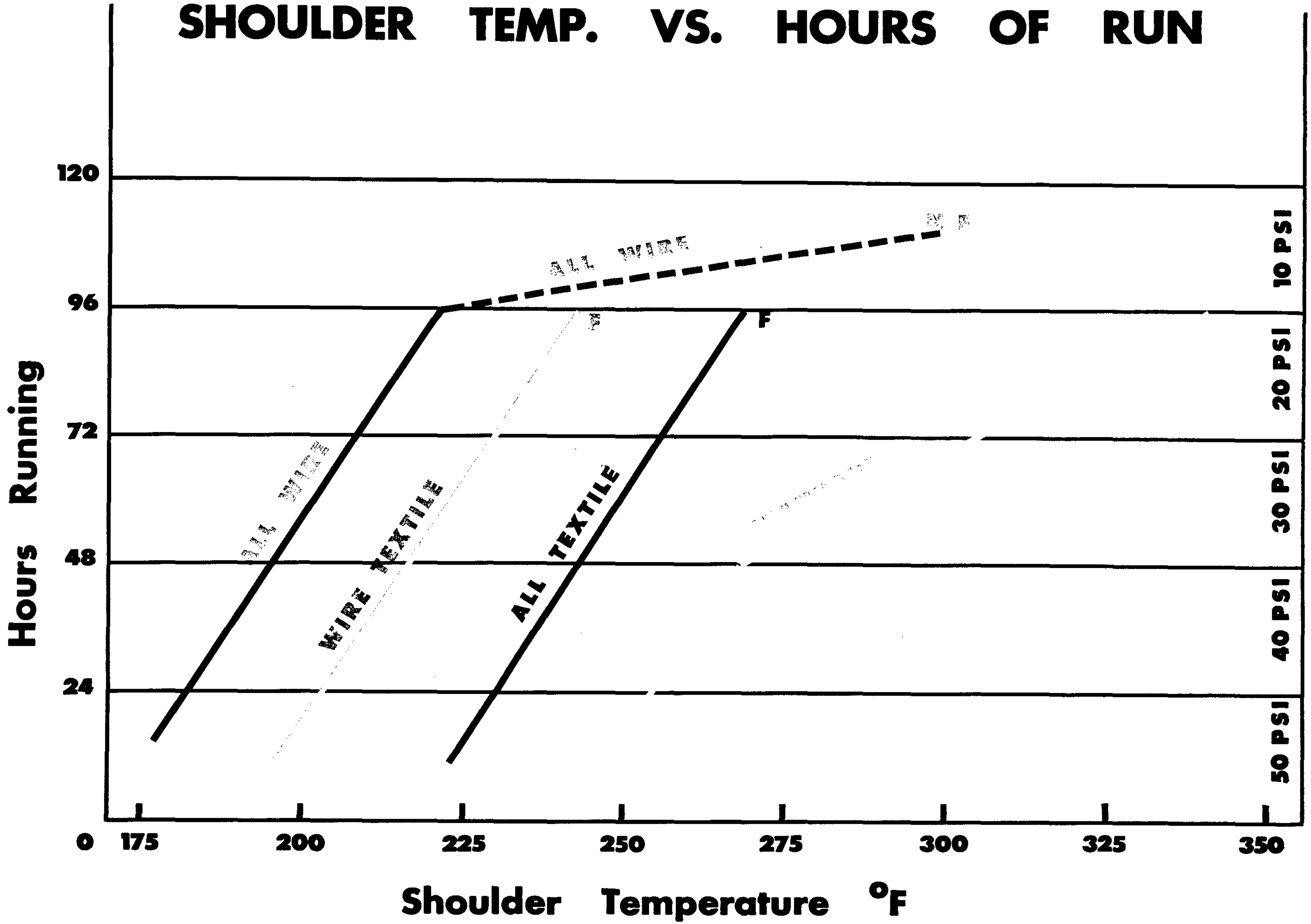


FIG. 7

12

THERMAL GRAPH
SHOULDER TEMP. VS. HOURS OF RUN

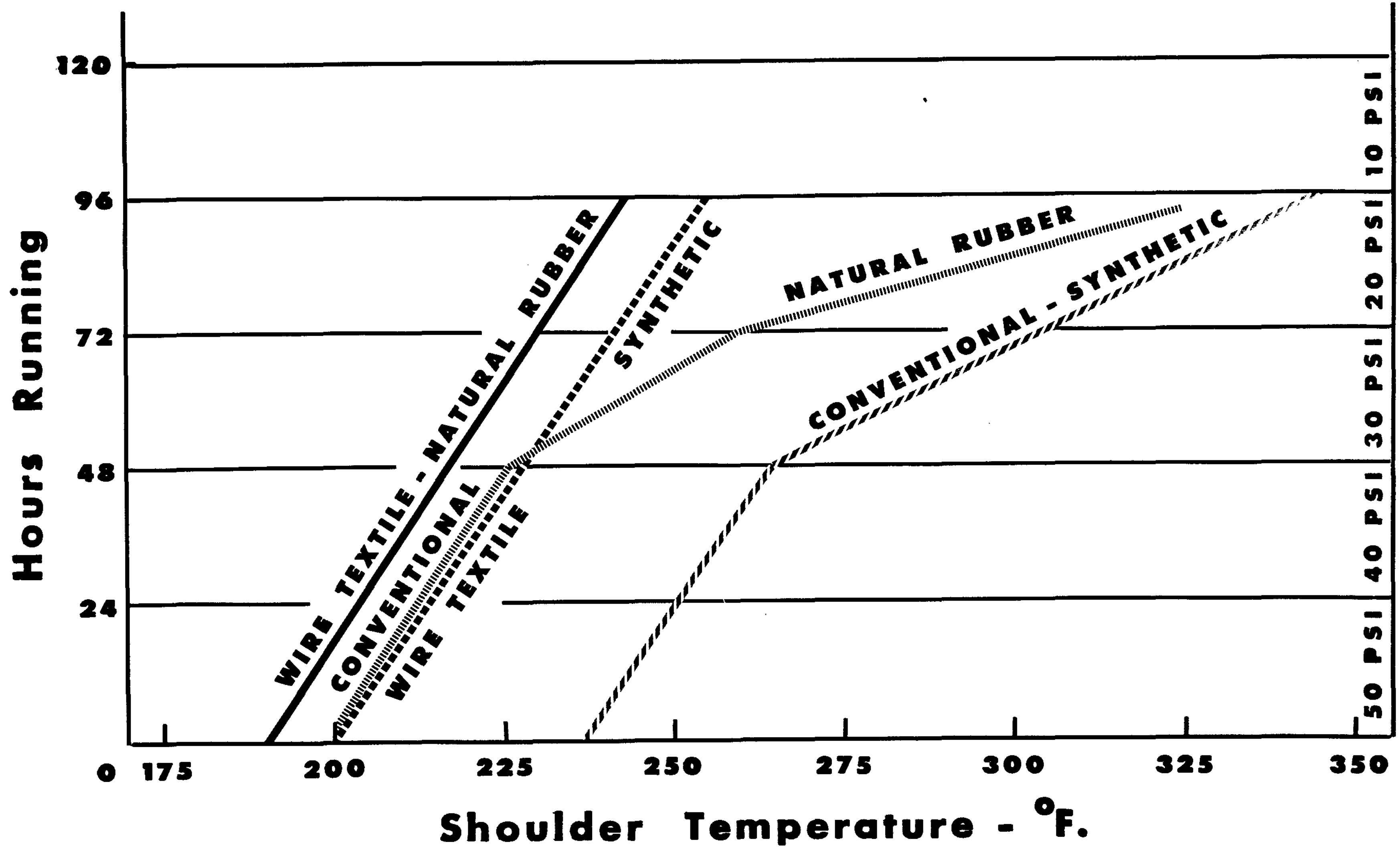


FIG. 8

13

61-175

TABLE I
SHOULDER TEMPERATURES
11:00-20 TACTICAL TIRES

	Wire-Tex.	Conv.	Conv.	Tex.-Tex.	Wire-Wire	Wire-Wire	Wire-Tex.
Hours	N.R.	Syn.	N.R.	N.R.	N.R.	Syn.	Syn.
2	205	248	201	232	181	198	217
4	205	266	208	-	180	198	217
6	204	262	209	231	181	196	214
8	205	254	201	231	182	195	214
10	200	255	205	230	182	196	211
12	202	254	200	226	179	194	211
16	202	252	198	223	181	194	210
20	202	247	204	229	176	196	210
24	190	256	191	231	178	185	215
28	205	268	211	234	189	198	219
32	208	257	216	238	191	197	215
36	211	251	217	237	188	202	217
40	211	263	221	232	190	198	216
44	210	254	-	232	178	200	219
48	207	272	225	231	183	199	217
52	219	275	248	254	200	209	238
56	214	275	244	253	198	200	231
60	208	289	244	239	201	211	234
64	215	297	244	240	204	221	234
68	218	299	251	250	201	213	234
72	220	300	256	249	199	211	230
76	240	320	312	275	222	226	245
80	234	331	305	-	210	227	248
84	241	330	316	266	214	229	254
88	241	331	306	265	219	232	253
92	237	333	-	266	215	229	255
95.2	245	331	-	-	-	-	-
96	-	-	-	277	220	-	-
98.5	-	-	-	272	-	-	-
100	-	-	-	-	267	-	-
104	-	-	-	-	275	-	-
109	-	-	-	-	290	-	-
113	-	-	-	-	291	-	-
115.7	-	-	-	-	-	-	-
116.0	-	-	-	-	287	-	-
116.4	-	-	-	-	287	-	-

TABLE II
BEAD TEMPERATURES
11:00-20 TACTICAL TIRES

	Wire-Tex.	Conv.	Conv.	Tex.-Tex.	Wire-Wire	Wire-Wire	Wire-Tex.
Hours	N.R.	Syn.	N.R.	N.R.	N.R.	Syn.	Syn.
2	159	149	151	166	153	149	166
4	160	162	162	-	151	157	160
6	160	154	152	171	158	158	159
8	158	154	165	160	157	151	135
10	164	158	152	157	154	155	145
12	160	152	166	161	154	151	144
16	162	174	152	161	159	143	149
20	160	169	166	167	149	-	180
24	149	159	137	159	148	142	165
28	168	158	147	169	155	174	164
32	168	163	148	171	162	139	162
36	168	168	157	171	162	152	178
40	174	168	159	168	157	144	164
44	178	146	-	164	156	156	157
48	168	162	151	163	158	161	167
52	171	165	188	178	171	173	175
56	178	172	166	181	171	178	178
60	179	197	146	174	162	171	179
64	176	191	175	176	178	160	185
68	188	189	173	179	179	173	190
72	178	186	204	185	171	171	186
76	207	206	216	202	186	188	194
80	210	212	222	-	177	182	186
84	224	220	237	200	191	206	199
88	216	222	248	193	193	241	228
92	194	212	-	208	179	187	214
95.2	215	-	-	-	-	-	-
96	-	201	-	200	190	-	-
98.5	-	-	-	188	-	-	-
100	-	-	-	-	222	-	-
104	-	-	-	-	239	-	-
109	-	-	-	-	228	-	-
113	-	-	-	-	230	-	-
115.7	-	-	-	-	-	-	-
116.0	-	-	-	-	-	-	-
116.4	-	-	-	-	239	-	-

4. DISCUSSION (cont'd)

4.1.3.1.2 Power Consumption and Rolling Resistance Test

Power consumption and rolling resistance tests, were conducted in the laboratory on a smooth wheel at 22 and 45 MPH, 3500# load and 30 and 20 psi inflation. Results of the tests show power consumption and rolling resistance of the radial tire to be approximately 20% less than synthetic or natural rubber conventional tire. This means that one-fifth of the horsepower is conserved for vehicle efficiency. Data on power consumption and rolling resistance is shown in Table III.

The only tire to complete the 45 MPH, 20 psi portion of the test was the all wire tire which completed a cycle at 10 psi, 22 MPH before failing. This is consistent with the endurance testing results.

The effect of inflation on power consumption is depicted in Figure 9 . It shows that inflation has the same influence on both types of tires, that is, as the inflation increases the HP consumed is less.

4.1.3.1.3 Hydroburst Test

A textile carcass wire belted tire was subjected to a hydrostatic burst test. The tire failed with a broken wire bundle at 325 psi. The burst value agrees with the calculated burst value of the tire.

4.1.3.2 USAA Tillage Machinery Laboratory Tests

Two evaluations of the radial tactical tires compared to the conventional tactical tire were made as a cooperative effort between the National Tillage Machinery Laboratory and the United States Rubber Company. The first evaluation was made on loose sand and concrete and the second on mud.

4.1.3.2.1 Sand and Concrete Test

Conclusions

1. Tractive performance of the belted wire was up to twice that of the regular tire.

2. The belted tire develops its maximum drawbar values at lower percent slip values indicating an increase in ton miles per hour.

TABLE III
ROLLING RESISTANCE AND
POWER CONSUMPTION DATA

Group	ROLLING RESISTANCE - LBS.				HORSE POWER CONSUMPTION			
	30psi 22mph	20psi 22mph	30psi 45mph	20psi 45mph	30psi 22mph	20psi 22mph	30psi 45mph	20psi 45mph
Standard Syn.	59.6	79.7	65.0	Failed	3.58	4.78	7.80	Failed
Standard NR	57.9	80.9	65.9	Failed	3.47	4.85	7.91	Failed
Wire-Brkr. Tex. Carc. NR	49.0	62.7	50.1	72.3 *	2.94	3.76	6.01	8.68 *
Tex. Brkr. Tex. Carc. NR	49.0	61.8	54.6	Failed	2.94	3.71	6.55	Failed
Wire Brkr. Wire Carc. NR	42.1	53.8	42.1	53.6	2.53	3.23	5.05	6.43

NOTE: All wire tire consumed 5.93 H.P. and had a 98.8# rolling resistance at 10 psi and 22 mph.

* Data based on 4th consecutive reading: Tire failed during the 5th and last required reading.

EFFECT OF INFLATION ON POWER CONSUMPTION ON STANDARD AND BELTED TIRES 11.00-20 TACTICAL - NDCC

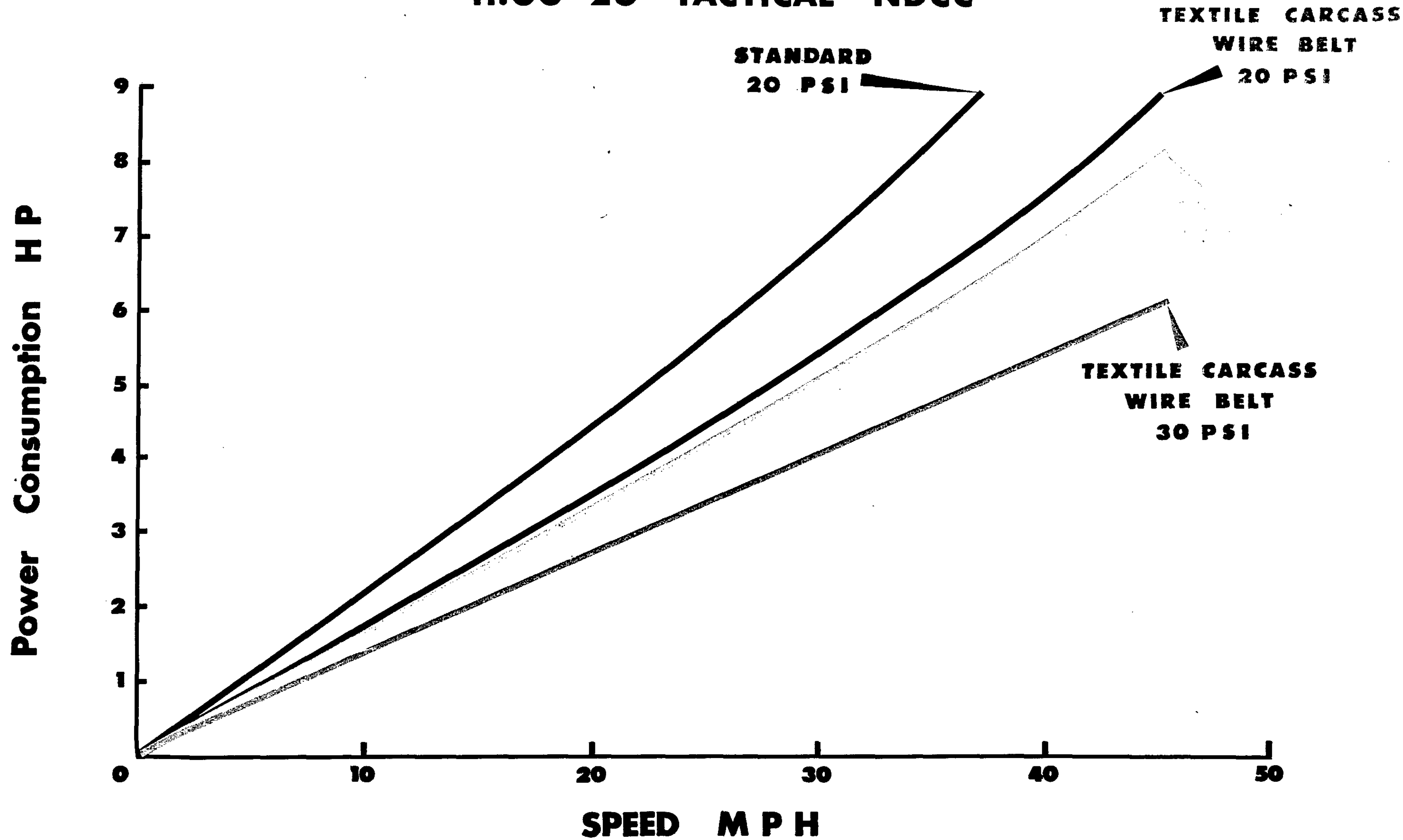


FIG. 18

4. DISCUSSION (cont'd)

Conclusions (cont'd)

3. On loose sand, the belted tire at on-the-road inflation had the same tractive performance as the regular tire at off-the-road inflation.

4. The belted tire offers increased maximum gradeability and improved efficiency at a given grade.

5. Belted tire susceptibility to sidewall buckle under torque is widely variable according to construction.

Details

Size:	11:00-20/12 P.R.
Brand:	U. S. Royal Tactical Cross Country
Rim:	8.0
Tread Stock:	Military Type, Synthetic
Construction Features:	Group A - Regular Production Group E - Experimental Wire Belt - Textile Body Group F - Experimental - Textile Belt - Textile Body Group G - Experimental - Wire Belt - Wire Body
Load:	3500 lbs.
Inflation:	10, 20 and 30 psi
Test Surfaces:	Loose Lakeland Sand Dry Concrete

The tire test machine was newly instrumented to electrically sense and record per cent slip, torque input, drawbar pull and load transfer. The variables were measured continuously while a stepped-up retarding force was applied to the advancing tractor. Results are given as curves of drawbar pull vs. per cent slip in the following figures:

Inflation comparison within group:	on loose sand, Figures 11-14 (Tables IV - VII)
Group comparison at constant inflation:	on loose sand, Figures 19-21 on concrete, Figures 22-24

4. DISCUSSION (cont'd)

Details (cont'd)

The belted tire shows an increased tractive efficiency which is attained through increased drawbar pull at lower slip rate. (See Figure 10). This would manifest itself in an increased ton mile per hour value.

The inflation comparisons on loose sand showed the belted tire at 30 psi equal to the regular tire at 20 psi. The belted tire thus presents the advantage of standardized inflation for on-and-off the road service. The gradeability advantage offered by the belted tire is illustrated in Figure 25 for a typical military vehicle.

Rolling radius measurements (see tabulated data) show belted tire radius much more uniform over the test range than the regular tire. In the belted tire the measured rolling radius came between the tread face and belt; in the regular tire, no simple relationship to tire construction was evident.

Maximum traction performance of constructions as summarized in the following table indicates an advantage for the belted construction when it is consistent as to fabric in belt and body.

Constructions Giving Maximum Drawbar Pull

On Loose Sand - PSI			On Concrete - PSI		
10	20	30	10	20	30
Wire Belt	Textile Belt	Textile Belt	Regular	Wire Belt	Wire Belt
Wire Body	Textile Body	Textile Body		Wire Body	Textile Body

Buckling characteristics at 10 psi are shown below in terms of drawbar pull at which buckling began. No buckling occurred at 20 or 30 psi.

4. DISCUSSION (cont'd)

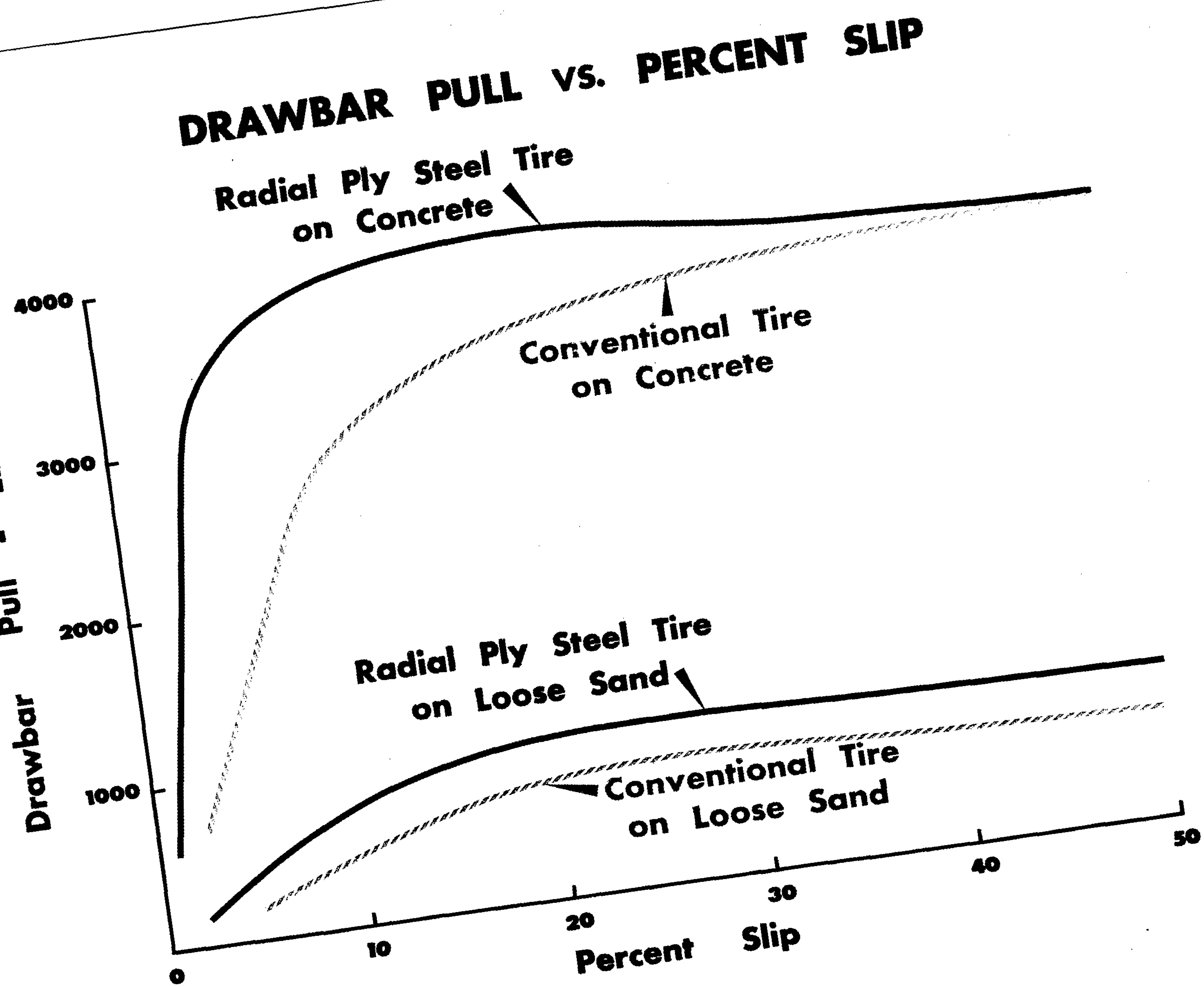
Details (cont'd)

Buckling Drawbar Pull at 10 psi

	On Loose Sand	On Concrete
Regular Production	*	2700 lbs.
Wire Belt - Textile Body	1332 lbs.	1300 "
Textile Belt - Textile Body	1360 "	1300 "
Wire Belt - Wire Body	1440 "	2600 "

* No buckle at 1220 lbs. maximum drawbar pull.

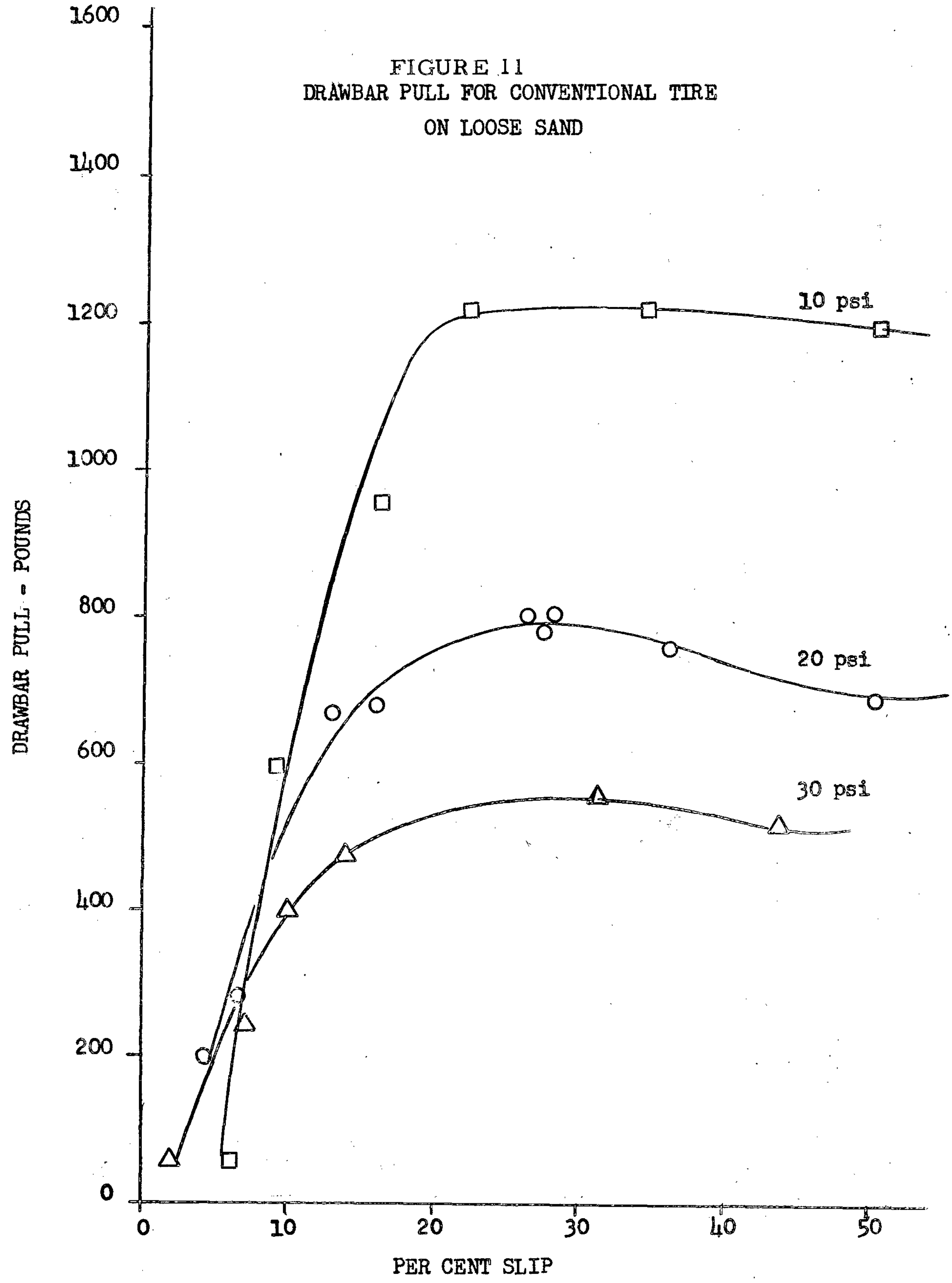
Note that buckling occurred at virtually the same load on sand and concrete for the textile body; also that the wire body was more buckle resistant, particularly on concrete.



DRAWBAR PULL VS. PERCENT SLIP
Radial Ply Steel Tire on Concrete
Conventional Tire on Concrete
Radial Ply Steel Tire on Loose Sand
Conventional Tire on Loose Sand
4000
3000
2000
1000
Drawbar Pull - Lb.
0
10
20
30
40
50
Percent Slip

