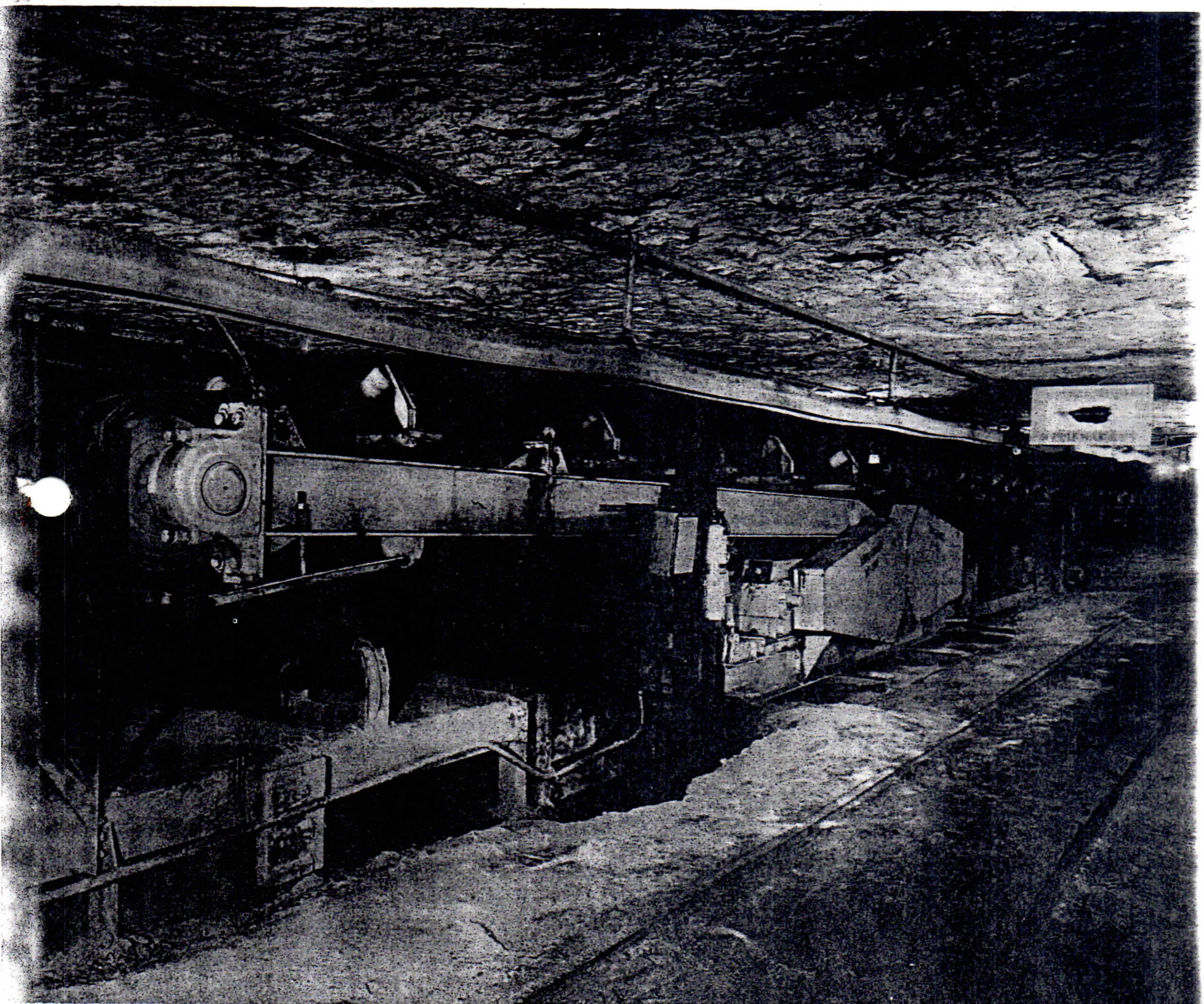
ENGINEERING A BELT CONVEYOR



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ENGINEERING A BELT CONVEYOR

PURPOSE

The purpose of this write-up is to make it possible for a salesman to select the most economical group of components making up a typical belt conveyor. No attempt has been made to set forth all of the variations that may be involved where unusual materials and/or unusual terrain are involved; such special conditions will require reference to existing handbooks or to experienced designers of belt conveyors.

ESSENTIAL INFORMATION

Length of conveyor, both actual and ultimate.

The length of the conveyor is the distance from the centerline of the head pulley to the centerline of the tail pulley. The length of an undulating conveyor can be determined from a profile taken along the centerline of the conveyor.

For an ascending or descending conveyor, the length can be calculated if the horizontal distance and either the vertical distance or the slope angle are known. Exhibit 1 of this section can be used for this purpose.

Vertical height that material is raised or lowered.

Kind of material to be handled and weight per cubic foot, both in the solid and as conveyed.

Average required capacity in tons per hour.

Peak required capacity in tons per minute or per hour.

Dimensions and weight of largest lumps.

Where and how material will be loaded on the belt. Method of loading as well as number and location of loading points.

Where and how material will be discharged.

Can conveyor be installed on grade or will all or part of the structure be above grade?

SUITABILITY OF A BELT CONVEYOR

The angle of inclination or declination will normally determine whether a belt conveyor is satisfactory for the haulage job involved. This angle can be determined from known dimensions using the chart appearing as Exhibit 1.

Different materials can be conveyed up or down maximum angles that vary widely. One of the manufacturers of conveyor belting, for example, lists the maximum permissible angles appearing in Exhibit 2. On this chart the following maximum permissible angles are given for coal:

Domestic-size anthracite	18°
Run-of-mine anthracite	16°
Run-of-mine bituminous	18°
Sized, dry bituminous	15°
Slack bituminous	22°

WIDTH AND SPEED

The belting should normally have a width equal to at least 2 times the largest dimension of the largest lumps to be handled. Material of uniform size, however, may require a belt width equal to as much as 4 times the largest dimension of the largest lumps.

The width of belting is also dependent upon the peak required capacity, the speed of the belt, and the weight of the material as follows:

1. NEMA Formula:

$$W = 13.6 \sqrt{\frac{10000P}{SU}} + 5$$

Where:

W = Width of belt in inches.
P = Peak load in tons per minute.
S = Speed of belt in feet per minute.
U = Weight of material as conveyed in pounds per cubic foot.

Or 2. Graph using above formula, for which:
See Exhibit 3.

The speed of the belt must be determined in order to apply the above formula. Normally the belt speed for handling coal can be anything up to 500 or 600 feet per minute and should be such that the conveyor has a rated peak capacity of about 2 times the anticipated required average capacity.

MOTOR HORSEPOWER REQUIRED FOR HORIZONTAL OR INCLINED CONVEYOR

The motor horsepower required to overcome friction can be determined as follows:

1. NEMA Formula:

$$\text{Friction Horsepower} = \left(0.085\,W + 3.92\,\frac{T}{S}\right)\left(\frac{L}{1000}\right)\left(\frac{S}{100}\right)$$

Where:

W = Width of belt in inches.
T = Average load in tons per hour.
S = Speed of belt in feet per minute.
L = Ultimate length of conveyor in feet.

Or 2. Nomograph using above formula, for which:
See Exhibits 4 (30"), 5 (36"), or 6 (42").

The motor horsepower required to lift the load can be determined as follows:

1. NEMA Formula:

$$\text{Gravity Horsepower} = \frac{TH}{840}$$

Where:

T = Average load in tons per hour.
H = Height in feet that the load is raised.

Or 2. Nomograph using above formula, for which:
See Exhibit 7.

The total motor horsepower required for a horizontal or inclined conveyor can then be determined by adding the above friction horsepower and gravity horsepower.

MOTOR HORSEPOWER REQUIRED FOR DECLINED CONVEYOR

The horsepower in the belt required to overcome friction of an empty belt can be determined from the NEMA formula:

$$\text{(a) Friction Horsepower for empty belt} = (0.072W)\left(\frac{L}{1000}\right)\left(\frac{S}{100}\right)$$

Where:

W = Width of belt in inches.
L = Ultimate length of conveyor in feet.
S = Speed of belt in feet per minute.

The horsepower in the belt required to overcome friction due to the load can be determined from the NEMA formula:

(b) Friction Horsepower for Load $= \left(0.033T \right) \left(\frac{L}{1000} \right)$

Where:

T = Average load in tons per hour.
L = Ultimate length of conveyor in feet.

The total friction horsepower in the belt is then determined by adding the above figures (friction horsepower for empty belt and for load, or a plus b).

The gravity horsepower in the belt due to the load which in a decline conveyor helps to drive the conveyor can be determined from the NEMA formula:

(c) Gravity Horsepower $= \frac{TH}{990}$

Where:

T = Average load in tons per hour.
H = Height in feet that the load is lowered.

If the calculated gravity horsepower in the belt (c) is less than the calculated total friction horsepower in the belt (a + b), then motor power is required to drive the conveyor and this required motor horsepower is the larger of the following:

$$\left(\frac{1}{0.85}\right)\left(a + b - \frac{2c}{3}\right)$$

Or

$$\left(\frac{1}{0.85}\right)\left(a\right)$$

On the other hand if the gravity horsepower in the belt (c) is greater than the calculated total friction horsepower in the belt (a + b), then generator power is required to resist the excess action of gravity on the load and this required motor (generator) horsepower is equal to the larger of the following:

$$\left(0.85\right)\left(c - \frac{a + b}{2}\right)$$

Or

$$\left(\frac{1}{0.85}\right)\left(a\right)$$

NOTE: If the last formula produces the larger figure, then motor power is required to drive the empty belt even though generator power is required to resist gravity on the load.

BELT TENSION

The effective tension or horsepower pull transmitted to the belt, due to the power required, can be determined from the following formula:

$$T_E = \frac{(\text{Required Motor Horsepower})\ (0.85)\ (33000)}{S}$$

Where:

T_E = Effective tension or horsepower tension in pounds.
S = Speed of belt in feet per minute.

This effective tension must be transmitted from the power source through the drive pulley or pulleys, and into the belt in order to handle the load requirements involved. This can be done using virtually any type of drive, but usually there is a most economical combination of type of drive and type of belting depending upon the belt tensions involved.

It is important, therefore, to determine the maximum belt tension, the type of drive, and the type of belting at virtually the same time.