FIG. 10
22

FIGURE 11
DRAWBAR PULL FOR CONVENTIONAL TIRE
ON LOOSE SAND



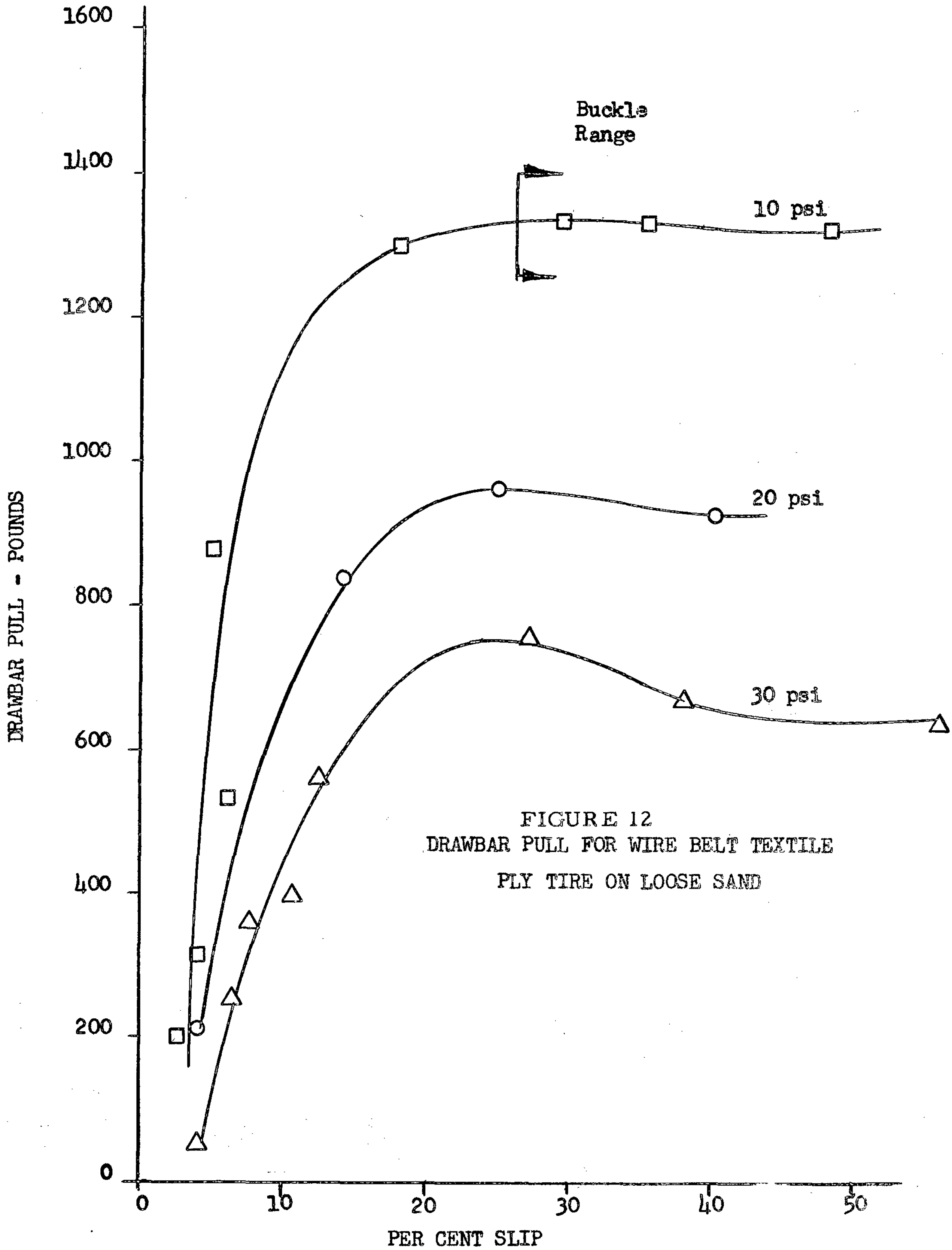


FIGURE 12
DRAWBAR PULL FOR WIRE BELT TEXTILE
PLY TIRE ON LOOSE SAND

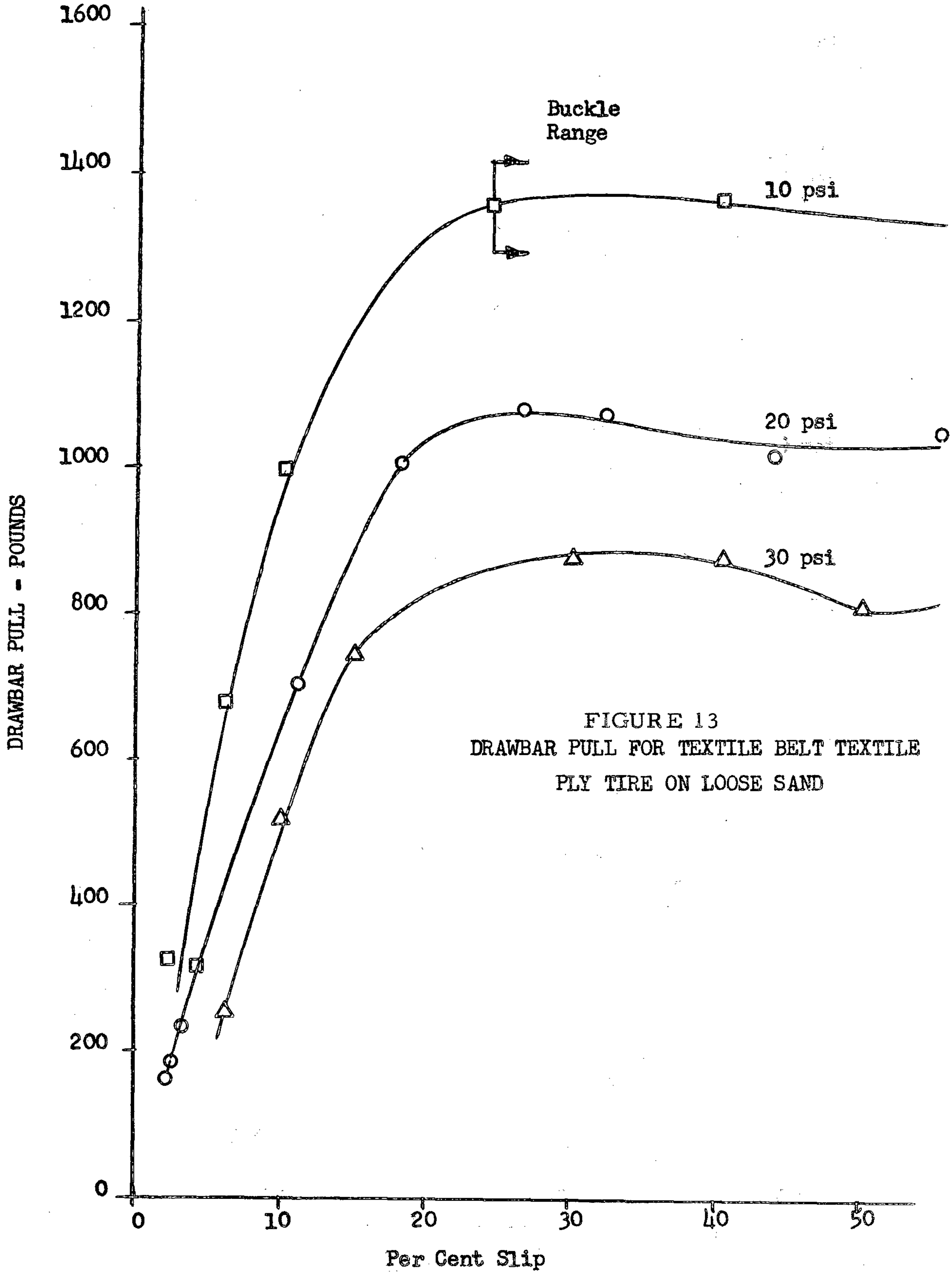


FIGURE 13
DRAWBAR PULL FOR TEXTILE BELT TEXTILE PLY TIRE ON LOOSE SAND

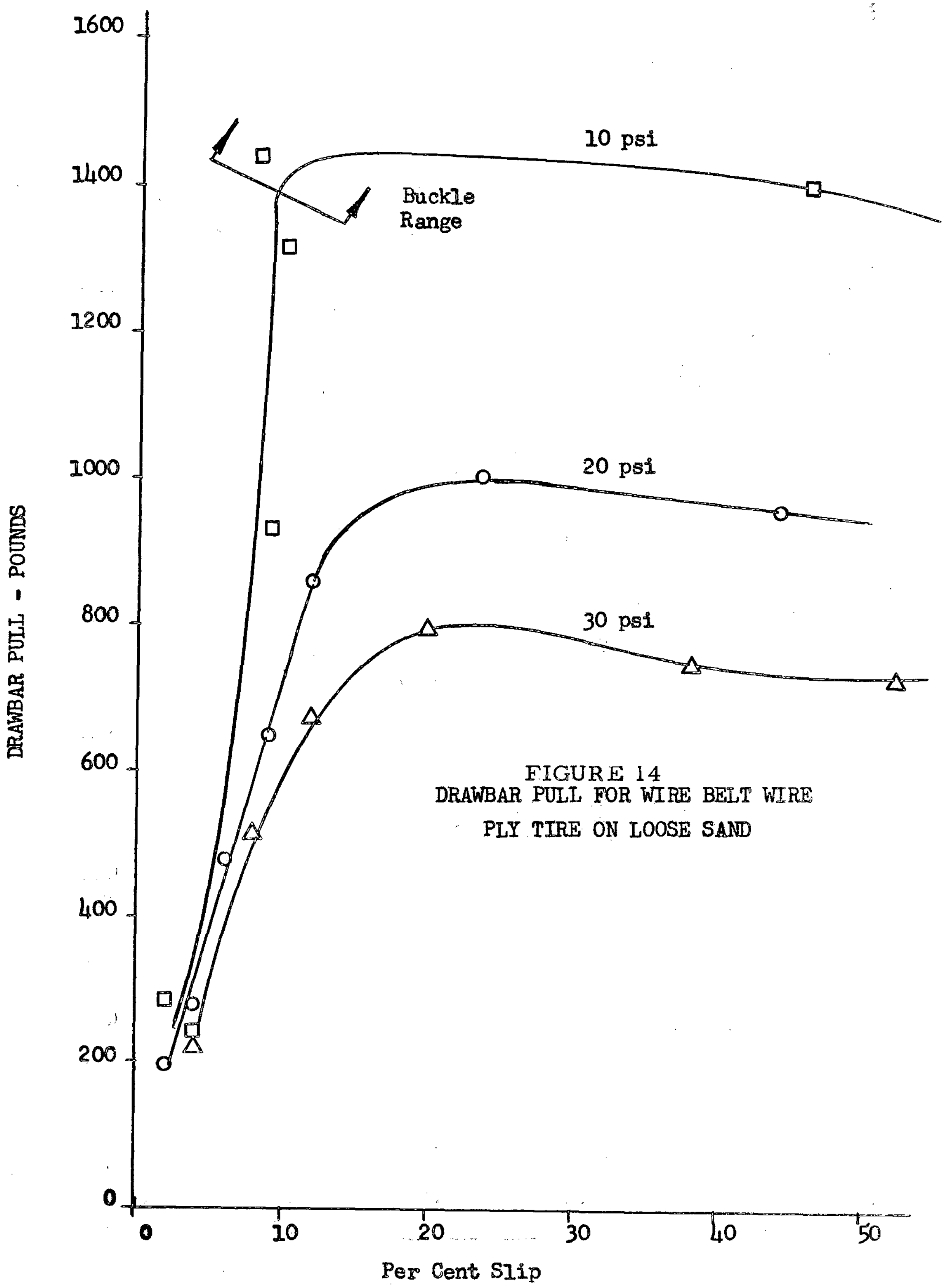


FIGURE 14
DRAWBAR PULL FOR WIRE BELT WIRE
PLY TIRE ON LOOSE SAND

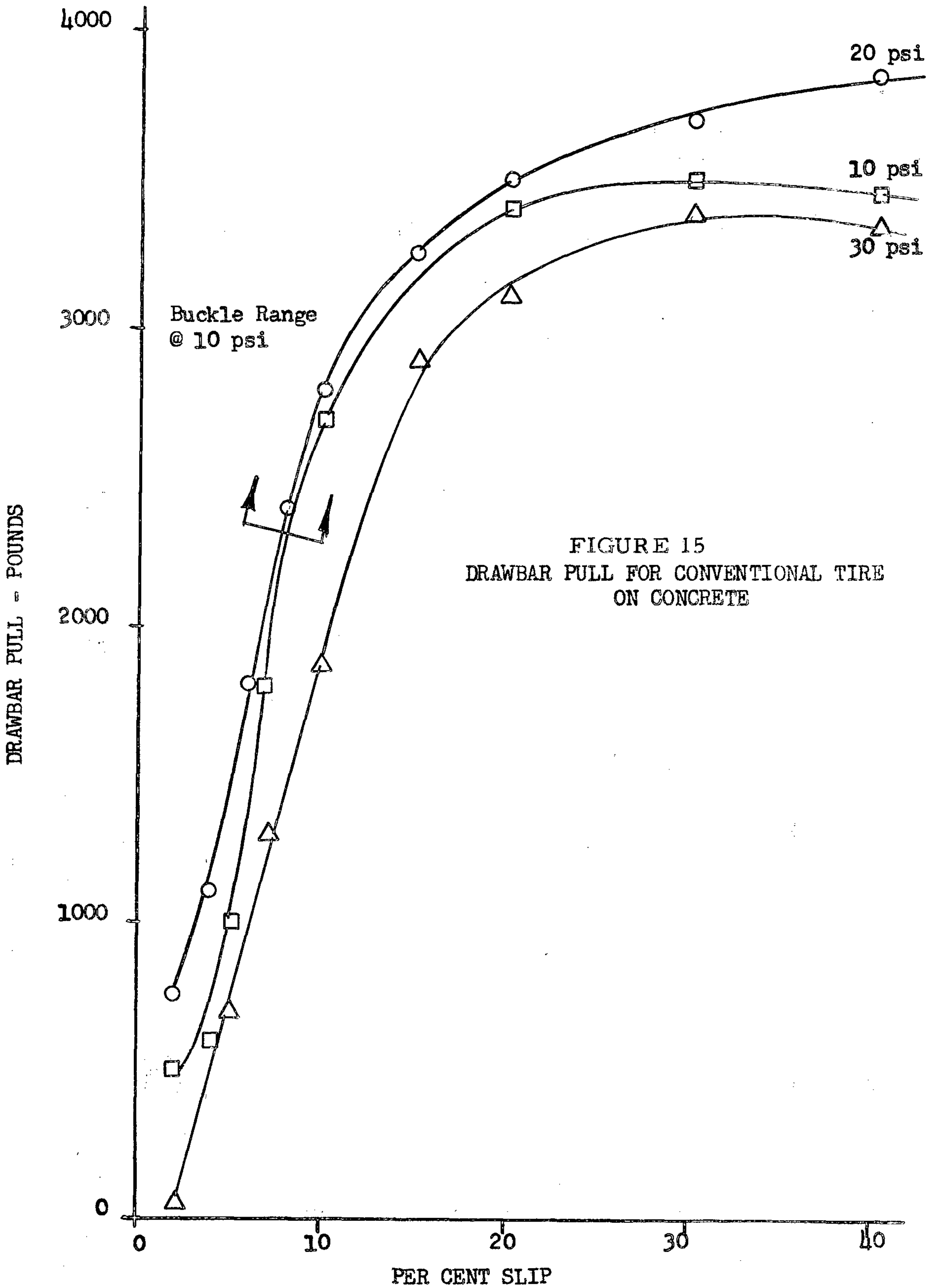


FIGURE 15
DRAWBAR PULL FOR CONVENTIONAL TIRE
ON CONCRETE

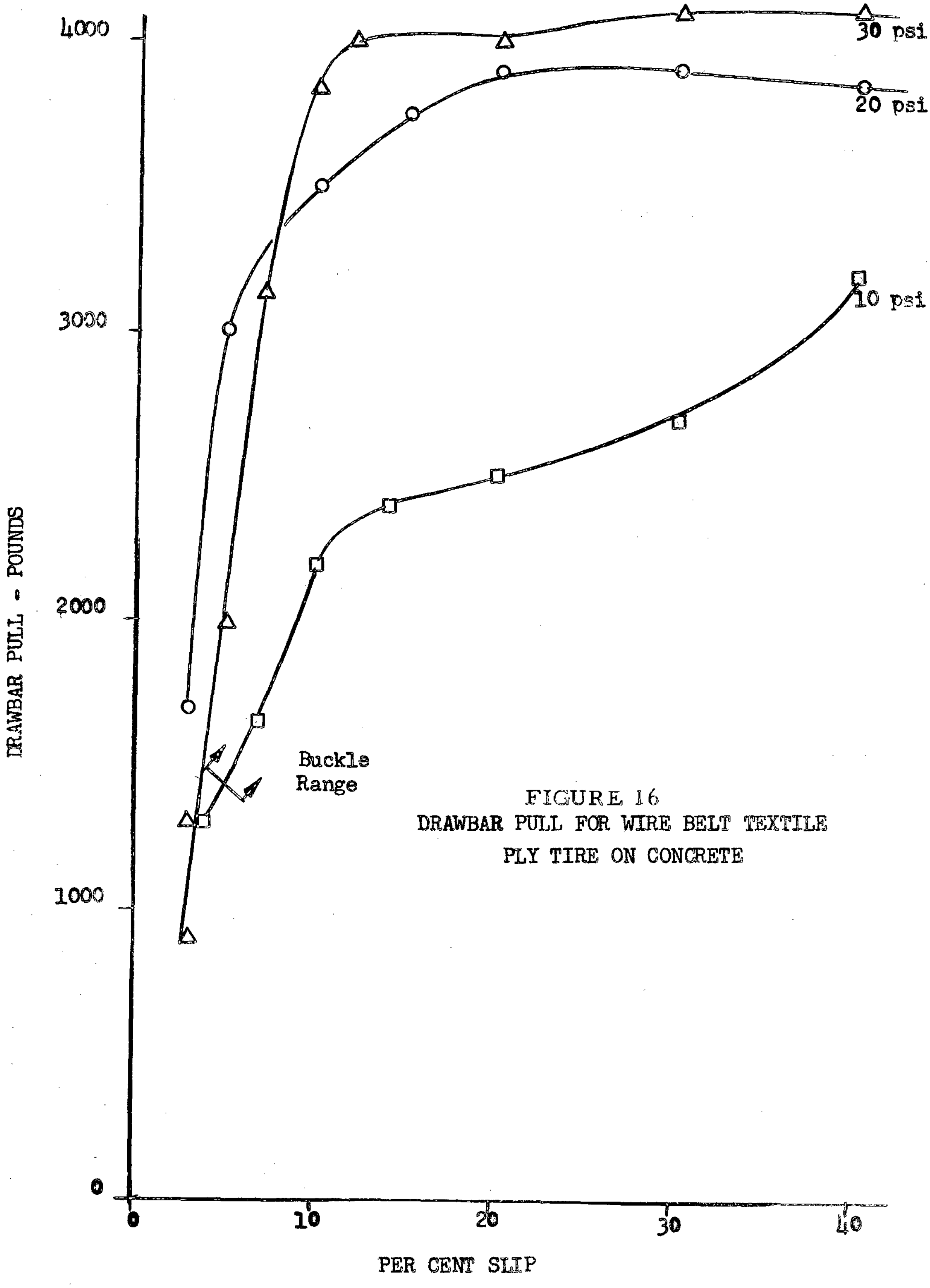


FIGURE 16
DRAWBAR PULL FOR WIRE BELT TEXTILE
PLY TIRE ON CONCRETE

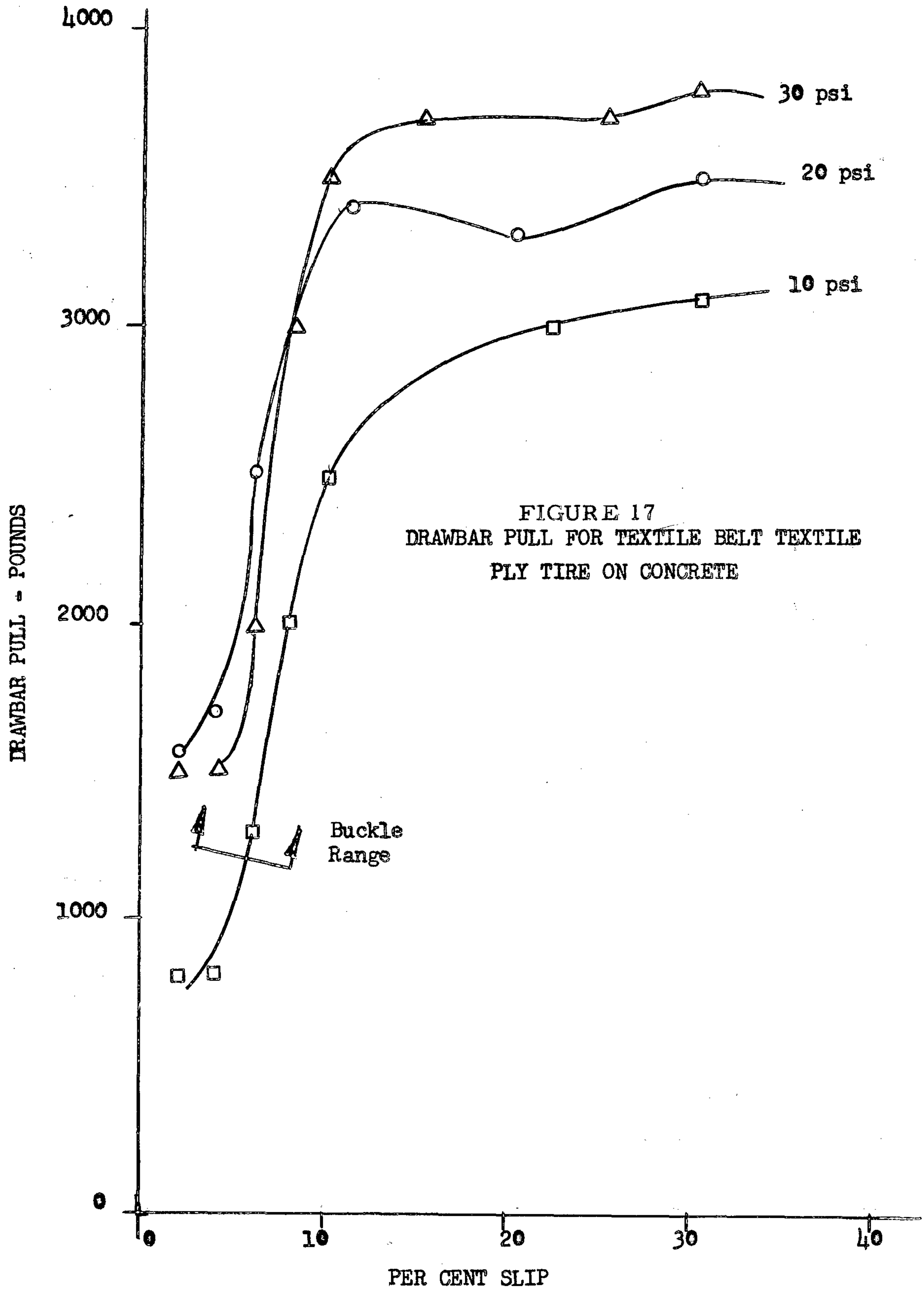


FIGURE 17
DRAWBAR PULL FOR TEXTILE BELT TEXTILE
PLY TIRE ON CONCRETE

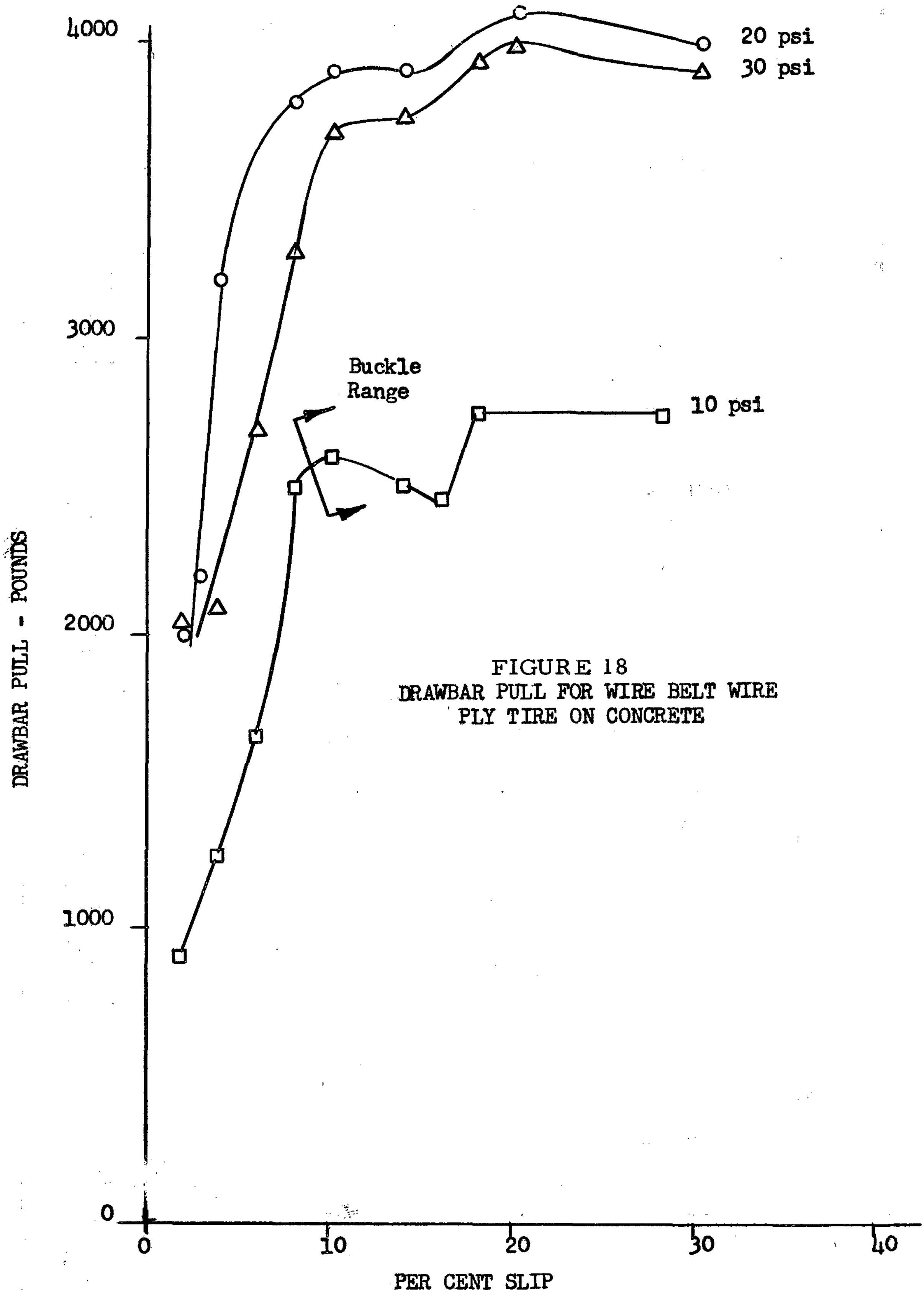
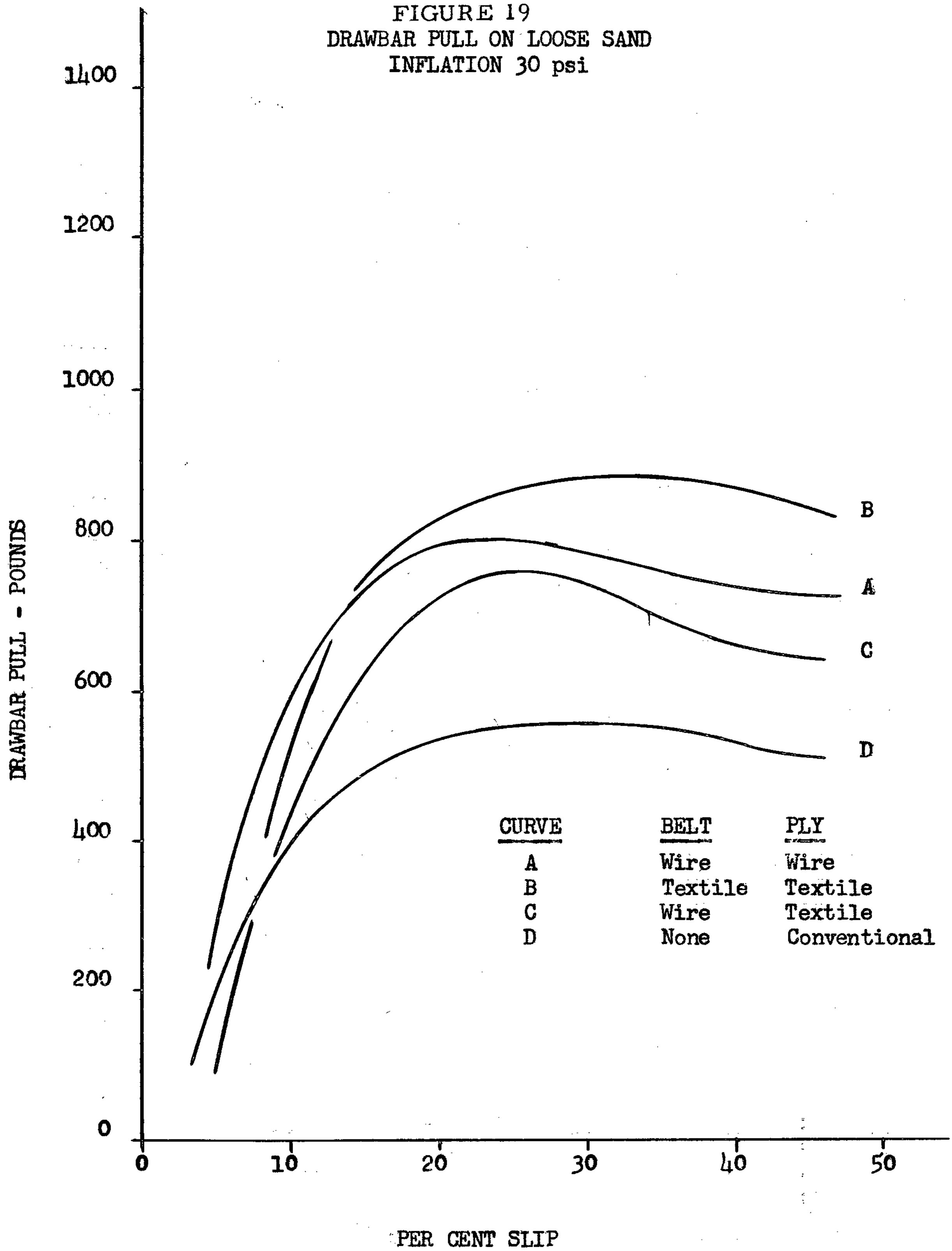


FIGURE 18
DRAWBAR PULL FOR WIRE BELT WIRE PLY TIRE ON CONCRETE

FIGURE 19
DRAWBAR PULL ON LOOSE SAND
INFLATION 30 psi



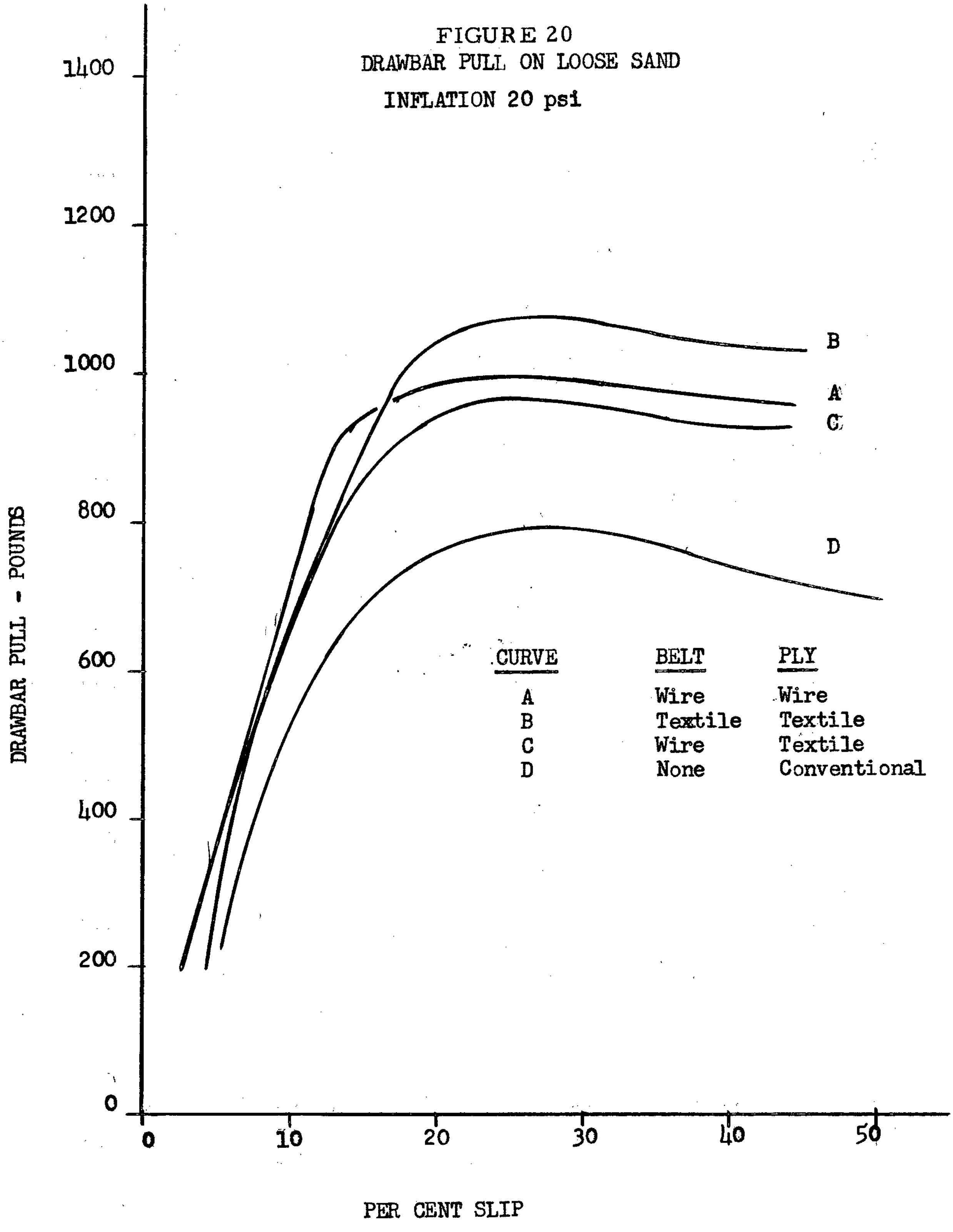


FIGURE 20
DRAWBAR PULL ON LOOSE SAND
INFLATION 20 psi
DRAWBAR PULL - POUNDS
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
PER CENT SLIP
B
A
C
D
CURVE BELT PLY
A Wire Wire
B Textile Textile
C Wire Textile
D None Conventional

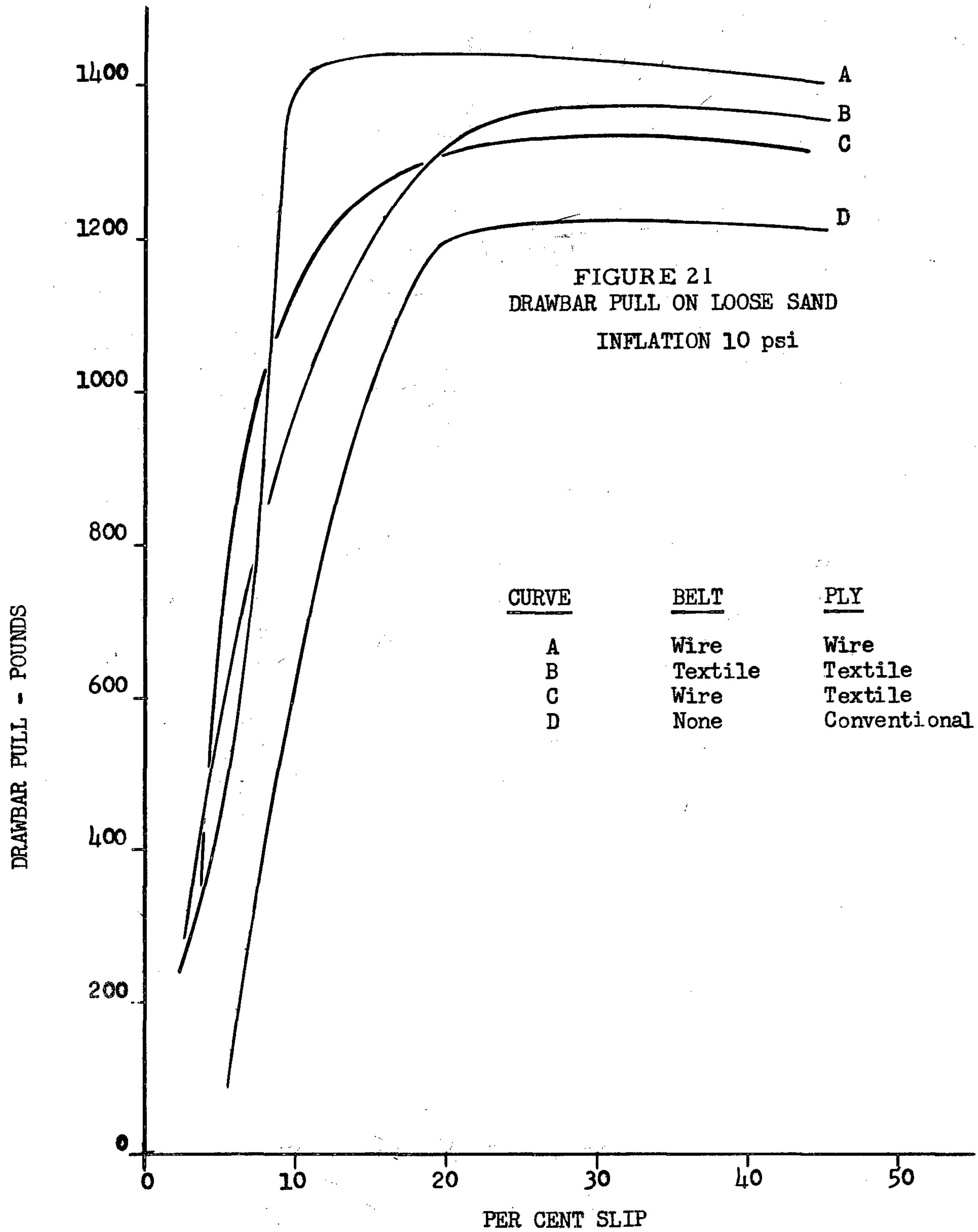


FIGURE 21
DRAWBAR PULL ON LOOSE SAND
INFLATION 10 psi

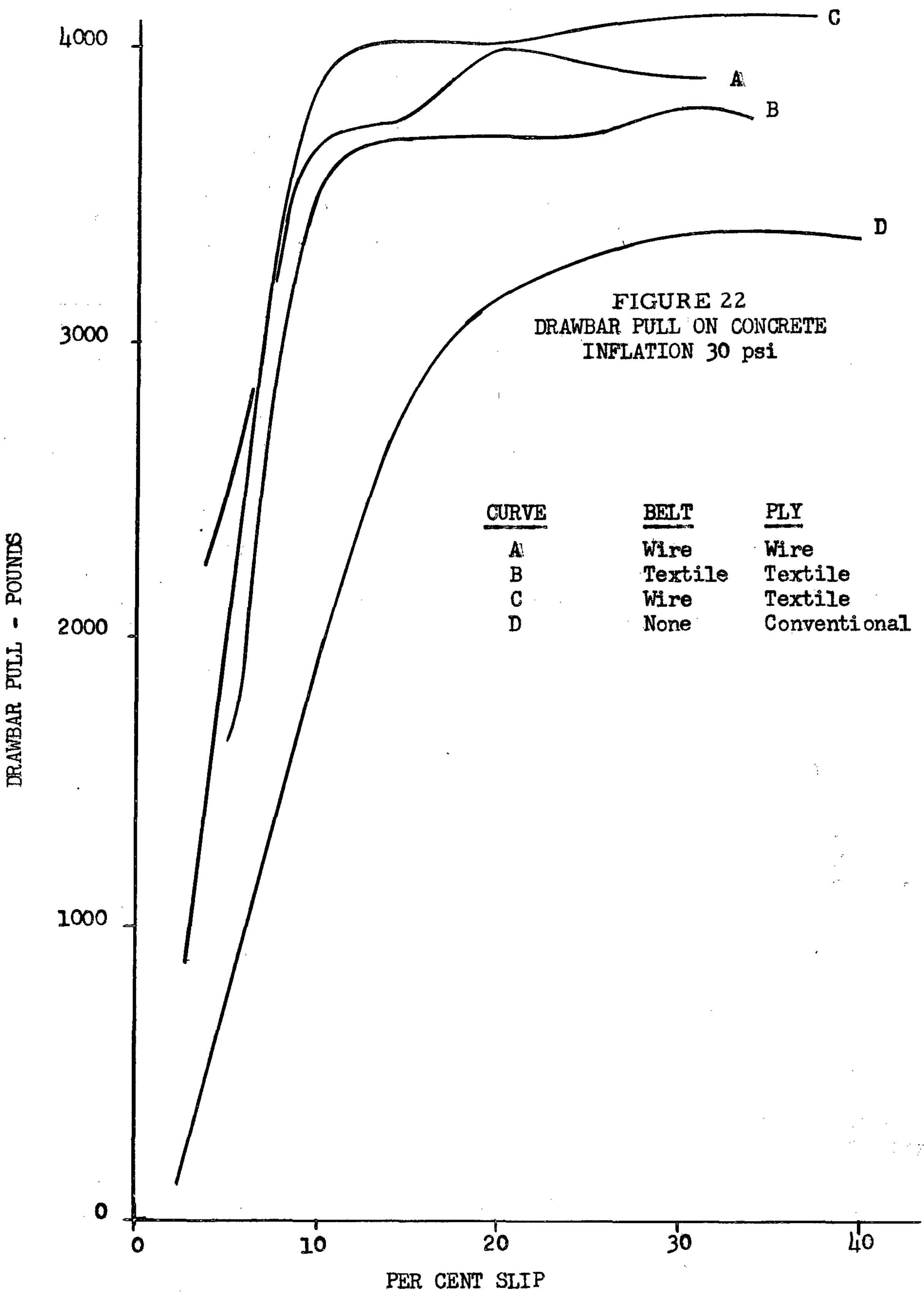


FIGURE 22
DRAWBAR PULL ON CONCRETE
INFLATION 30 psi
CURVE BELT PLY
A Wire Wire
B Textile Textile
C Wire Textile
D None Conventional
A
B
C
D
4000
3000
2000
1000
0
0
10
20
30
40
DRAWBAR PULL - POUNDS
PER CENT SLIP

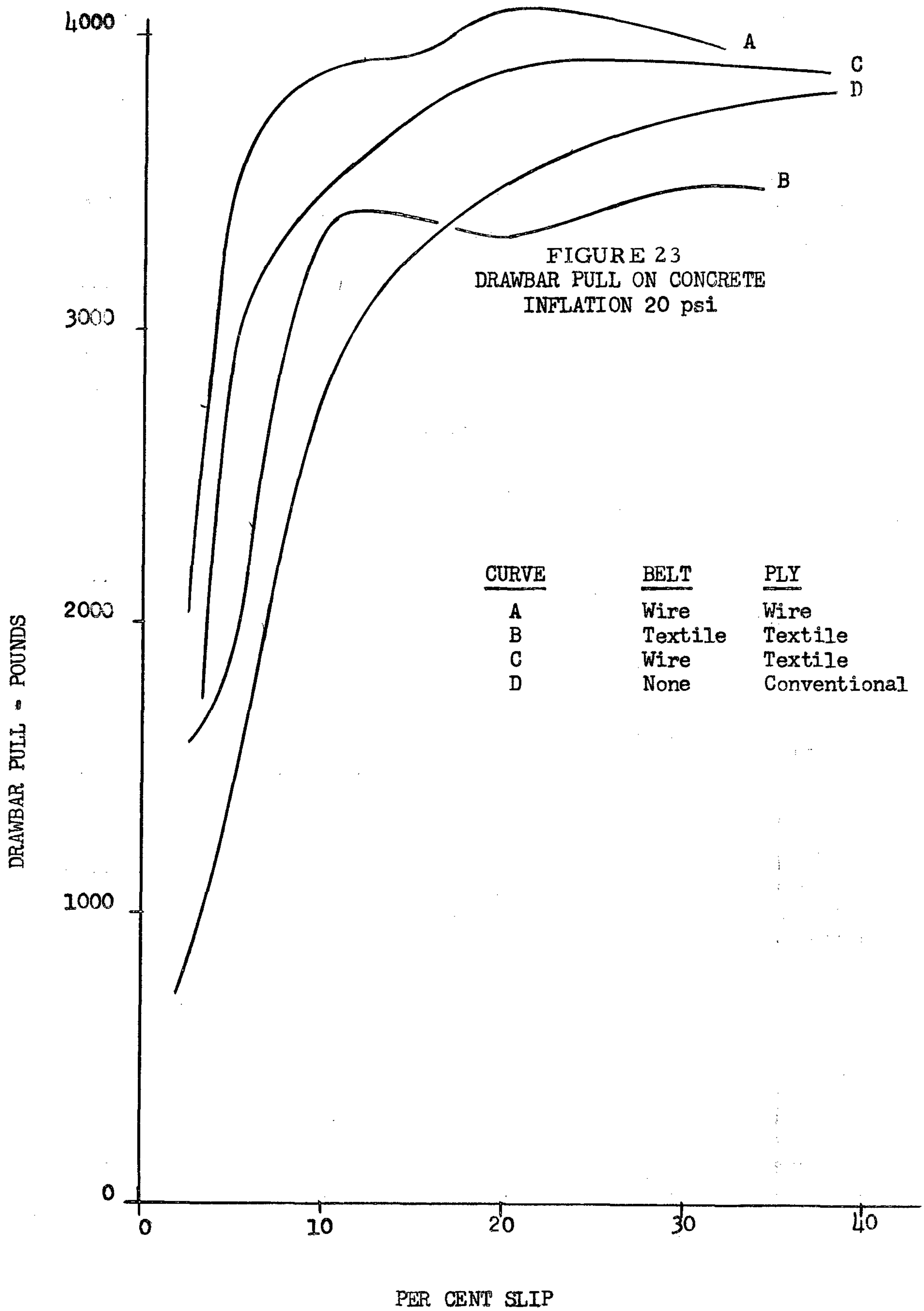


FIGURE 23
DRAWBAR PULL ON CONCRETE
INFLATION 20 psi

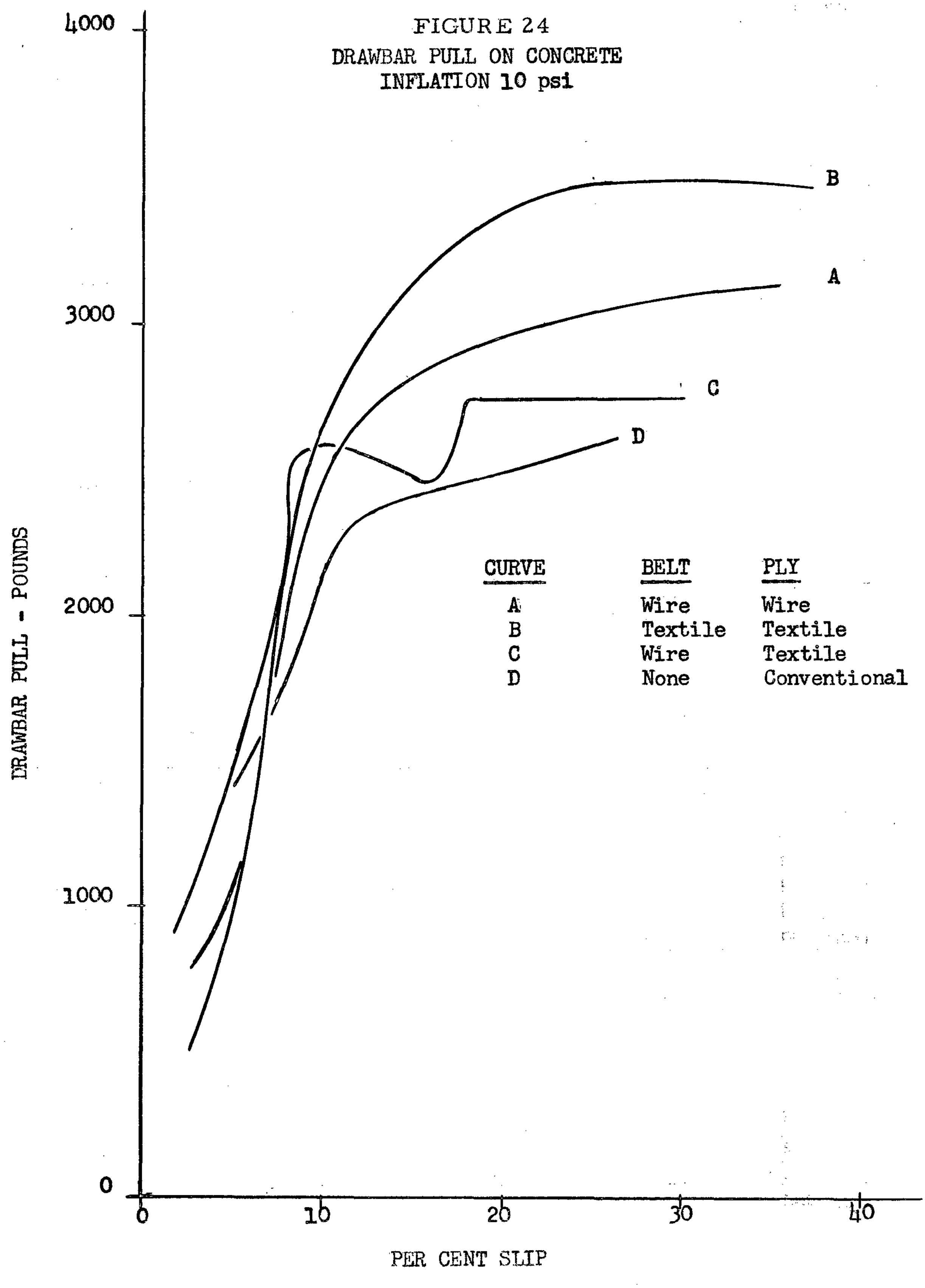


FIGURE 24
DRAWBAR PULL ON CONCRETE
INFLATION 10 psi
4000
3000
2000
1000
0
DRAWBAR PULL - POUNDS
0
10
20
30
40
PER CENT SLIP
B
A
C
D
CURVE BELT PLY
A Wire Wire
B Textile Textile
C Wire Textile
D None Conventional

FIGURE 25

GRADEABILITY OF BELTED VS. CONVENTIONAL TIRE ON 6X6 TRUCK IN LOOSE SAND AT CONSTANT POWER

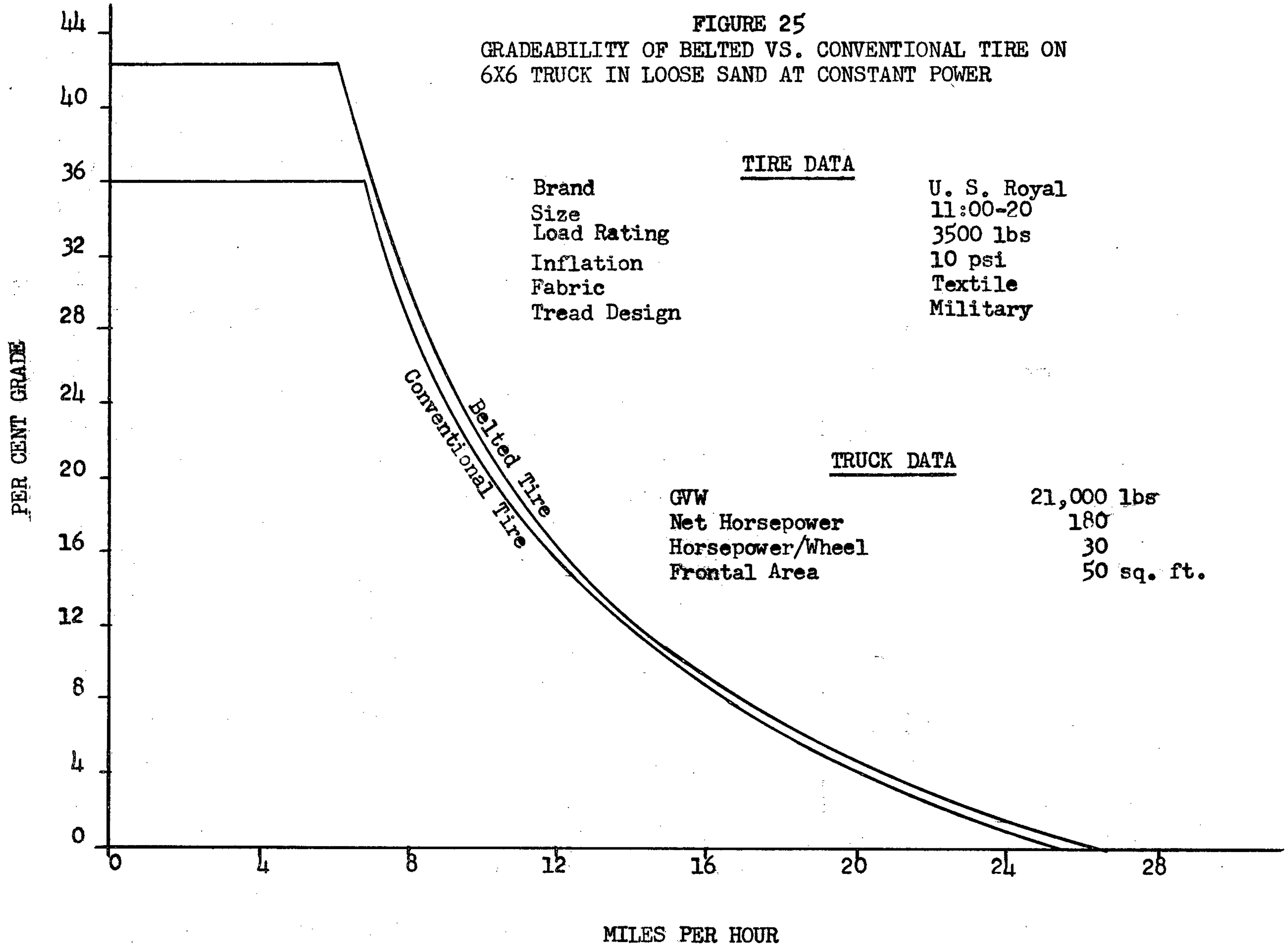


TABLE IV
REGULAR TIRE ON LOOSE LAKELAND SAND

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Sidewall Buckle	Meas. Roll. Rad. Ft.
10	6	920	160	130	3630	.0441	-	1.90
	9	1600	600	200	3700	.1621	-	
	16	2240	960	280	3780	.2539	-	
	22	2680	1220	340	3840	.3177	-	
	34	2880	1220	380	3880	.3144	-	
	50	3120	1200	390	3890	.3084	-	
	70	3400	1180	440	3940	.2994	-	
20	4.4	1265	200	176	3676	.0544	-	1.91
	6.4	1360	280	170	3670	.0762	-	
	8	1535	400	210	3710	.1078	-	
	16	2140	680	270	3770	.1803	-	
	28	2560	810	380	3880	.2087	-	
	36	2800	760	424	3924	.1936	-	
	50	3020	690	480	3980	.1733	-	
	68	3300	740	500	4000	.1850	-	
30	2	1120	60	130	3630	.0165	-	1.67
	7	1520	240	180	3680	.0652	-	
	10	1760	400	205	3705	.1079	-	
	14	2020	480	240	3740	.1283	-	
	31	2560	560	340	3840	.1458	-	
	43.5	2880	520	420	3920	.1326	-	
	60	3280	580	470	3970	.1460	-	
	66	3510	600	480	3980	.1507	-	

TABLE V
WIRE BELT, TEXTILE PLY TIRE ON LOOSE LAKELAND SAND

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	2.6	1056	200	156	3656	.0547	-	1.70
	4.0	1280	312	160	3660	.0852	-	
	5	2240	880	264	3764	.2337	-	
	6	1600	536	194	3694	.1451	-	
	18	3080	1300	400	3900	.3333	-	
	29.3	3290	1332	460	3960	.3363	X	
	35.5	3465	1332	480	3980	.3346	X	
	48	3550	1324	502	4002	.3308	X	
	67	3760	1328	520	4020	.3303	X	
	69.2	3825	1240	530	4030	.3076	X	
20	4	1200	208	140	3640	.0571	-	1.76
	14	2330	840	322	3822	.2197	-	
	25	2790	968	394	3894	.2485	-	
	40	3140	928	440	3940	.2355	-	
	61.5	3470	1080	442	3942	.2739	-	
	74	3690	856	496	3996	.2142	-	
	74	3680	840	528	4028	.2085	-	
30	4.2	984	56	80	3580	.0156	-	1.77
	6.4	1360	256	110	3610	.0709	-	
	7.6	1520	360	136	3636	.0990	-	
	10.6	1600	400	132	3632	.1101	-	
	12.4	1935	568	160	3660	.1551	-	
	27	2560	760	200	3700	.2054	-	
	38	2840	688	284	3784	.1818	-	
	56	3200	640	330	3830	.1671	-	
	66.6	3600	712	396	3896	.1827	-	
	73.6	3640	680	400	3900	.1743	-	