In order to transmit the effective tension to the belt, the following formula applies:

$T_E = T_1 - T_2$

Where:

T_E = Effective tension or horsepower tension in pounds.
T_1 = Tight side tension in pounds required to transmit the required horsepower to the belt.
T_2 = Slack side tension in pounds to prevent slippage.

It has been found that T_1 can be determined from the following formula:

$T_1 = T_E + T_E K$

Where:

T_1 = Tight side tension in pounds required to transmit the required horsepower to the belt.
T_E = Effective tension or horsepower tension in pounds.
K = Drive Factor.

With following typical values for K:

Type of Drive	With Manual Belt Takeup	With Automatic Belt Takeup
Single pulley drive with lagged drive pulley and:		
210 degree wrap	0.70	0.38
180 degree wrap	0.80	0.50
Tandem pulley drive with lagged drive pulleys and:		
420 degree wrap	0.30	0.09

Using the above formulas it is possible to determine the tight side tension (T_1) and the slack side tension (T_2) due to the horsepower requirements to handle the load requirements involved.

Maximum belt tension, however, may exceed the tight side tension due to tension required to limit belt sag or due to the additional tension due to the weight of the belt on an inclined conveyor.

The belt tension required to limit sag may be determined as follows:

(1) Average experience value of 20# per inch of belt width.

Or (2) Graph for which:

See Exhibit 8

To use this sag chart, it is necessary to know the weight of load per foot of length; this can be determined from the nomograph appearing as Exhibit 9. Belt weight can then be combined with load weight to use the sag chart.

The added belt tension on an incline due to the weight of the return strand of belt can be determined by multiplying the weight per foot of the belt by the height in feet that the load is raised (H).

Maximum belt tension (T_M) can then be determined by formula; it will be equal to the larger of the following:

(1) T_1

Or (2) $T_1 + (T_W + T_{SAG} - T_2)$ which also equals $T_E + (T_W + T_{SAG})$

Where (all tension figures in pounds):

T_E = Effective tension in pounds due to power.
T_M = Maximum tension.
T_1 = Tight side tension.
T_2 = Slack side tension to prevent slippage.
T_W = Tension due to weight of return belt.
T_{SAG} = Tension required to limit sag.

It then becomes possible to compare various belt and drive combinations based upon the maximum belt tension involved in each different setup.

PULLEY DIAMETER

Pulleys should generally be as large as possible to obtain long life from the belting. In underground applications, however, it is seldom possible to use pulleys as large as those recommended by the manufacturers of belting.

The following minimum pulley sizes are commonly used underground in coal mines:

Belting	High Tension Pulleys (Head, Drive, Etc.)	Low Tension Pulleys (Tail, Snub, Etc.)
Woven carcass belt, about 5/16" thick	16"	10"
Ply-type cotton-nylon carcass:		
4 Ply, 28 - 32 - 36 Oz.	16"	10"
4 Ply, 42 - 48 Oz.	20"	12"
5 Ply, 28 - 32 - 36 Oz.	20"	12"
5 Ply, 42 - 48 Oz.	24"	14"

IDLER SPACING

Carrying idlers should be close enough together so that the load will not rise and fall too much due to excessive sag as it moves along the conveyor. Material such as coal weighing about 50 pounds per cubic foot can normally be conveyed with carrying idlers on 5' and 6' centers, since only about 20 pounds of load plus perhaps 5 to 10 pounds for belt weight apply for every foot of length on the carrying idlers. Frequent lumps weighing appreciably more than these average figures make it necessary to use 4' or even closer spacing.

Return idlers serve to keep the return belt clear of the bottom, so they can sometimes be spaced 20' or 24' apart depending upon the condition of the bottom and the height of the return belt.

At loading points the carrying idlers can be mounted close together, while at bend points return idlers can be closer together.

BELT TAKE-UP

A belt takeup is necessary to provide sufficient belt tension at all times (the belt may stretch or shrink) to prevent slippage at the drive and to maintain sag at a minimum.

The common method of taking up the belt is by manually pulling the tail section with jacks; with this method subsequent adjustment may be required as conditions change.

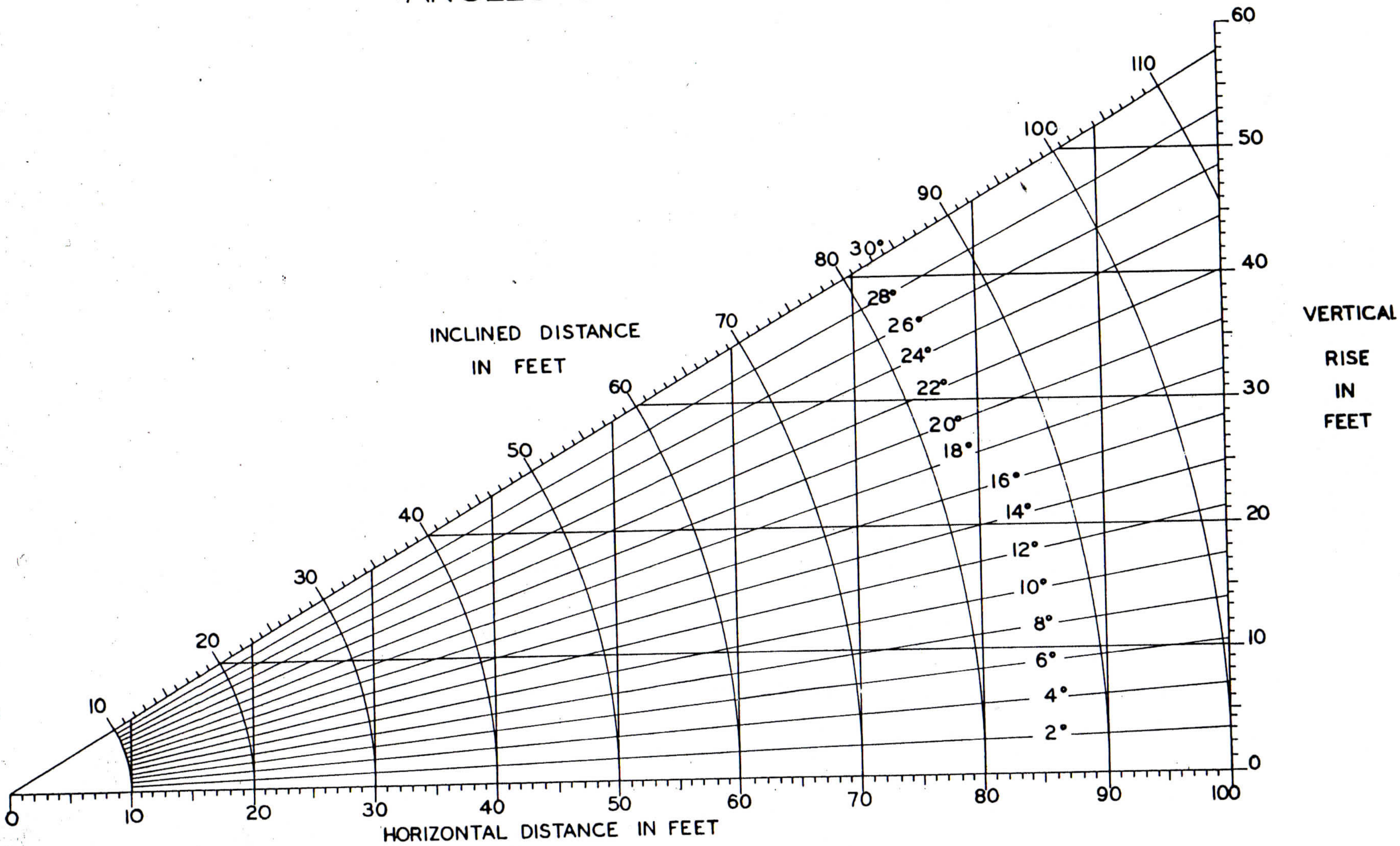
A more desirable method of belt takeup would be an automatic takeup that would maintain a predetermined tension in the belt; such a takeup might be gravity operated or power operated. Frequently such a belt takeup may also serve as a means for storing a small amount of extra belt.

BRAKES AND HOLDBACKS

A brake may be required on a decline conveyor to prevent the load from running away in the event of power failure, etc., providing calculations show that generator power is required to resist the excess action of gravity on the load. The torque of the brake must be at least equal to the gravity horsepower less the friction horsepower.

A holdback or brake may be required on an incline conveyor to prevent the load from running backward in the event of power failure, etc. The torque of the holdback or brake must also be at least equal to the gravity horsepower less the friction horsepower.

DIMENSIONS FOR VARIOUS ANGLES OF INCLINE



MAXIMUM PERMISSIBLE ANGLES OF CONVEYOR INCLINATION

	MATERIAL	ANGLE
Alumina:	sized or briquette	10°
Ashes:	dry	25°
	wet	30°
Bauxitee:	ground dried	23°
	R. O. M.	17°
Briquettes:		10°
Cement:	clinker	20°
	finished	23°
	loose Portland	20°
Clay:	dry fine	22°
	dry lump	16°
	wet lump	18°
Coal:	domestic-size anthracite	18°
	R. O. M. anthracite	16°
	R. O. M. bituminous	18°
	sized dry bituminous	15°
	slack bituminous	22°
Coke:	breeze	20°
	run of oven	18°
	screened	18°
Concrete:	2 in. lump	26°
	4 in. lump	20°
	6 in. lump	12°
Copper:	primary crushed ore	17°
	secondary crushed and finer ore	20°
Earth:	dry loose	20°
	moist loose	22°
Feldspar:	dry fine	17°
Glass Batch:		21°
Grain:		15°
Gravel:	bank run	19°
	screened	15°

	MATERIAL	ANGLE
Gypsum:	powered	23°
	lump	16°
Iron:	soft ore	21°
Lime:	powdered	23°
Limestone:	powdered	23°
	crushed	19°
Manganese:		24°
Molybdenite:	powdered	23°
Ore:	fine crushed	22°
	hard primary crushed	17°
	hard secondary crushed and finer	20°
	mixed lumps and fines	20°
	sized	18°
Pebbles:	(including Florida Phosphate Rock)	14°
Phosphate:	ground super	27°
Rock:	fine crushed	22°
	mixed lumps and fines	20°
	sized	18°
Salt:		20°
Sand:	bank run	20°
	dry	15°
	tempered	24°
Slag:	furnace fines	16°
Sulphur:	mixed lump and fines	18°
	powdered	23°
Taconite:	primary crushed	17°
	secondary crushed and finer	20°
Wood Chips:		27°
Zinc:	roasted granular ore	25°

CAPACITY OF BELT CONVEYORS

I. CROSS–SECTIONAL AREA OF LOAD AND TONNAGE CAPACITY–NORMAL MATERIALS

The volumetric capacity of a troughed conveyor belt is determined by the cross-sectional area of the load that can be piled onto the belt without excessive spillage either at the loading point or subsequently due to the small undulations of the belt in passing over idlers. This cross-sectional area is affected by the screen analysis of the material, its moisture content, and the shape of the particles, all of which influence the slope at which the material will stand.