TABLE VI
TEXTILE BELT, TEXTILE PLY TIRE ON LOOSE LAKELAND SAND

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	2	1080	328	170	3670	.0893	-	1.66
	4	1120	320	180	3680	.0869	-	
	6	1740	680	240	3740	.1818	-	
	10	2240	1000	296	3796	.2634	-	
	24	3040	1360	480	3980	.3417	X	
	40	3320	1368	516	4016	.3406	X	
	68	3440	1320	524	4024	.3280	X	
20	2	888	164	84	3584	.0457	-	1.71
	2.4	944	184	116	3616	.0508	-	
	3	960	236	108	3608	.0654	-	
	11	1930	704	240	3740	.1882	-	
	18	2440	1008	300	3800	.2652	-	
	32	2880	1072	528	4028	.2661	-	
	43.5	3040	1016	480	3980	.2552	-	
	55	3280	1048	512	4012	.2612	-	
	60	3320	1020	520	4020	.2537	-	
	77.5	3600	1076	564	4064	.2647	-	
30	6	1280	256	180	3680	.0695	-	1.73
	10	1760	520	230	3730	.1394	-	
	15	2080	748	272	3772	.1983	-	
	30	2670	880	400	3900	.2256	-	
	40	2880	880	454	3954	.2225	-	
	49.8	3060	812	484	3984	.2038	-	
	63.5	3360	928	520	4020	.2308	-	
	85	3840	1160	580	4080	.2843	-	

TABLE VII
WIRE BELT, WIRE PLY TIRE ON LOOSE LAKELAND SAND

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Transfer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	2	1040	280	160	3660	.0765	-	1.72
	4	1040	240	160	3660	.0656	-	
	8	2940	1440	426	3926	.3667	X	
	9	2350	928	302	3802	.2440	X	
	10	3070	1312	446	3946	.3324	X	
	46	3520	1400	520	4020	.3482	X	
	70.7	3380	1168	468	3968	.2943	X	
20	2	1040	196	150	3650	.0536	-	1.72
	4	1160	280	160	3660	.0765	-	
	6	1535	480	200	3700	.1211	-	
	9	1935	648	238	3738	.1733	-	
	12	2220	860	270	3770	.2281	-	
	23.5	2720	1000	424	3924	.2548	-	
	44	3070	960	476	3976	.2414	-	
	74	3610	992	580	4080	.2431	-	
30	4	1280	224	172	3672	.0610	-	1.73
	8	1760	516	230	3730	.1383	-	
	12	2040	676	264	3764	.1795	-	
	20	2400	800	300	3800	.2105	-	
	38	2800	744	440	3940	.1888	-	
	52	3200	728	504	4004	.1818	-	
	70	3600	780	570	4070	.1916	-	

TABLE VIII
REGULAR TIRE ON CONCRETE

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	2	820	500	10	3510	.142	-	1.55
	4	1100	600	30	3530	.170	-	
	5	1760	1000	50	3550	.282	-	
	7	2840	1800	110	3610	.499	-	
	10	4000	2700	200	3700	.730	X	
	20	5040	3400	250	3750	.906	X	
	30	5280	3500	250	3750	.935	X	
	40	4960	3450	230	3730	.925	X	
20	2	1280	750	140	3640	.206	-	1.59
	4	1800	1100	170	3670	.300	-	
	6	2960	1800	280	3780	.477	-	
	8	3760	2400	340	3840	.625	-	
	10	4280	2800	370	3870	.724	-	
	15	5000	3250	410	3910	.831	-	
	20	5240	3500	440	3940	.888	-	
	30	5440	3700	450	3950	.936	-	
	40	5600	3850	470	3970	.970	-	
	60	5360	3700	440	3940	.939	-	
30	2	400	50	60	3560	.014	-	1.64
	5	1520	700	150	3650	.192	-	
	7	2280	1300	230	3730	.349	-	
	10	3200	1850	330	3830	.484	-	
	15	4640	2900	510	4010	.724	-	
	20	4970	3120	510	4010	.778	-	
	30	5280	3400	510	4010	.848	-	
	40	5120	3350	530	4030	.831	-	
	50	5040	3350	550	4050	.828	-	
	80	5200	3450	570	4070	.848	-	

TABLE IX
WIRE BELT, TEXTILE PLY TIRE ON CONCRETE

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	4	2720	1300	140	3640	.3575	X	1.69
	7	3200	1650	180	3680	.4485	X	
	10	4000	2200	240	3740	.5880	X	
	14	4000	2400	270	3770	.6370	X	
	20	4320	2500	280	3780	.6620	X	
	30	4240	2700	300	3800	.7110	X	
	40	4880	3200	340	3840	.8330	X	
20	3	3280	1700	200	3700	.4595	-	1.65
	5	5040	3000	310	3810	.7880	-	
	10	5840	3500	360	3860	.9070	-	
	15	6160	3750	380	3880	.9660	-	
	20	6320	3900	360	3860	1.0100	-	
	30	6320	3900	360	3860	1.0100	-	
	40	6320	3850	370	3870	.9950	-	
	50	6080	3850	380	3880	.9920	-	
30	3	1360	900	20	3520	.2600	-	1.70
	5	3200	2000	160	3660	.5500	-	
	7	5200	3120	360	3860	.8100	-	
	10	6080	3850	410	3910	.9850	-	
	12	6320	4000	480	3980	1.0000	-	
	20	6400	4000	500	4000	1.0000	-	
	30	6400	4100	510	4010	1.0200	-	
	40	6400	4100	470	3970	1.0300	-	
	50	6400	4100	460	3960	1.0300	-	

TABLE X
TEXTILE BELT, TEXTILE PLY TIRE ON CONCRETE

Infl. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll, Rad. Ft.
10	2	1600	800	150	3650	.2191	-	1.62
	4	1600	800	160	3660	.2185	-	
	6	2400	1300	260	3760	.3457	X	
	8	3360	2000	370	3870	.5167	X	
	10	4320	2500	470	3970	.6297	X	
	22	4880	3000	520	4020	.7462	X	
	30	5120	3100	540	4040	.7673	X	
20	2	2560	1550	290	3790	.3904	-	1.66
	4	2800	1700	290	3790	.4485	-	
	6	4000	2500	420	3920	.6377	-	
	8	4800	3000	490	3990	.7518	-	
	11	5280	3400	580	4080	.8333	-	
	20	5280	3300	580	4080	.8088	-	
	30	5600	3500	600	4100	.8536	-	
	40	5440	3400	580	4080	.8333	-	
30	2	2600	1500	270	3770	.3978	-	1.69
	4	2600	1500	260	3760	.3989	-	
	6	3360	2000	330	3830	.5221	-	
	8	4800	3000	490	3990	.7518	-	
	10	5600	3500	620	4120	.8945	-	
	15	5920	3700	630	4130	.8958	-	
	25	5920	3700	640	4140	.8937	-	
	30	5920	3800	640	4140	.9178	-	
	40	5600	3600	600	4100	.8780	-	

TABLE XI
WIRE BELT, WIRE PLY TIRE ON CONCRETE

Inf. PSI	Slip %	Torque Lbs. - Ft.	Drawbar Pull - Lbs.	Load-Trans-fer-Lbs.	Dynamic Load - Lbs.	Coefficient of Traction	X-Side-wall Buckle	Meas. Roll. Rad. Ft.
10	2	1760	900	230	3730	.241	-	1.68
	4	2400	1250	270	3770	.332	-	
	6	3040	1650	350	3850	.233	-	
	8	4320	2500	500	4000	.625	-	
	10	4560	2600	520	4020	.647	X	
	16	4000	2450	510	4010	.611	X	
	18	4560	2750	470	3970	.693	X	
	28	4560	2750	520	4020	.684	X	
20	2	3280	2000	360	3860	.518	-	1.69
	3	3520	2200	360	3860	.570	-	
	4	5120	3200	600	4100	.780	-	
	8	6000	3800	740	4240	.896	-	
	10	6000	3900	750	4250	.918	-	
	14	6240	3900	750	4250	.918	-	
	20	6400	4100	750	4250	.965	-	
	30	6240	4000	730	4230	.946	-	
30	2	3040	2050	450	3950	.519	-	1.70
	4	3360	2100	450	3950	.532	-	
	6	4000	2700	530	4030	.670	-	
	8	4800	3300	660	4160	.793	-	
	10	5440	3700	740	4240	.873	-	
	14	5600	3750	740	4240	.884	-	
	18	5760	3950	720	4220	.936	-	
	20	5760	4000	730	4230	.946	-	

4. DISCUSSION (cont'd)

4.1.3.2.2 Mud Test

Conclusion

The belted tire offers a major improvement in mud traction, the improvement varying inversely with inflation pressure.

Details

Size:	11.00-20-12 P.R.
Brand:	U.S. Royal Tactical Cross Country
Rim:	8.0
Tread Stock:	Military Type, Synthetic
Construction Features:	Group A - Regular Production, Conventional Group B - Experimental, Wire Belt - Textile Body
Load:	3500 lbs.
Inflation:	10 and 30 psi
Test surface:	Wet Decatur Clay

The soil was prepared dry by rolling the over-inflated tire at high thrust to form a track approximately 4" deep, having a layer of approximately 2" of powdered clay. The track was filled with water to form a layer of very soft mud overlaying the compacted subsoil. Trials immediately after wetting demonstrated that reliable comparisons could not be expected due to extremely low drawbar output (traction coefficients ran under .01). The loss in drawbar pull was due in part to the high lubricity of the mud, formation of a "mud wedge" at the leading edge of the tire, and tire sinkage under normal load and slip. To alleviate these difficulties, subsequent tracks were prepared as follows: Width was increased to two feet with depth diminishing toward the edges. A waiting time of 18 hours was introduced to permit surface water to diffuse into the subsoil or evaporate. The resultant track could support traction coefficients $\approx$.06, which was sufficient for resolving group differences.

The test plan in Table XII was adopted to minimize error in group comparisons due to progressive drying of the mud. Thus data averaging would provide a comparison at constant moisture

4. <u>DISCUSSION</u> (cont'd)

4.1.3.2.2 <u>Mud Test</u> (cont'd)

<u>Details</u> (cont'd)

content at a mean inflation of 20 psi. The method of averaging is shown in Table XIII; in the table the hyphen symbolizes an interpolation.

The test car was instrumented to electrically sense and record car velocity, per cent slip, torque input, load transfer and drawbar pull. To make the test the car was driven by the test tire at a rotational speed of 1.065 rads/sec., a braking force was applied until the car was brought to a stop and the tire reached 100% slip. A run made on the prepared track was immediately followed by a re-run in the rut.

Throughout the tests the tread design voids were solidly filled with mud; moisture content remained above the plastic limit.

The coefficient of traction was taken as the performance criterion. The coefficient was calculated as the ratio of maximum drawbar pull to dynamic load. The values are given in Tables XIV and XV for each run and re-run, respectively. Averaging to arrive at the 20 psi and constant moisture content comparison, discussed above, showed the belted tire 20% superior on unbroken mud; further comparison at a less complete cancellation of error associated with moisture change showed the superiority increasing to 52% at 10 psi. With firmer contact established on the compacted subsoil, by increasing inflation or re-running the track, the difference between the belted and conventional tires was minor. These results also appeared in the mud traction tests performed at the Detroit Plant during the last spring thaw. See combined summaries in Table XVI.

Table XVII gives the cone penetrometer readings indicating the soil strength profile.

TABLE XII - TEST PLAN

West Track			East Track		
Group	Inflation psi	Test Number	Group	Inflation psi	Test Number
A	10	T-506	B	10	T-503
A	30	T-499	B	30	T-502
B	10	T-504	A	10	T-507
B	30	T-501	A	30	T-498
A	10	T-508 Finish	B	10	T-505
A	30	T-497 Start	B	30	T-500

TABLE XIII- DATA AVERAGING SEQUENCE

Inflation psi	Group	West Track	East Track	East-West Average and Corresponding Block of Time
30	A	T-497-T-499	T-498	1
30	B	T-501	T-500-T-502	2
10	A	T-506-T-508	T-507	4
10	B	T-504	T-503-T-505	3
30-10	A			1-4
30-10	B			2-3

Group A - Regular Production, Conventional

Group B - Experimental, Wire Belt-Textile Body

TABLE XIV

Test Number	Group	Inflation psi	Track	Slip %	Torque Lbs.-Ft.	Load Trans. Lbs.	DBP Lbs.	Dyn. Load Lbs.	Coeff. of Traction
T-497	A	30	W	60	1000	200	250	3700	.0675
8	A	30	E	100	1040	220	320	3720	.0860
9	A	30	W	100	920	220	260	3720	.0698
500	B	30	E	100	1080	250	320	3750	.0853
1	B	30	W	100	880	200	270	3700	.0729
2	B	30	E	70	960	220	230	3720	.0618
3	B	10	E	100	1440	280	520	3780	.1375
4	B	10	W	100	1760	300	680	3800	.1789
5	B	10	E	100	1760	300	660	3800	.1736
6	A	10	W	100	1260	230	340	3730	.0910
Avg.									
7	A	10	E	100	1240	240	420	3740	.1122
8	A	10	W	100	1360	220	460	3720	.1236

Group A - Regular Production, Conventional

Group B - Experimental, Wire Belt-Textile Body

TABLE XV

Test Number	Group	Inflation psi	Track	Slip %	Torque Lbs.-Ft.	Load Trans. Lbs.	DBP Lbs.	Dyn. Load Lbs.	Coeff. of Traction
T-497A	A	30	W	100	1420	260	640	3760	.1702
8A	A	30	E	60	1160	230	560	3730	.1501
9A	A	30	W	100	1200	250	440	3750	.1173
500A	B	30	E	90	1400	200	630	3700	.1702
1A	B	30	W	100	1240	220	540	3720	.1451
2A	B	30	E	100	1400	260	590	3760	.1569
3A	B	10	E	87	2060	320	900	3820	.2356
4A	B	10	W	100	2160	340	1000	3840	.2604
5A	B	10	E	100	2000	280	880	3780	.2328
6A	A	10	W	90	1900	280	925	3780	.2447
Avg.									
7A	A	10	E	87	1840	260	880	3760	.2340
8A	A	10	W	100	1920	280	920	3780	.2433

Group A - Regular Production, Conventional

Group B - Experimental, Wire Belt - Textile Body

TABLE XVI
MUD TRACTOR PERFORMANCE SUMMARY

Infl. psi	Group	Traction Coefficients				Ratings			
		First Run		Re-Run		First Run		Re-Run	
		Detroit	Auburn	Detroit	Auburn	Detroit	Auburn	Detroit	Auburn
40	A	.2655		.4017		100		100	
40	B	.2915		.4368		110		109	
30	A	(.2433)	.0774	(.3686)	.1470	100	100	100	100
30	B	(.3189)	.0733	(.4412)	.1544	131	95	120	105
20	A	.2210	(.0936)	.3355	(.1930)	100	100	100	100
20	B	.3463	(.1203)	.4456	(.2009)	156	129	133	104
10	A		.1098		.2390		100		100
10	B		.1673		.2473		152		103

Group A - Regular Production, Conventional

Group B - Experimental, Wire Belt-Textile Body

Note: Bracketed values obtained by interpolation.

TABLE XVII

Depth In.	Penetrometer Reading on Unbroken Track
1.0	14
1.5	58
2.0	119
2.5	211
3.0	270

4. DISCUSSION (cont'd)

4.1.3.3 Field Tests

The contractor conducted a series of field tests in the Detroit area. The tests were conducted with a M-135, 6x6, 2 1/2 ton cargo, 1952 G.M.C. truck fully loaded to 3500# per tire.

4.1.3.3.1 Ride and Handling Test

A general ride and handling test was conducted on a paved highway with an M-135, 6 x 6, 2-1/2 ton Cargo 1952, GMC truck, fully loaded to 3500# per tire. The experimental 11:00-20 Tactical CC tires (wire breakers, textile carcass) were evaluated against the standard 11.00-20 Tactical CC tires (all-textile). The test inflation range was 10-40 psi and the speed range 0-58 mph.

The standard tire was inferior at all inflations to the experimental tire for ride, bounce, stability, recovery and steering effort except when standing still. Below 30 psi the standard was not acceptable for the above characteristics. In contrast, the experimental tires were not acceptable below 20 psi.

The performance of the experimental tires was comparable at 20 psi to the standard tires at 40 psi (30 psi plus build up).

The following ride and handling data sheets give the test driver's ratings of the tires at various inflations:

RIDE AND HANDLING TEST DATA SHEET

GROUP A TIRES - CONVENTIONAL TACTICAL TIRE

GROUP A (30 P.S.I. plus build-up)

Ride	Considered good for truck.
Bounce	Medium (Acceptable for truck)
Nibbling	Very good
Stability	Tires spot well on high angle curves and turns. No slide, but are fairly slow on recovery. Considered satisfactory.

Steering response and steering effort acceptable.

GROUP A (20 P.S.I. plus build-up)

Ride	The ride is much softer than at 30 psi but bounce is considered bad, which in general, make the ride objectionable. Tires pulsate at all times.
Steering effort	Objectionable
Stability	Objectionable due to slow recovery.

GROUP A (10 P.S.I. plus build-up)

Stability	Very objectionable due to very slow response and recovery on turns and curves.
Bounce	Very noticeably worse. (Rhythmic). Pulsating of tires considered very bad.

NOTE: A very pronounced scrubbing noise similar to buzz saw present on high angle stability check. Rated very objectionable.

GROUP B - TEXTILE CARCASS - WIRE BELT RADIAL TIRES

GROUP B (30 P.S.I. plus build-up)

Ride *	Approximately same. Very slight lateral shake, fore and aft motion present at all speeds.

* All comparisons made to Group A.

RIDE AND HANDLING TEST DATA SHEET

GROUP B - TEXTILE CARCASS - WIRE BELT RADIAL TIRES (cont'd)

GROUP B (30 P.S.I. plus build-up) (cont'd)

Bounce	Slightly less.
Nibbling	Very slightly more, but acceptable.
Stability	These tires are considerably better for response and recovery on curves and turns. Overall stability is much better than Group A.
Steering effort	Slightly worse when standing, but easier when vehicle is in motion.

GROUP B (20 P.S.I. plus build-up)

All ride and handling characteristics were approximately same as Group A at 30 psi.

GROUP B (10 P.S.I. plus build-up)

Approximately same as Group A at 20 psi.

CONCLUSION

In general, for ride and handling properties, Group B was superior to Group A.

4. DISCUSSION (cont'd)

4.1.3.3.2 Curb Climbing Test

To determine the climbing ability of the subject tires, a curb climbing test was conducted at full load. The tires were positioned adjacent to curbs of varying height. From the static position an attempt was made to climb the curb with the right front tire of the vehicle. At 40 psi, the standard tire climbed a maximum of 7-1/4". In contrast, all three type belted tires maximized at 9". All tires tested at 10 and 20 psi again maximized at a 9" height.

Since the belted tires deflect more than standard tires for a given inflation, the belted tires tested above performed comparably to textile tires at a lesser ground clearance. In addition, the belted tires negotiated the curb with less driver effort.

Post test examination of the sidewall of the standard tire revealed cutting and abrading while, in contrast, all experimental tires exhibited undamaged sidewalls.

4.1.3.3.3 Run Flat Test

Run flat tests were conducted on a concrete test area. The test procedure was to drive the truck in three circles around the test area, complete five tight figure eight turns and again circle the area three times. One set of tubeless tires was tested on the right rear position and one set on the right front.

All test tires were mounted on Job Master Rims and maximum speed reached was 15 m.p.h.

All tires failed with sidewall chipping and breaking on the outside face (load carrying side due to weight shifting), except the standard tire on the right front. This tire had cords broken on the inside sidewall area. When reinflated to 40 psi, the inflation dropped to 3 psi in approximately 24 hours.

The belted tires were considered very superior to the standard tires for handling when flat. The standard tire became unseated at the beginning of the test and then swayed and loped during the test. This enabled the tire to fold beneath the outside rim edge and consequently the rim edge was loaded during the vast majority of the test especially on cornering. Conversely, the radial tires remained seated and beneath the rim edge even on cornering, except the all wire tire which became unseated at the half way

4. DISCUSSION (cont'd)

4.1.3.3.3 Run Flat Test (cont'd)

point of the test. At the completion of the tests, the textile belted tires were still completely seated and were difficult to dismount.

Both standard tires tested dislodged the Job Master lock ring and then the inside rim flange near the end of each testing phase.

4.1.3.3.4 Air Loss Test

The air loss tests were conducted on a concrete test area. The test procedure was to drive the truck in three circles around the test area, complete five tight figure eight turns and again circle the area three times. All test tires were mounted on Job Master Rims and inflated to 10 psi and run on the right front wheel positions. All tires remained seated with no measurable air loss.

4.1.3.3.5 Field and Rupture Test

A field cut and rupture test on a test area of broken brick, rock, steel rods, glass, etc., revealed no apparent crown deficiencies in any of the tires under full load. Tires were tested at 20 psi and 40 psi inflation.

However, at 20 psi, the wire tire received a bruise split in the sidewall when brushed against a large boulder.

4.1.3.3.6 Mud Mobility and Drawbar Test

A general mud mobility test was conducted in mud with varying coefficients and composition. Testing indicated a mobility advantage with the belted tire. During testing the vehicle continually "bottomed out"; however, the belted tires made the "bottomed" vehicle easier to retrieve.

An effort was made to determine a time - distance correlation, but the inconsistent automatic up-shifting of the vehicle invalidated the results.

A vehicle-accelerated-drawbar test was performed with the following results:

4. DISCUSSION (cont'd)

4.1.3.3.6 Mud Mobility and Drawbar Test (cont'd)

	40 psi 14.95% Avg. Moisture		20 psi 16.0% Avg. Moisture	
	Std.	Belted	Std.	Belted
DBP - Unbroken Soil	5577#	6122#	4642#	7273#
DBP - Broken Soil	8438#	9174#	7046#	9360#
Ratings:				
Unbroken	100	110	100	157
Broken	100	109	100	133

From the above data it is concluded that the belted construction affords a decided tractive advantage in both broken and unbroken soil.

Because of the difficulty of obtaining homogeneous mud in this vicinity which resulted in questionable data, U. S. Rubber Company conducted the mud traction test at the National Tillage Machine Laboratory at Auburn as reported in section 4.1.3.2.2.

4.1.3.3.7 Gasoline Consumption

This test was conducted on Belle Isle around the outside perimeter of the island. Each testing phase was conducted with full load at an uninterrupted 20 mph, twice around the island which totals 11.8 miles. Four wheel, rear and intermediate drive was used for all testing.

At 40 psi, the standard tires consumed 15% more gas than the wire-textile belted tires and at 20 psi, 19% more gas was consumed. At completion of the runs, the inflation build up at 40 psi was slightly higher in the standards. At 20 psi, there was equal build up.

Revolutions per mile changed approximately twice as much for the standards compared to the experimental when the inflation was dropped from 40 to 20 psi.

4. DISCUSSION (cont'd)

4.2 Modified Contract

Due to the excellent performance of the radial tire on laboratory and limited field testing, the contract was modified to provide tires for a field endurance test. The contract was modified to provide:

(1) Twenty (20) 11:00-20 Tactical C C conventional tires.

(2) Twenty (20) 11:00-20 Tactical C C radial textile carcass, wire breaker tires.

(3) Forty (40) inner tubes for above tires.

4.2.1 Tire Design

The tire construction was identical to the textile carcass-wire breaker tire tested on this contract. The basic construction featured four (4) rayon body plies with a wire belt. The tread and sidewalls were natural rubber compounds.

4.2.2 Testing

4.2.2.1 Laboratory Testing

Two tires were subjected to the laboratory endurance test as described in section 4.1.3.1.1. The performance of the tires was comparable to the tire previously run on this test.

4.2.2.2 Camp Bullis Field Test (Project B215)

The test lot of tires was field tested at Camp Bullis under the direction of the Research and Development Division of the Ordance Tank Automotive Command. The tires were tested under Contract DA-23-072-ORD-1552 Project B-215 by Automotive Research Associates.

The testing on these tires was stopped at approximately 5,000 miles due to excessive failures in the radial ply tires. The radial tires showed a deficient bead structure.

This resulted from the low carcass strength of the radial tires plus insufficient modulus gradient in the bead region. The standard tires were those designed to function at 75 psi and 5150#, whereas the radials were designed to 30 psi and 3500# as per contract requirements. Calculations showed the standard

4. DISCUSSION (cont'd)

4.2.2.2 Camp Bullis Field Test (Project B215)

tires to have a strength advantage in excess of 50%.

However, the radial tires displayed, in off-the-road service, the tractive superiority predicted from earlier limited testing. In addition, the radial tires (at mileages up to 5068) manifested a 30% plus tread wear advantage over the entire course. These features warranted further testing of this type tires after the bead deficiencies were corrected.

For detailed results of testing refer to Automotive Research Associaties, final report on Contract DA-23-072-ORD-1552 Project B-215.

4.3 Camp Bullis Field Test (Project B219)

As the first test lot of tires furnished for Camp Bullis were under strength, the contractor agreed to furnish a second lot of test tires at no cost for further testing.

4.3.1 Tire Design

The second lot of tires tested at Camp Bullis were designed to correct the previous performance deficiencies. Also, since the OTAC group expressed a desire to have at least a 60% synthetic content in these tires, synthetic tread and sidewall stock were incorporated into the construction. Basic conditions for the test were; 30 psi (standard 40 psi) and 3500# load. The constructions evaluated were:

(1) one ply wire carcass - wire breakers

(2) four ply nylon carcass - wire breakers

(3) six ply nylon carcass - wire breakers, plus steel reinforced sidewall

NOTE: These tires performed satisfactorily on the laboratory endurance test.

4.3.2 Field Test

The tires were tested at Camp Bullis by Automotive Research Associates under Contract No. DA-23-072-ORD-1552 Project B219 under the direction of the Research and Development Division of the Ordance Tank Automotive Command.

4. DISCUSSION (cont'd)

4.3.2 Field Test (cont'd)

At 10,000 plus miles all of the radial groups were displaying an approximate 30% tread wear advantage over the control tires. None of the textile carcass tires evidenced the bead deficiencies which were prevalent in the first series of tests. Two of the wire carcass tires did show junction openings in the bead regions.

The primary reason for removal of the tires from test was failures in the shoulder region where sidewall-tread junctions opened and separations occurred. The inside of the tire on the shoulder region evidenced loss of rubber-cord adhesion and liner degradation.

A gasoline consumption test revealed no significant difference between the six ply nylon, radial tires and the standard tire. Running temperatures at the end of the day's run also showed no significant differences between groups.

The six ply nylon tires utilizing the steel-loaded sidewall provided more resistance to side-wall cracking and cutting compared to the wire radial tire and the standard tire but showed little advantage over the four ply.

At 11,584 miles four tires had been removed from each of the experimental groups. None of the standards had been removed. However, the six ply nylon tire did attain the highest mileage before failure and provided the soundest overall performance.

In order to better understand the failures and to provide improved tires for the next test, we are attempting to duplicate the failures with our wheel facilities.

In summary, there was a very pronounced improvement in endurance over that of the first set. Moreover, the handling and mobility characteristics of the radial tires still maintained the previously attained advantages.

For detailed results of testing refer to Automotive Research Associaties, Final Report on Contract DA-23-072-ORD-1552 - Project B219.

4. DISCUSSION (cont'd)

4.4 Sand Mobility Tests Conducted by Nevada Automotive Test Center

Under the supervision of the Research and Development Division of the Ordance Tank Automotive Command, the Nevada Automotive Test Center conducted Sand Mobility tests on the 11:00-20 radial tactical tires. The tires were tested under Contract DA-04-200-ORD-1274.

The radial tires were obtained from the original test lot shipped to Camp Bullis for test. They were compared to a 11:00-20 Competitive Military Standard Tire.

The tires were tested in a dry sand (0.4-0.5% moisture content) course 800' long x 30' wide x 6' in depth harrowed to a depth of 24" to provide a course compaction of 10 psi at 4" depth, 18 psi at 9" depth and 40 psi at 16" depth. Suitable prepared slopes were used for grade confirmation. The tires were mounted on a 1950 M-34, 2 1/2 ton, 6 x 6 cargo truck.

The conclusion of the report as applied to the radial tire is as follows:

The 11:00-20 radial ply belted design tires (Group C) provided significantly better sand traction than the standard military tires (Group A) at 12 psi, a safe inflation pressure, durability wise, for low speed operation, the Group C tires (Radial Ply) showed a significant improvement over Group A (Std. tires). No tire slip occured with any of the tires tested; however, the control tires experienced a slight to medium traction buckle at 12 psi inflation pressure and a severe traction buckle at 8 psi whereas the Group C (Radial tires) experienced only a slight traction buckle at 8 psi.

A brief summary of the data is shown in Table XVIII.

TABLE XVIII
SAND MOBILITY

GROUP	A -	STD.	TIRE	C -	RADIAL	TIRES
Inflation Pressure, psi	16	12	8	16	12	8
Maximum Drawbar, lbs.	2250	2750	3100	2650	3200	4200
Loss in Travel Effiency, %	14-15	12-13	13-14	14-15	14-16	12
Calculated Gradeability, %	12.5	15.3	17.2	14.7	17.8	23.3
Will-Go Gradeability, %	12	15	17	14	17	22
Will-Not-Go Gradeability, %	14	16	18	15	18	24

For detailed results of testings refer to:

Final Technical Report
Contract DA-04-200-ORD-1274

SAND MOBILITY TESTS OF GOVERNMENT
FURNISHED TIRES

SEPTEMBER, 1962

ISSUED BY NEVADA AUTOMOTIVE TEST CENTER

5. TIRE MEASUREMENTS

The measurements taken in conjunction with the testing program were:

1: Cross Section
2: Outer Diameter
3: Crown Radius
4: Load Deflection Curves
5: Closed Loop Load Deflection Curve
6: Tread Width
7: Anti Skid Depth
8: Weight
9: Gross and Net Contact Area
10: Tread Pressures
11: Loaded Cross Section
12: Olsen Rupture Resistance

Conclusions from the correlation of laboratory measurement data are as follows:

(a) The belted tires afford a more uniformly distributed load in the deflected contact area.

(b) For a given inflation and deflection the wire - textile tire has the greatest potential loading capacity as shown below at 20 psi and 2.5" deflection:

TIRE	LOAD CAPACITY
Standard	3,500#
Wire - Textile	3,675#
All Textile	3,100#
All Wire	2,975#

(c) The wire - textile tire has the greatest spring rate at full load for all tested inflations:

TIRE	Spring Rate - #/in.		
	10 psi	20 psi	30 psi
Standard	1313	1580	2087
Wire - Textile	1338	1675	2225
All Textile	1125	1500	1987
All Wire	1112	1512	1963

5. TIRE MEASUREMENTS (cont'd)

(d) The wire belted tires provide a higher rupture level than that of the standard, and an acceptable rupture level for the all textile belted tire would necessitate an excessive number of breaker belts.

(e) Contact areas on a steel plate at 3500# show comparable N/G ratios for all tires. The belted tires gross more area for the same inflation except the wire - textile tire at 10 psi.

	10 p.s.i.			20 p.s.i.			30 p.s.i.		
	Gross	Net	N/G	Gross	Net	N/G	Gross	Net	N/G
Standard	169.40	96.4	56.91	117.48	67.47	57.43	90.40	52.00	57.52
Wire-Tex.	164.70	93.18	56.58	124.71	70.17	56.27	101.49	57.09	56.25
All Tex.	178.34	104.78	58.75	132.06	76.58	57.99	108.32	61.98	57.22
All Wire	180.00	102.73	57.07	131.40	74.14	56.42	107.00	60.33	56.38

Tables XIX and XX which follow, lists all measurements taken on the original and the redesigned tires. The pages which immediately follow the Tables contain Figures 26 through 47 which are load deflection curves, closed loop deflection curves and foot print tread pressure charts.

TABLE XIX
ORIGINAL DESIGNS
TIRE MEASUREMENTS

Measurement	Conventional	Tex. Carcass Wire Brkr.	Tex. Carcass Tex. Brkr.	Wire Carcass Wire Brkr.
Cross Section				
10 psi	11.33	11.55	11.75	11.63
20 "	11.43	11.59	11.74	11.65
30 "	11.48	11.62	11.71	11.68
Outside Dia.				
10 psi	42.70	42.47	42.20	42.48
20 "	42.68	42.49	42.37	42.50
30 "	42.67	42.50	42.50	42.52
Crown Radius				
10 psi	9.25	9.54	9.40	9.54
20 "	9.50	9.55	9.49	9.55
30 "	9.50	9.55	9.55	9.56
Defl. @ 3500# Load				
10 psi	3.685	3.571	4.540	4.400
20 "	2.525	2.393	2.807	2.890
30 "	1.865	1.842	2.090	2.200
Spring Rate @ 3500# Load (#/in.)				
10 psi	1313	1338	1125	1112
20 "	1580	1675	1500	1512
30 "	2087	2225	1987	1963
Tread Width 30 psi	-	8.26	8.26	8.22
Anti Skid 30 psi	.697	.631	.644	.628
Weight (#)	117.5	100.0	93.0	110.6
Olsen Rupture (in. #)	21,635	27,504	7,658	27,159
Rim	8.0	8.0	8.0	8.0
Loaded Section @ 3500# load				
10 psi	14.23	14.67	15.27	15.13
20 "	13.24	13.83	14.18	14.16
30 "	12.59	13.34	13.57	13.67

TABLE XX
MODIFIED TIRE DESIGNS FOR
2nd CAMP BULLIS TEST
TIRE MEASUREMENT

Measurement	Wire Carcass Wire Brkr.	4 Ply Nylon Wire Brkr.	6 Ply Nylon S.R.T. Wire Brkr.
Cross Section			
30 psi	11.72	11.77	11.81
Outside Diameter			
30 psi	42.52	42.58	42.50
Crown Radius			
30 psi	16.62	15.45	17.48
Defl. 3500# load			
10 psi	4.486	3.977	3.415
20 psi	3.019	2.704	2.494
30 psi	2.278	2.091	1.954
Spring Rate - 3500# load (#/in.)			
10 psi	1087	1244	1399
20 psi	1439	1618	1755
30 psi	1877	2060	2205
Tread Width - 30 psi	8.24	8.20	8.21
Anti-Skid - 30 psi	.585	.582	.586
Weight	112# 5 oz.	106# 12 oz.	125# 13 oz.
Rim	8.0	8.0	8.0
Loaded Section - 3500#			
10 psi	15.04	14.75	14.51
20 psi	14.25	13.94	13.90
30 psi	13.65	13.55	13.54

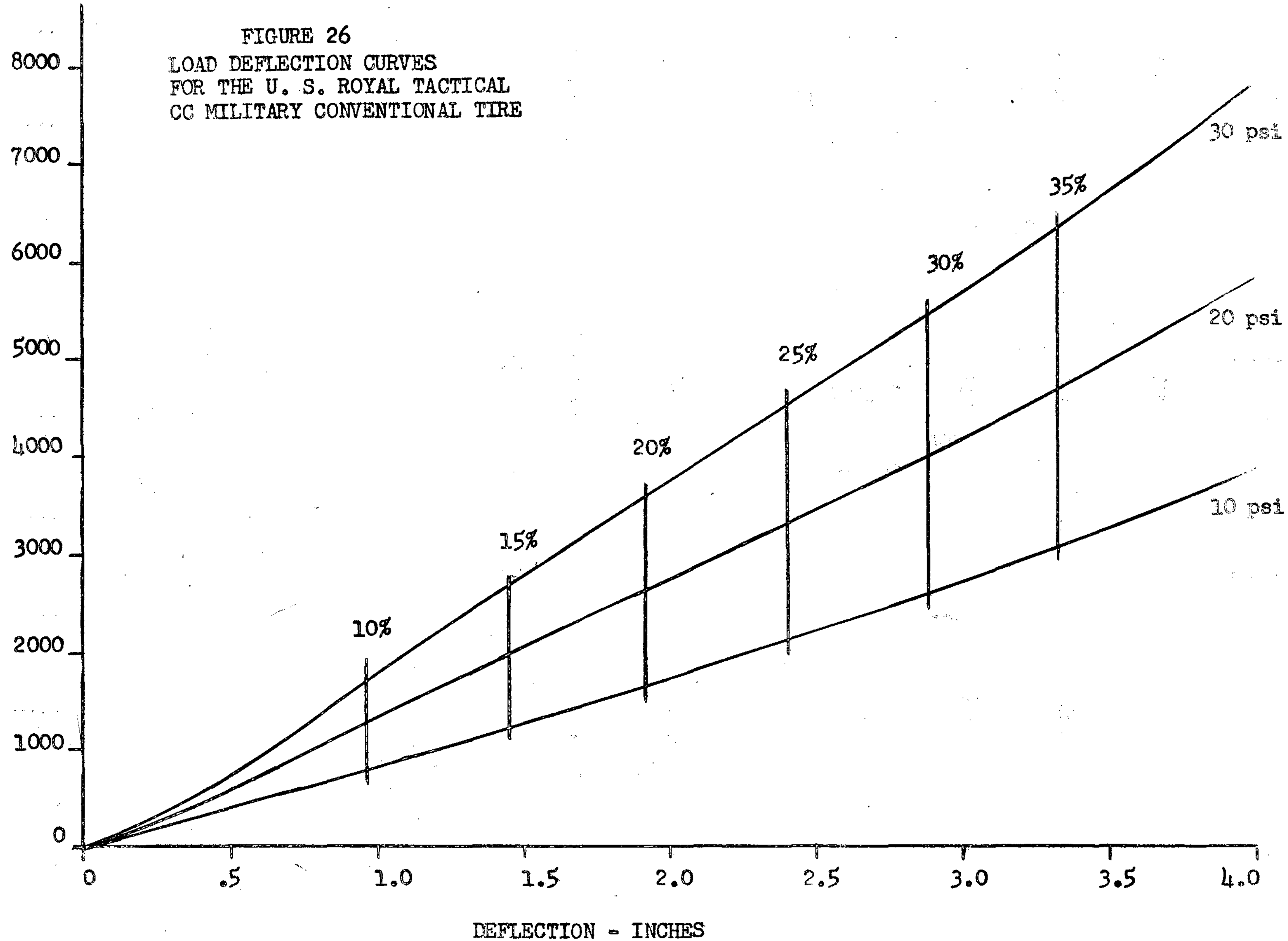


FIGURE 26
LOAD DEFLECTION CURVES
FOR THE U. S. ROYAL TACTICAL
CC MILITARY CONVENTIONAL TIRE

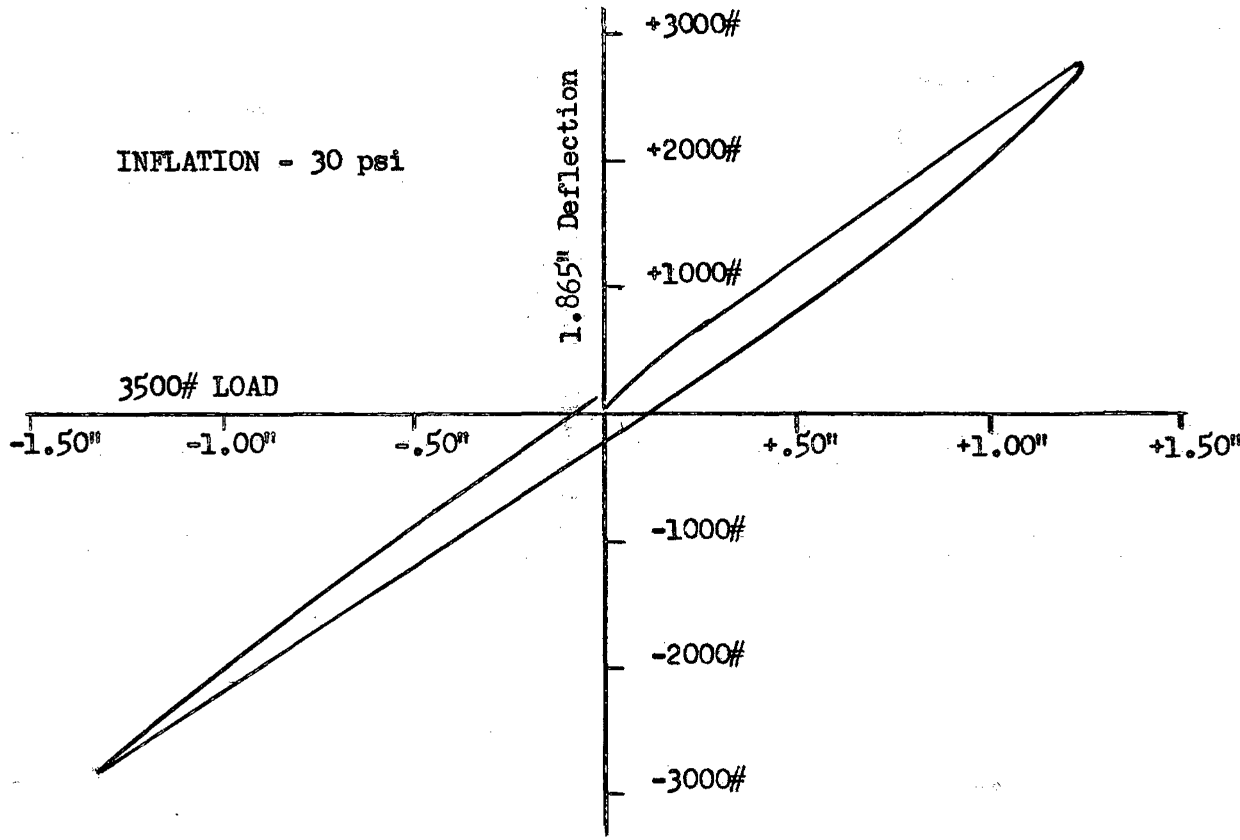


FIGURE 27
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL TACTICAL
CC MILITARY CONVENTIONAL TIRE

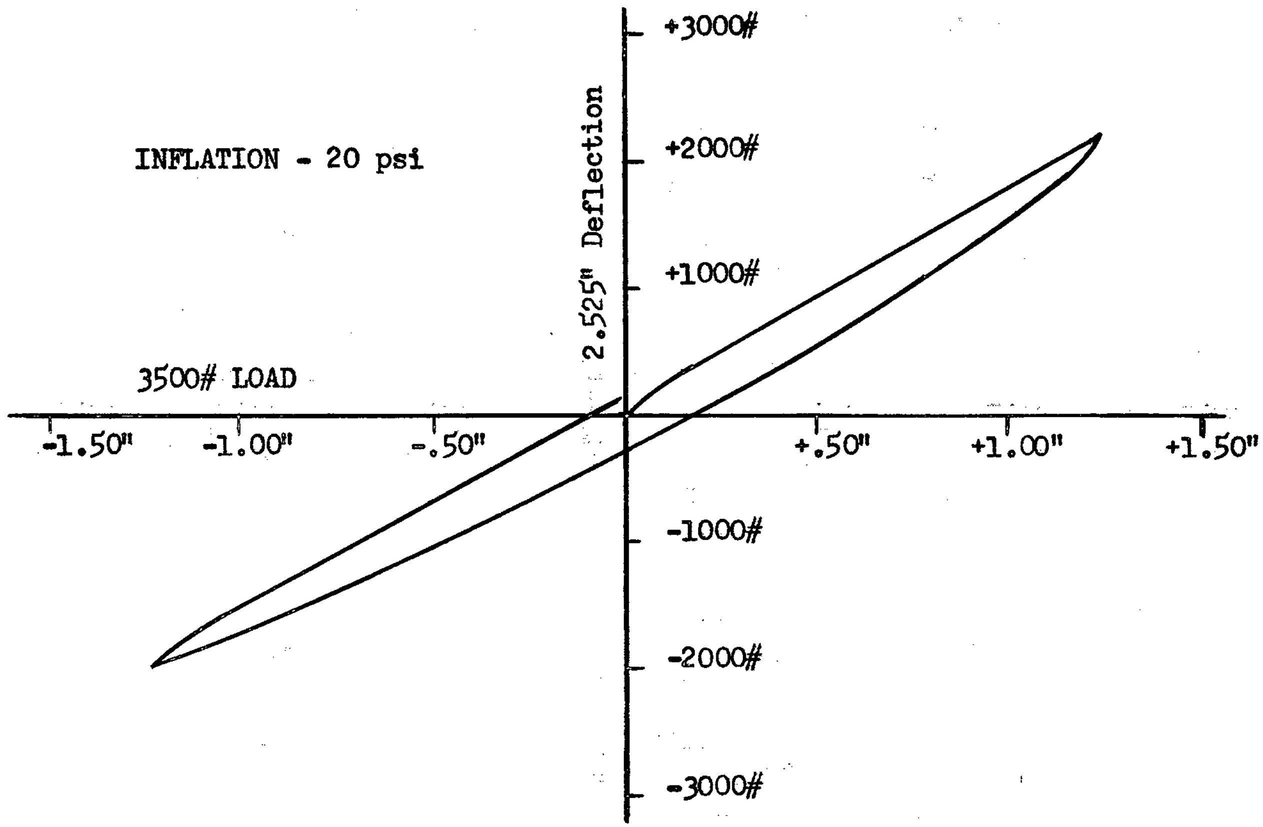


FIGURE 28
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL TACTICAL
CC MILITARY CONVENTIONAL TIRE

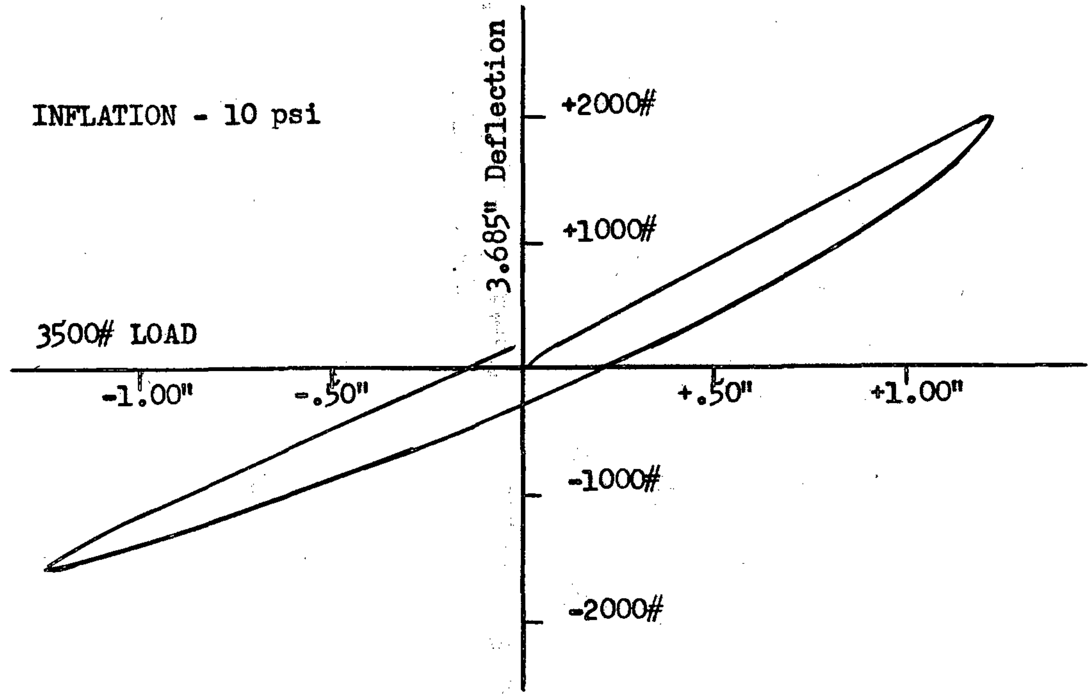


FIGURE 29
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL TACTICAL
CC MILITARY CONVENTIONAL TIRE

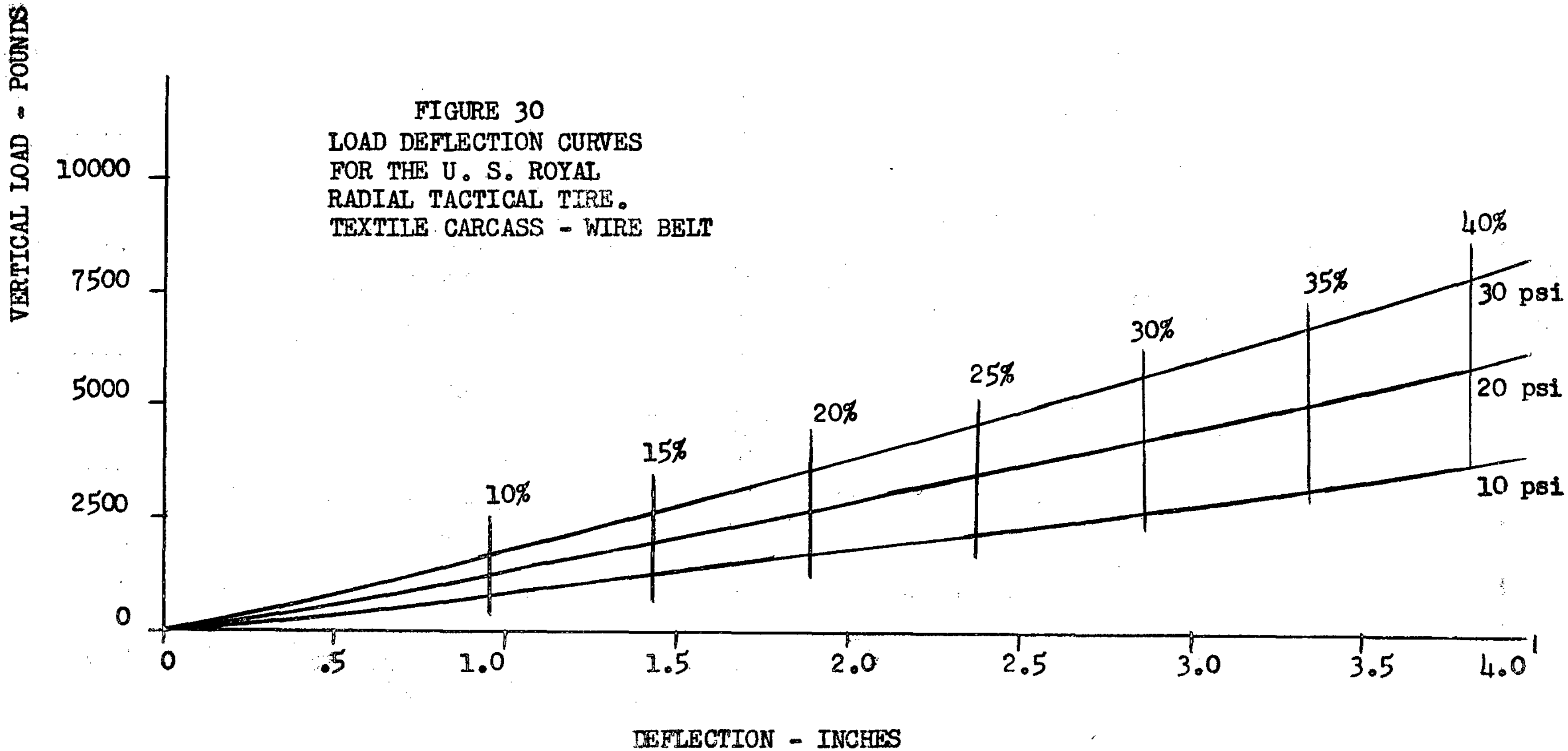


FIGURE 30
LOAD DEFLECTION CURVES
FOR THE U. S. ROYAL
RADIAL TACTICAL TIRE.
TEXTILE CARCASS - WIRE BELT

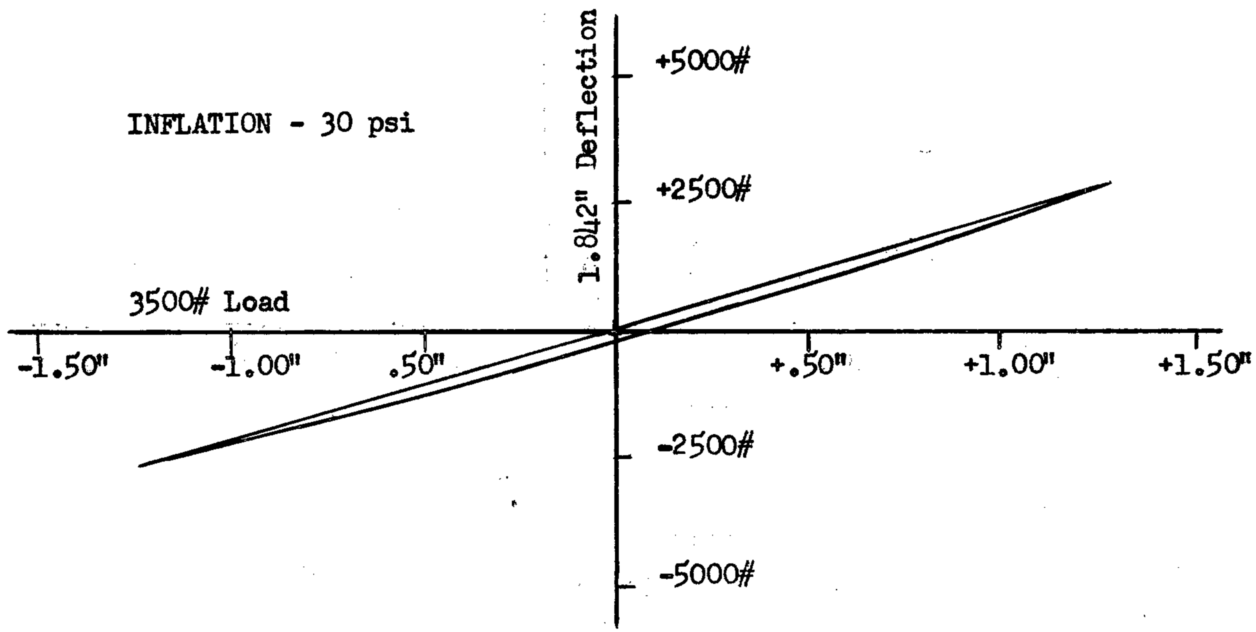


FIGURE 31
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - WIRE BELT

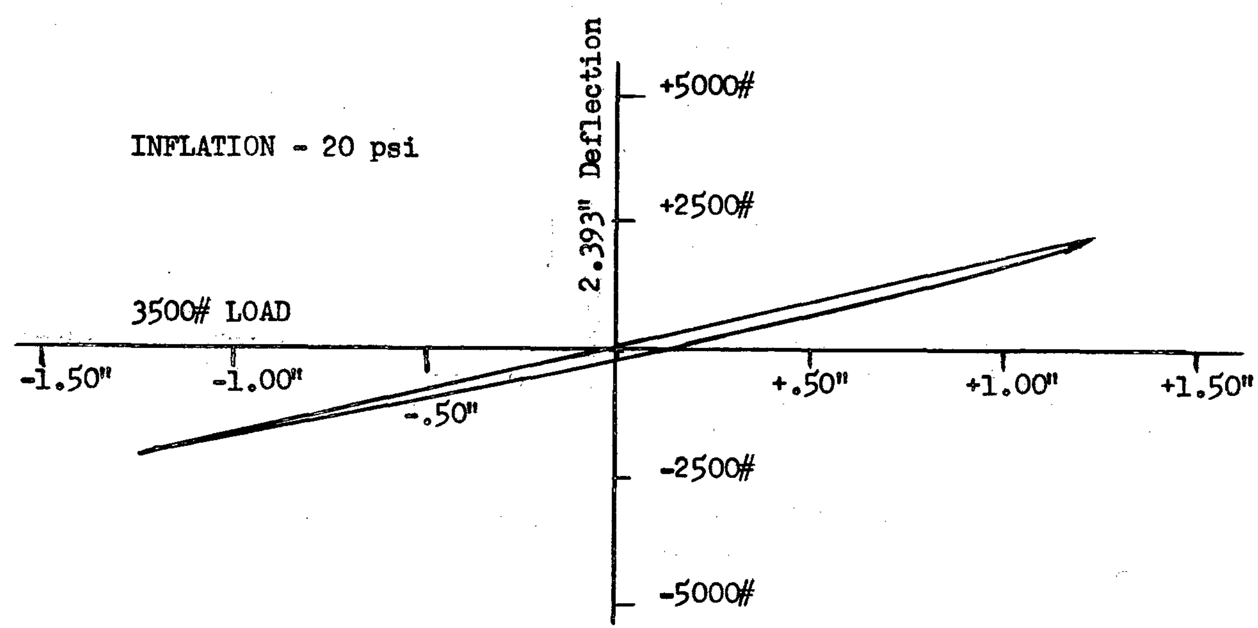


FIGURE 32
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - WIRE BELT

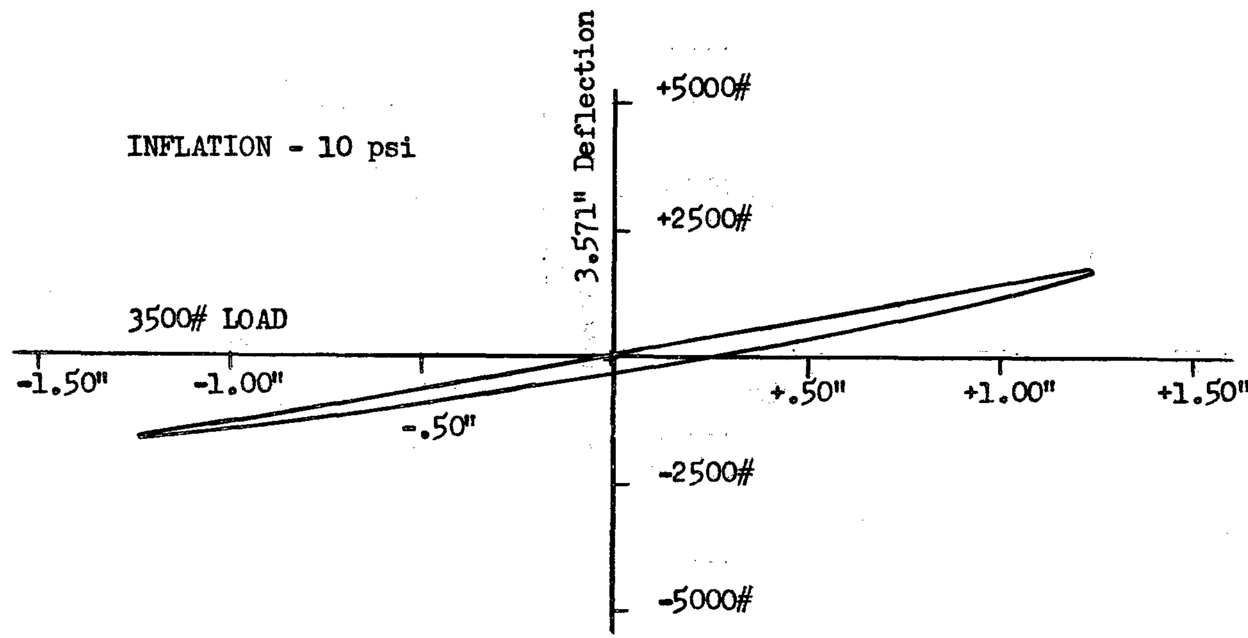


FIGURE 33
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - WIRE BELT

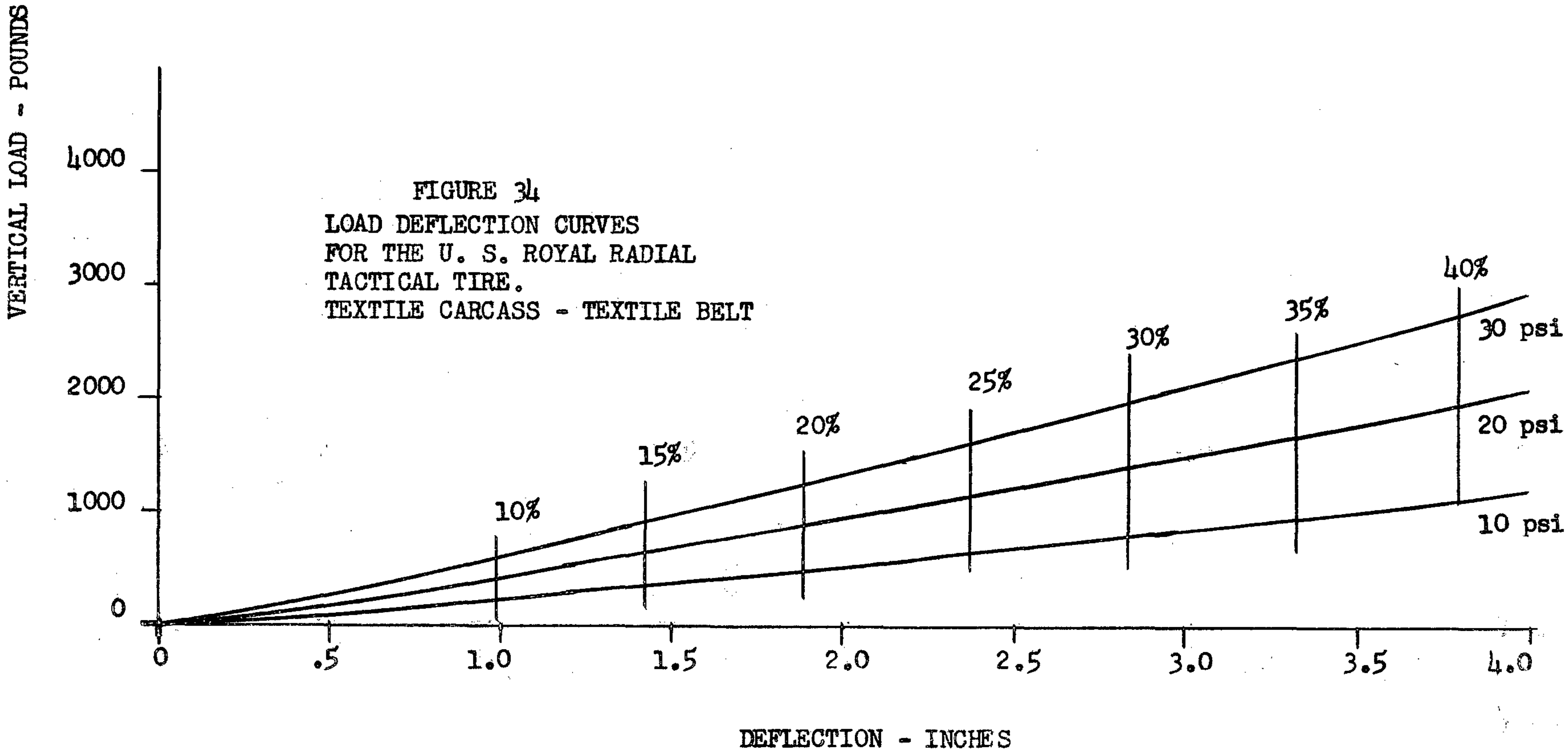


FIGURE 34
LOAD DEFLECTION CURVES
FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE.
TEXTILE CARCASS - TEXTILE BELT

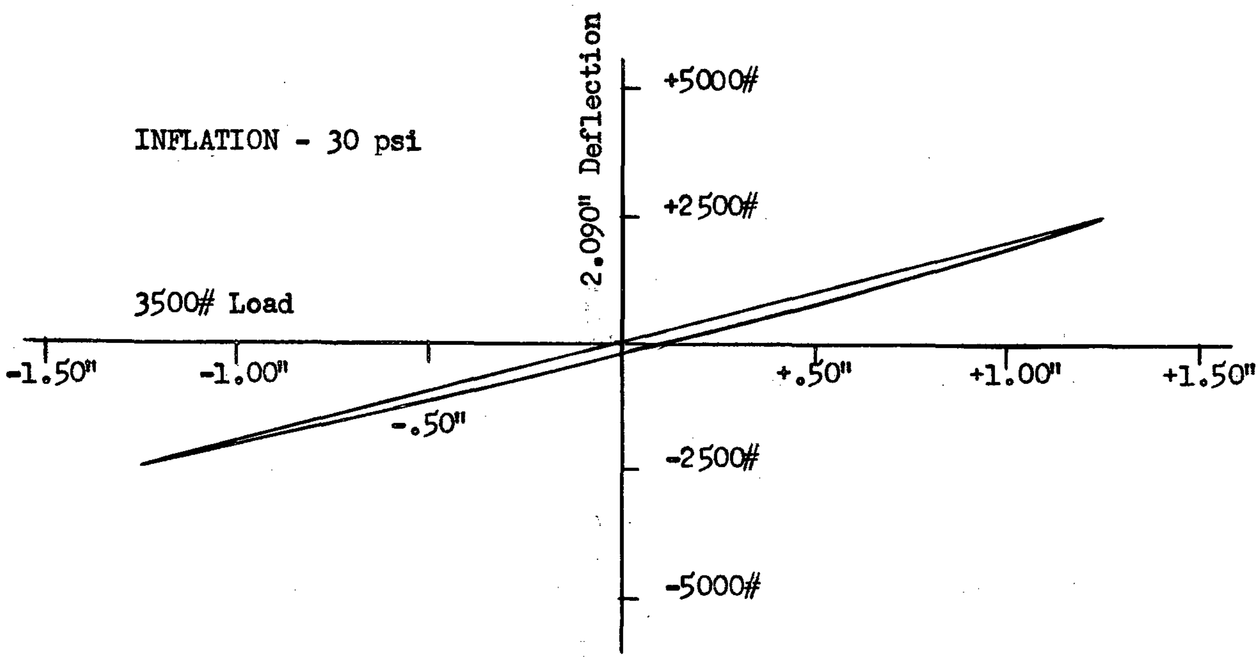


FIGURE 35
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - TEXTILE BELT

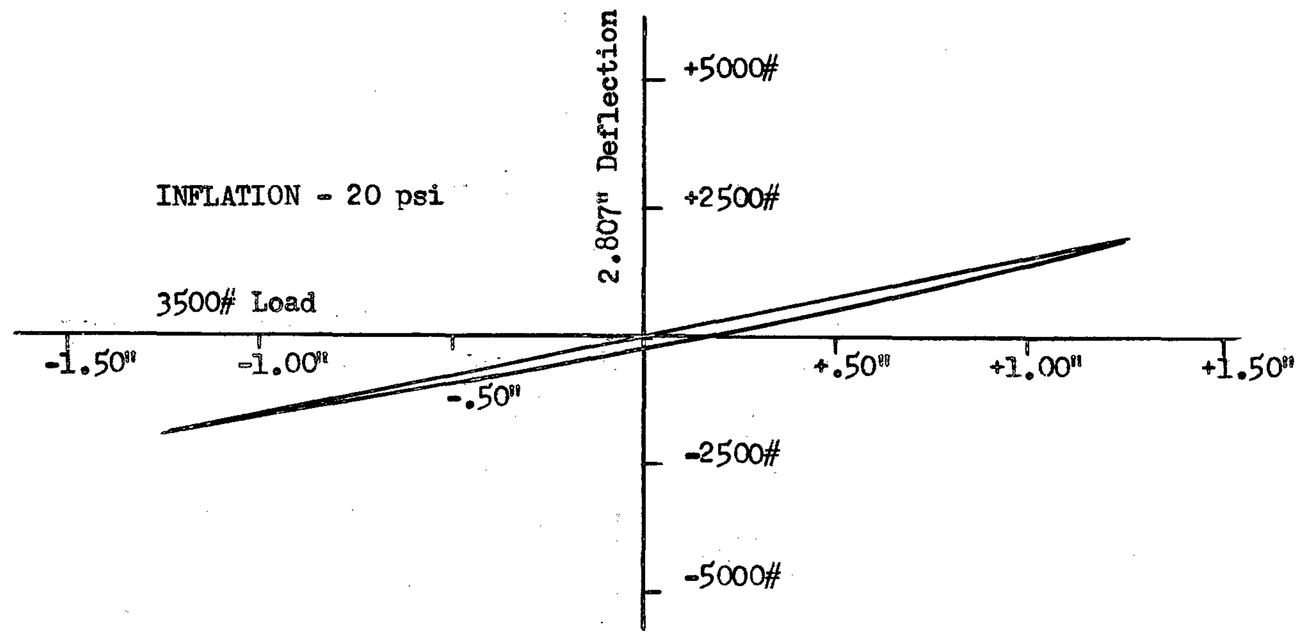


FIGURE 36
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - TEXTILE BELT

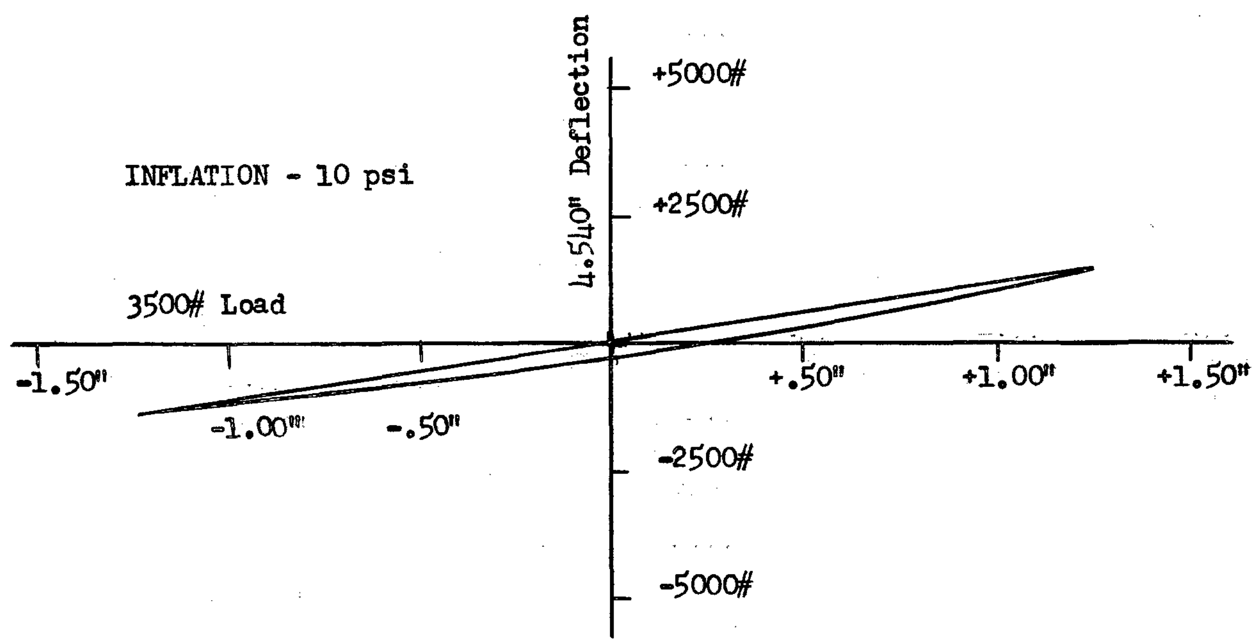


FIGURE 37
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. TEXTILE CARCASS - TEXTILE BELT

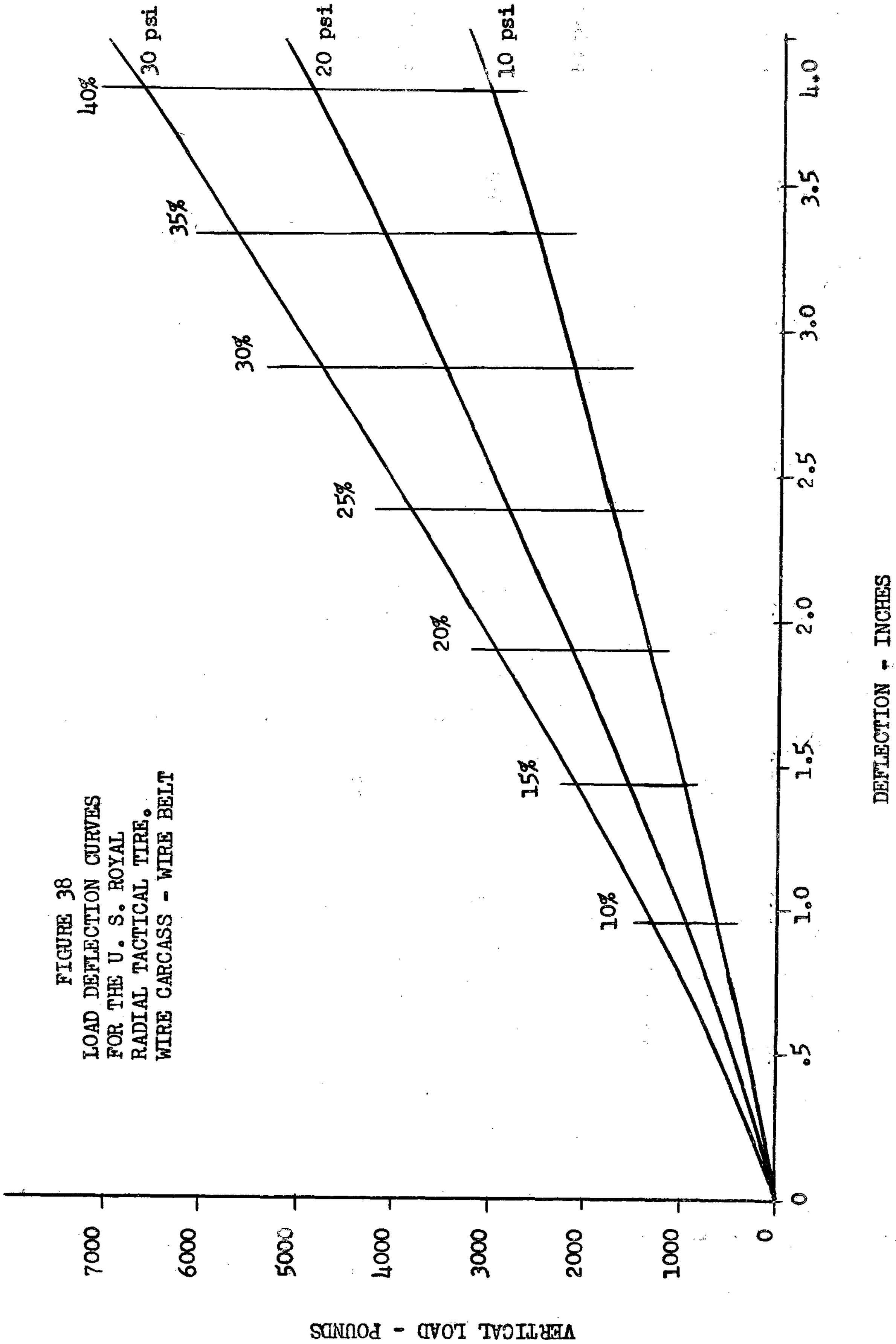


FIGURE 38
LOAD DEFLECTION CURVES
FOR THE U. S. ROYAL
RADIAL TACTICAL TIRE.
WIRE CARCASS - WIRE BELT

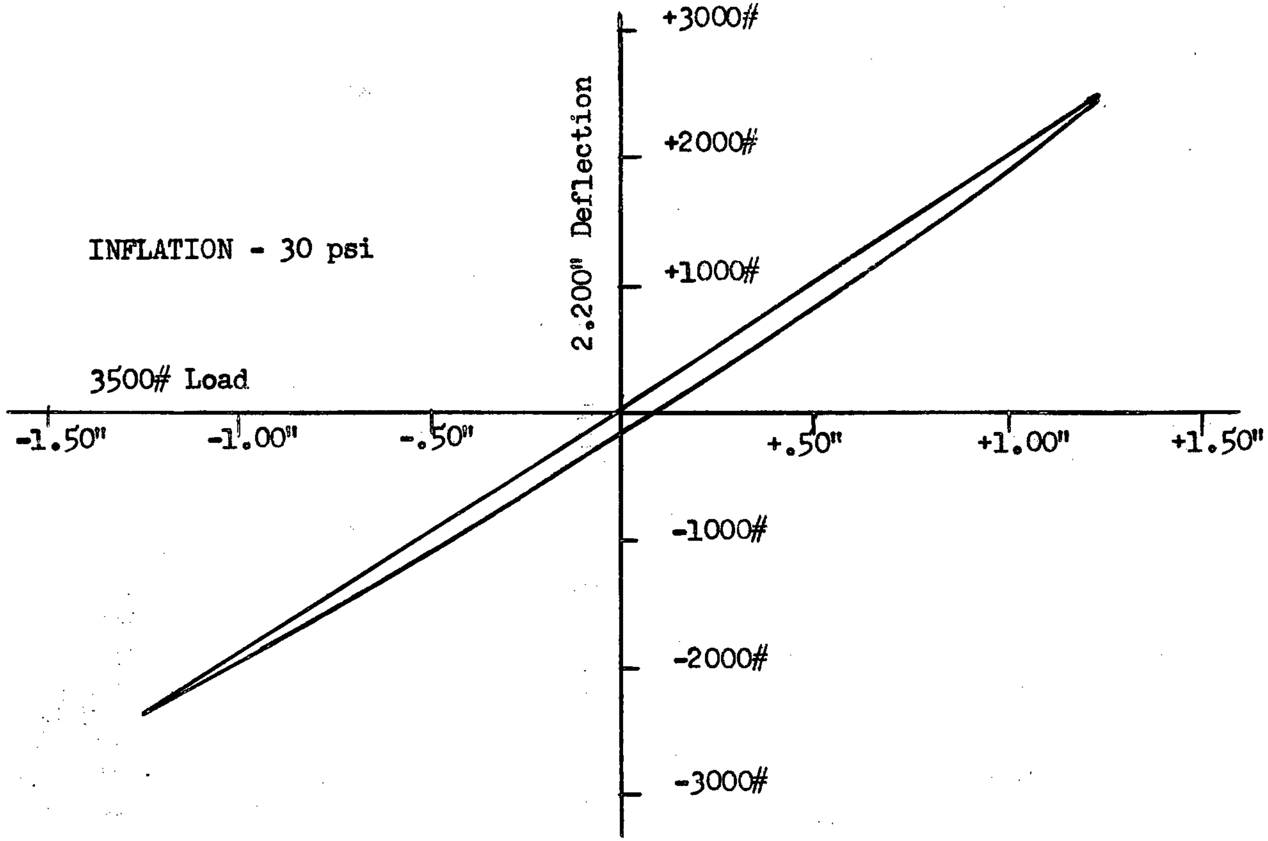


FIGURE 39
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. WIRE CARCASS - WIRE BELT

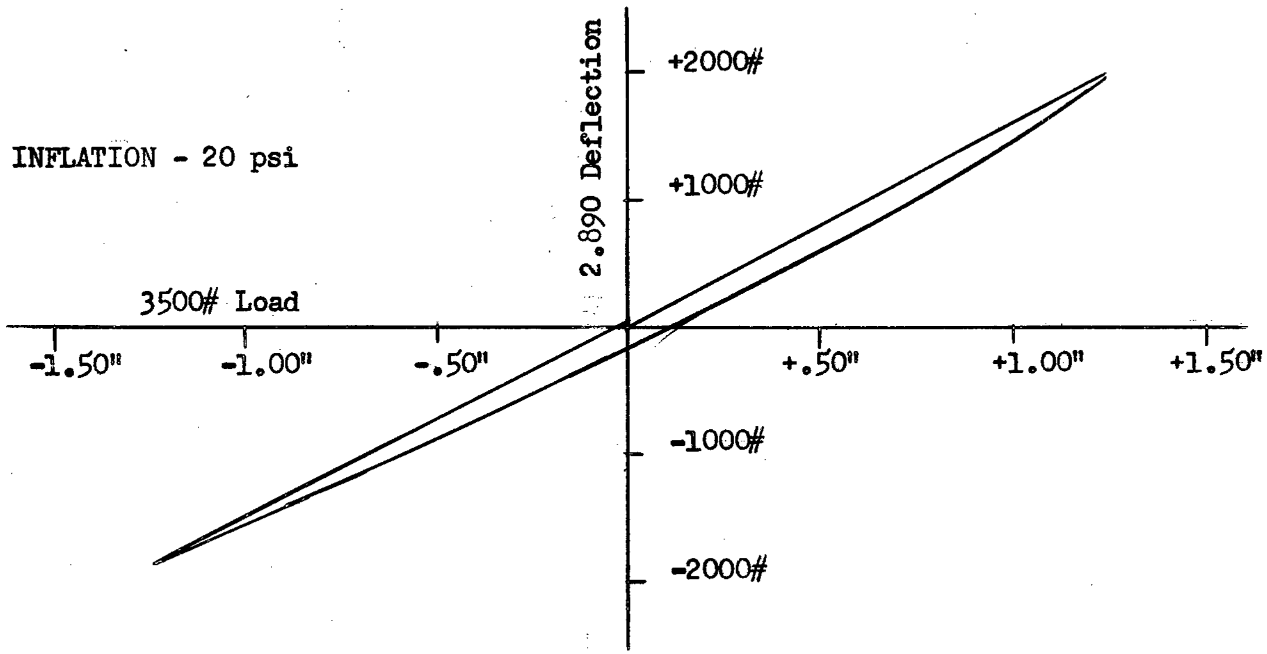


FIGURE 40
CLOSED LOOP LOAD DEFLECTION
CURVE FOR THE U. S. ROYAL RADIAL
TACTICAL TIRE. WIRE CARCASS - WIRE BELT

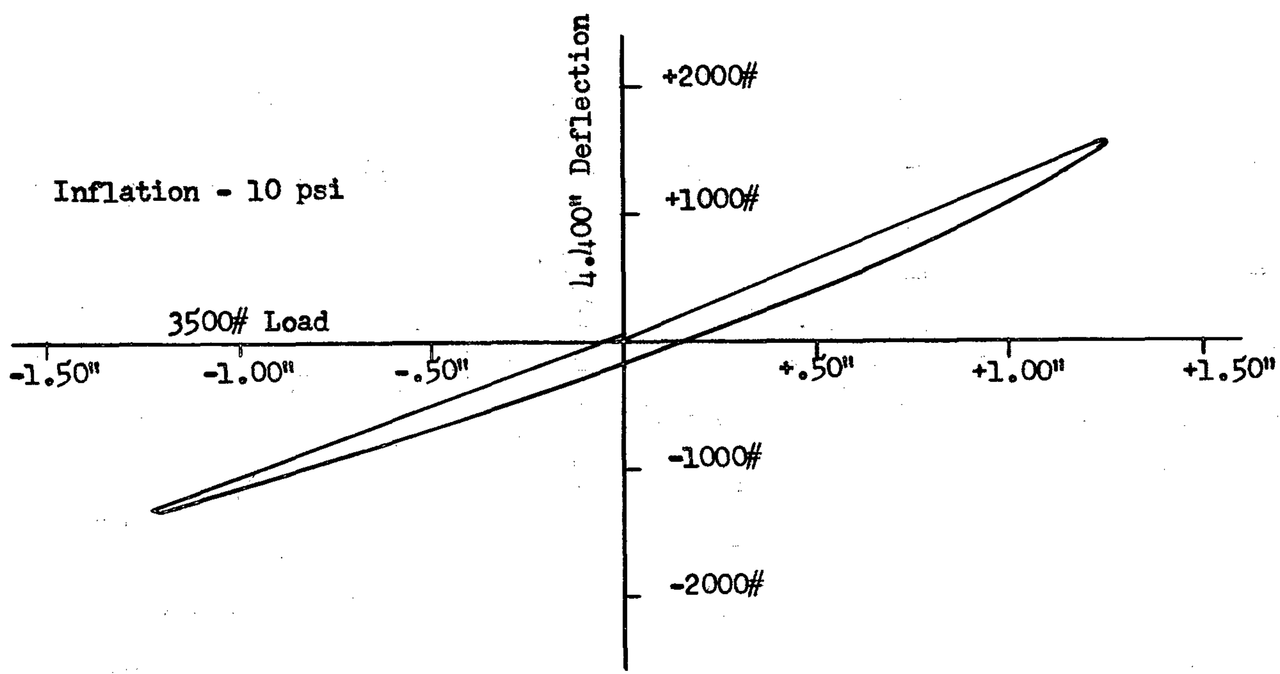
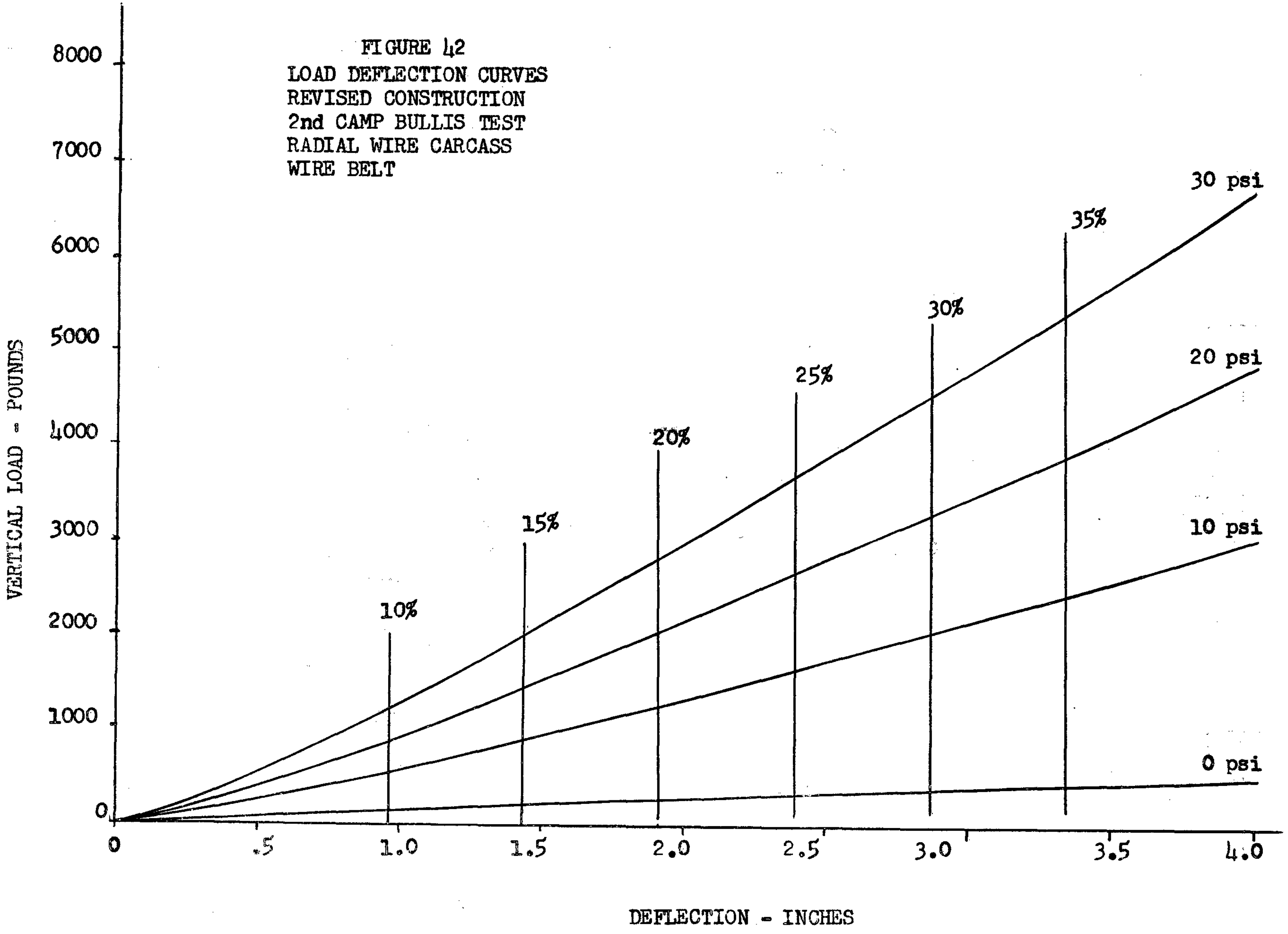


FIGURE 41
CLOSED LOOP LOAD DEFLECTION CURVE FOR THE U. S. ROYAL RADIAL TACTICAL TIRE. WIRE CARCASS. WIRE BELT.