Since it is usually impractical to evaluate these factors specifically enough to predict their effect on the cross-sectional area of the load, capacity tables are made sufficiently conservative that any ordinary combination of the above conditions can be accepted.

Tonnage capacities shown in Table 5-A for normal bulk material on three-roll, equal-length idlers are based on a cross-sectional load area such as that indicated in Figure 5-1. This, of course, does not presume that load shapes are always as depicted here, as they will vary with different materials, dampness, lump size, etc. The load shape is influenced initially by the loading chute and skirt boards. The design of these parts is to some degree controlled by what is expected to happen to the shape of the load after it leaves the skirt-board confinement. However, tonnage capacities derived from this cross section

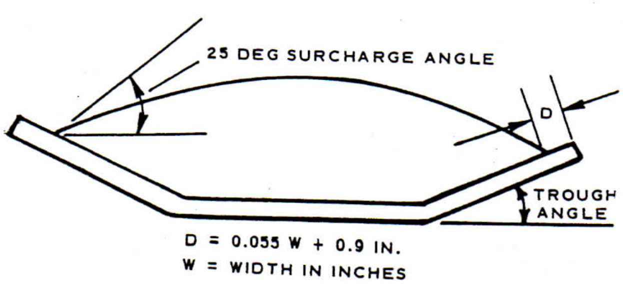


Figure 5-1 - Typical Load Cross Section of Normal Bulk Materials on Three Equal Length Rolls

have been found attainable with most bulk materials and, with favorable combinations of material size and moisture content, loading rates up to 20 percent in excess of these values can be achieved. Cross-sectional load areas derived from the Figure 5-1 configuration are shown in Table 5-B.

To obtain capacities indicated by this method, some normal precautions are required:

1. Free-flowing dry materials or slumping wet mixtures must be considered as special problems. Capacities are determined by methods given later.
2. Lump size limitations tabulated herein must be observed.
3. Skirt board location at the loading point must be properly designed to give the most advantageous initial load shape.
4. The belt must be trained to enter the loading point centrally.
5. The idler spacing must be suitably related to belt tension to minimize belt sag. This, in turn, will limit load settling and possible spillage.
6. The delivering chute must be pitched (by trial if necessary) to deliver material with a velocity in the direction of belt travel close to that of the belt. This will reduce turbulence and hasten the settling of the load.
7. With lumps near the limit on size, it may be necessary to place lump deflectors on the skirt boards to move inward any surface lumps lying near the edges as the load approaches the end of the skirts.
8. The belt capacity thus determined must be considered against peak, not average, requirements.

TABLE 5-A – NORMAL BULK MATERIAL CAPACITY* OF TROUGHED CONVEYOR BELTS

Material	Idler roll angle (deg)	Material density lb/cu ft	Width (in.) 14	16	18	20	24	30	36	42	48	54	60
Most bulk materials Surcharge angle: 25 deg Edge distance of load: (0.055W + 0.9) in.	20	30	10	13	17	22	33	53	78	108	144	183	228
		50	16	22	28	36	55	88	130	180	240	305	380
		75	24	32	42	54	83	132	195	270	360	458	570
		100	32	43	56	72	110	176	260	360	480	610	760
		125	40	54	70	90	138	220	325	450	600	762	950
		150	48	65	84	108	165	264	390	540	720	915	1140
	35	30	12	16	20	26	40	65	95	132	176	224	278
		50	19	27	34	44	67	108	159	220	293	373	464
		75	29	40	51	66	100	161	238	329	439	558	696
		100	39	53	68	88	134	215	317	439	585	745	928
		125	49	66	85	110	168	269	396	549	732	932	1160
		150	59	80	102	132	201	322	476	660	878	1118	1392
	45	30	13	17	22	28	43	69	101	141	187	238	296
		50	21	28	37	47	72	115	169	234	312	397	494
		75	32	42	55	71	107	172	244	352	468	595	741
		100	42	56	73	94	143	229	338	468	624	793	988
		125	53	70	91	117	179	286	422	586	780	990	1235
		150	63	84	110	141	214	344	507	702	936	1190	1482
Maximum recommended lump size+	Uniform size		2	3	4	4	5	6	7	8	10	11	12
	Mixed with fines		4	5	6	6	8	10	12	14	16	20	24

Material	Idler roll angle (deg)	Material density lb/cu ft	Width (in.) 66	72	78	84	90	96	102	108	114	120
Most bulk materials Surcharge angle: 25 deg Edge distance of load: (0.055W + 0.9) in.	20	30	279	335	396	462	533	608	688	774	864	959
		50	465	557	661	770	887	1013	1147	1289	1440	1599
		75	697	837	992	1153	1330	1519	1722	1933	2160	2400
		100	930	1115	1321	1539	1774	2026	2294	2579	2880	3198
		125	1163	1395	1653	1923	2217	2532	2869	3222	3600	3999
		150	1395	1672	1982	2309	2661	3039	3441	3868	4320	4797
	35	30	341	408	485	565	652	745	842	948	1058	1172
		50	568	680	809	943	1086	1240	1404	1580	1763	1958
		75	852	1020	1214	1412	1628	1860	2105	2370	2645	2935
		100	1135	1360	1618	1885	2172	2480	2808	3160	3526	3915
		125	1420	1700	2023	2355	2714	3100	3509	3950	4408	4893
		150	1703	2040	2427	2828	3258	3720	4212	4740	5289	5873
	45	30	363	435	514	599	692	789	893	1003	1121	1242
		50	605	725	857	999	1151	1314	1488	1672	1868	2073
		75	908	1088	1287	1499	1725	1973	2240	2510	2800	3110
		100	1210	1450	1715	1998	2302	2628	2976	3344	3735	4146
		125	1512	1810	2144	2498	2876	3287	3738	4182	4668	5183
		150	1815	2175	2572	2997	3453	3942	4464	5016	5603	6219
Maximum recommended lump size+	Uniform size		12	12	12	12	12	12	12	12	12	12
	Mixed with fines		24	24	24	24	24	24	24	24	24	24

*In tons per hour (2000-lb tons) at 100 fpm belt speed (three equal-length idler rolls).
+Larger lumps often can be considered with special impact constructions and loading point designs.

NOTE: Obtain capacities of other material densities and belt speeds by direct interpolation. Example - Find the capacity of a 42-in. belt carrying 90 lb bulk material at 500 fpm on 35-deg, equal-roll idlers:

$$\text{Capacity} = (439) \times \left(\frac{90}{100}\right) \times \left(\frac{500}{100}\right) = 1975 \text{ tph}$$

(Table 5-A 100 lb material) x (Material conversion) x (Speed conversion)

GRAPH FOR DETERMINING

WIDTH OF TROUGHED BELT CONVEYORS

FOR MAT'L WEIGHING 30 POUNDS PER CU. FT. FROM THE NEMA FORMULA

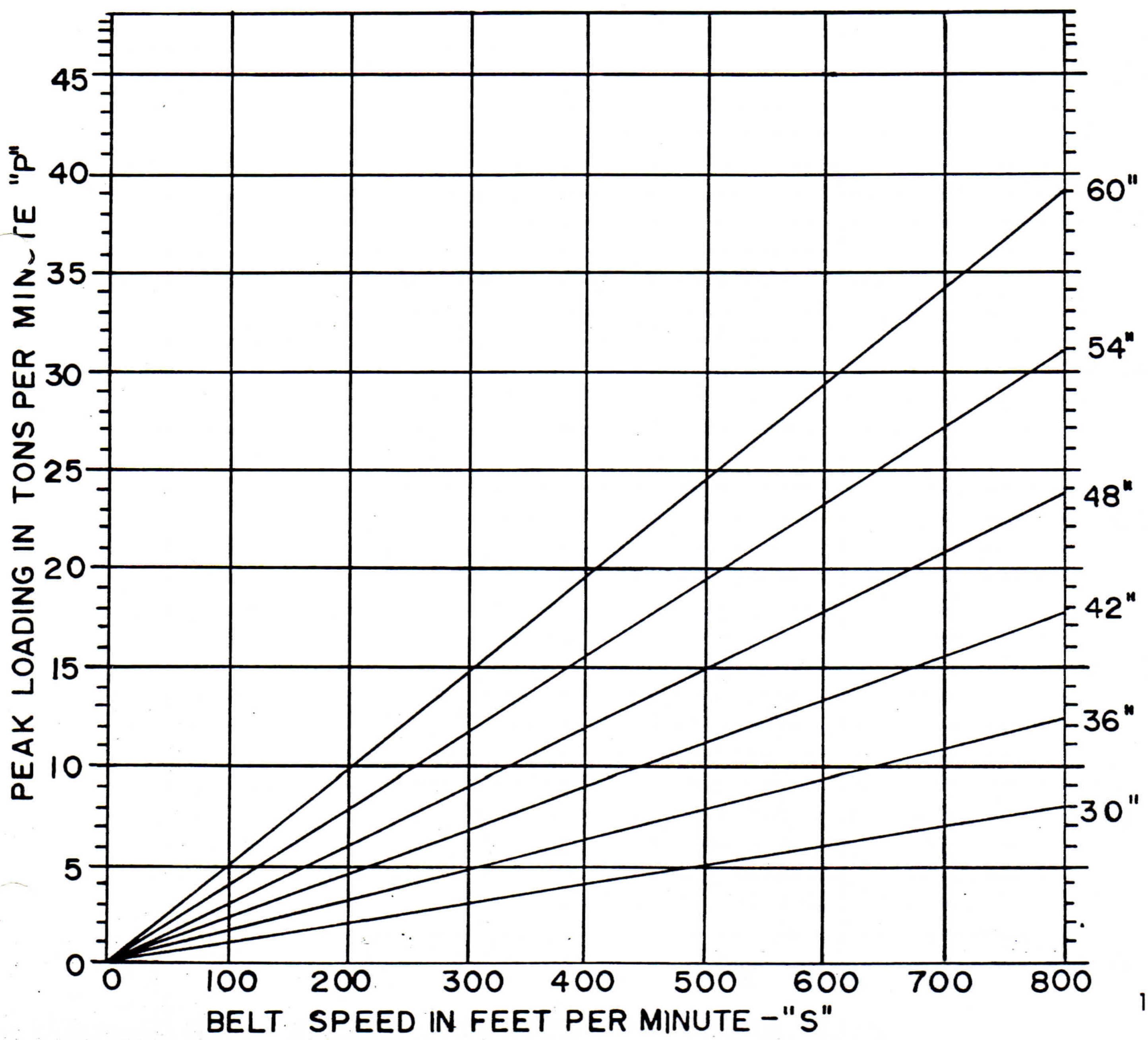
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P=PEAK LOADING IN TONS PER MINUTE