FIGURE 42
LOAD DEFLECTION CURVES
REVISED CONSTRUCTION
2nd CAMP BULLIS TEST
RADIAL WIRE CARCASS
WIRE BELT



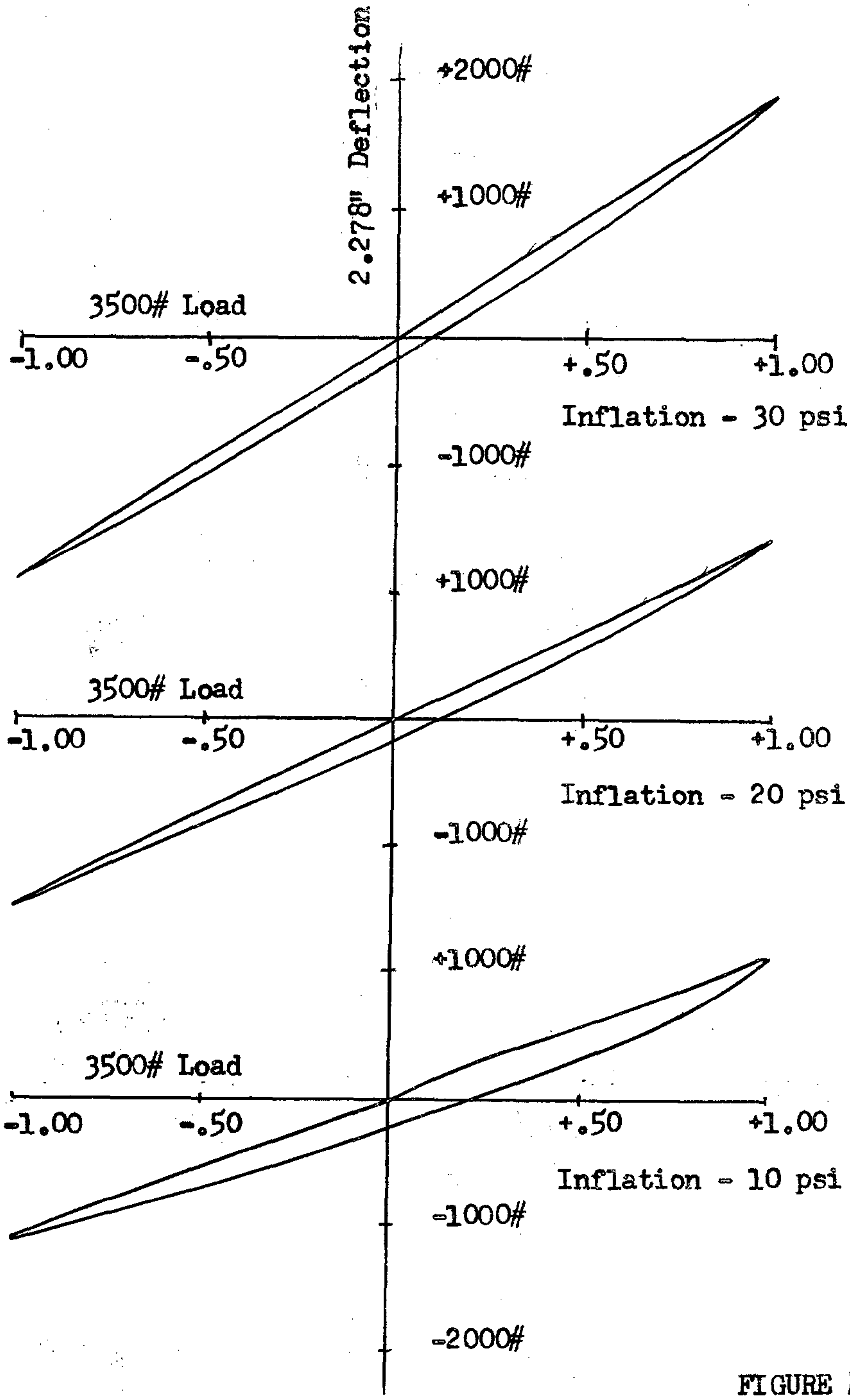


FIGURE 43
Closed Loop Load Deflection Curve
for the Revised Construction
2nd Camp Bullis Test Tire
Radial Wire Carcass
Wire Belt

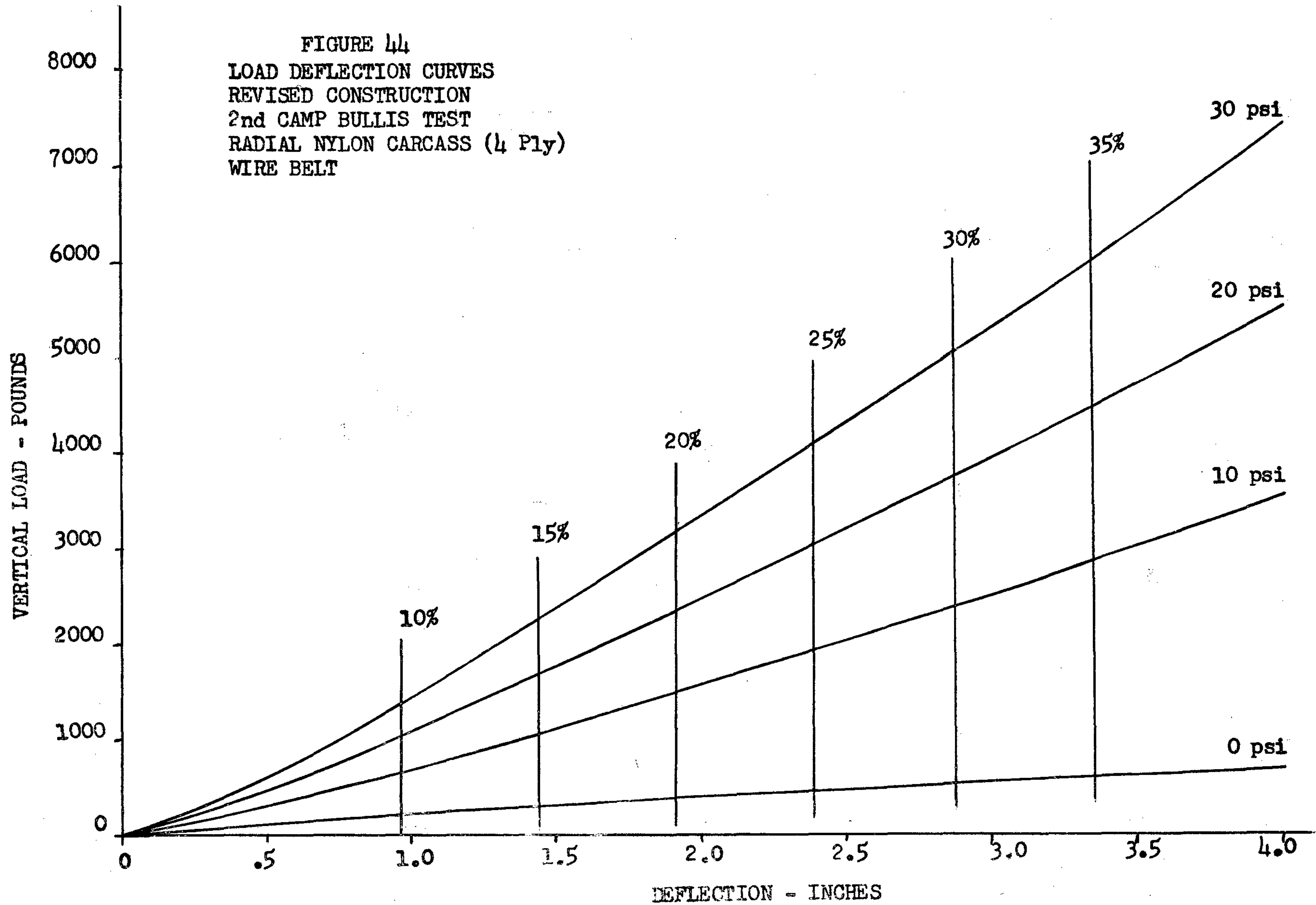


FIGURE 44
LOAD DEFLECTION CURVES
REVISED CONSTRUCTION
2nd CAMP BULLIS TEST
RADIAL NYLON CARCASS (4 Ply)
WIRE BELT

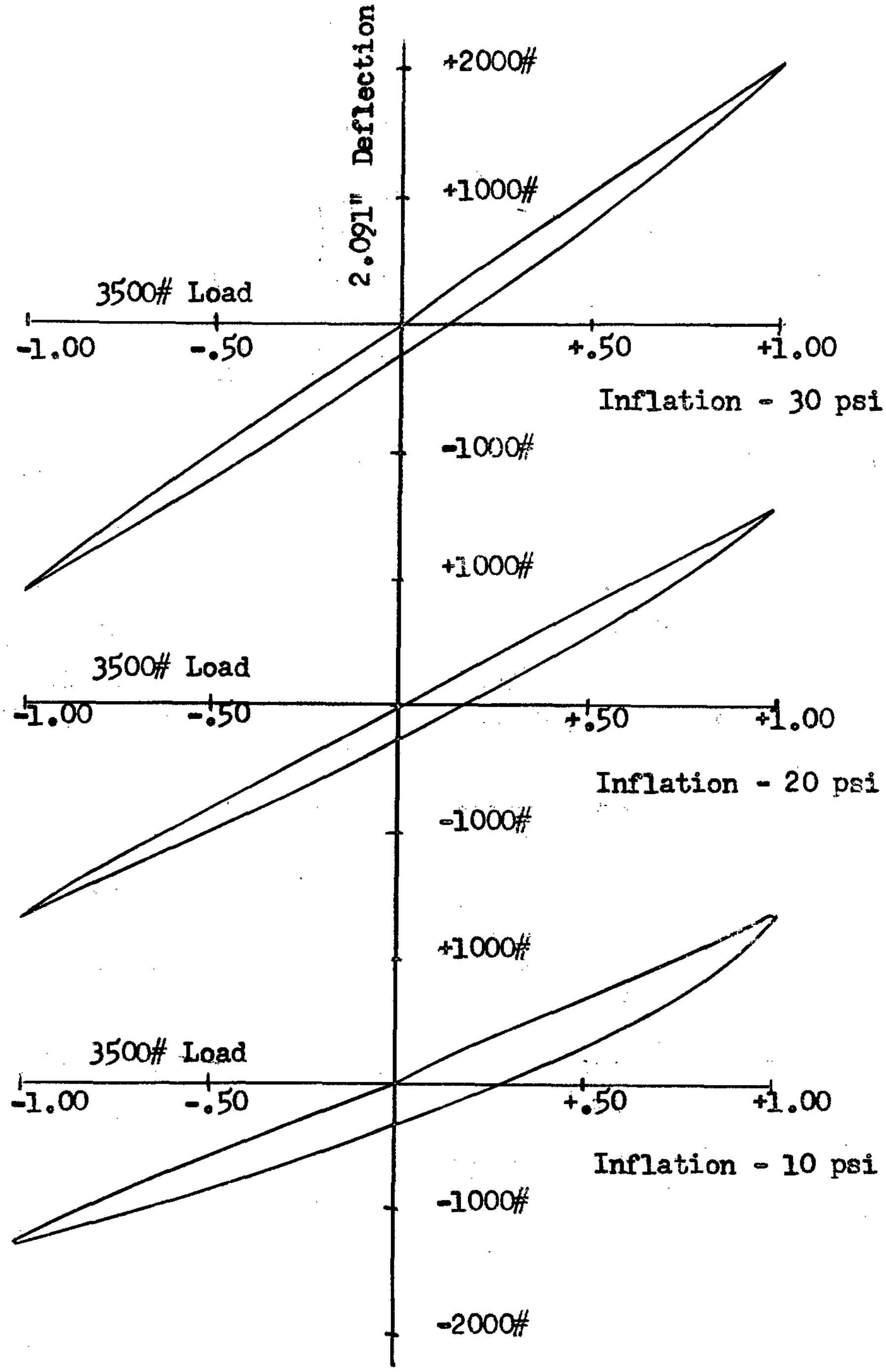


FIGURE 45
Closed Loop Load Deflection Curve
for the Revised Construction
2nd Camp Bullis Test Tire.
Radial Nylon Carcass (4 Ply).
Wire Belt

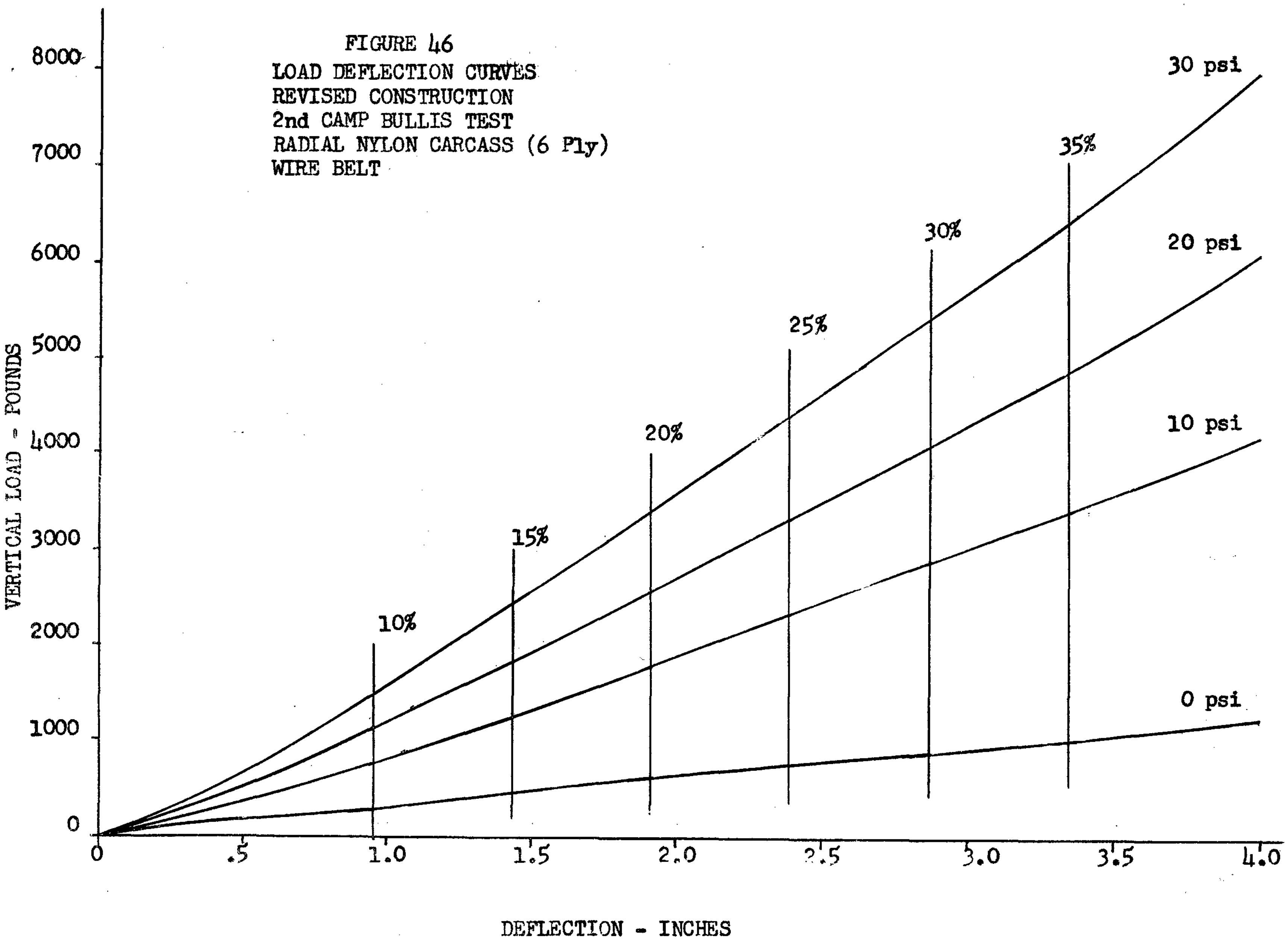


FIGURE 46
LOAD DEFLECTION CURVES
REVISED CONSTRUCTION
2nd CAMP BULLIS TEST
RADIAL NYLON CARCASS (6 Ply)
WIRE BELT

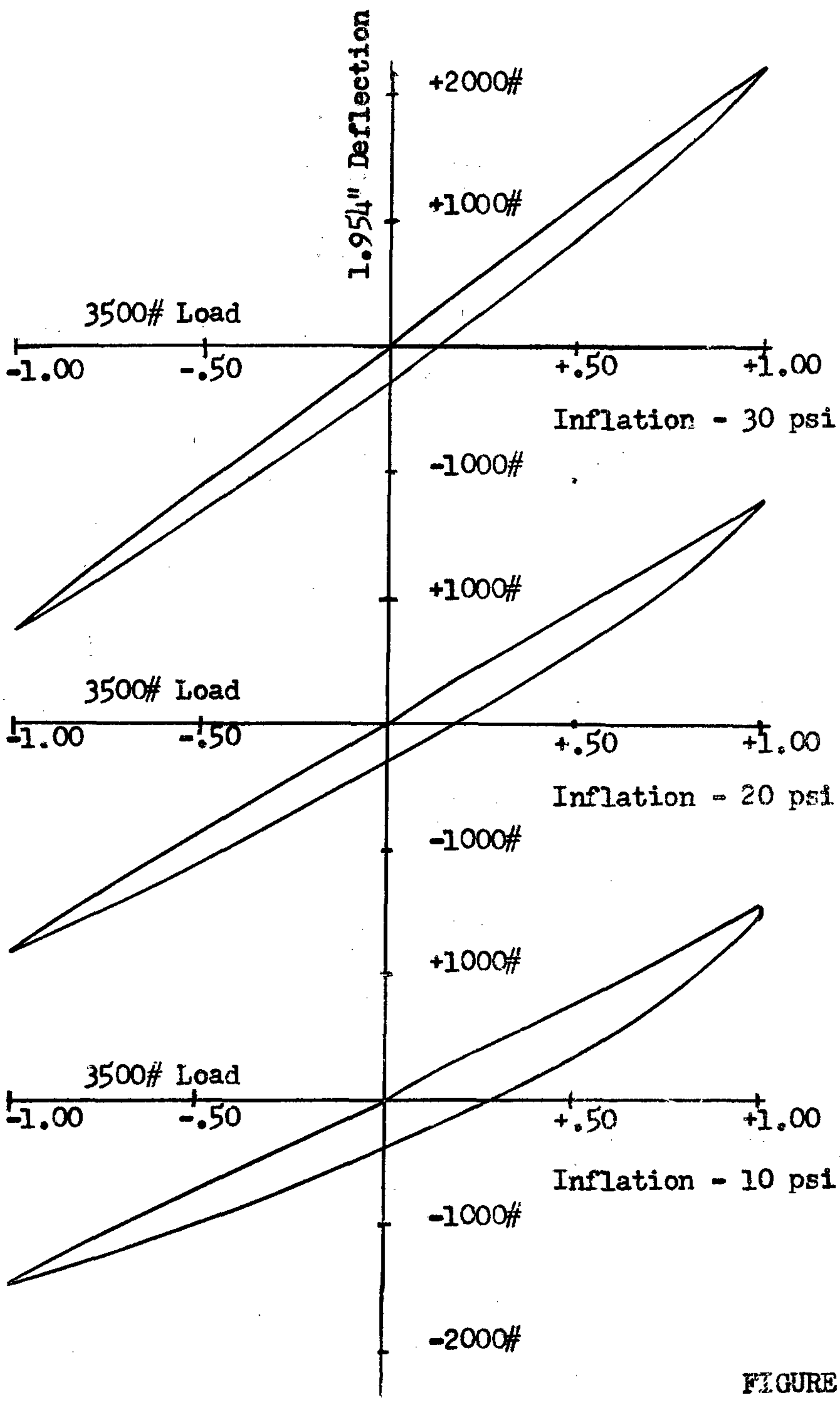
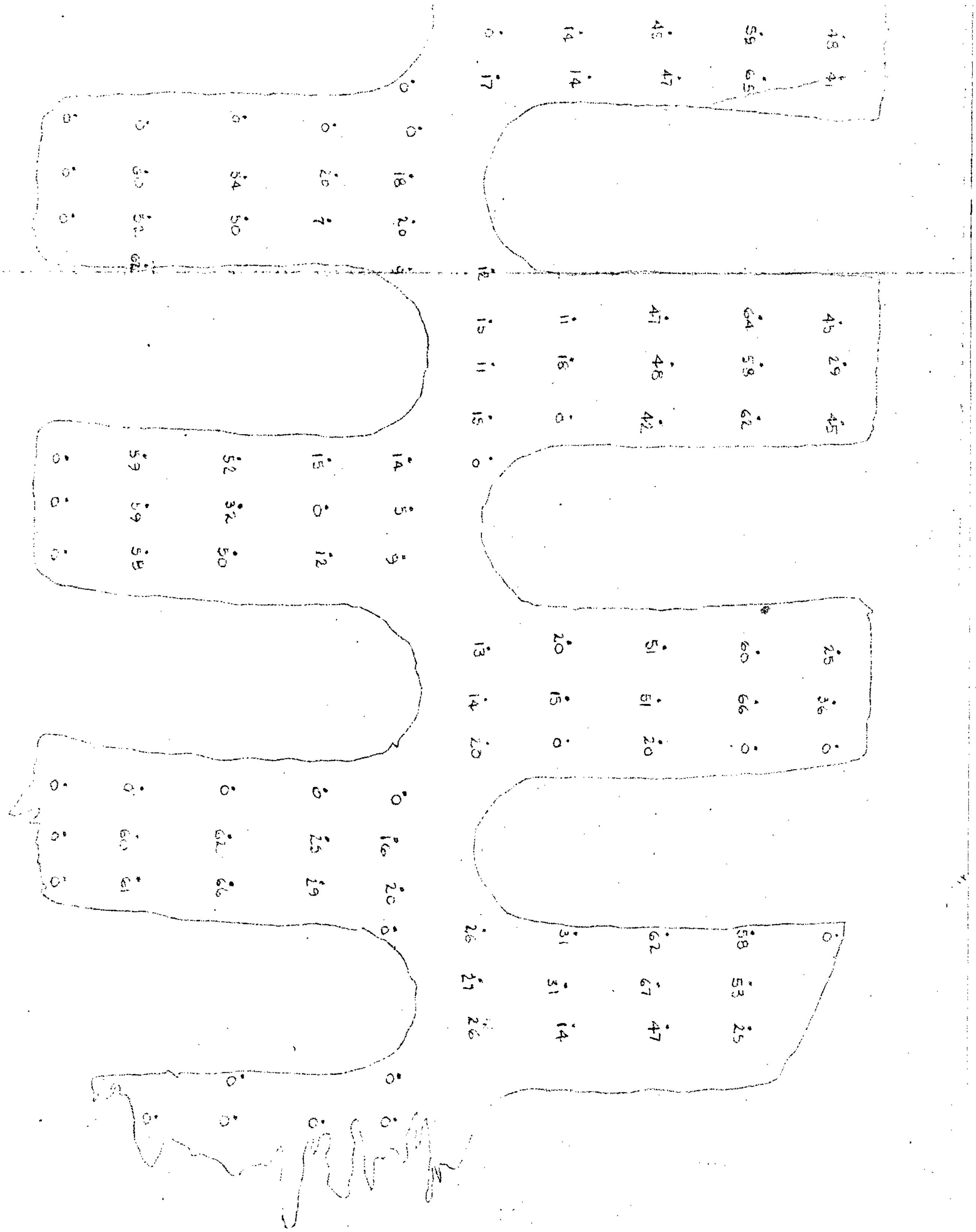
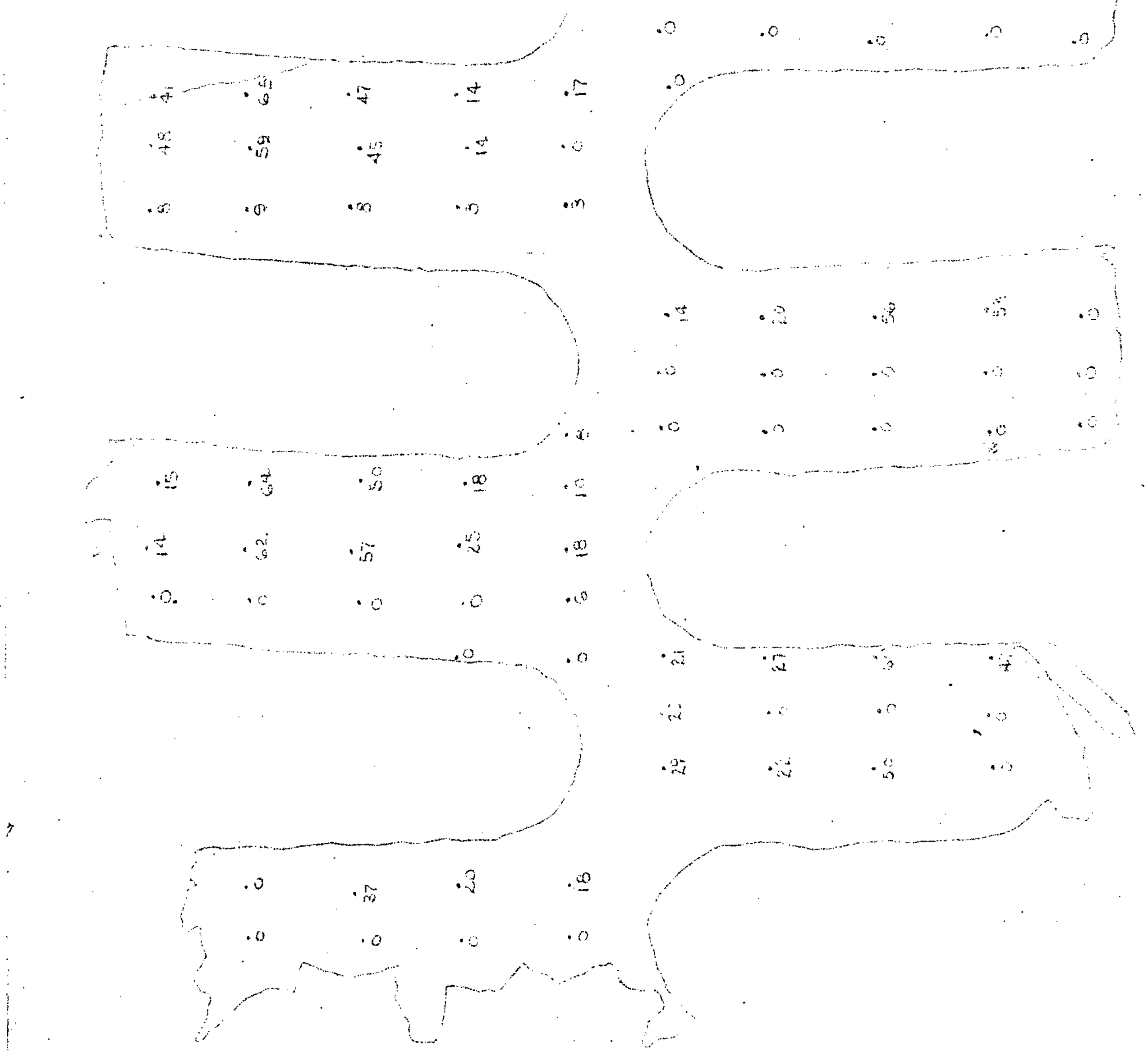


FIGURE 47
Closed Loop Load Deflection Curve
for the Revised Construction
2nd Camp Bullis Test Tire
Radial Nylon Carcass (6 Ply)
Wire Belt

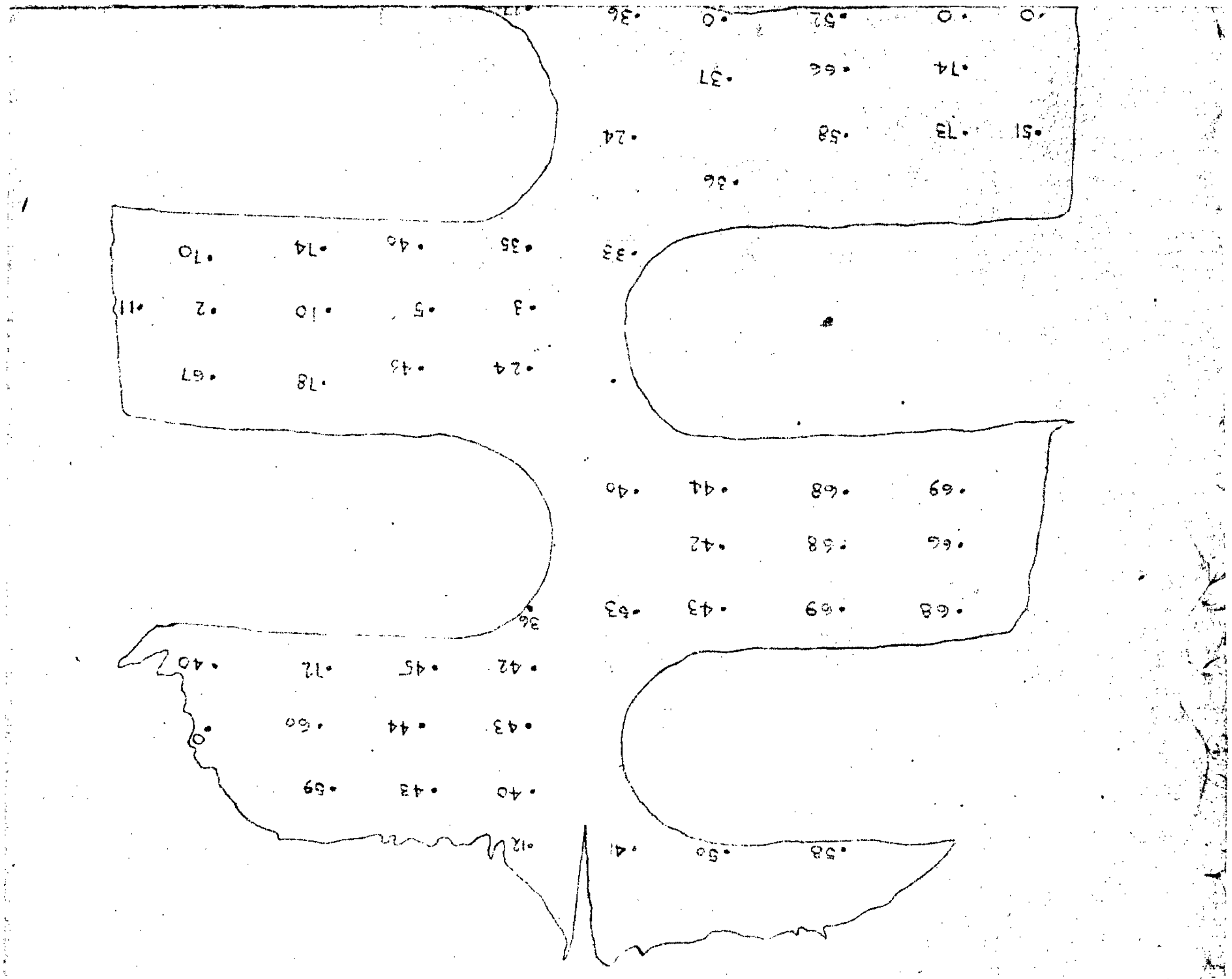


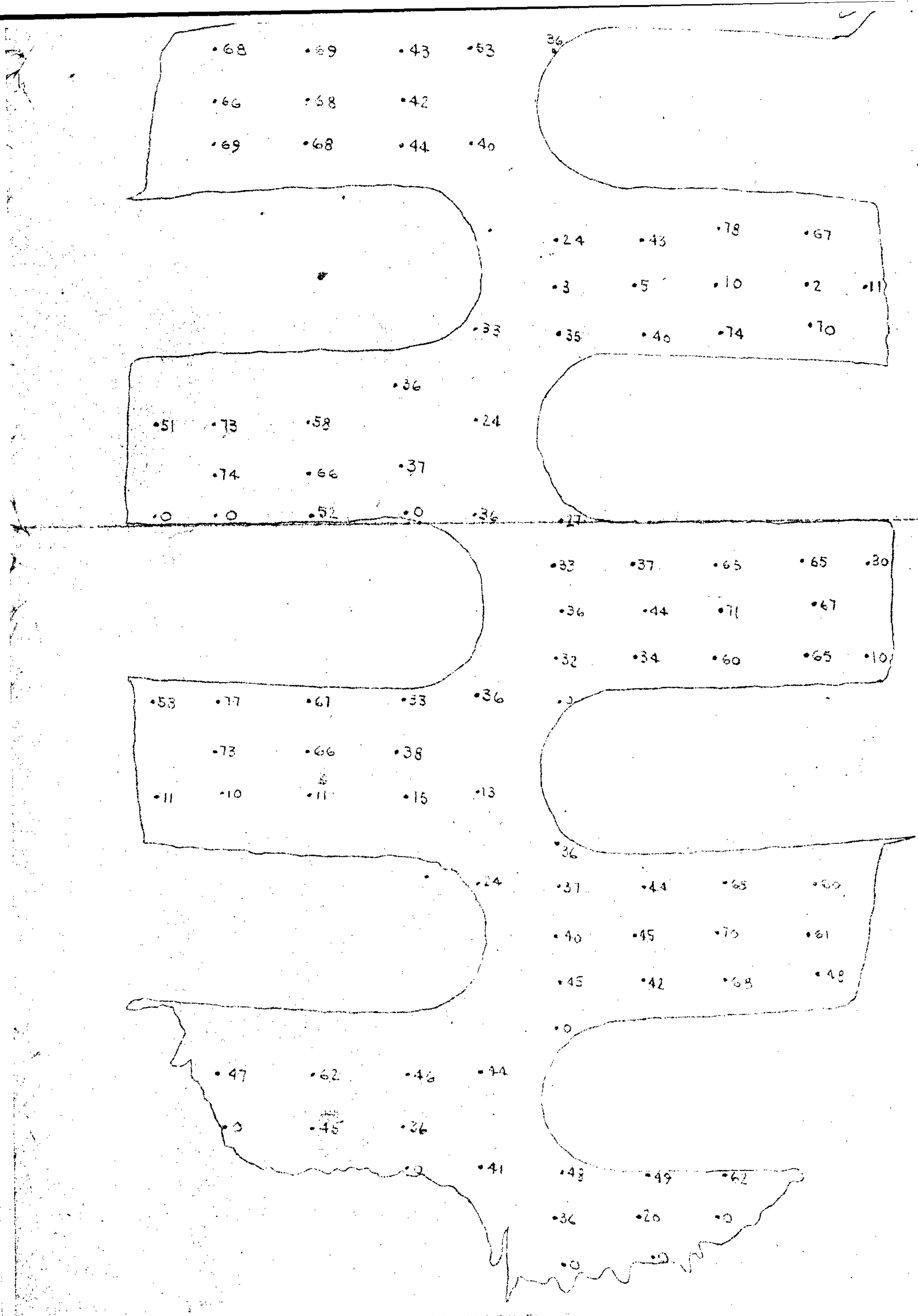


11.00-20
U.S. ROYAL TACTICAL CC MILITARY
20X8
MR 13268 HA32146 10\# LOAD 3500\#
— 11.43 42.70 14.23
169.40 96.40 56.90 38.19

CONVENTIONAL TIRE

2of





SIZE & BRAND **11.00-20 U.S. ROYAL TACTICAL CC MILITARY**

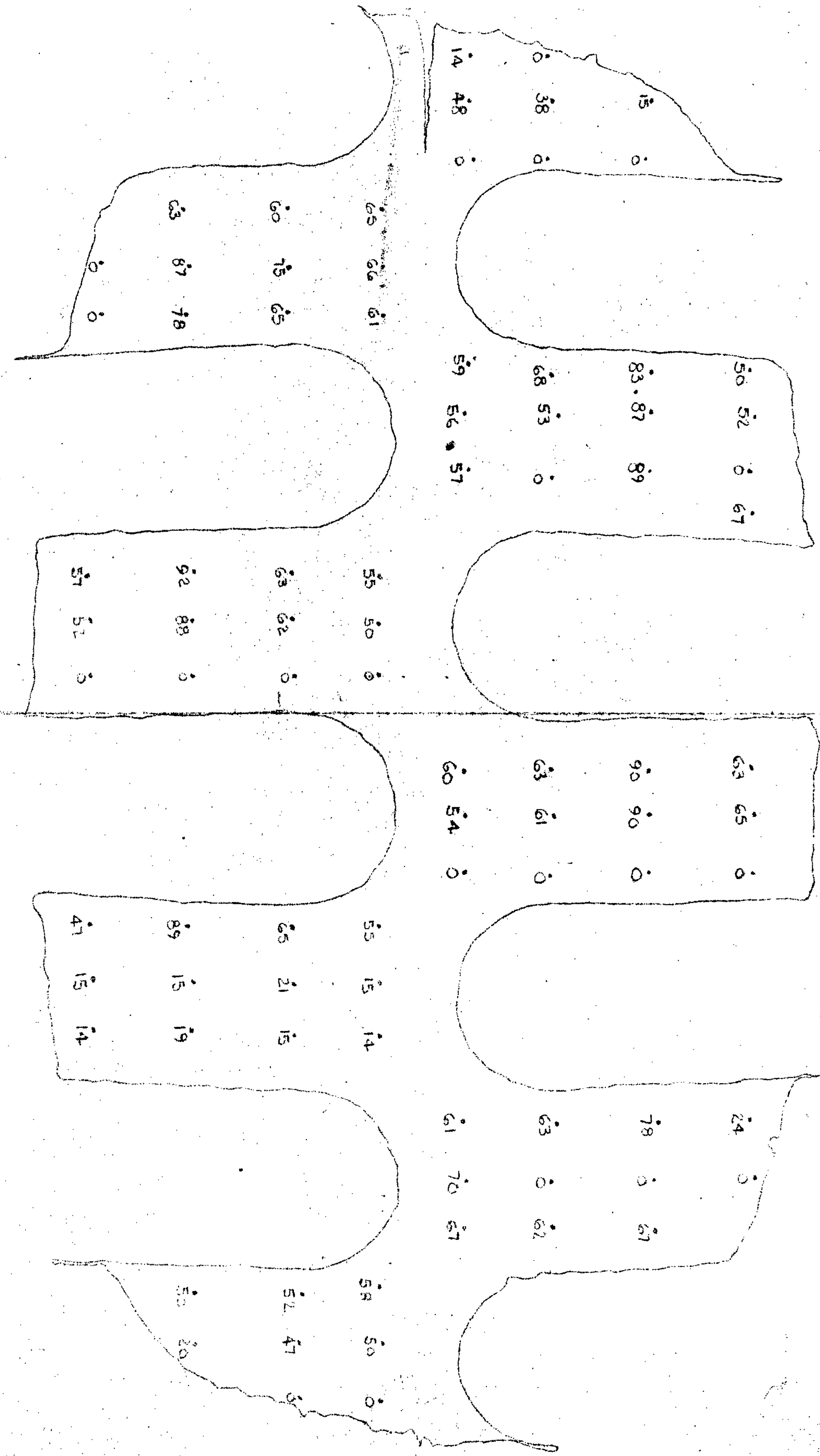
RIM SIZE **20 X 8**

MR. # 13268 SER. NO. **HA32146** INFL. **20#** LOAD **3500**

AREA **—** SEC. DIA. **11.43** O.D. **42.68** LOADED SEC. **13.24**

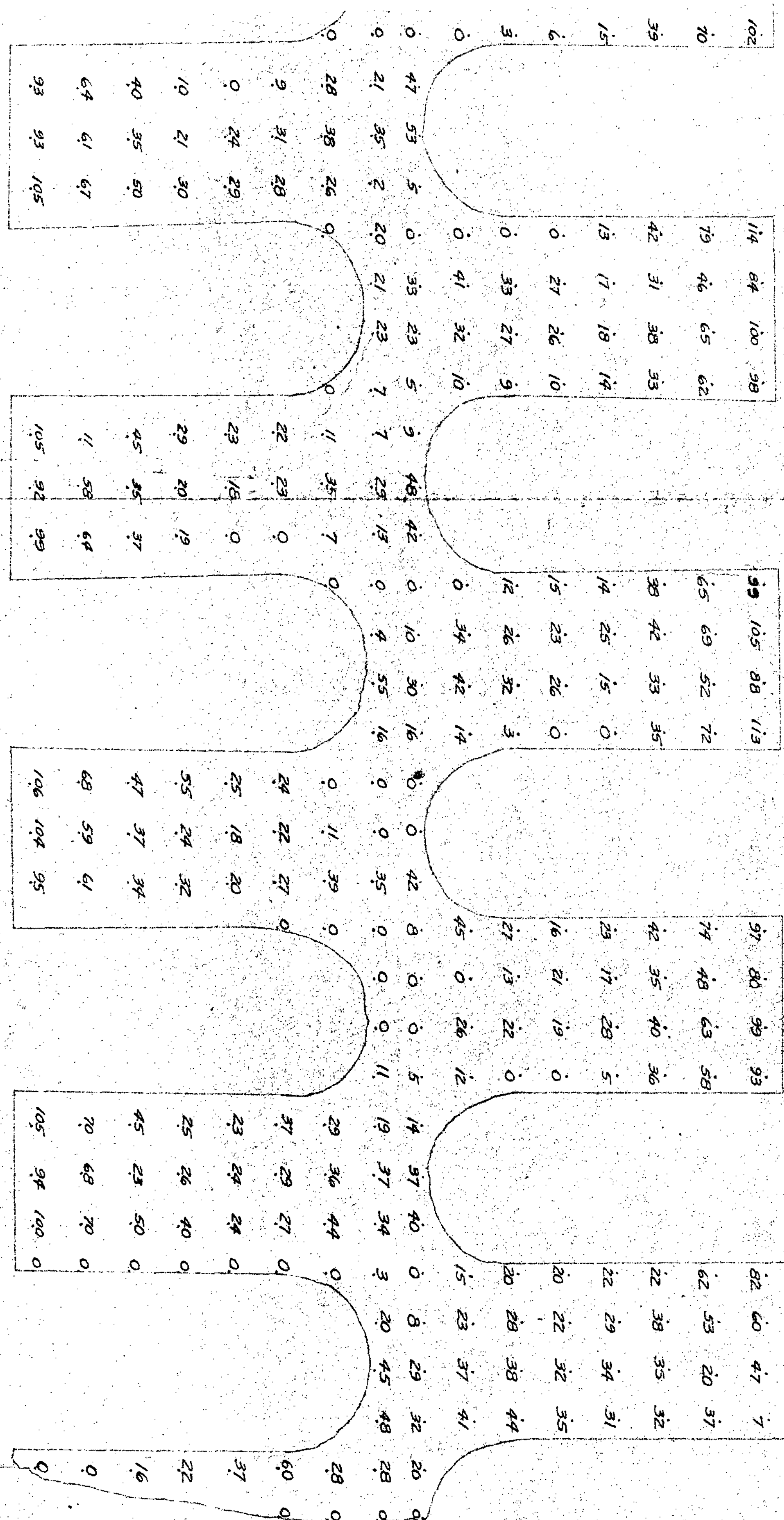
GROSS **117.48** NET **67.47** % NET **57.43** AT **26.19** HOURS