W=WIDTH OF BELT IN INCHES

S=SPEED OF BELT IN FEET PER MINUTE

U=WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT (30 FOR THIS CHART)



GRAPH FOR DETERMINING

WIDTH OF TROUGHED BELT CONVEYORS

FOR COAL WEIGHING 50 POUNDS PER CU. FT. FROM THE NEMA FORMULA

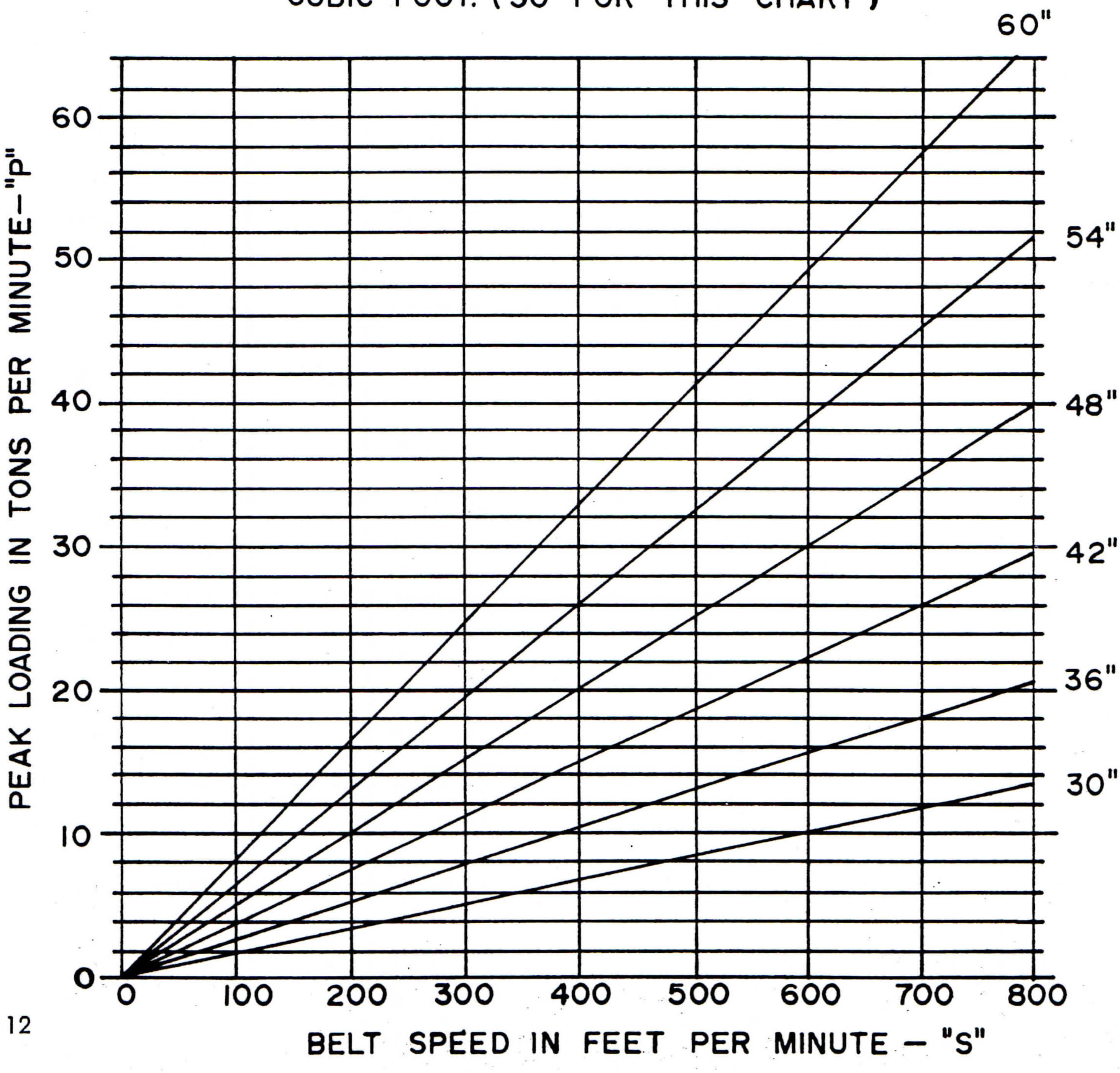
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P = PEAK LOADING IN TONS PER MINUTE

W = WIDTH OF BELT IN INCHES

S = SPEED OF BELT IN FEET PER MINUTE

U = WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT. (50 FOR THIS CHART)



GRAPH FOR DETERMINING

WIDTH OF TROUGHED BELT CONVEYORS

FOR MAT'L WEIGHING 75 POUNDS PER CU. FT. FROM THE NEMA FORMULA

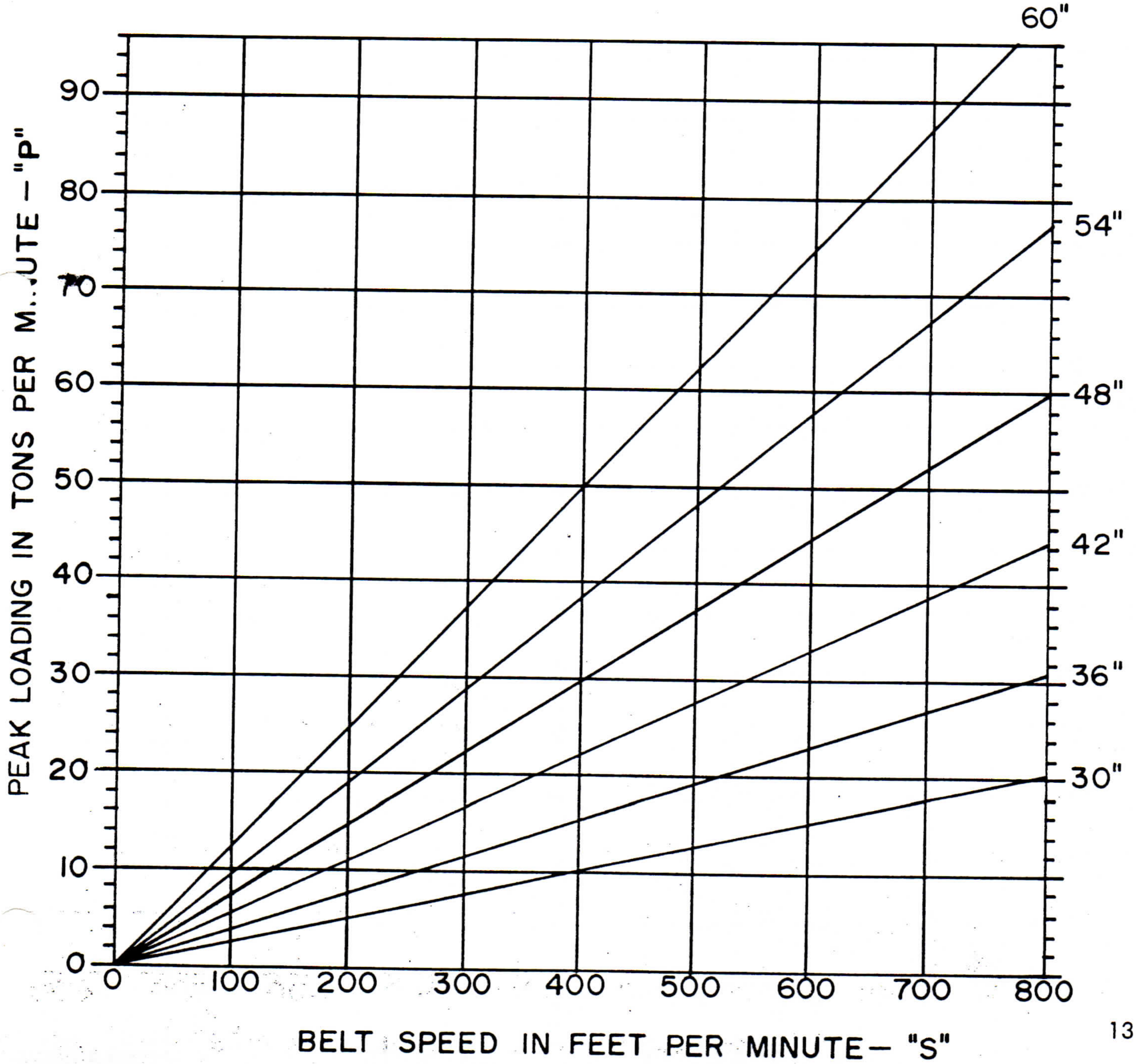
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P = PEAK LOADING IN TONS PER MINUTE

W = WIDTH OF BELT IN INCHES

S = SPEED OF BELT IN FEET PER MINUTE

U = WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT. (75 FOR THIS CHART)



GRAPH FOR DETERMINING WIDTH OF TROUGHED BELT CONVEYORS FOR MAT'L WEIGHING 100 POUNDS PER CU. FT. FROM THE NEMA FORMULA

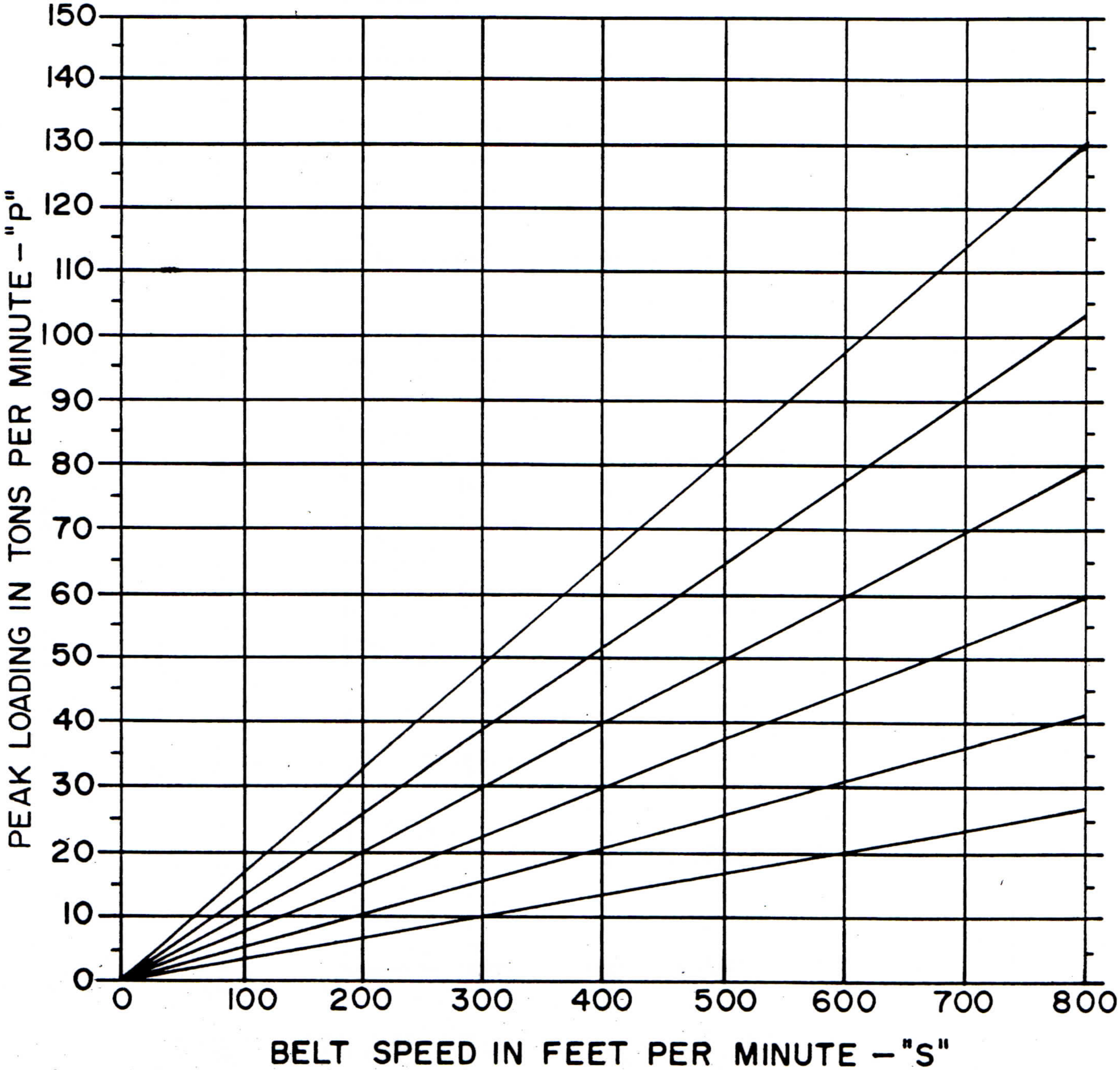
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P = PEAK LOADING IN TONS PER MINUTE.

W = WIDTH OF BELT IN INCHES.

S = SPEED OF BELT IN FEET PER MINUTE.

U = WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT. (100 FOR THIS CHART)



GRAPH FOR DETERMINING

WIDTH OF TROUGHED BELT CONVEYORS

FOR MAT'L. WEIGHING 125 POUNDS PER CU.FT. FROM THE NEMA FORMULA

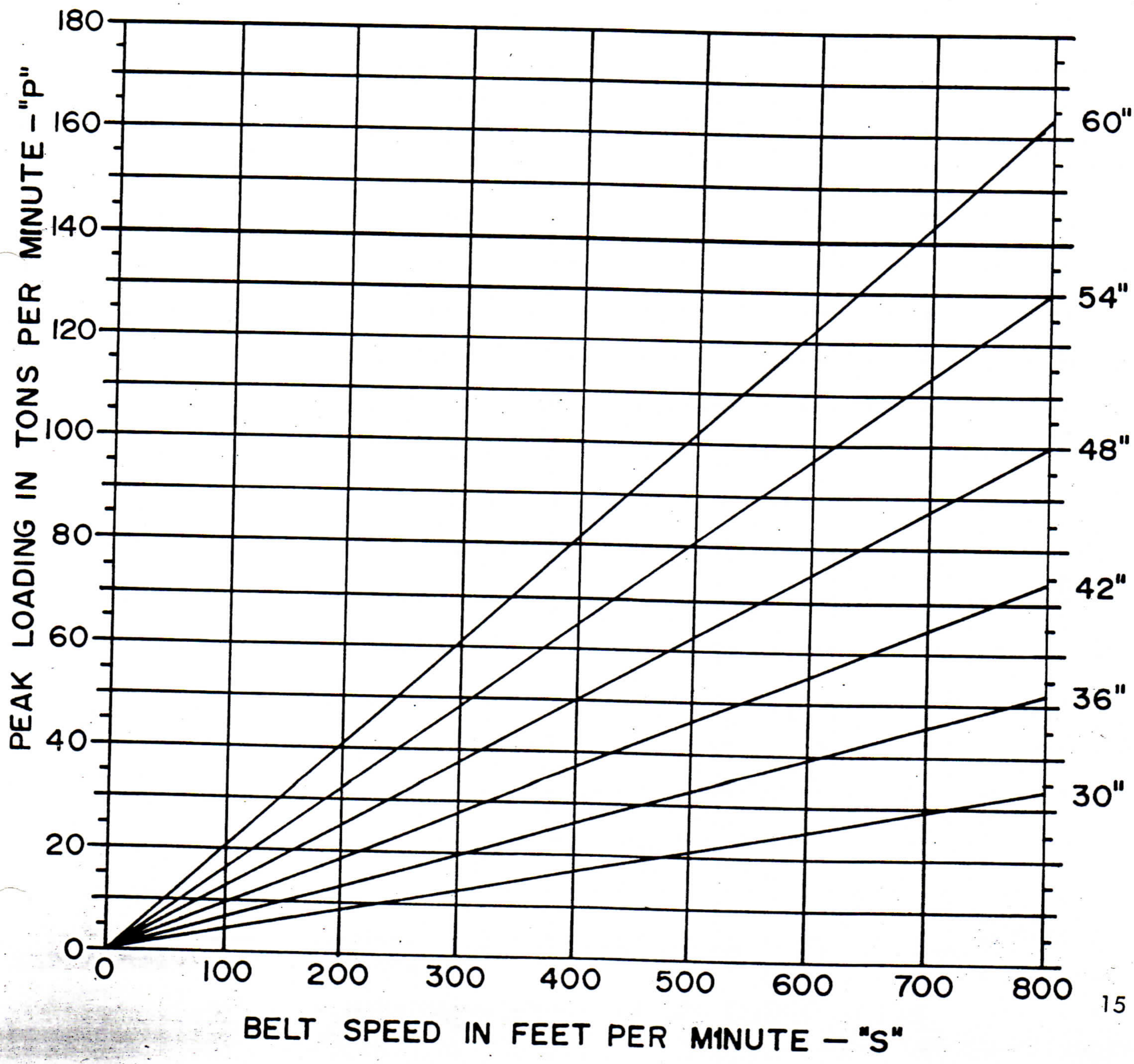
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P = PEAK LOADING IN TONS PER MINUTE.

W = WIDTH OF BELT IN INCHES.

S = SPEED OF BELT IN FEET PER MINUTE.

U = WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT. (125 FOR THIS CHART)



GRAPH FOR DETERMINING

WIDTH OF TROUGHED BELT CONVEYORS
FOR MAT'L WEIGHING 150 POUNDS PER CU. FT. FROM THE NEMA FORMULA

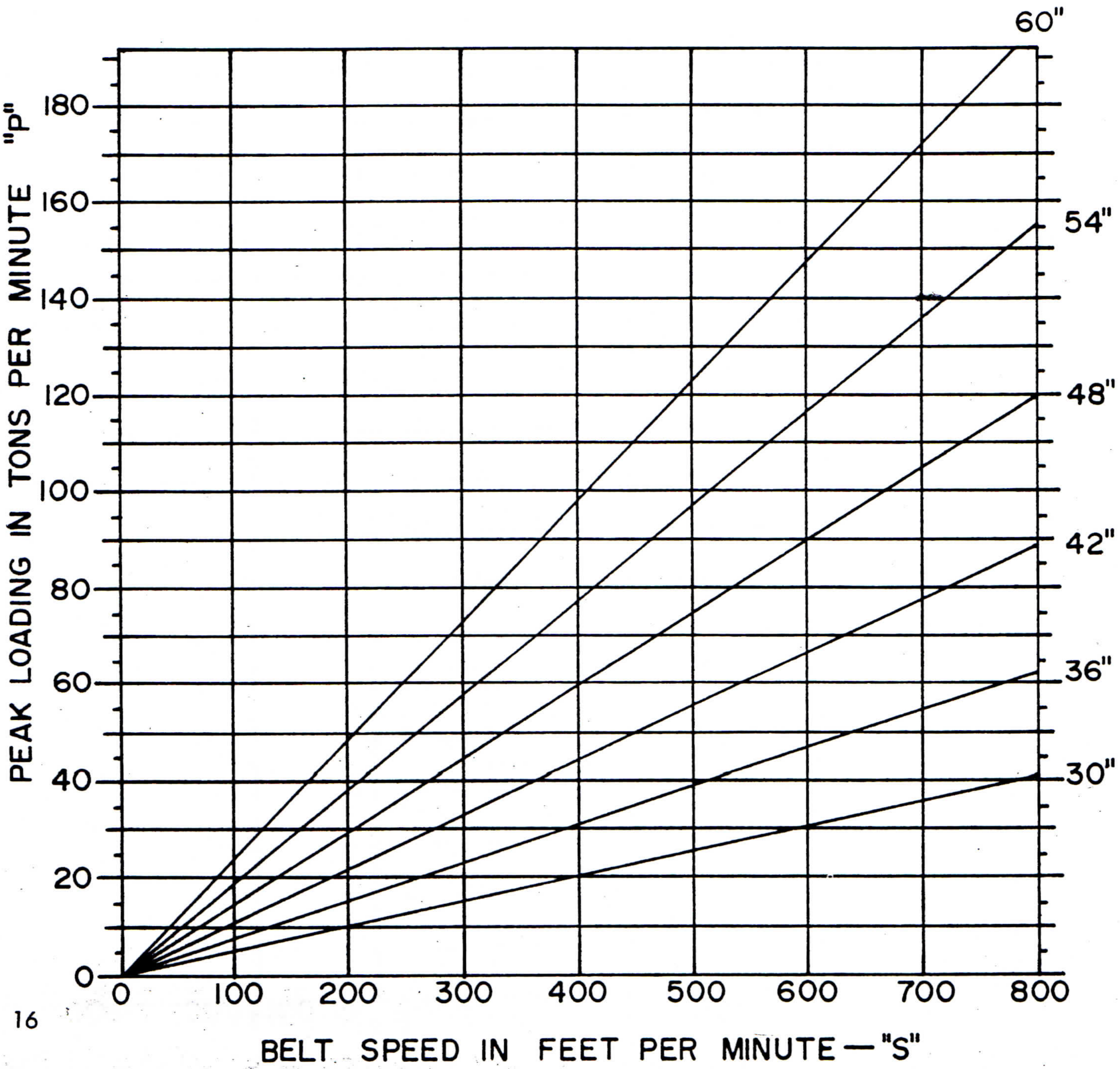
$$W = 13.6\sqrt{\frac{10000P}{SU}} + 5$$

P = PEAK LOADING IN TONS PER MINUTE.