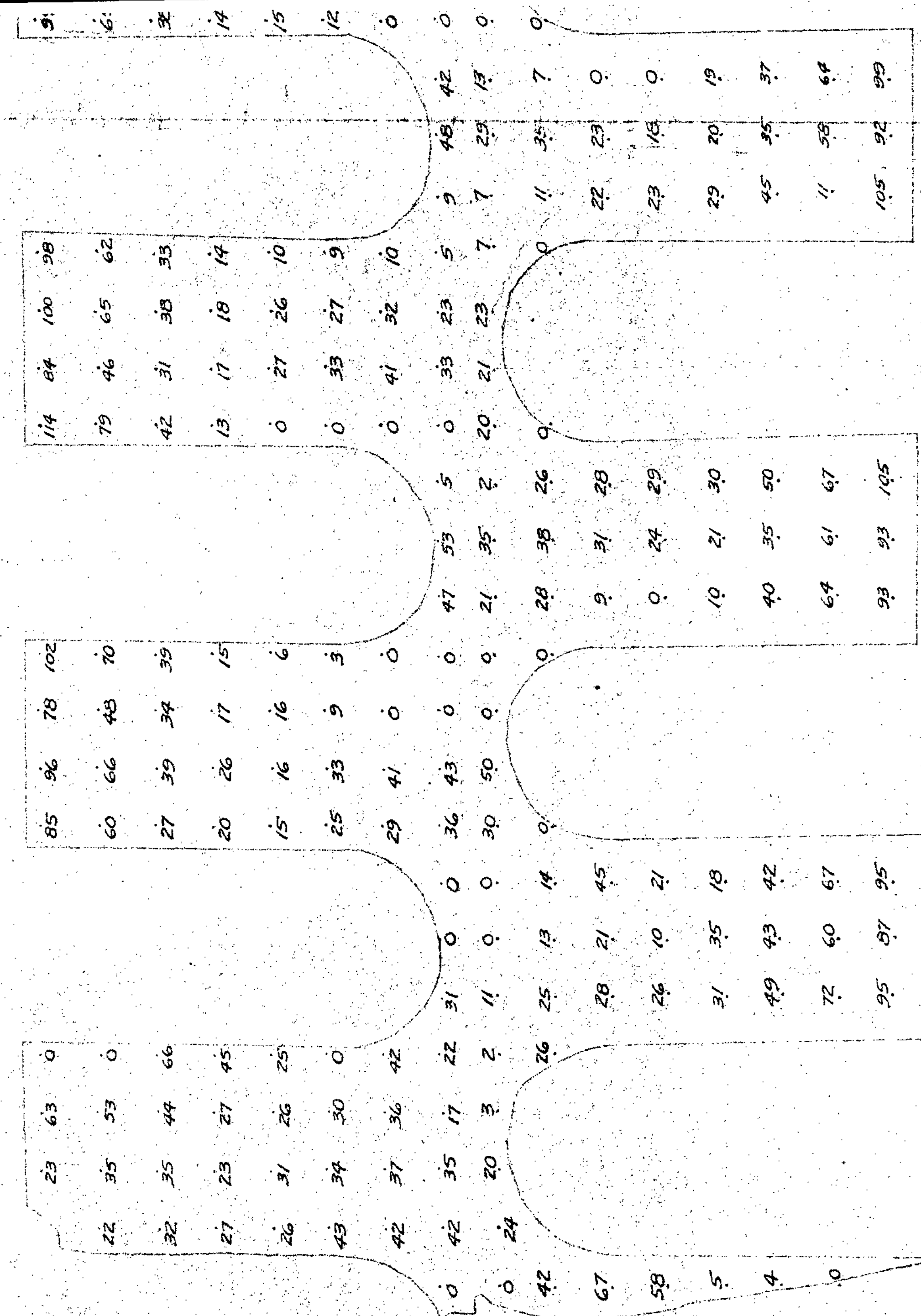
CONVENTIONAL TIRE



SIZE & BRAND	1100-20 U.S. ROYAL TACTICAL C.C. MILITARY			
RIM SIZE	20X8			
M.R. 13268	HA32146	30#	3500#	
AREA —	DIA 11.48	42.67		12.59

CONVENTIONAL TIRE





SIZE & BRAND **11.00-20 U.S. ROYAL MP TACTICAL** WIRE BREAKER

RIM SIZE **20X8**

M.R. 13268 SER. NO. **WA29353** INFL. **10*** LOAD **3500***

AREA **—** SEC. DIA. **11.55** O.D. **42.47** L'DD. SEC. **14.67**

GROSS **164.70** NET **93.18** % N/G **56.57** AT **37.45** % DEFL.

RADIAL PLY TIRE
RAYON CARCASS
WIRE BELT

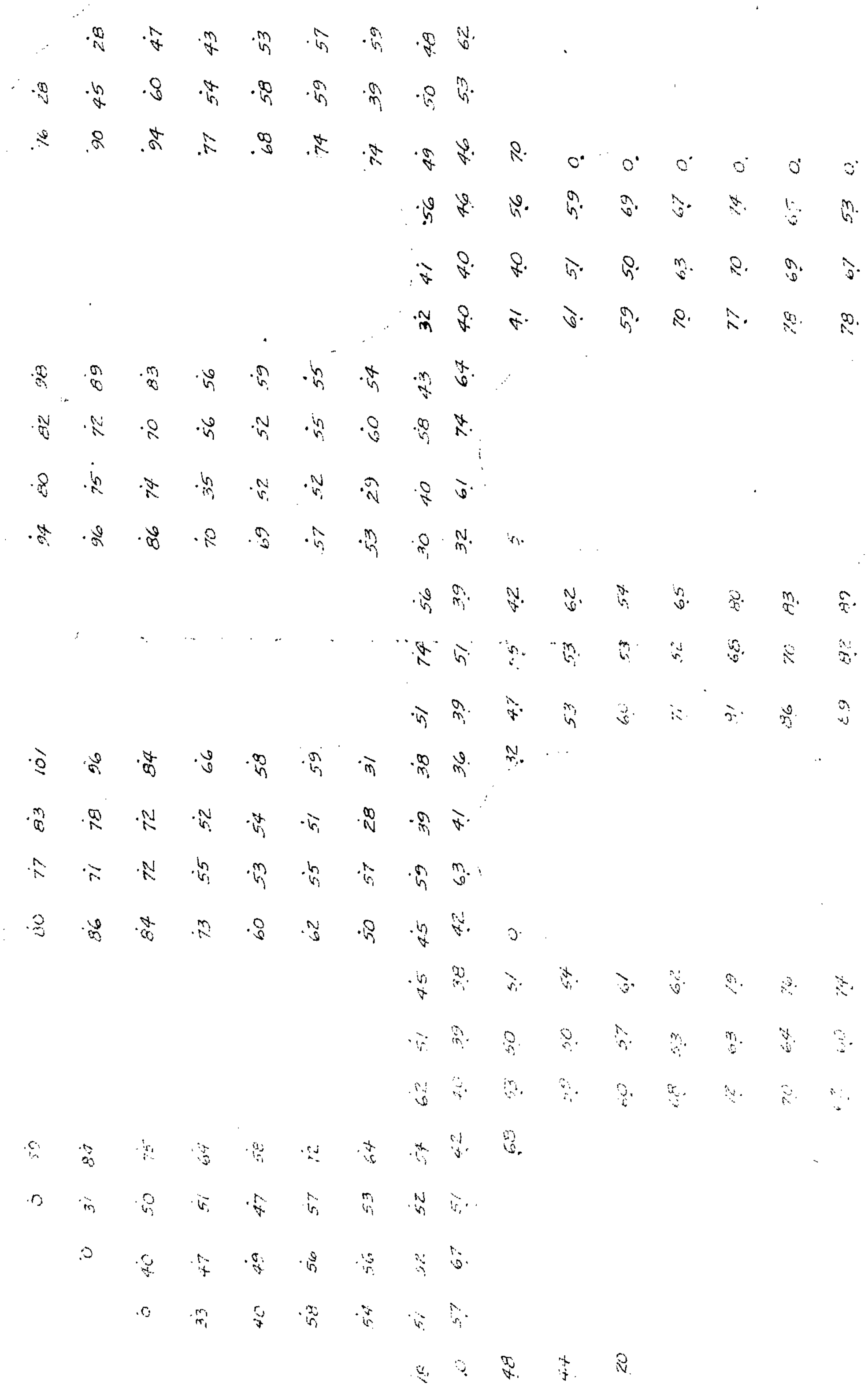
104	96	92	98				90	67	64	61				
83	70	60	77				82	61	59	70				
67	56	57	56				66	55	55	68				
44	37	40	31				42	38	37	53				
39	38	37	30				37	38	38	50				
39	37	44	38				51	37	40	55				
23	34	51	35				61	29	37	48				53
11	17	48	54	0	60	53	33	19	19	30	40	57	55	0
10	41	76	64	11	14	50	33	8	19	38	37	47	44	0
0				17	25	45	32				57	47	46	0
				34	30	40	0				63	44	45	0
				39	34	30	0				50	32	33	0
				53	49	52	0				60	35	34	
				66	55	66	0				68	47	8	
				80	70	75	0				68	0		
				100	97	87	0				47			

64	59	55	37	38	40	37	19	19							
67	61	55	38	38	37	29	19	8							
90	82	66	42	37	51	61	33	33	32	0	0	0	0	0	0
							53	30	45	40	30	52	66	75	87
							60	14	25	30	34	49	55	70	97
							0	11	17	34	39	53	66	80	100
98	77	56	31	30	38	35	54	64							
92	60	57	40	37	44	51	48	76							
96	70	56	37	38	37	34	17	41							
104	83	67	44	39	39	23	11	10	0						
							51	33	39	30	33	48	65	75	98
							58	41	43	37	37	36	55	72	90
							23	23	35	38	41	50	66	82	101
105	90	82	0	0	0	32	20	32							
96	79	54	35	37	38	41	31	45							
51	69	37	35	36	42	30	50	64							
55	76	71	42	38	24	26	20	18	0						
							22	13	35	41	40	45	69	83	94
							45	38	43	40	37	38	53	69	84
							51	37	42	41	37	51	68	88	77
75	67	59	34	36	37	37	10	17	7						
57	58	55	37	35	36	26	19	7							
47	53	53	45	40	46	45	40	57							
38	52	58	54	49	56	53	49	62	0						
							48	37	52	59	58	54	54	47	7
							47	31	47	49	37	37	22	0	
							38	23	32	30	5	0			
						0	0	0	0						

11.00-20
U.S. ROYAL MP TACTICAL
20X8 WIRE BREAKER

M.R. 13268 WA29353 20 3500#
— 11.59 42.49 13.83
124.71 70.17 56.26 25.07

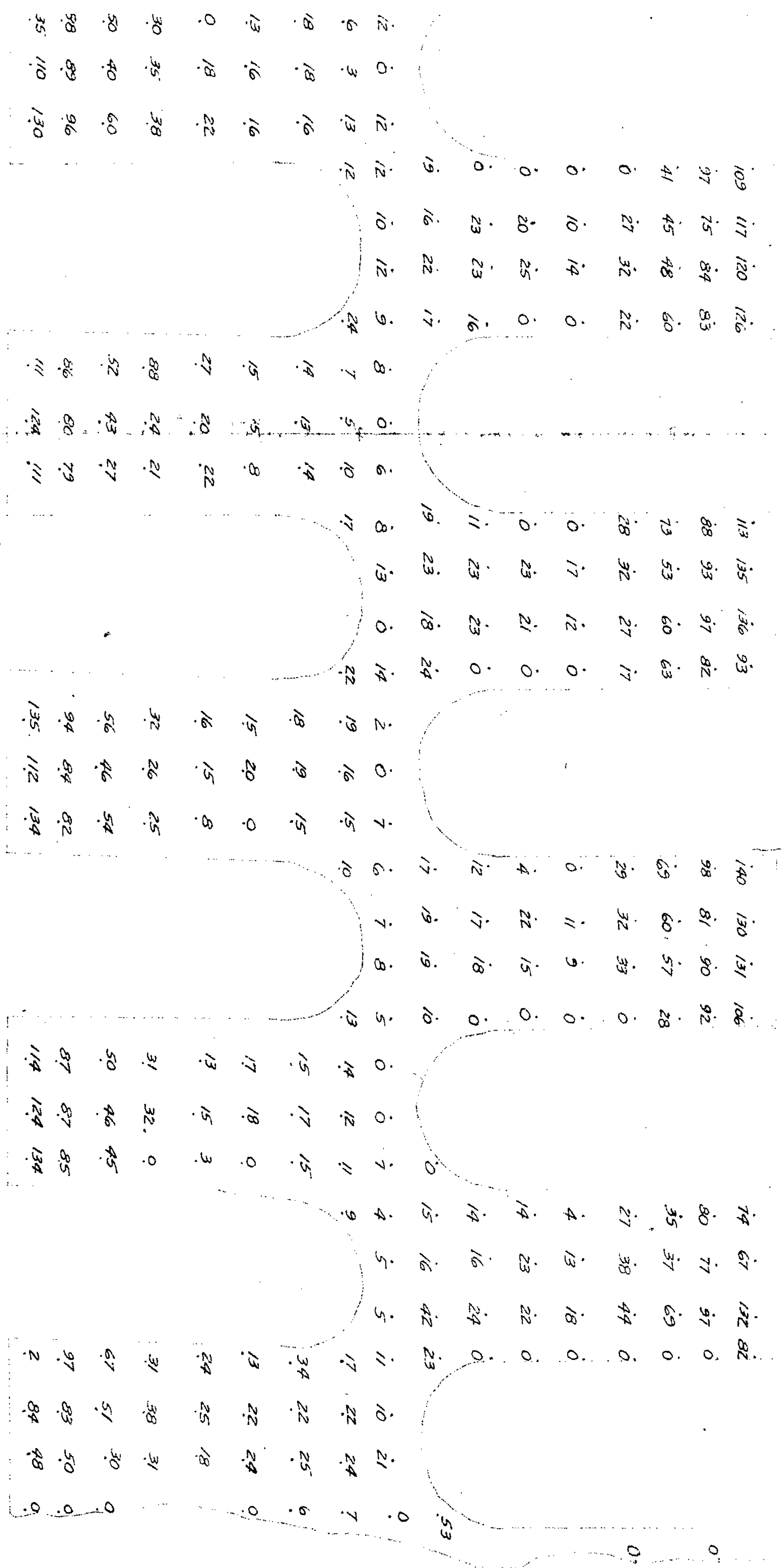
RADIAL PLY TIRE
RAYON CARCASS
WIRE BELT

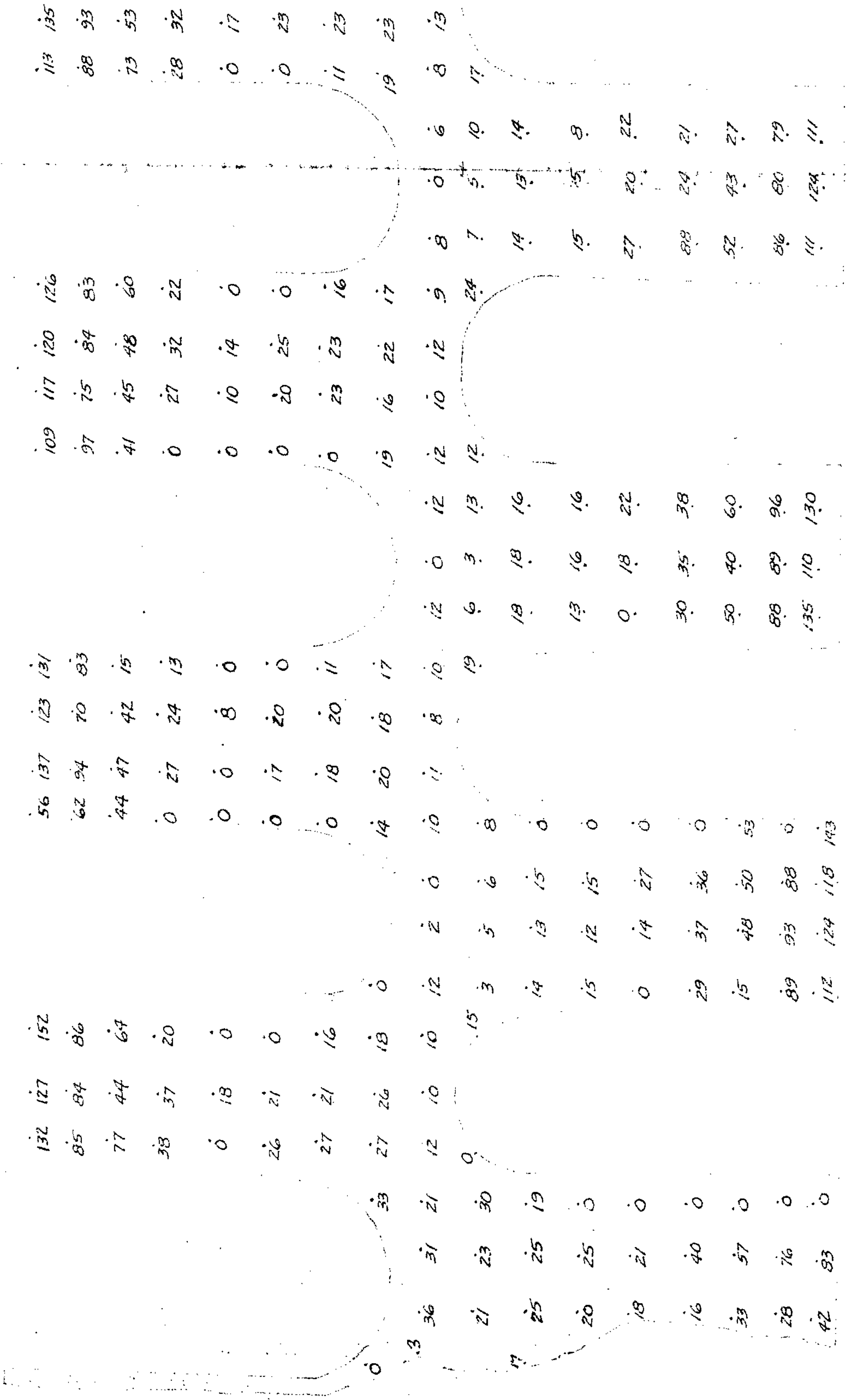


11.00-20
U.S. ROYAL M.P. TACTICAL
WIRE BREAKER
20X8

M.R. 13268 WA29353 30$^{\#}$ 3500$^{\#}$
— 11.62 42.50 13.34
— — 56.25 19.28

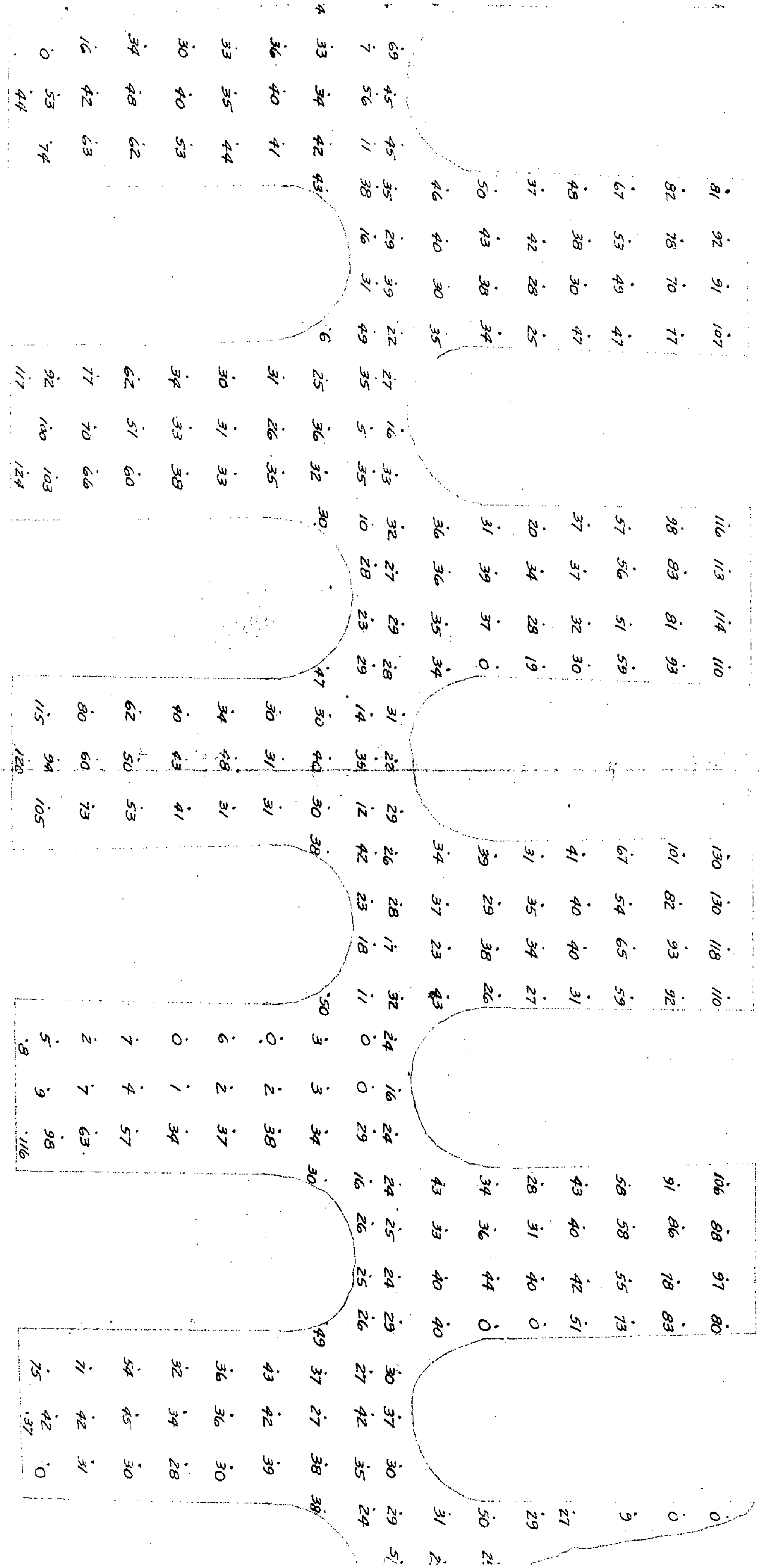
RADIAL PLY TIRE
RAYON CARCASS
WIRE BELT

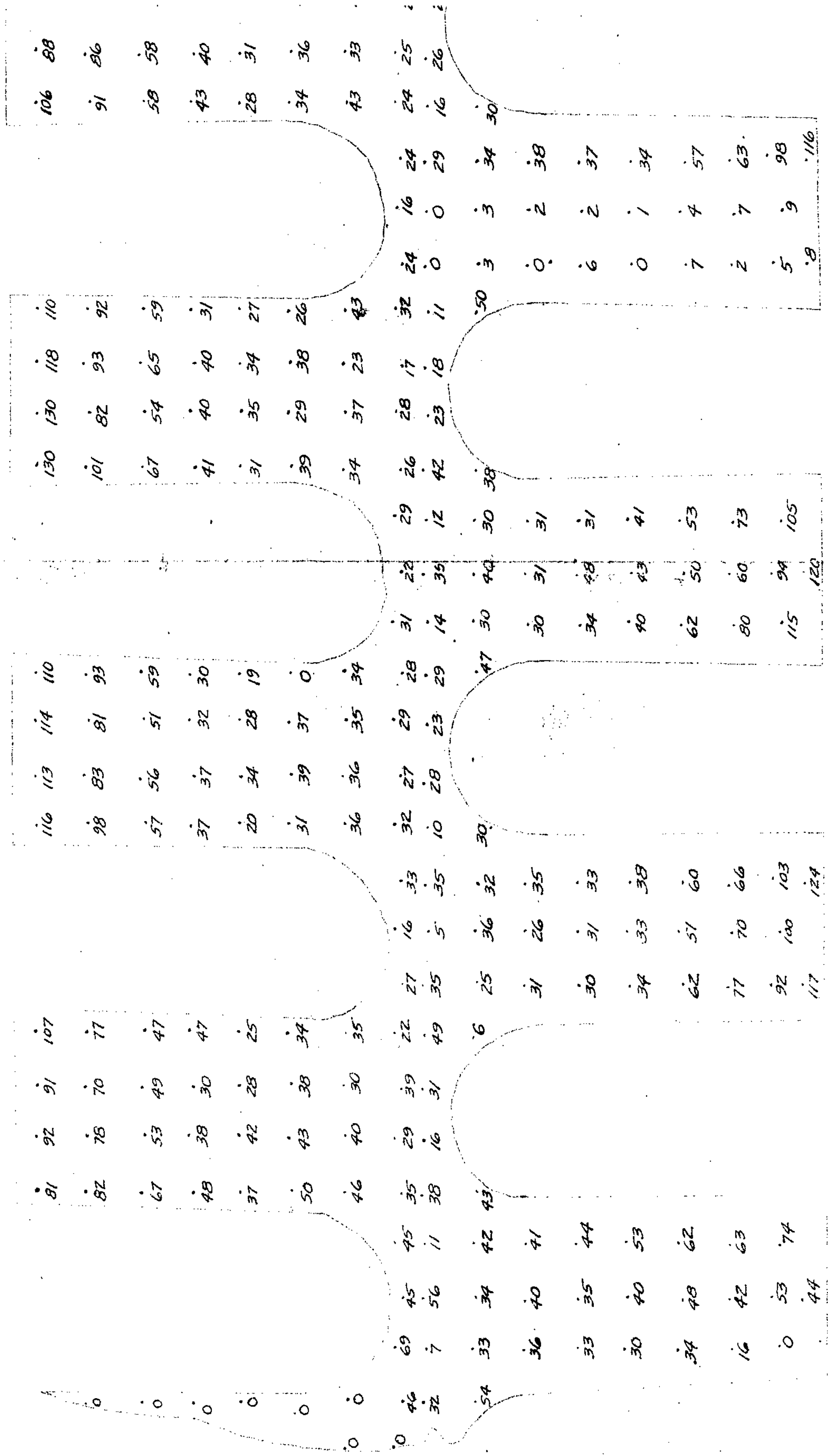




11.00-20
U.S. ROYAL TACTICAL RADIAL EXPL.
20 X 8.0
MR 13268 ZA38592 10# 3500#
— 11.75 42.20 15.27
178.34 104.78 58.75 4830

RADIAL PLY TIRE
RAYON CARCASS
RAYON BELT





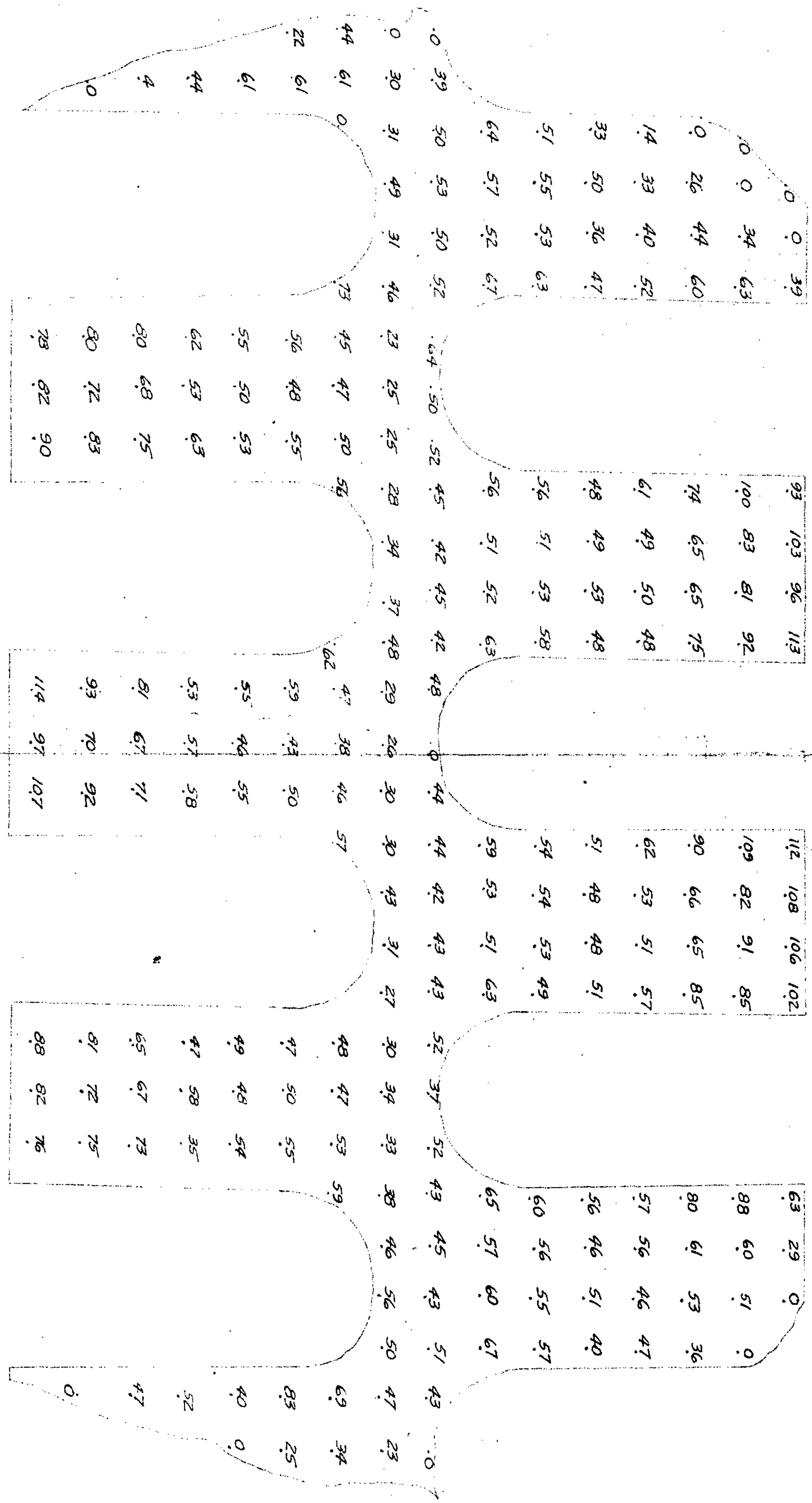
SIZE & BRAND	11.00-20 U.S. ROYAL TACTICAL EXP.
	20X8
MR	13268 ZA38592 20* 3500*
TREA	— 11.74 42.37 14.18
	132.06 76.58 57.99 29.59

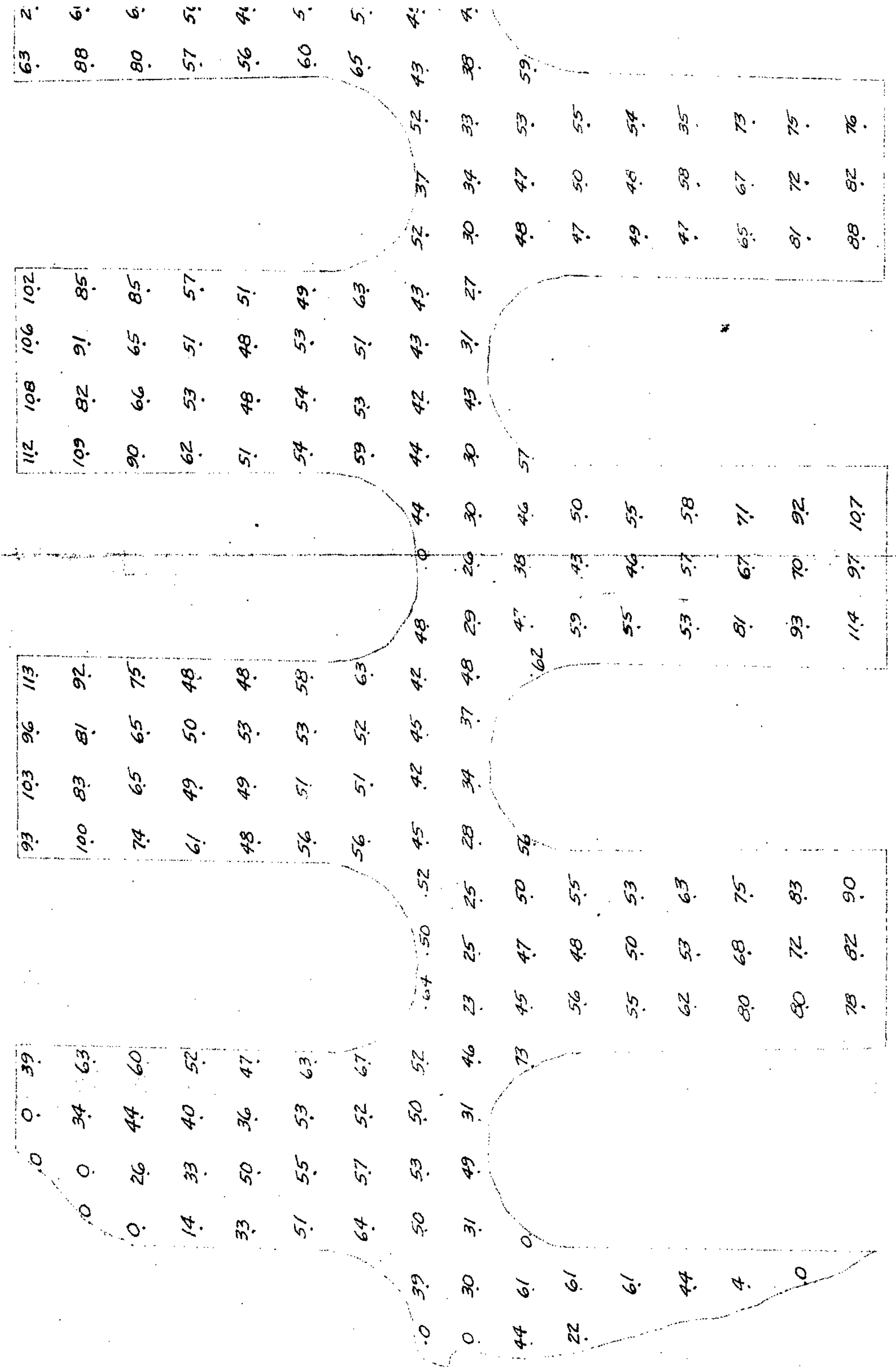
RADIAL PLY TIRE
RAYON CARCASS
RAYON BELT

2 of 2

11.00-20 U.S Royal Tactical Exp.

1of2

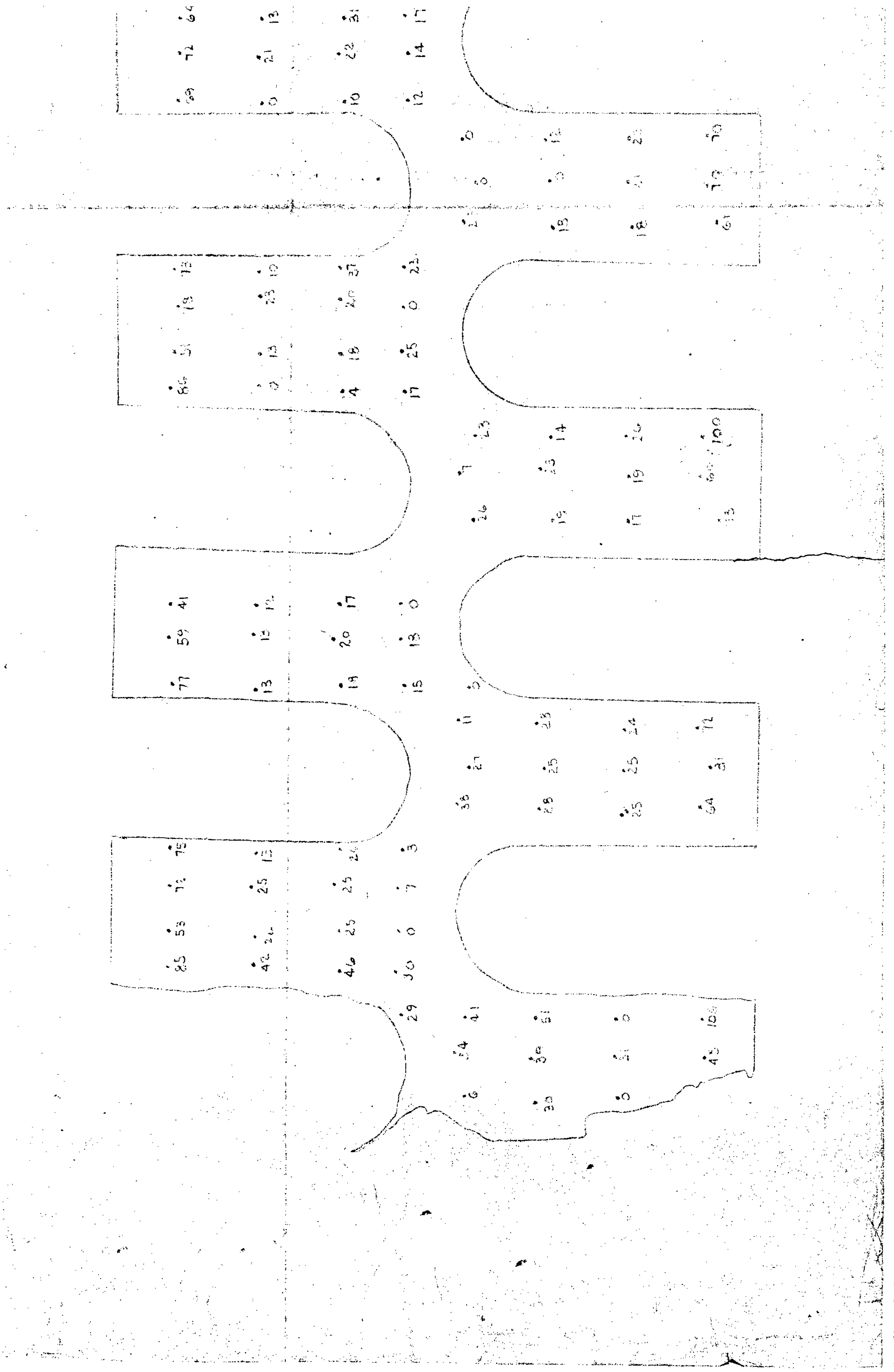


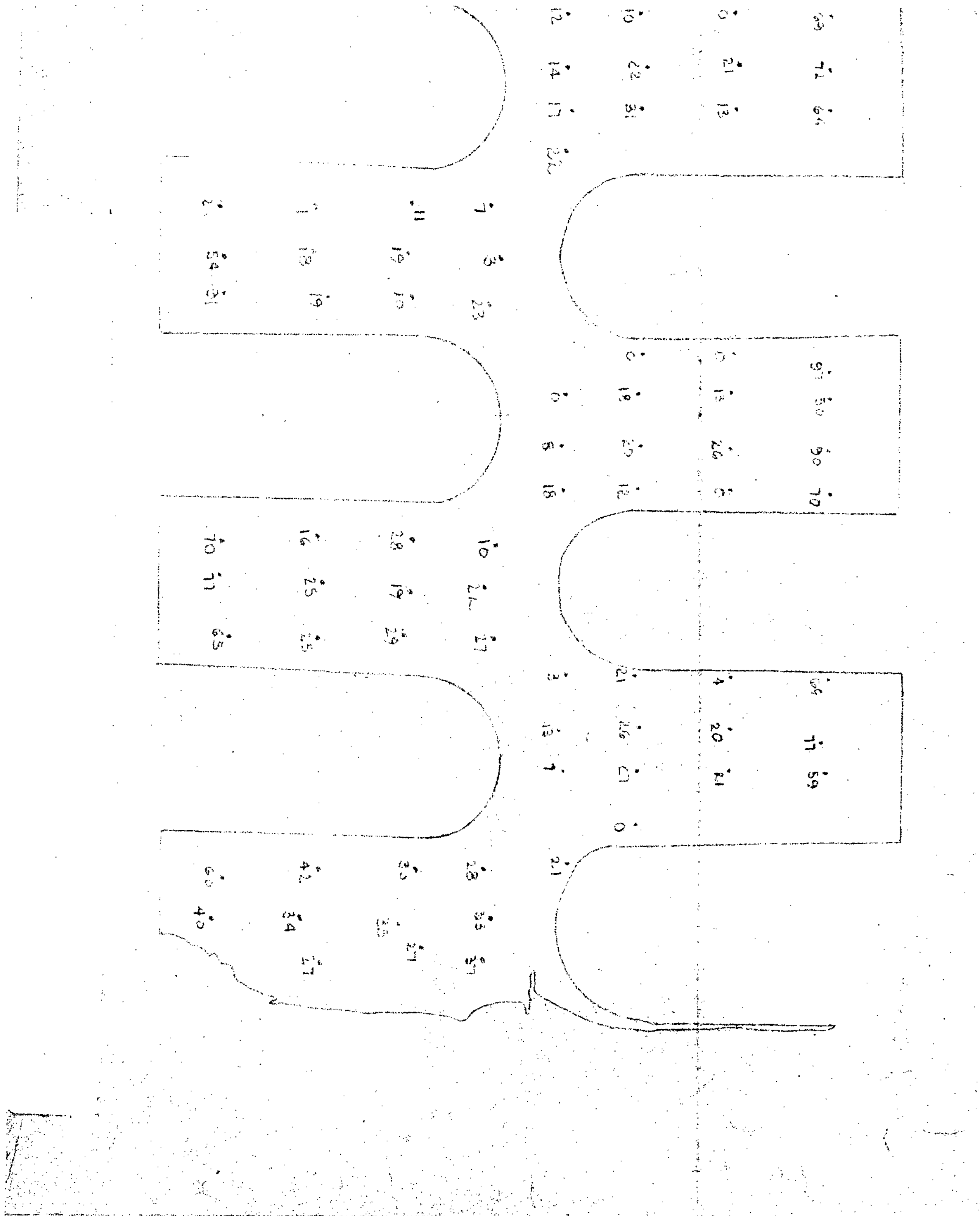


11.00-20
U.S. ROYAL TACTICAL EXP.
20X8

M.R. 13268	ZA38592	30#	3500#
—	11.71	42.50	13.57
108.32	61.98	57.22	21.88

RADIAL PLY TIRE
RAYON CARCASS
RAYON BELT

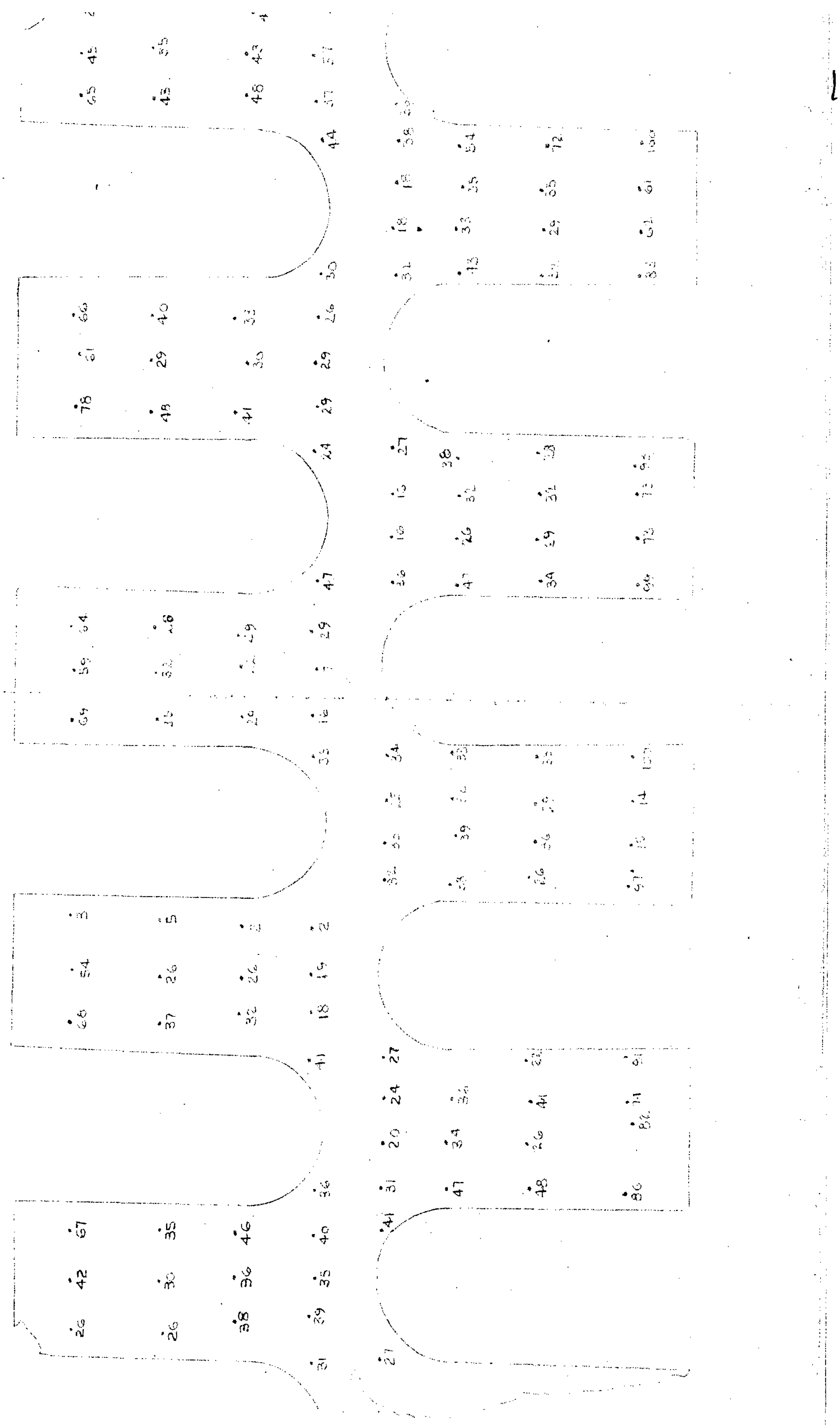


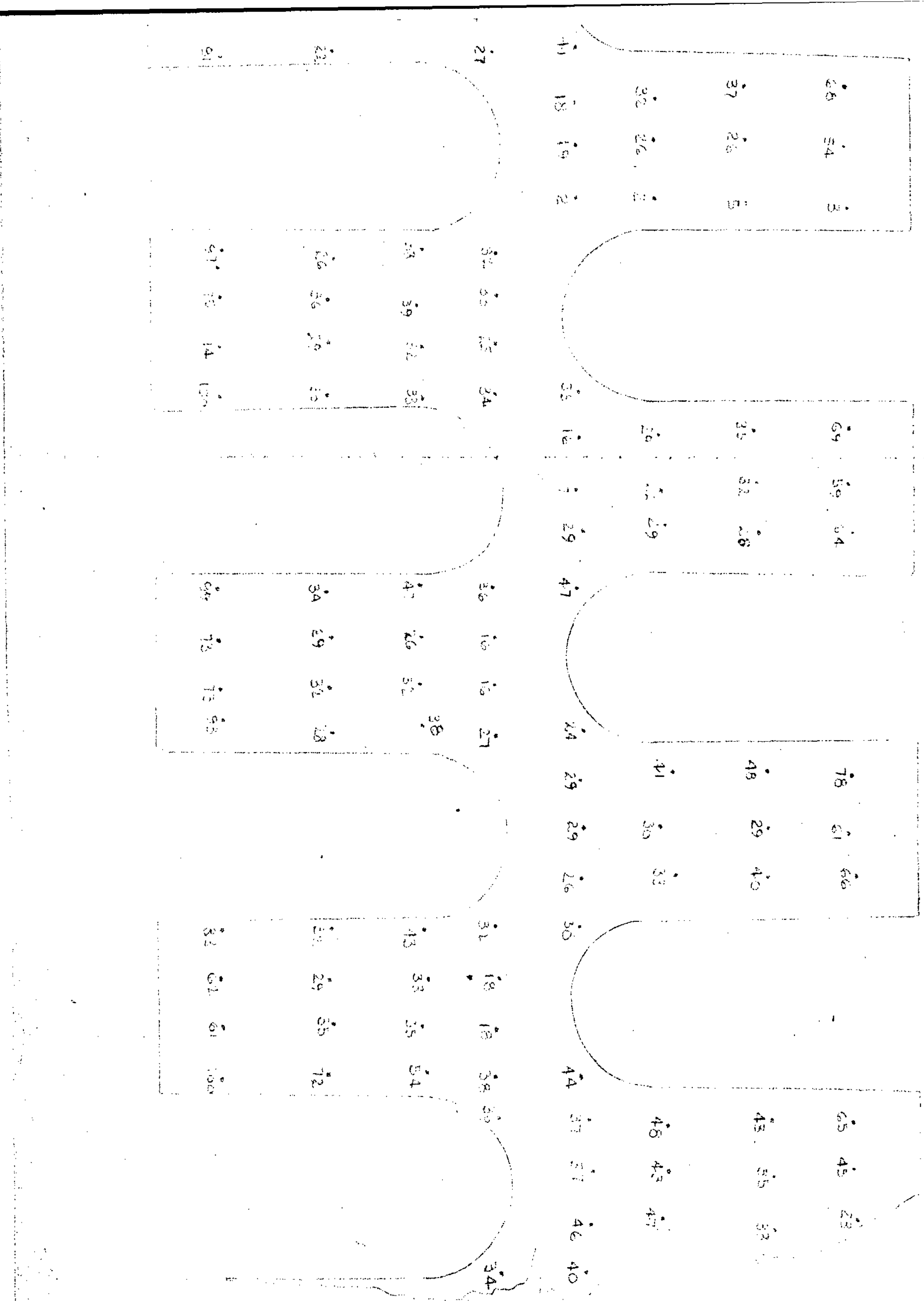


11.00-20
U.S. ROYAL MP TACTICAL 1 PLY
20x8

M.R. 13268	WA35211	10*	3500*
—	11.63	42.48	15.13
180.00	102.33	56.85	46.12

RADIAL PLY TIRE
WIRE CARCASS
WIRE BELT





SIZE & BRAND 11.00-20 U.S. ROYAL MP TACTICAL

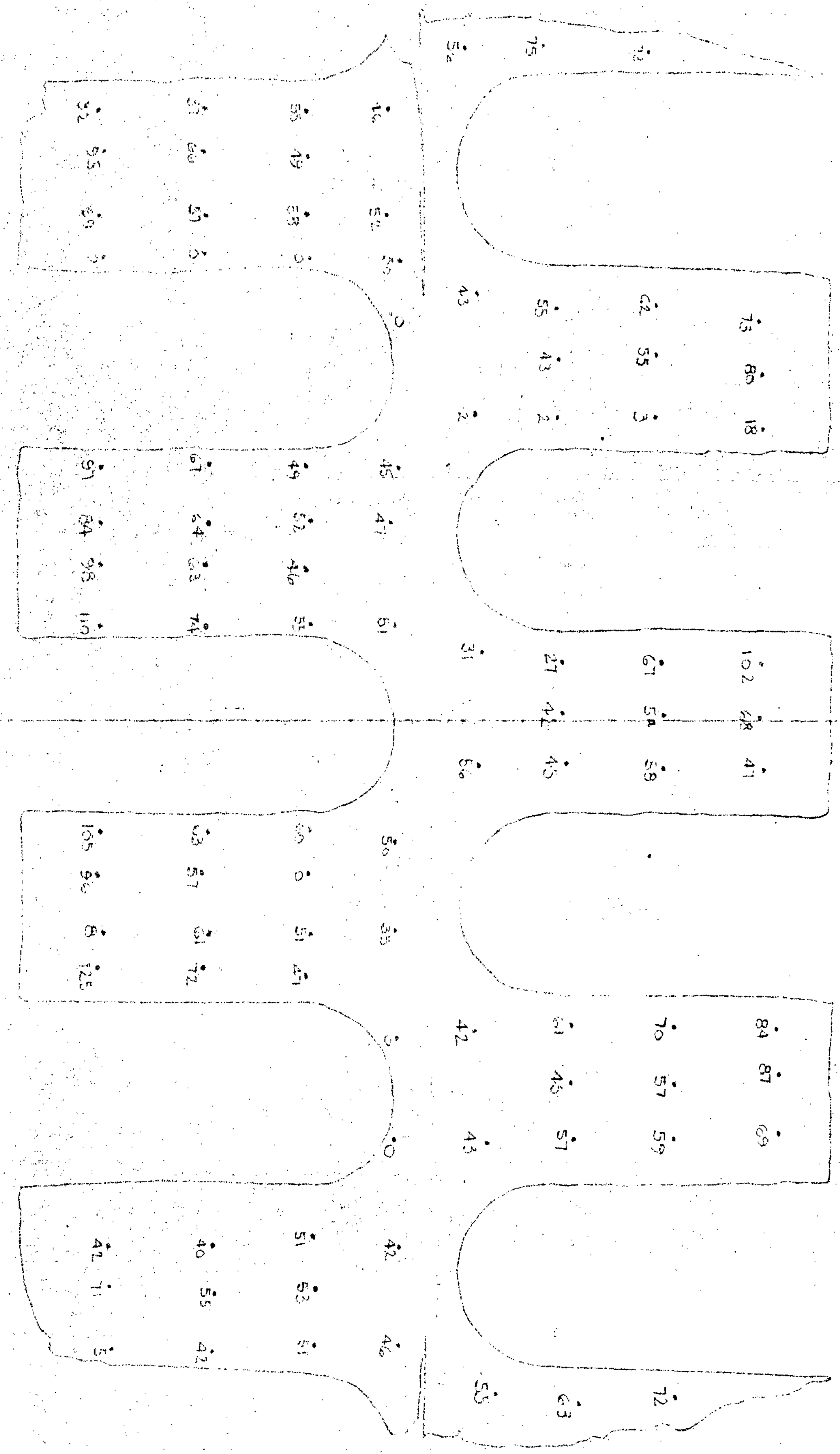
20 X 8

M.R 13268 WA35211 20# 3500#

AREA — 11.65 42.50 14.16

131.40 74.14 56.92 30.26

RADIAL PLY TIRE
WIRE CARCASS
WIRE BELT



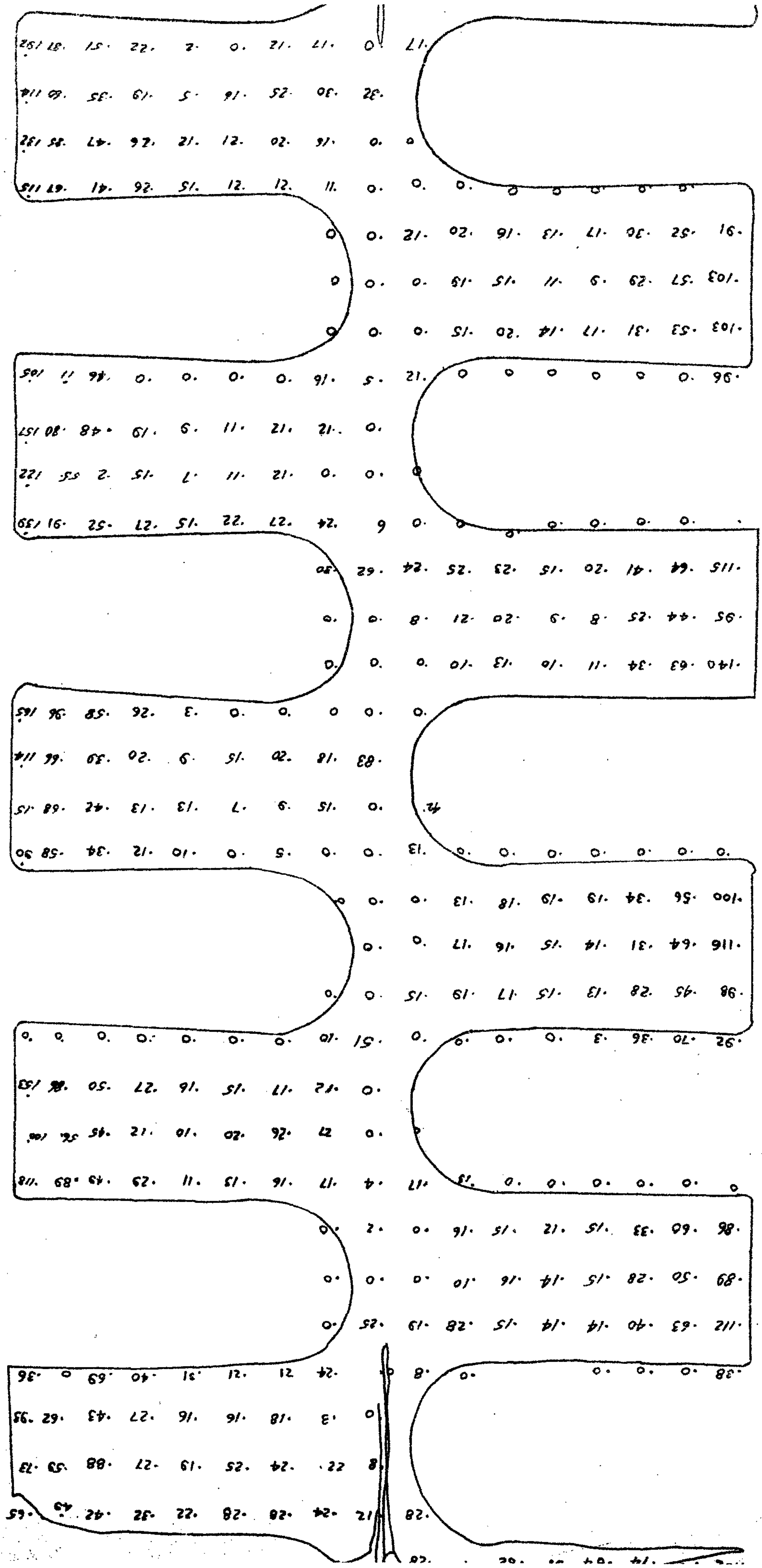
SIZE & BRAND 11.00-20 U.S. ROYAL MP TACTICAL

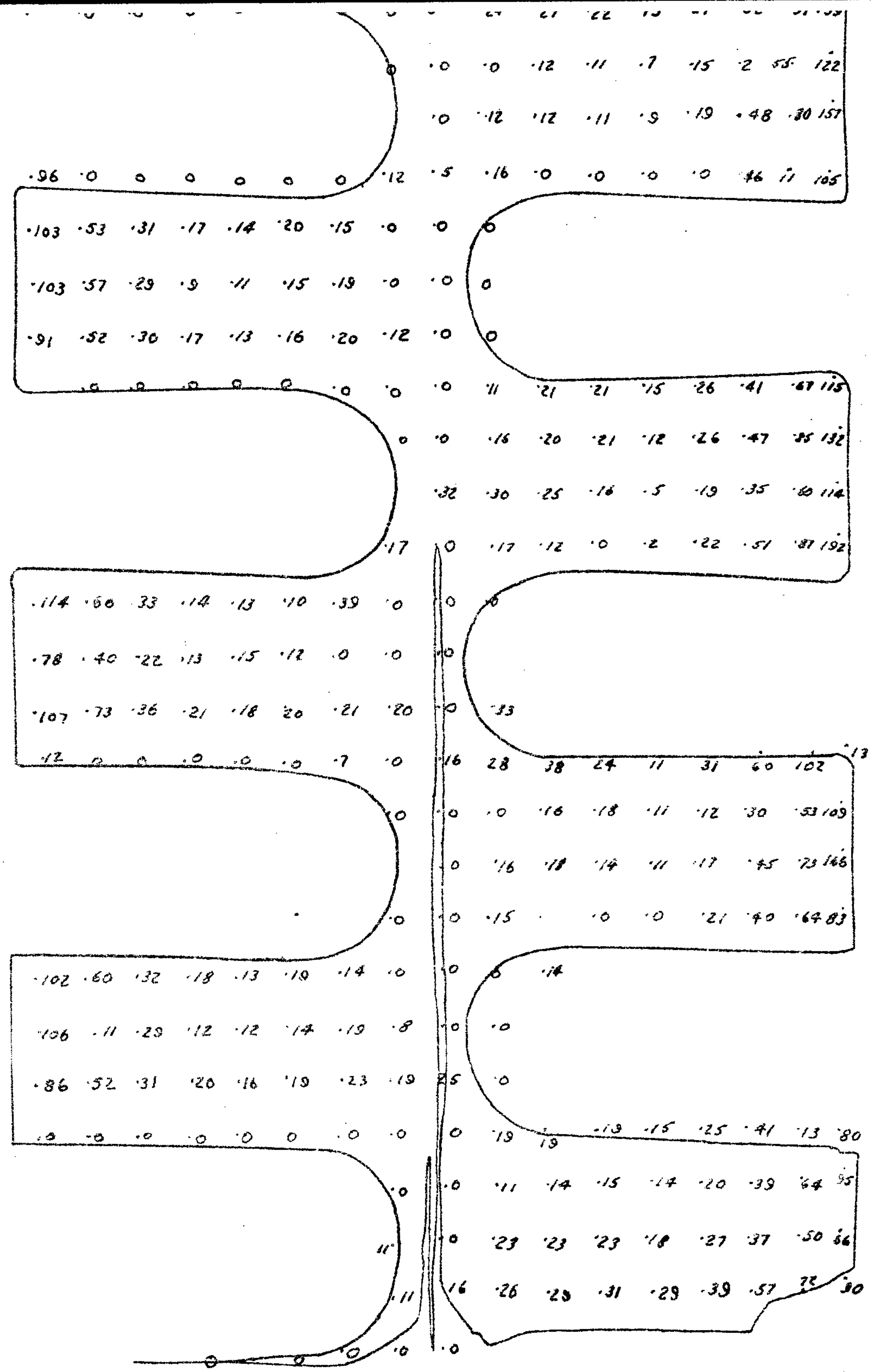
RIM SIZE 20X8

M.R. 13268 SER NO. WA35211 30# LOAD 3500#

AREA — S.C. DIA 11.68 O.D. 42.50 L'DG. SEC 13.67

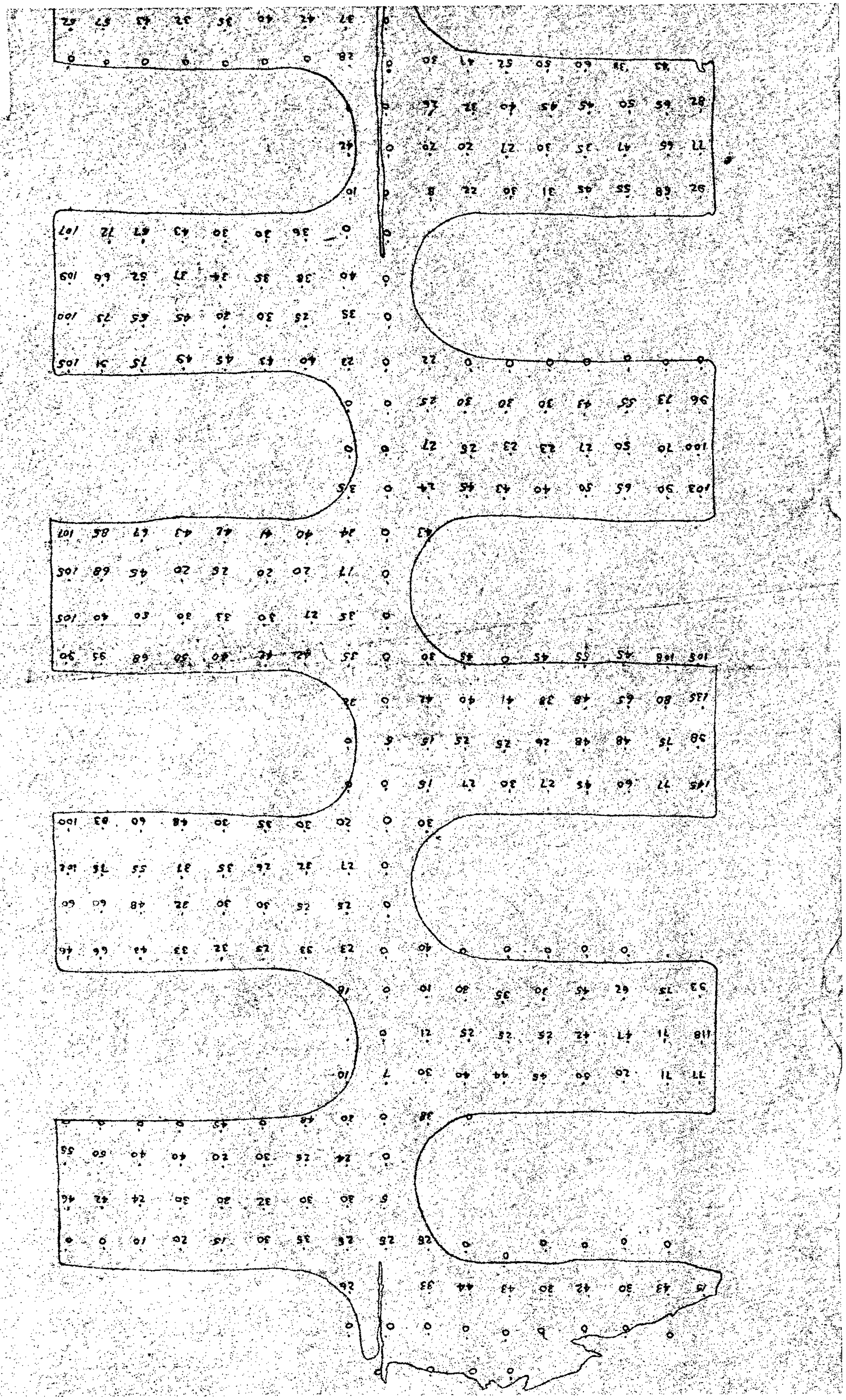
RADIAL PLY TIRE
WIRE CARCASS
WIRE BELT

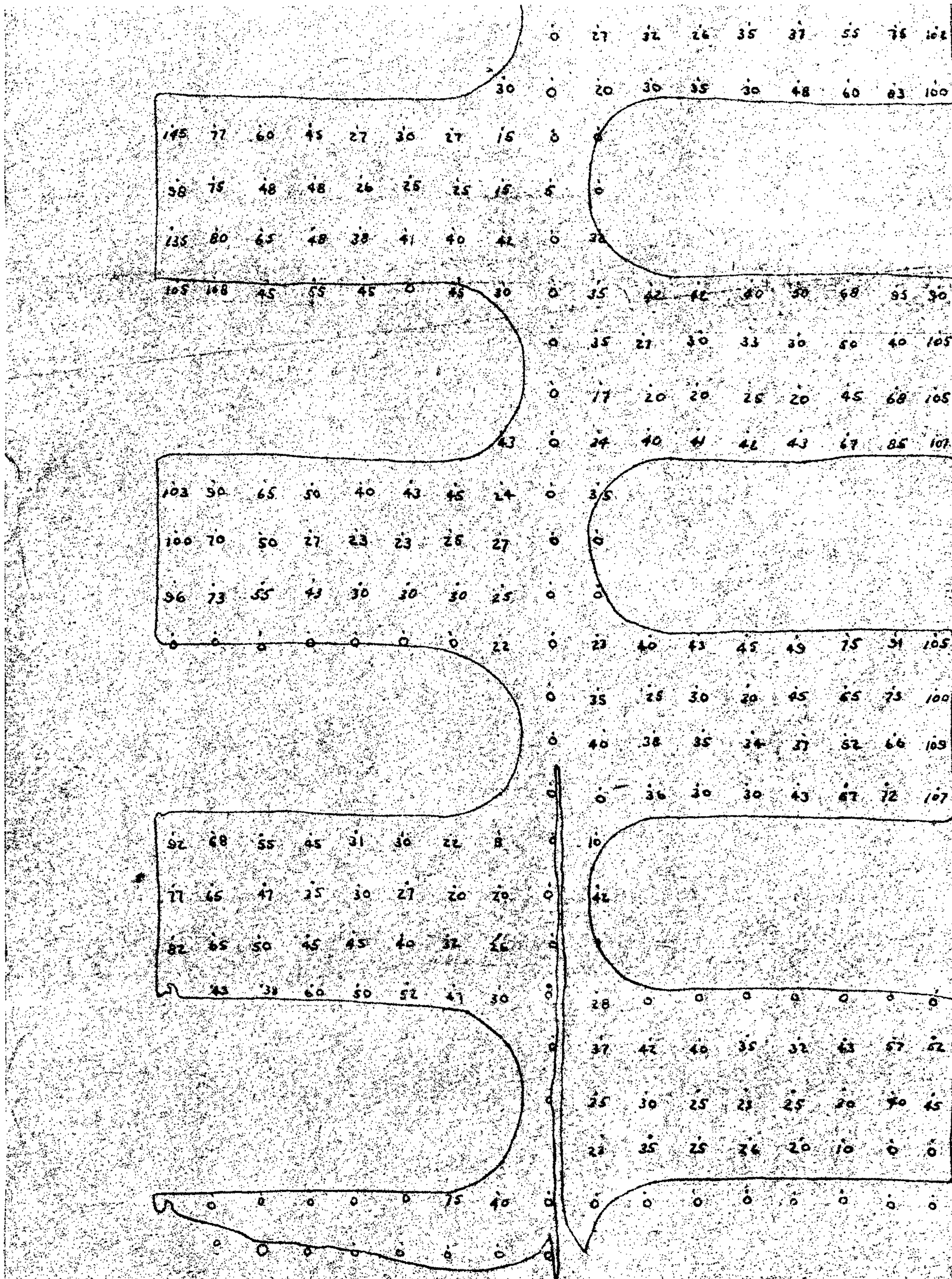




Revised Construction
2nd Camp Bullis Test
Wire Carcass
Wire Belt

2 of 2





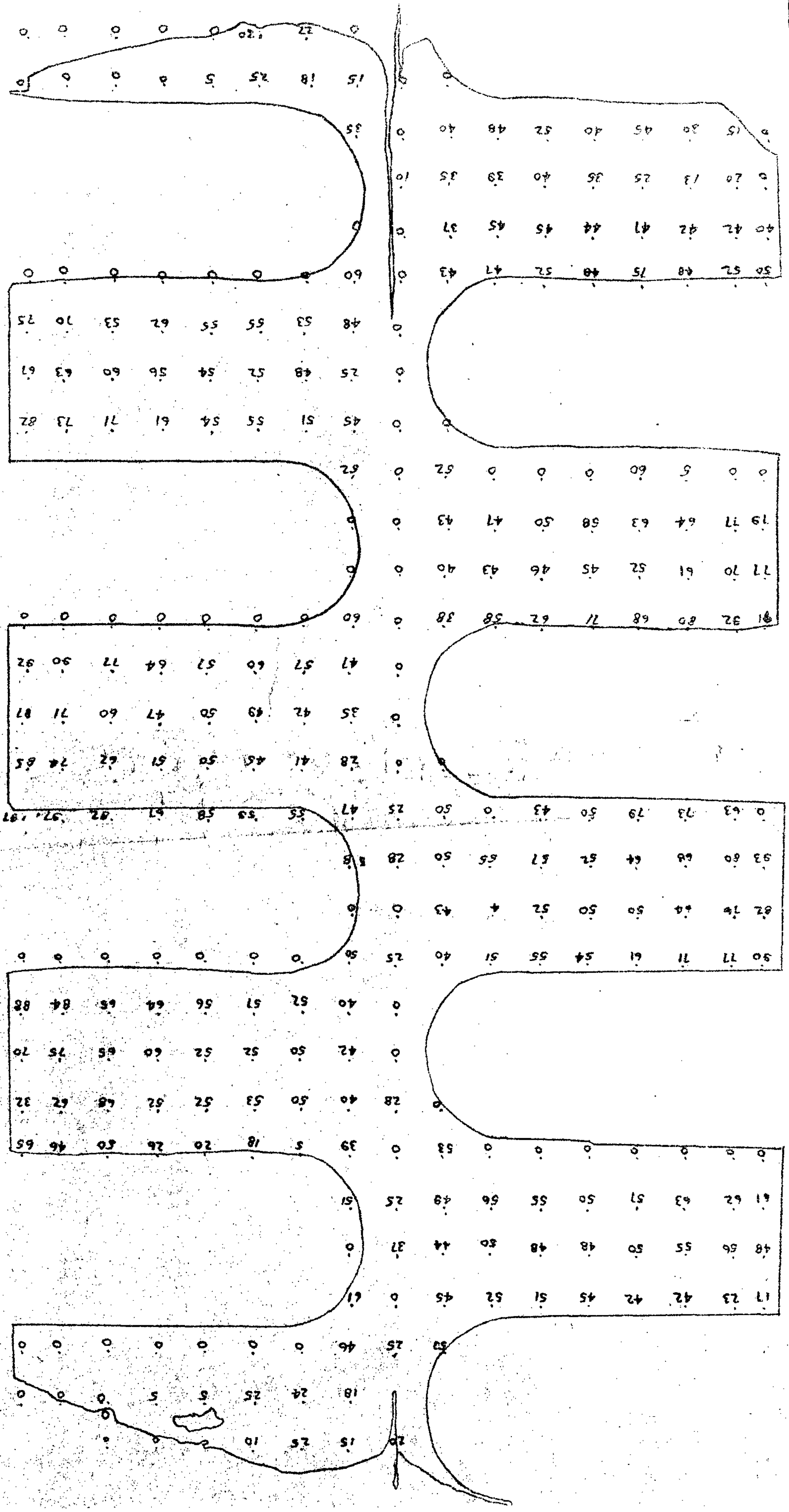
11.00-20
U.S. ROYAL TACTICAL RADIAL EXP.

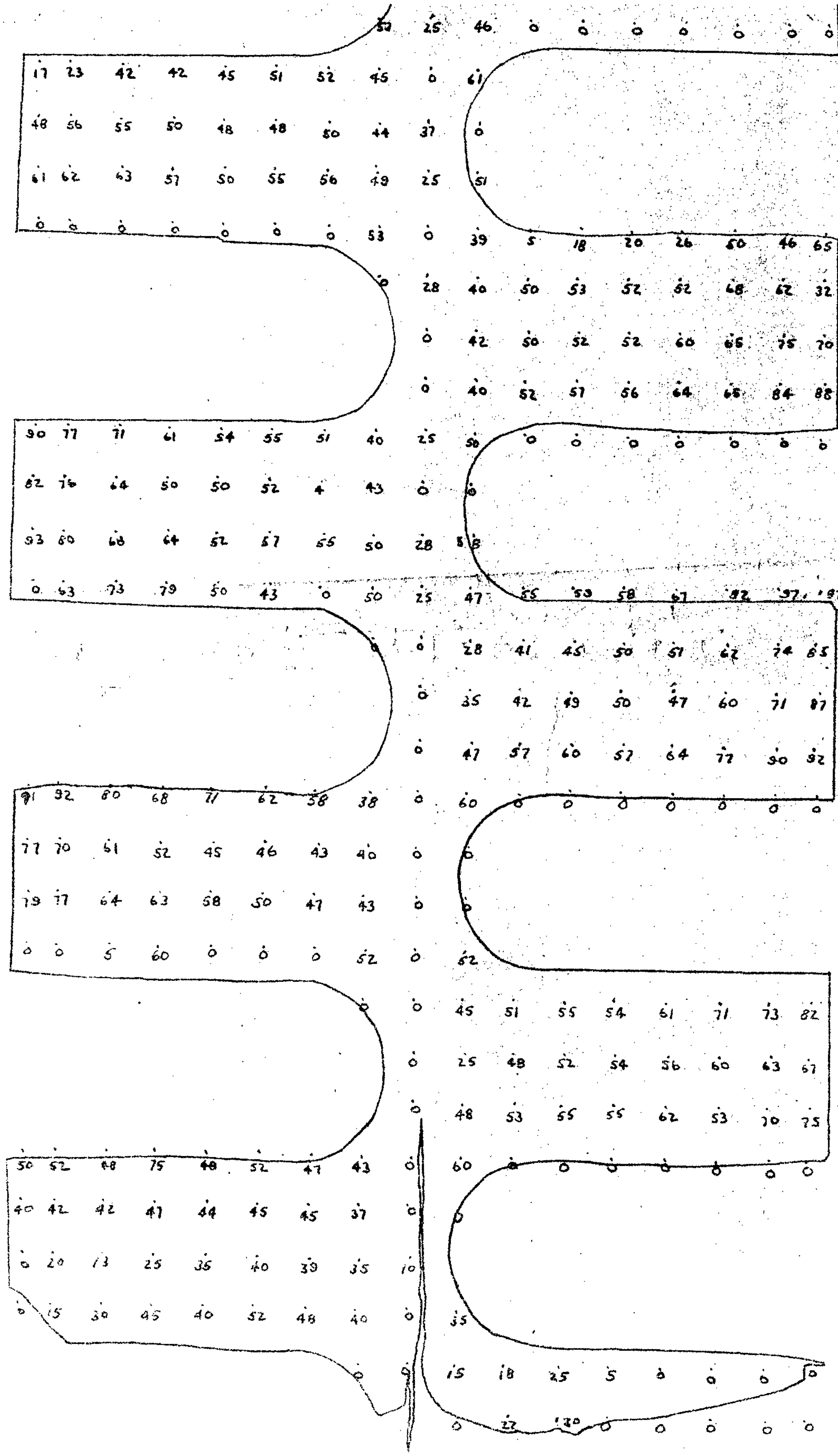
20X8 — REVISED CONSTRUCTION

M.R. 16446 — 0D01347 — 20* — 3500* — 2ND CAMP BULLIS TEST

— — 11.72 — 42.52 — 14.25 — WIRE CARCASS

147.28 — 86.68 — 58.85 — 31.58 — WIRE BELT



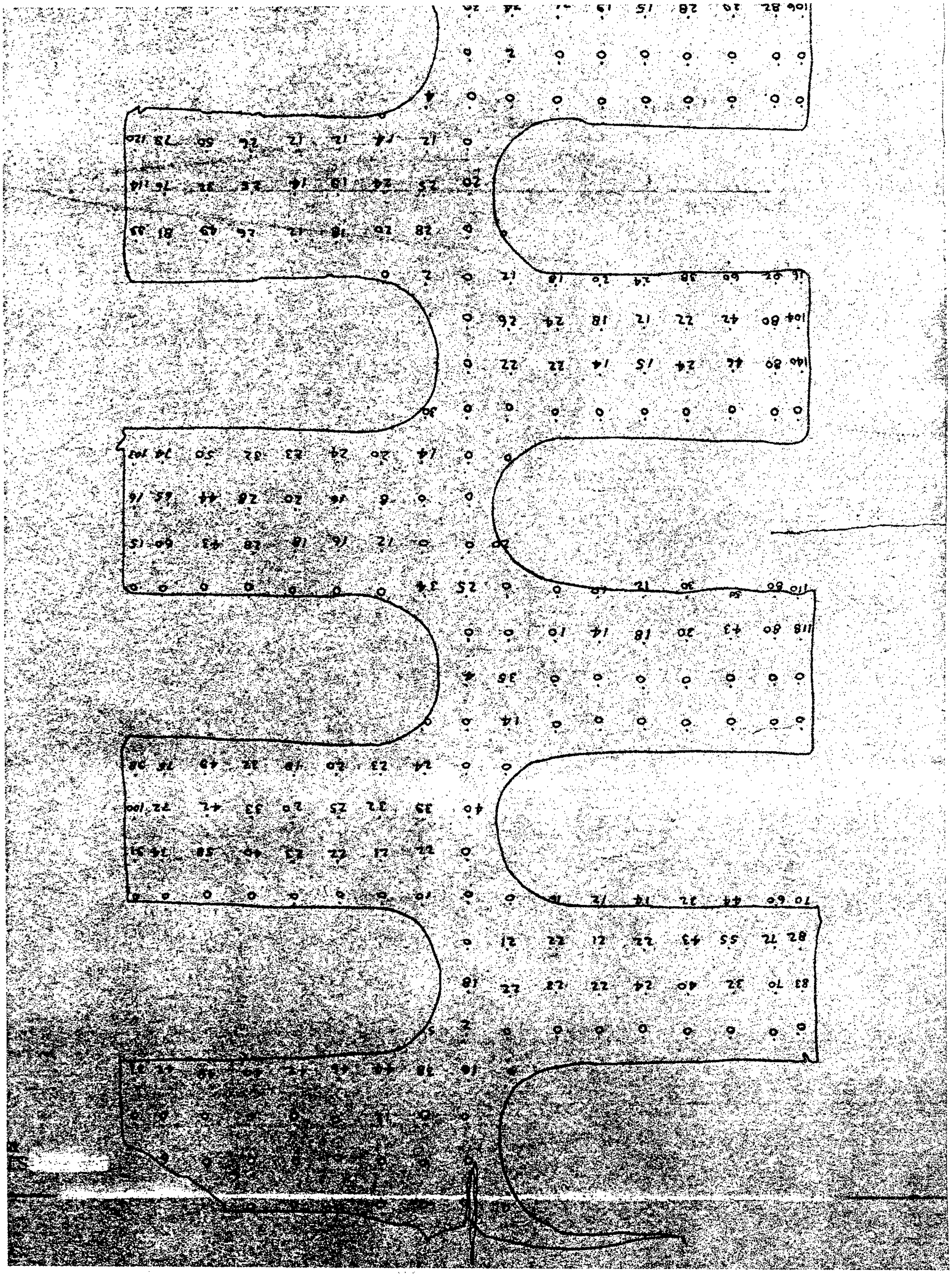


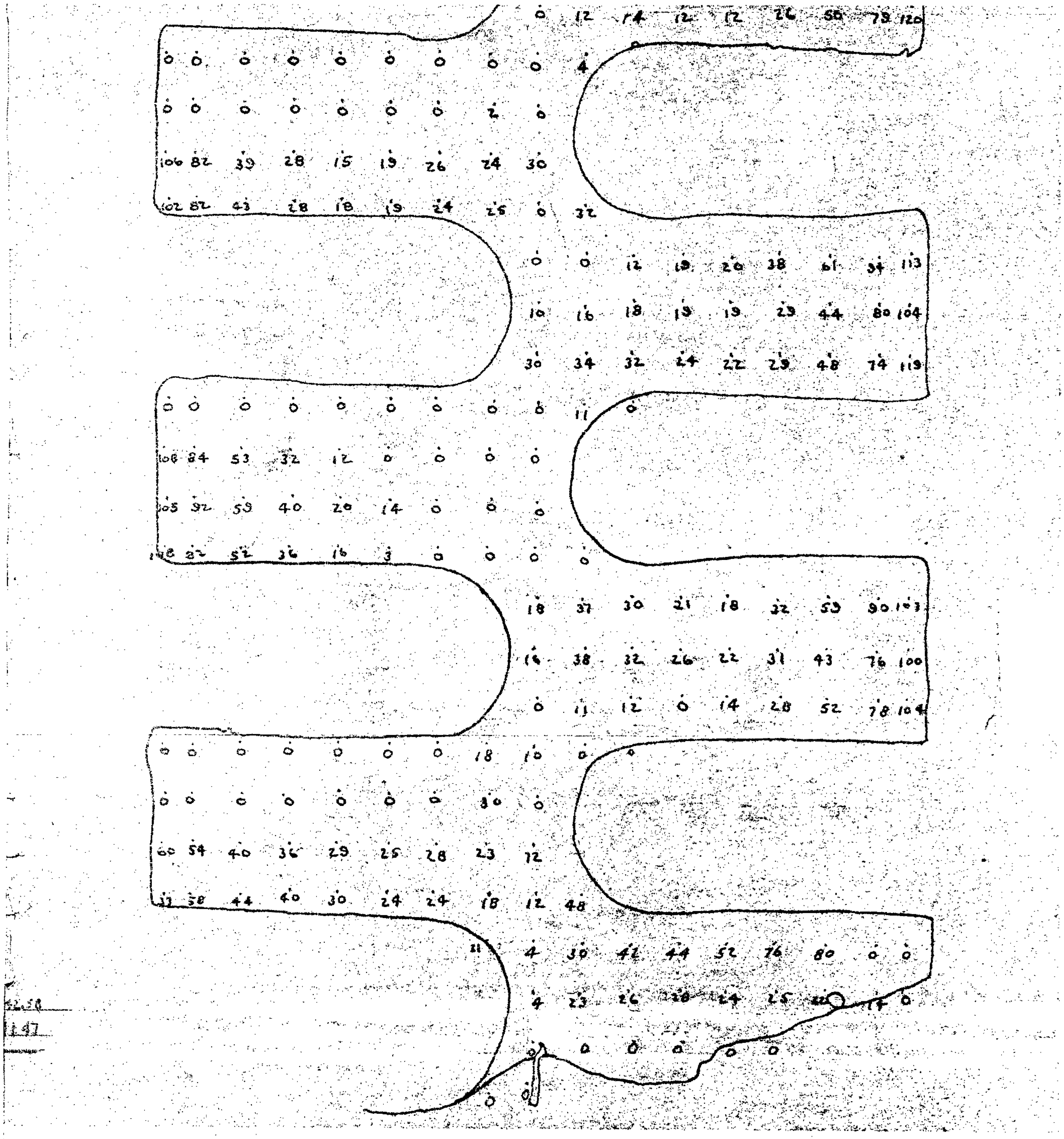
11.00-20
U.S. ROYAL TACTICAL RADIAL EXP.
20 X 8