W = WIDTH OF BELT IN INCHES.

S = SPEED OF BELT IN FEET PER MINUTE

U = WEIGHT OF MATERIAL IN POUNDS PER CUBIC FOOT. (150 FOR THIS CHART)



NOMOGRAPH FOR DETERMINING
TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH
FOR
30" LEVEL BELT CONVEYOR
FROM THE NEMA FORMULA

$$HP\,(FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

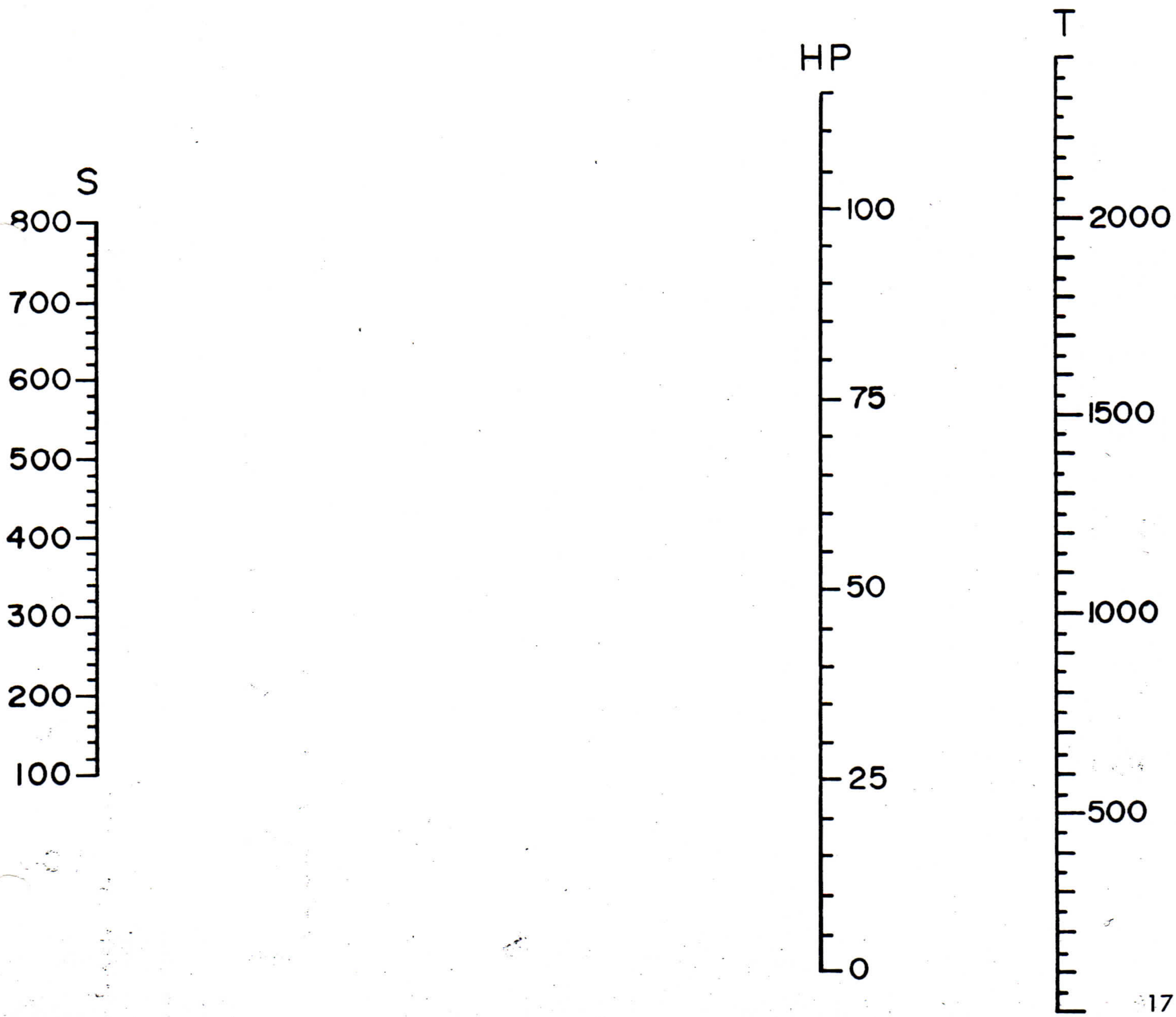
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES.
(30" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH.
(1000 FOR THIS CHART)



NOMOGRAPH FOR DETERMINING

TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH

FOR

36" LEVEL BELT CONVEYOR

FROM THE NEMA FORMULA

$$HP\,(FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

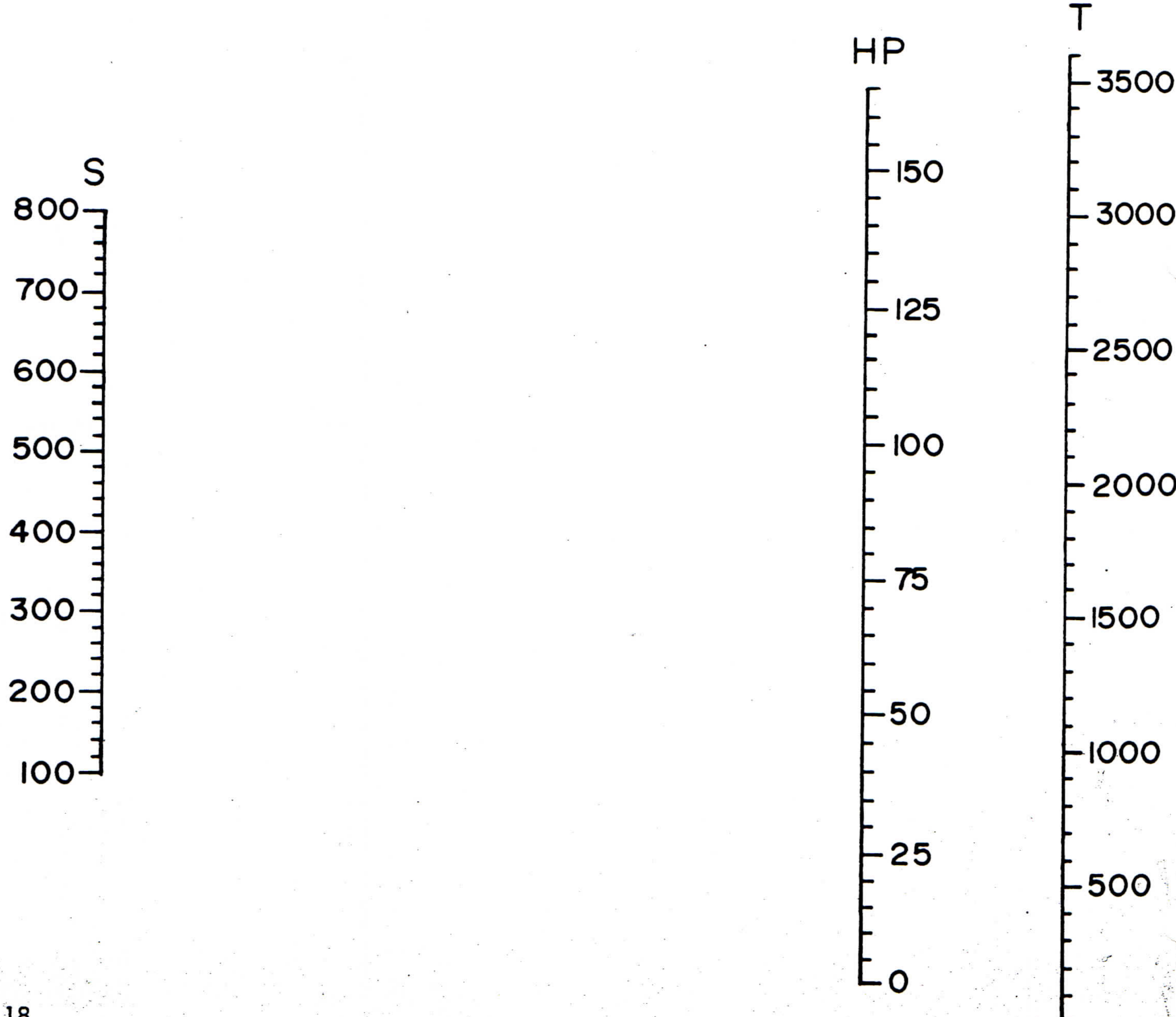
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES. (36" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH. (1000 FOR THIS CHART)