M.R. 16446	0D01347	30*	3500*
—	11.72	42.52	13.65
117.56	67.92	57.77	23.83

REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
WIRE CARCASS
WIRE BELT

2 of 2



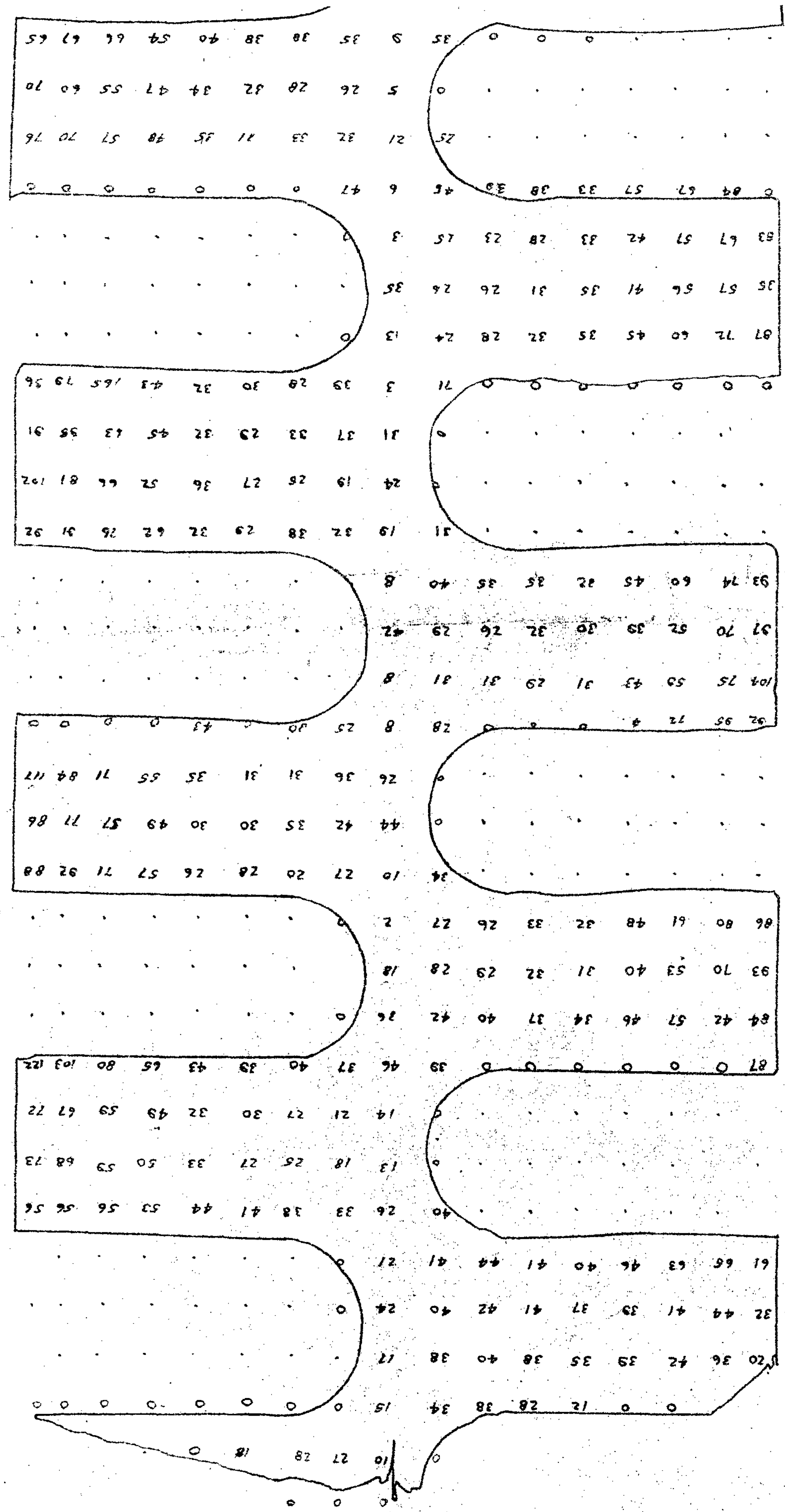


11.00-20
U.S. ROYAL TACTICAL RADIAL EXPL.
20 X 8.0

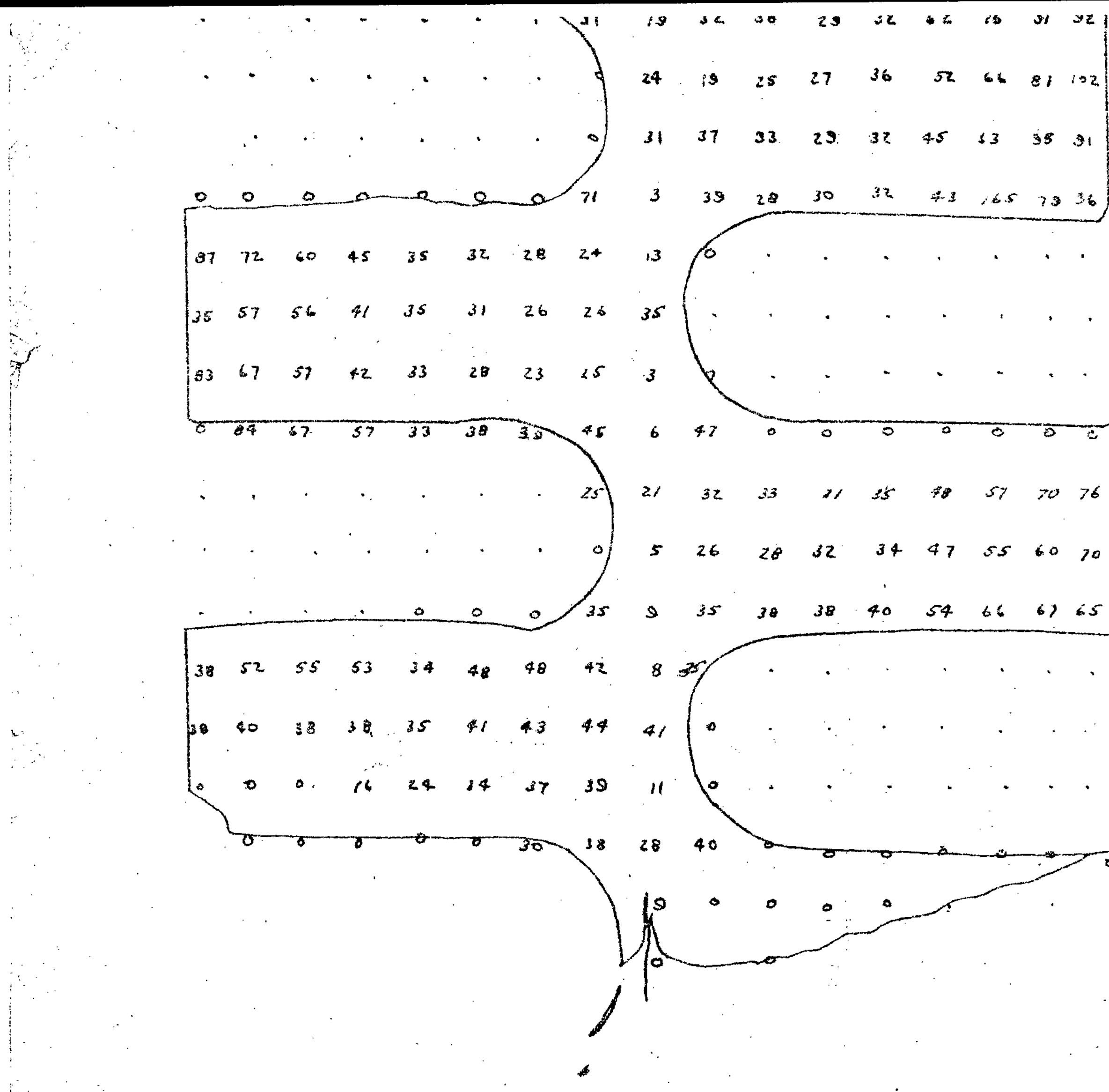
M.R. 16446	—		10/32	3500
—	11.77	42.58		14.75
181.87	104.41	58.51	41.47	

REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (4 PLY)
WIRE BELT

2of2

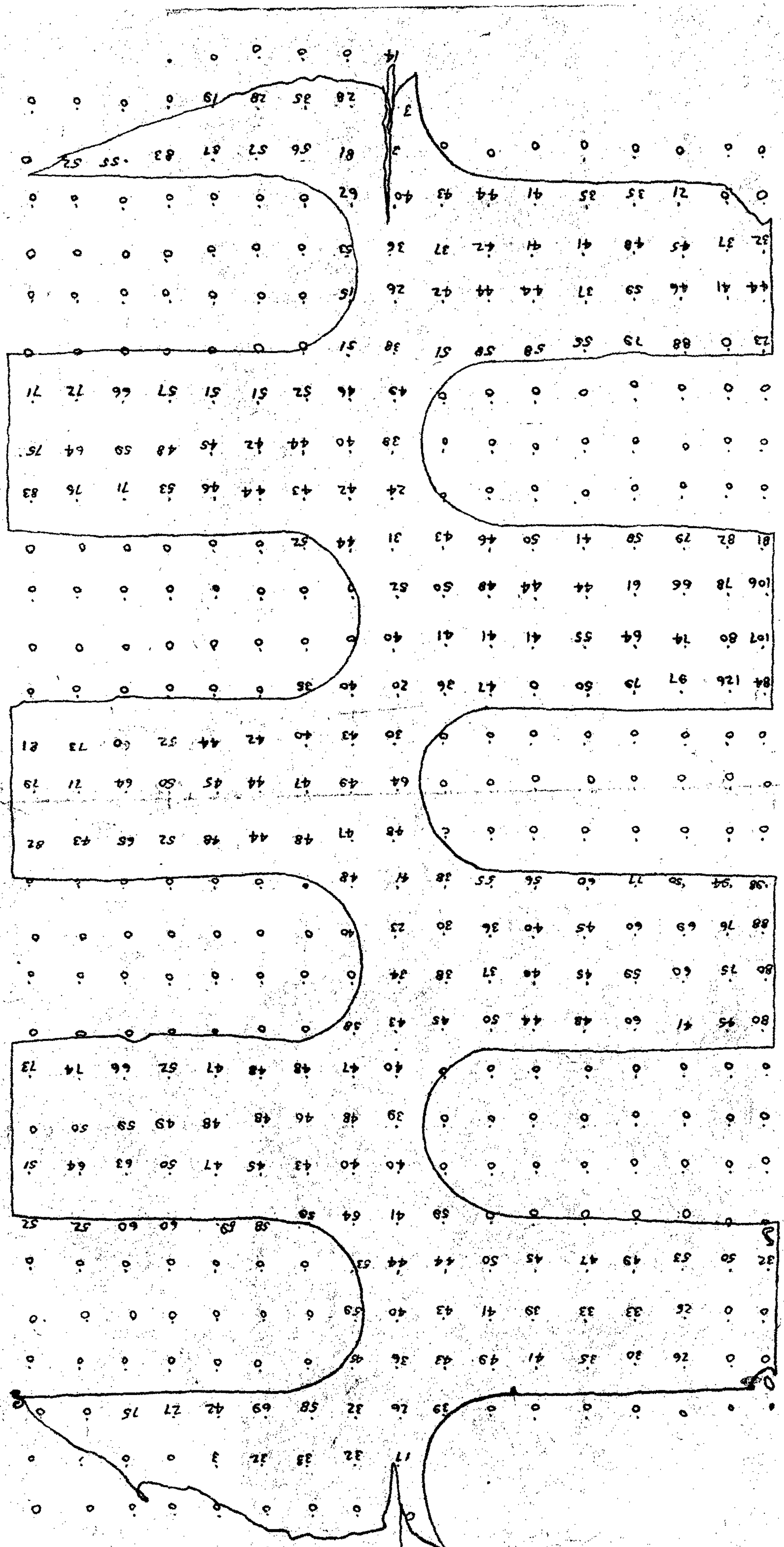


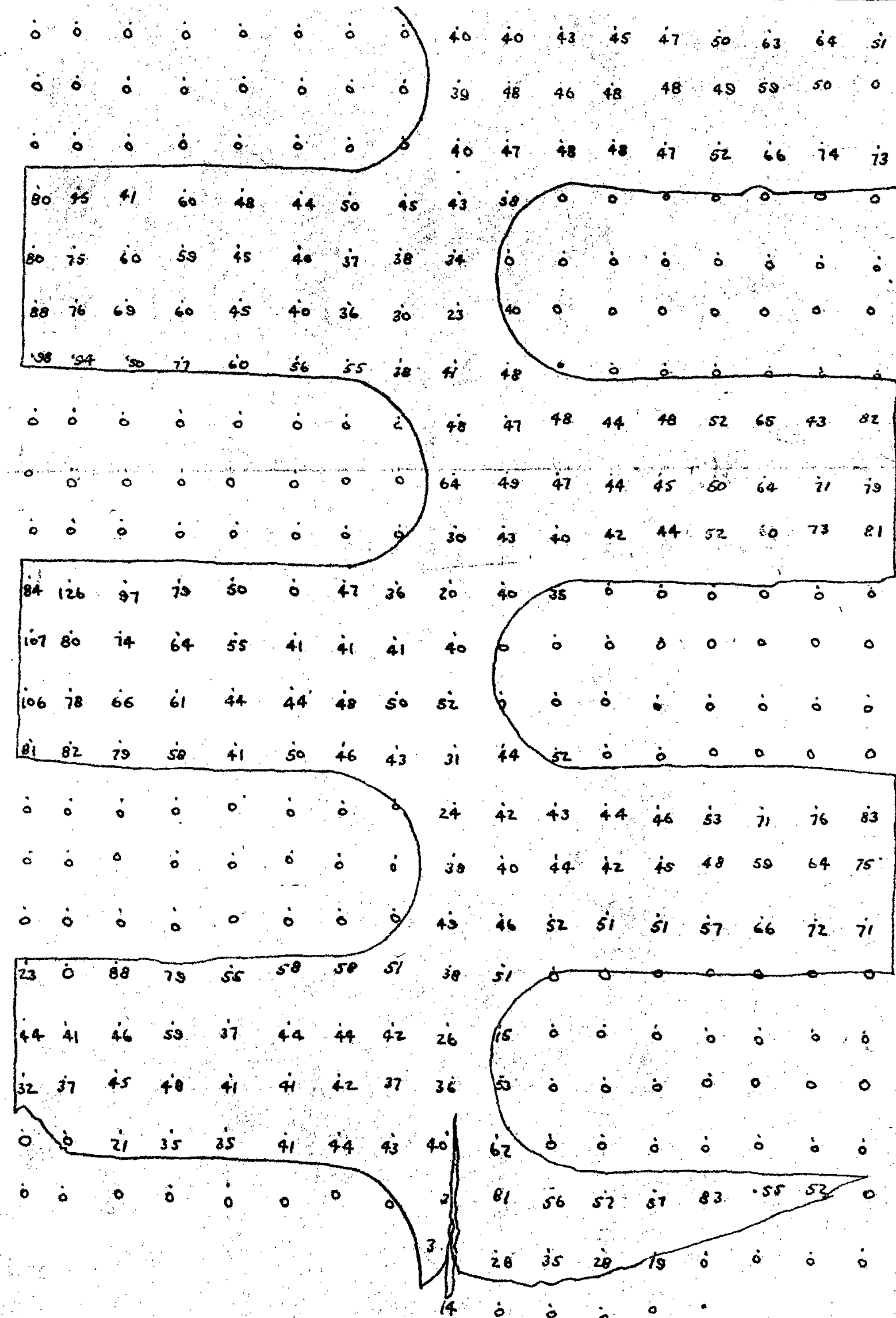
1of2



11.00-20
U.S. ROYAL TACTICAL RADIAL EXP.
20 X 8
M.R. 16446 WD30602 20# 3500#
— 11.77 42.58 13.94
141.69 82.09 57.94 28.20

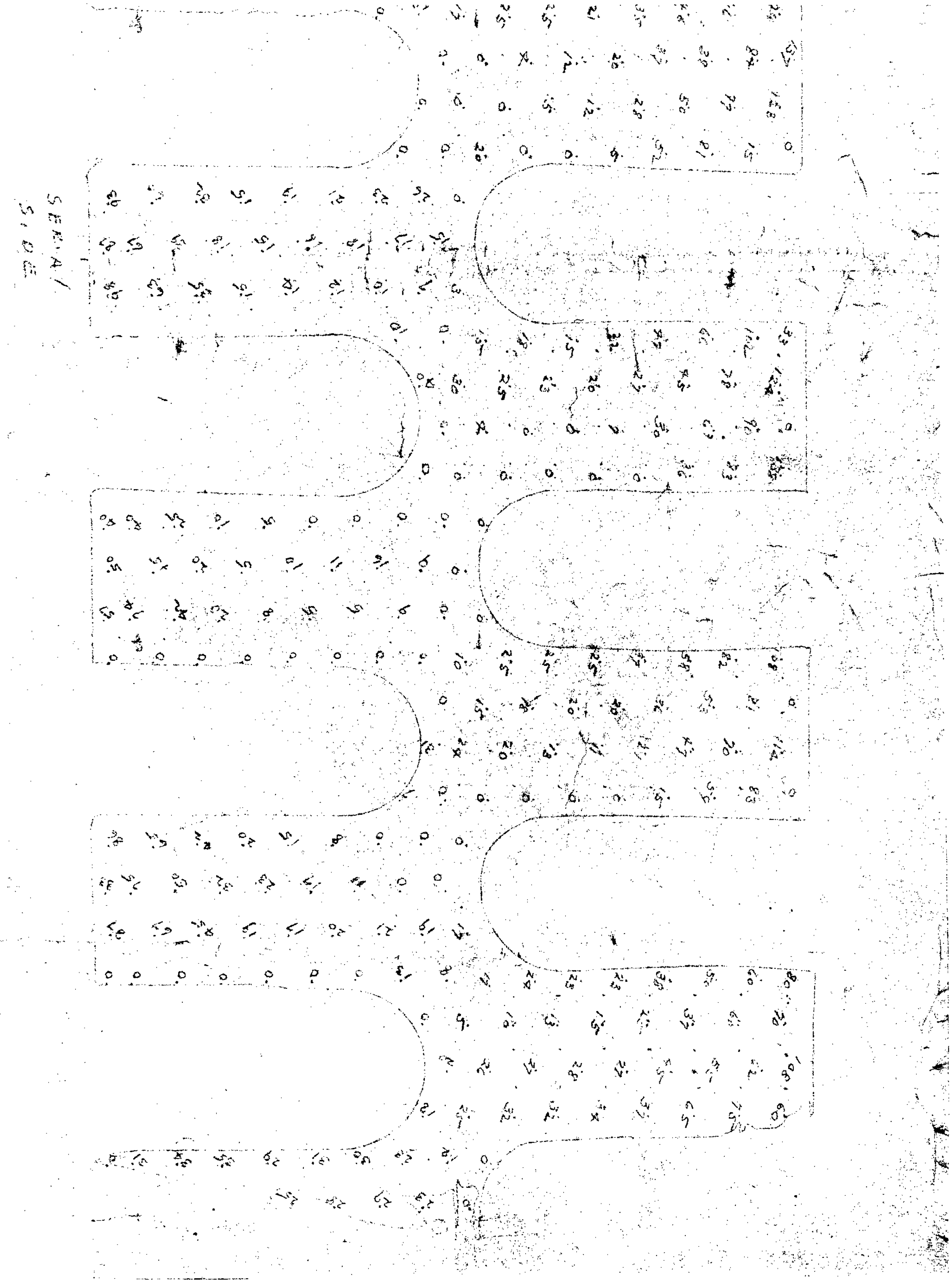
REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (4 PLY)
WIRE BELT

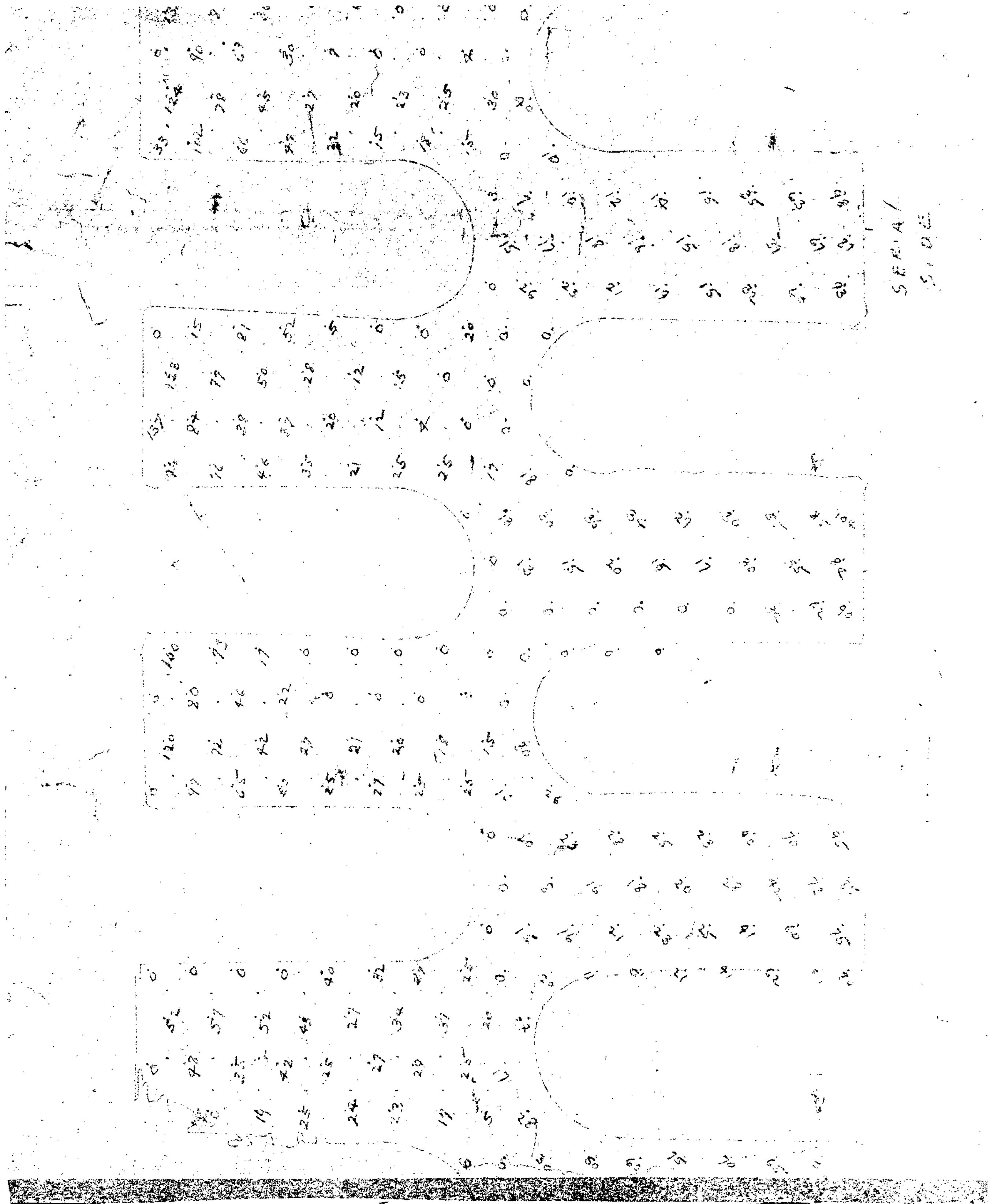




SIZE & BRAND: 11:00-20 US Royal Tactical Radial Expl.
RIM SIZE: 20 X 8.0
MR # 16446 SER. NO. WO30602 INFL. 30" LOAD 3500#
AREA — SEC. DIA. 11.72 O.D. 42.58 L'DD. SEC. 13.55
GROSS 117.03 NET 67.99 %L/G 58.10 AT 21.80 % DEFL.

Revised Construction
2nd Camp Bullis Test
Nylon Carcass (4 Ply)
Wire Belt

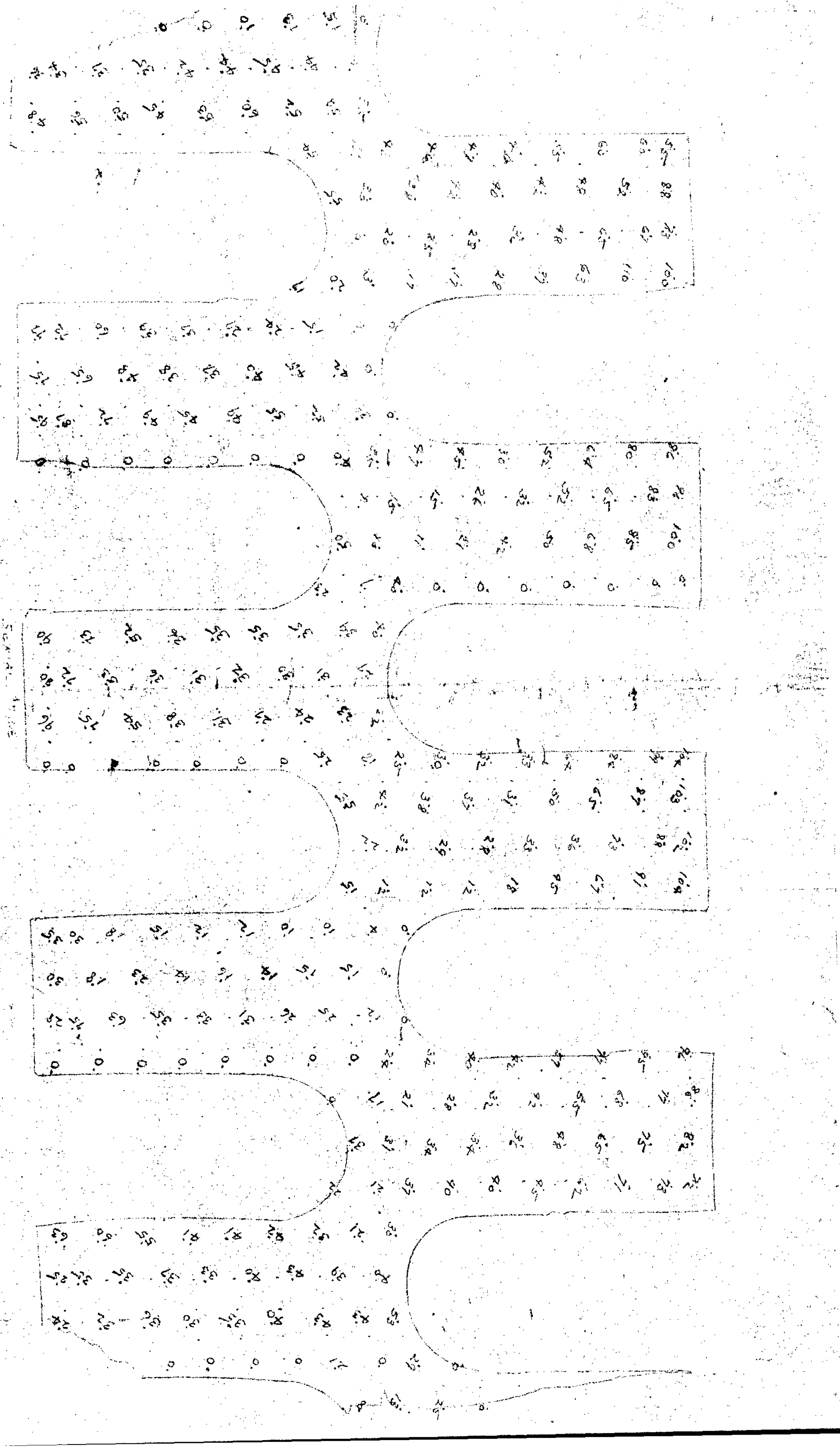


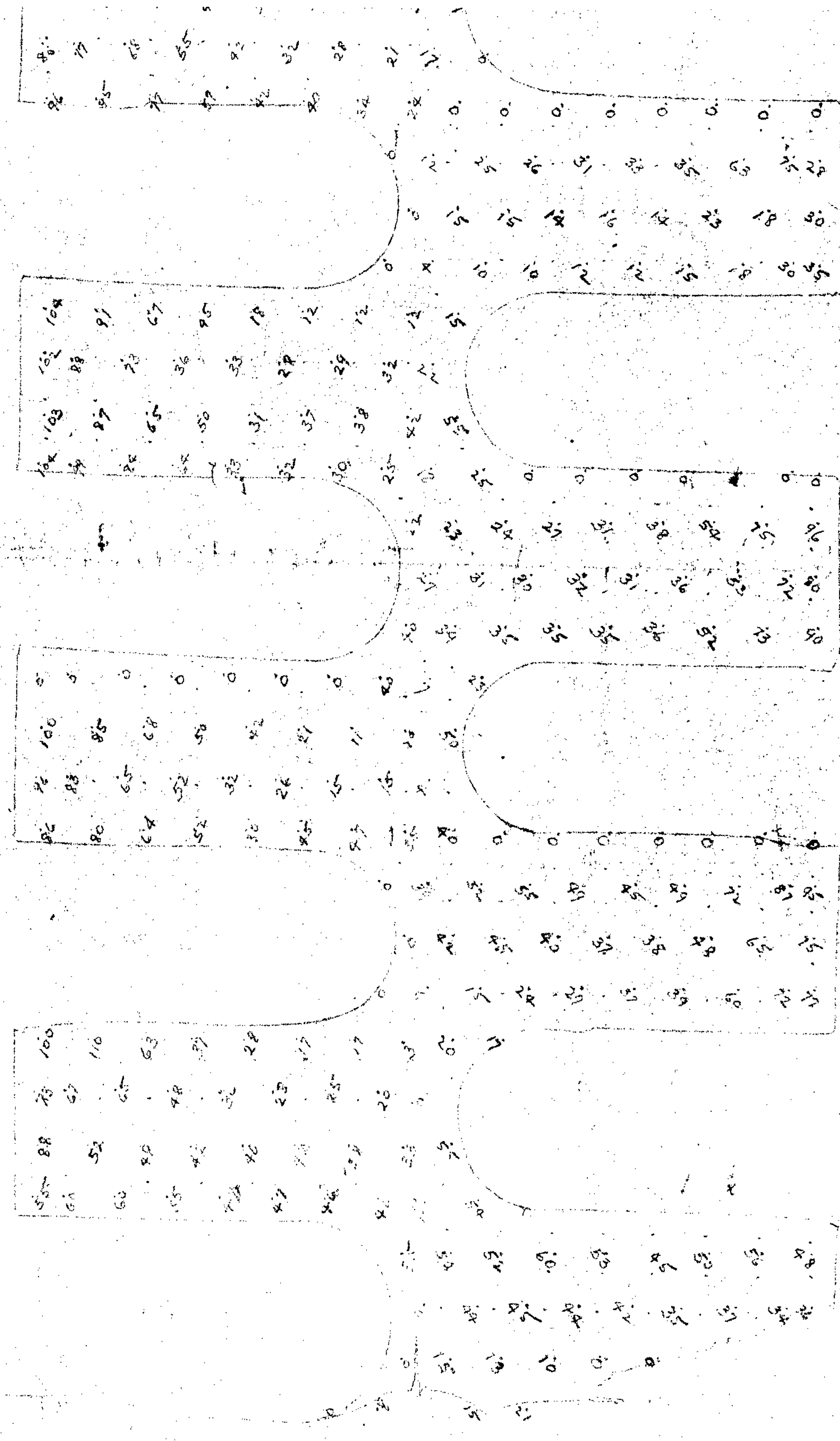


11.00-20
U.S. ROYAL TACTICAL RADIAL EXP.
20X8

M.R.	—	HE19219	10*	3500*
	—	—	—	—
	—	—	—	3.415 DEFL.

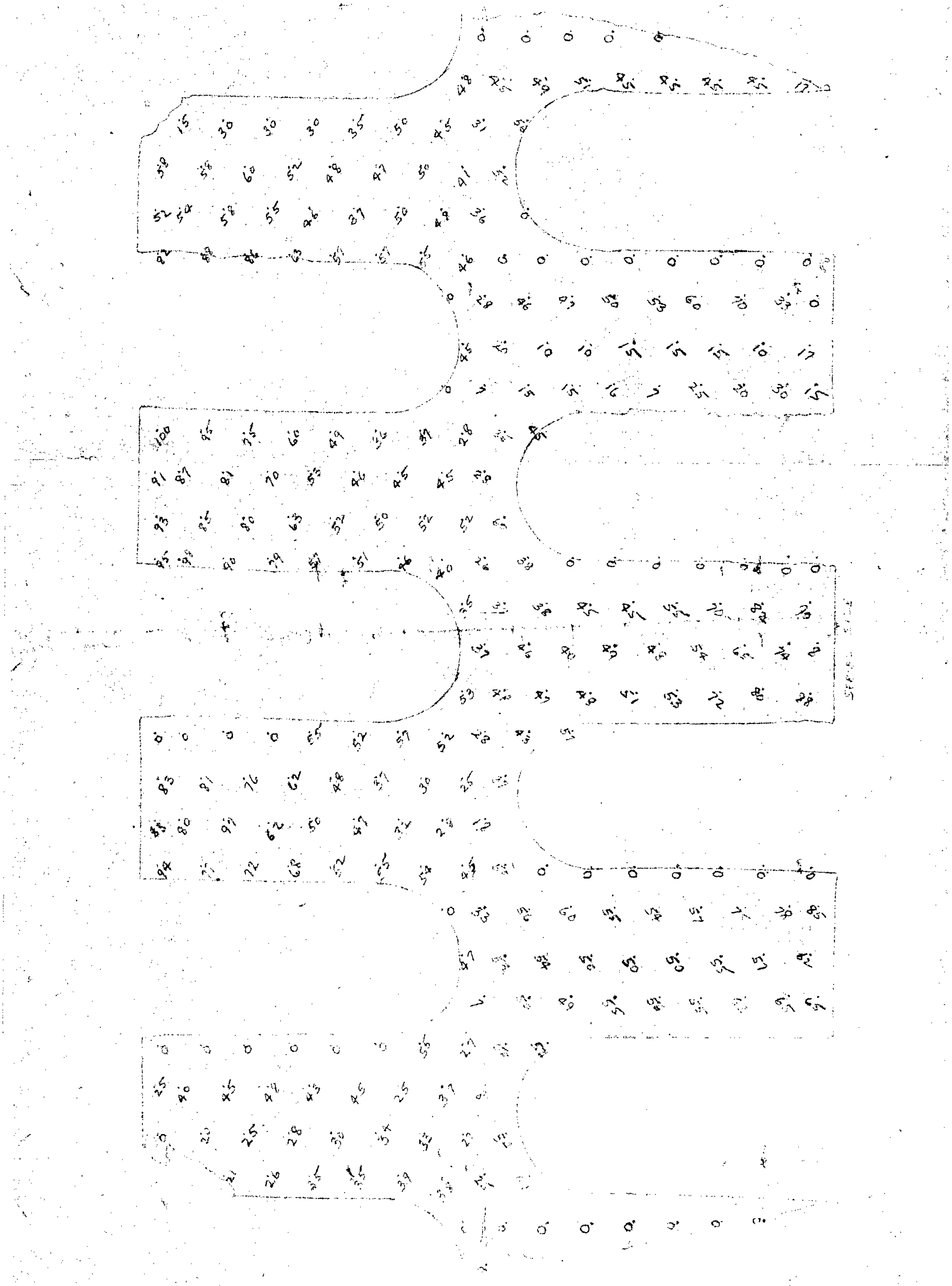
REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (6 PLY)
WIRE BELT





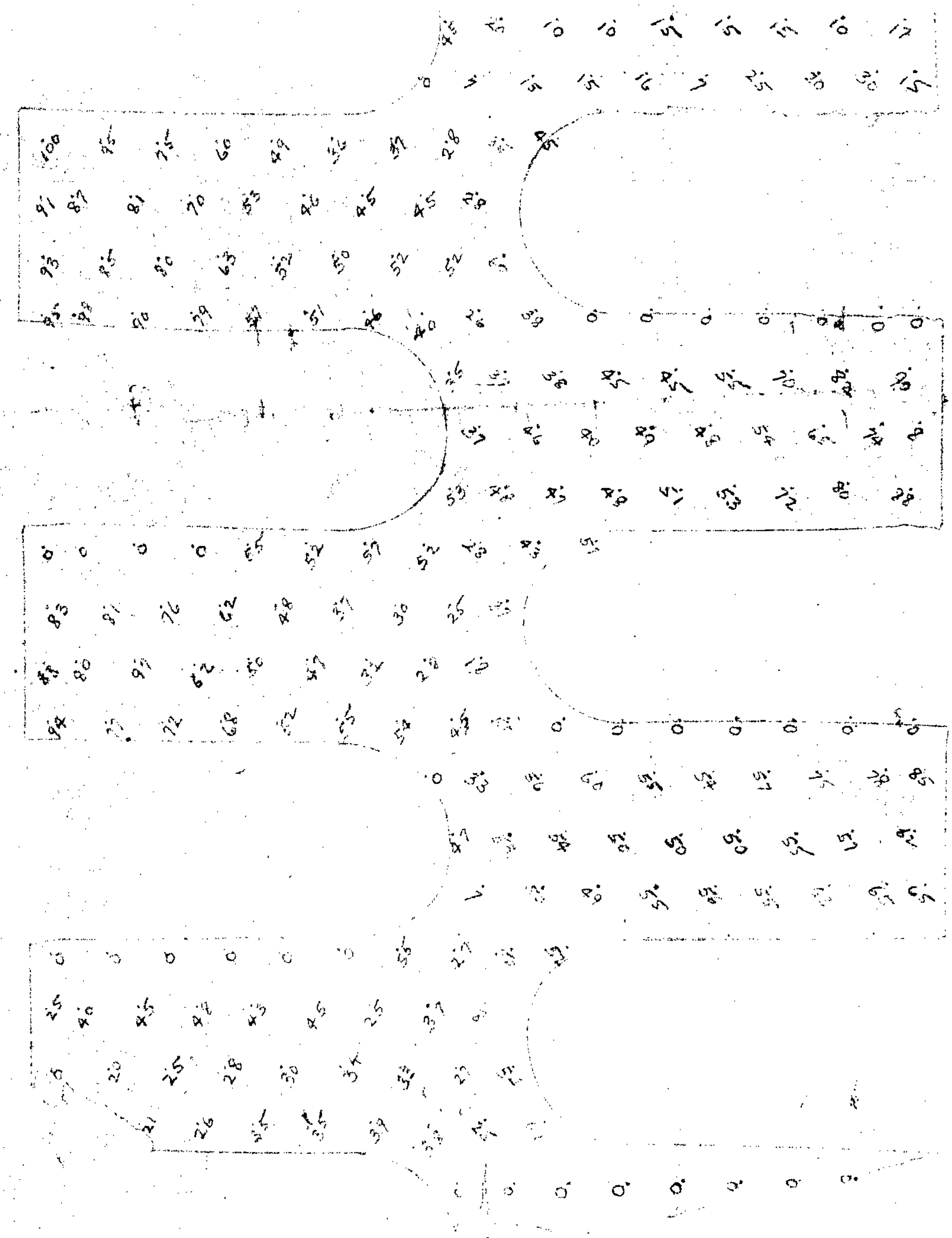
11.00-20
U.S. ROY. TACTICAL RADIAL EXP.
20X8
M.R.# 16446 HE19219 20# 3500#
– – – –
– – – 2.494 DEFL.

REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (6 PLY)
WIRE BELT



SIZE & BRAND	11.00-20 U.S. ROYAL TACTICAL RADIAL EXP.
RIM SIZE	20 X 8
MR 16446	HE19219 30# 3500#

REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (6 PLY)
WIRE BELT



11.00-20
U.S. ROYAL TACTICAL RADIAL EXP.
20 X 8
M.R. 16446 HE19219 30# 3500#
— — — —
— — — 1.954 DEFL.

REVISED CONSTRUCTION
2ND CAMP BULLIS TEST
NYLON CARCASS (6 PLY)
WIRE BELT

AD ______________ Accession No. ______________

U. S. Rubber Tire Co., Detroit, Michigan
Development of Tires for New Family of Medium Tactical Truck - L. S. Stokes - W. C. Macklem
Final Report, Phase III, December 1962
Contract No. DA-20-018-ORD-20440
Project No. 215 and 219
The tests results show the feasibility of the radial belted tire concept for military application, vehicle performance, tread wear, mobility, fuel economy, crown penetration resistance, ride and handling are improved. Power consumption, running temperature and rolling resistance are decreased.

AD ______________ Accession No. ______________

U. S. Rubber Tire Co., Detroit, Michigan
Development of Tires for New Family of Medium Tactical Truck - L. S. Stokes - W. C. Macklem
Final Report, Phase III, December 1962
Contract No. DA-20-018-ORD-20440
Project No. 215 and 219
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