NOMOGRAPH FOR DETERMINING
TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH
FOR
42" LEVEL BELT CONVEYOR
FROM THE NEMA FORMULA

$$HP\ (FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

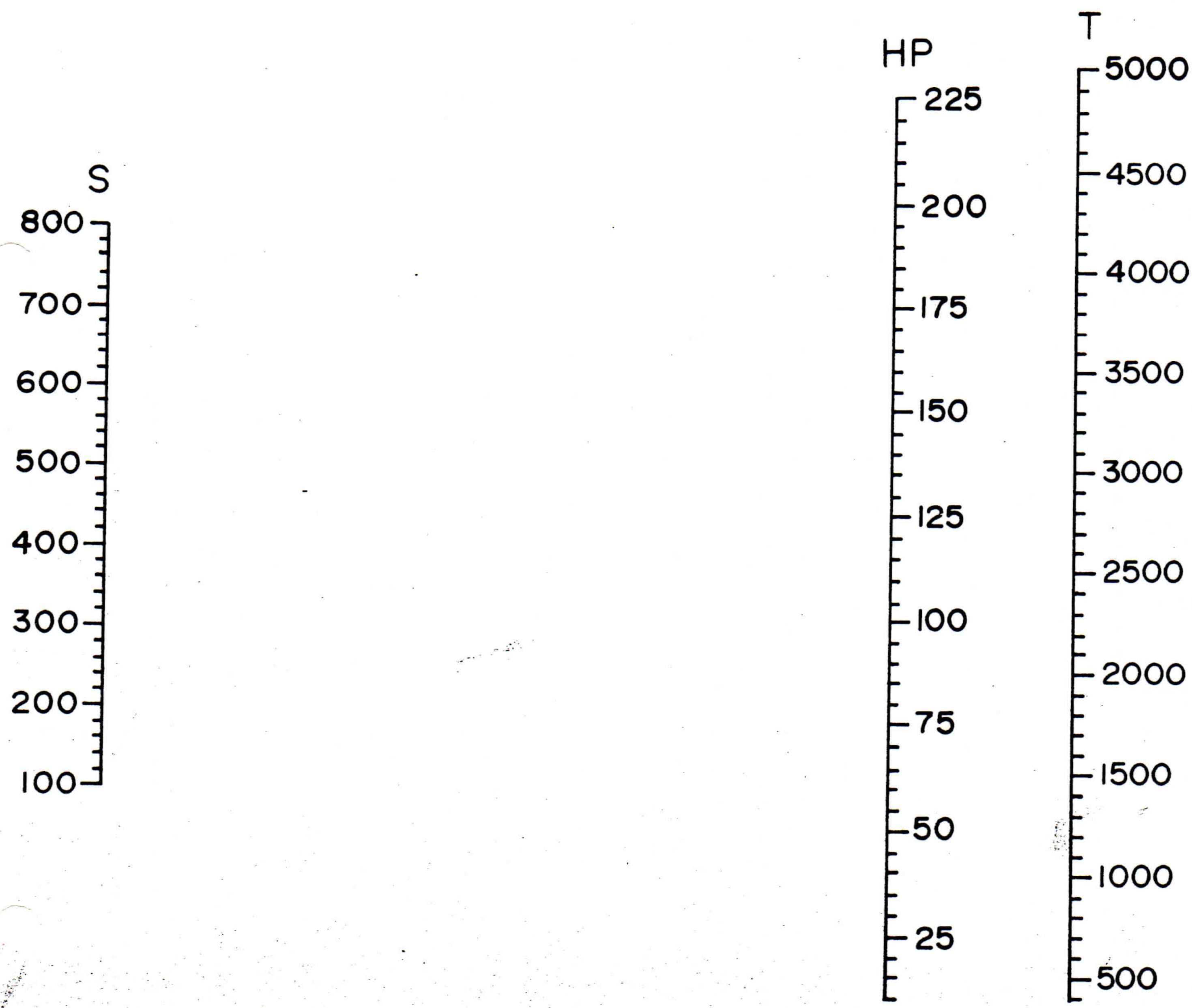
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES. (42" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH (1000' FOR THIS CHART)



NOMOGRAPH FOR DETERMINING
TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH
FOR
48" LEVEL BELT CONVEYOR
FROM THE NEMA FORMULA

$$HP\,(FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

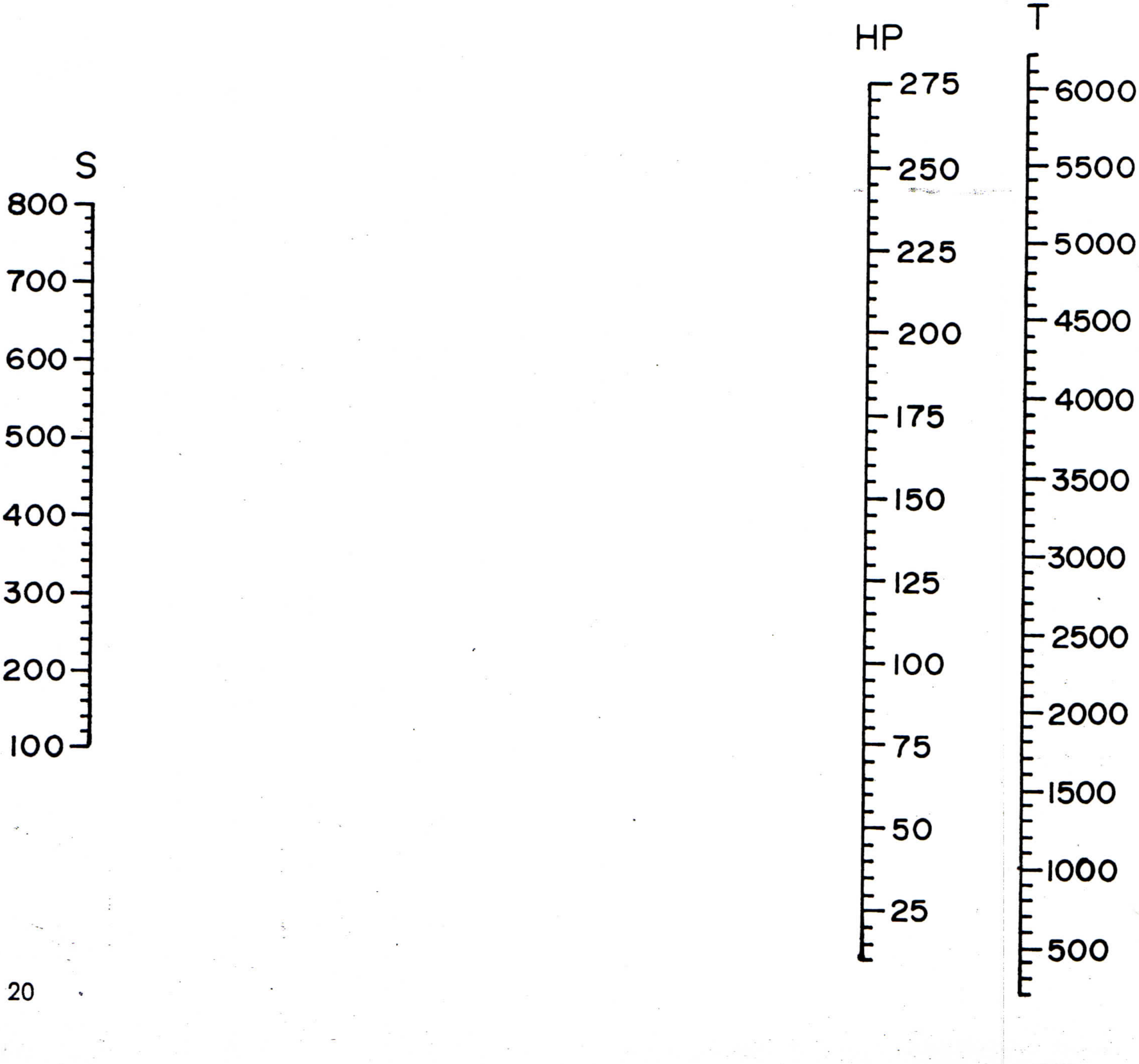
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES.
(48" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH.
(1000' FOR THIS CHART)



NOMOGRAPH FOR DETERMINING

TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH

FOR

54" LEVEL BELT CONVEYOR

FROM THE NEMA FORMULA

$$HP\,(FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

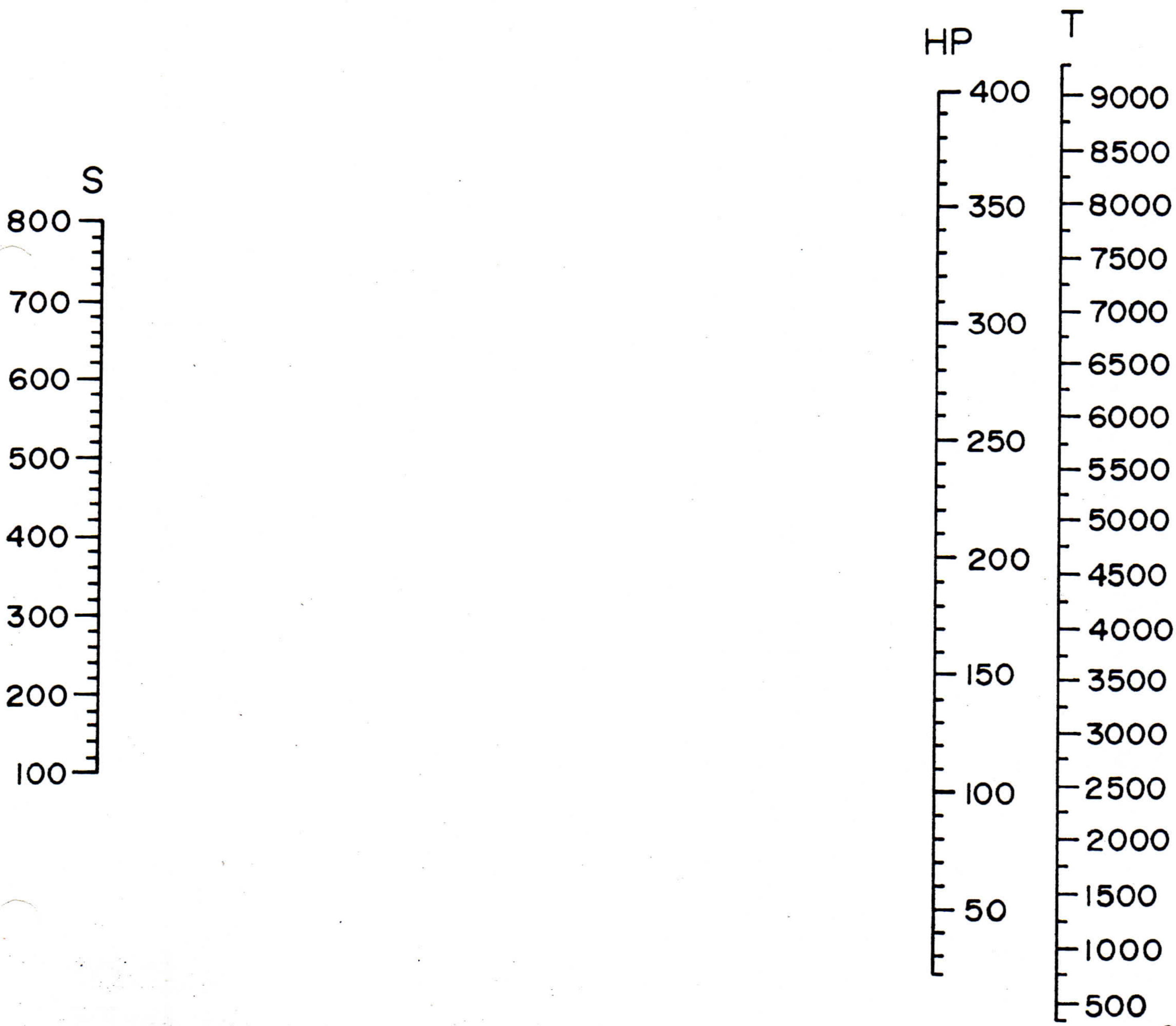
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES.
(54" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH.
(1000' FOR THIS CHART)



NOMOGRAPH FOR DETERMINING

TOTAL HORSEPOWER AT MOTOR SHAFT PER 1000' OF CONVEYOR LENGTH

FOR

60" LEVEL BELT CONVEYOR

FROM THE NEMA FORMULA

$$HP(FRICTION) = \left[0.085W + \frac{3.92T}{S}\right]\left[\frac{L}{1000}\right]\left[\frac{S}{100}\right]$$

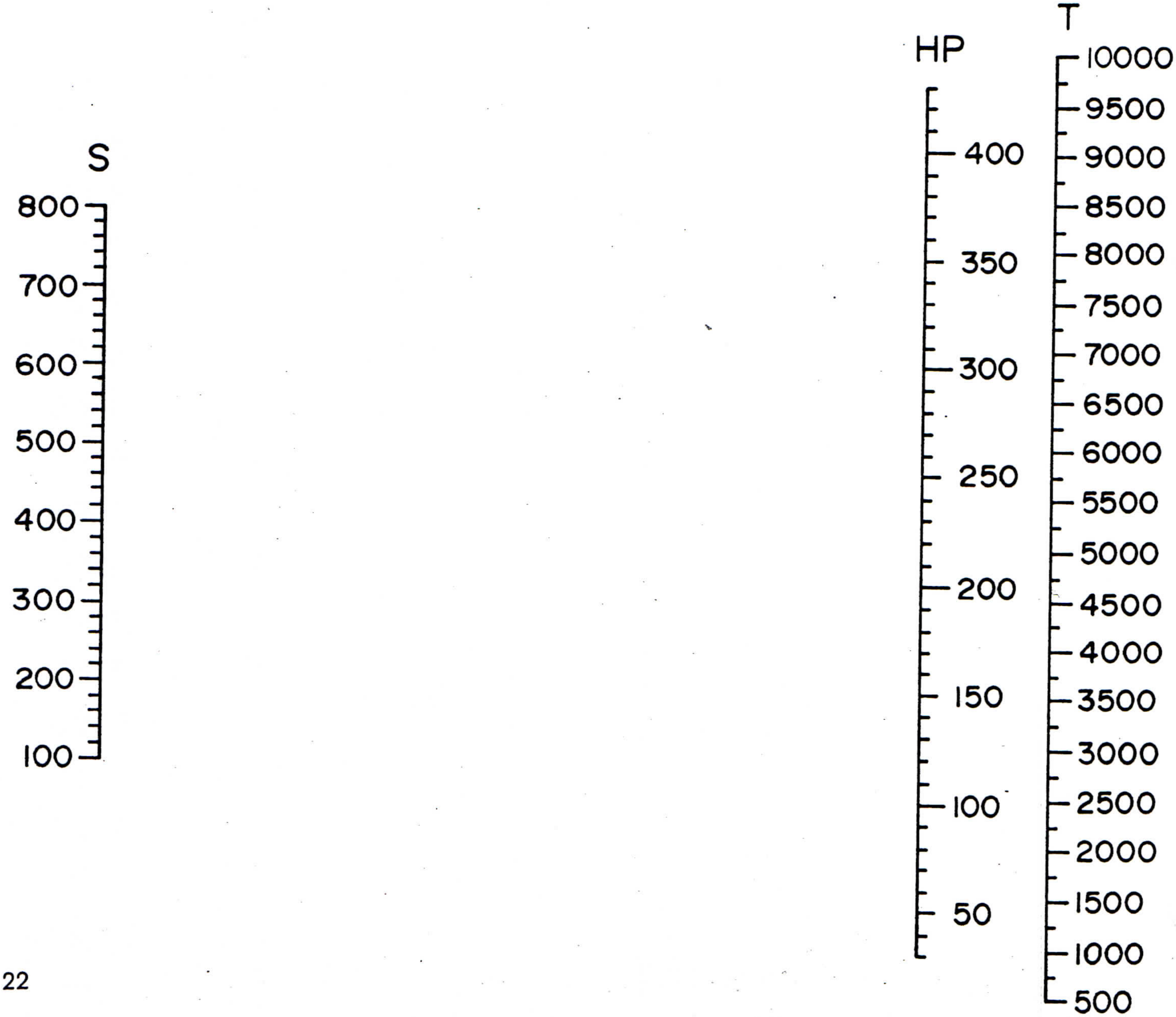
HP = HORSEPOWER PER 1000' CONVEYOR.

W = WIDTH OF BELT IN INCHES.
(60" FOR THIS CHART)

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT. (FPM)

L = CONVEYOR LENGTH.
(1000' FOR THIS CHART)



NOMOGRAPH FOR DETERMINING

TOTAL HORSEPOWER AT MOTOR SHAFT

TO

RAISE LOAD

FOR

INCLINED BELT CONVEYORS

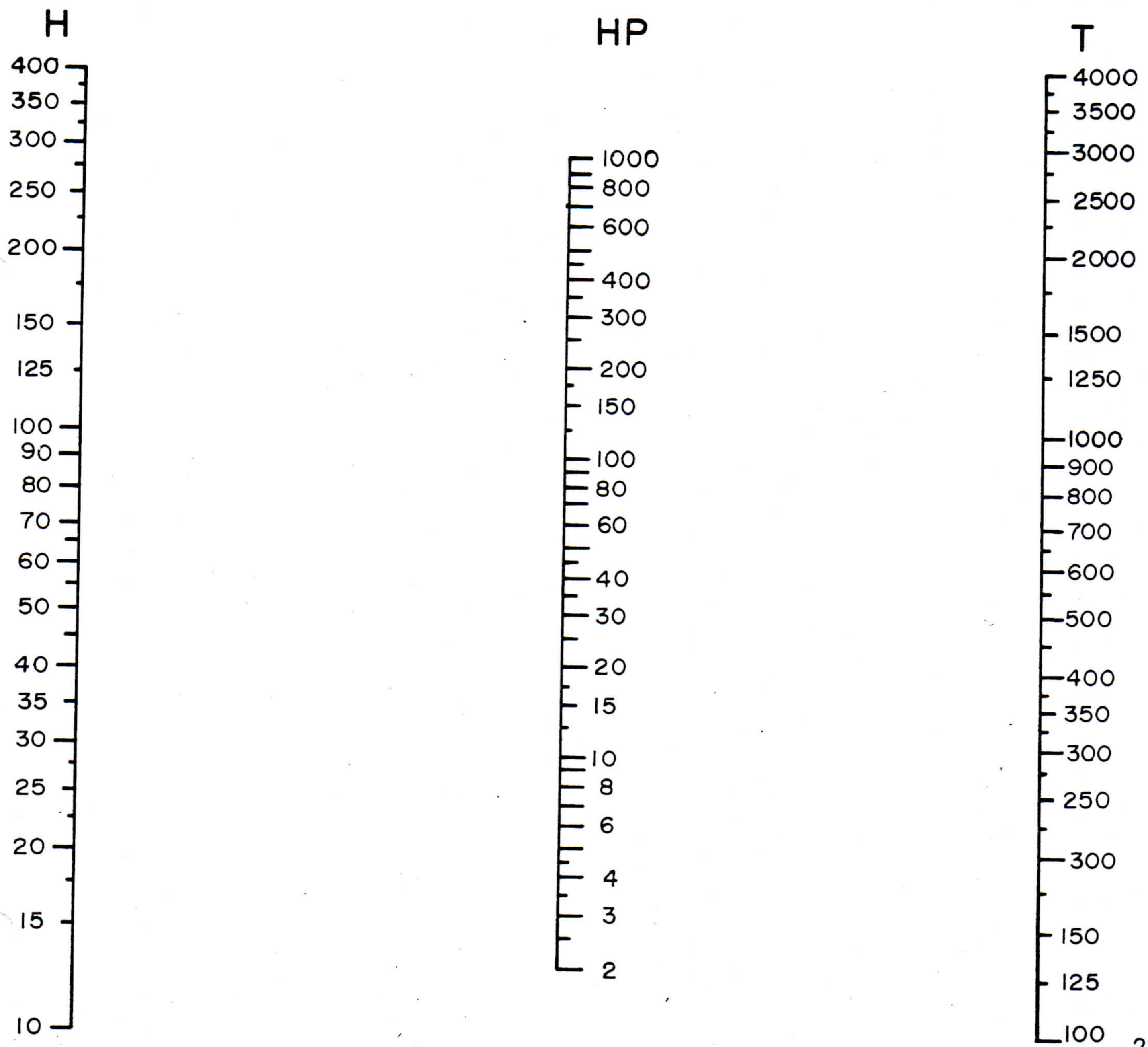
FROM THE NEMA FORMULA

$$HP(GAVITY) = \frac{TH}{840}$$

HP = TOTAL HORSEPOWER.

T = AVERAGE LOAD IN TONS PER HOUR.

H = HEIGHT LOAD IS RAISED IN FEET.



NOMOGRAPH FOR DETERMINING
IDLER SPACING FOR BELT CONVEYORS
WITH
SAG LIMITED TO 2% OF IDLER SPACING
FROM THE FORMULA

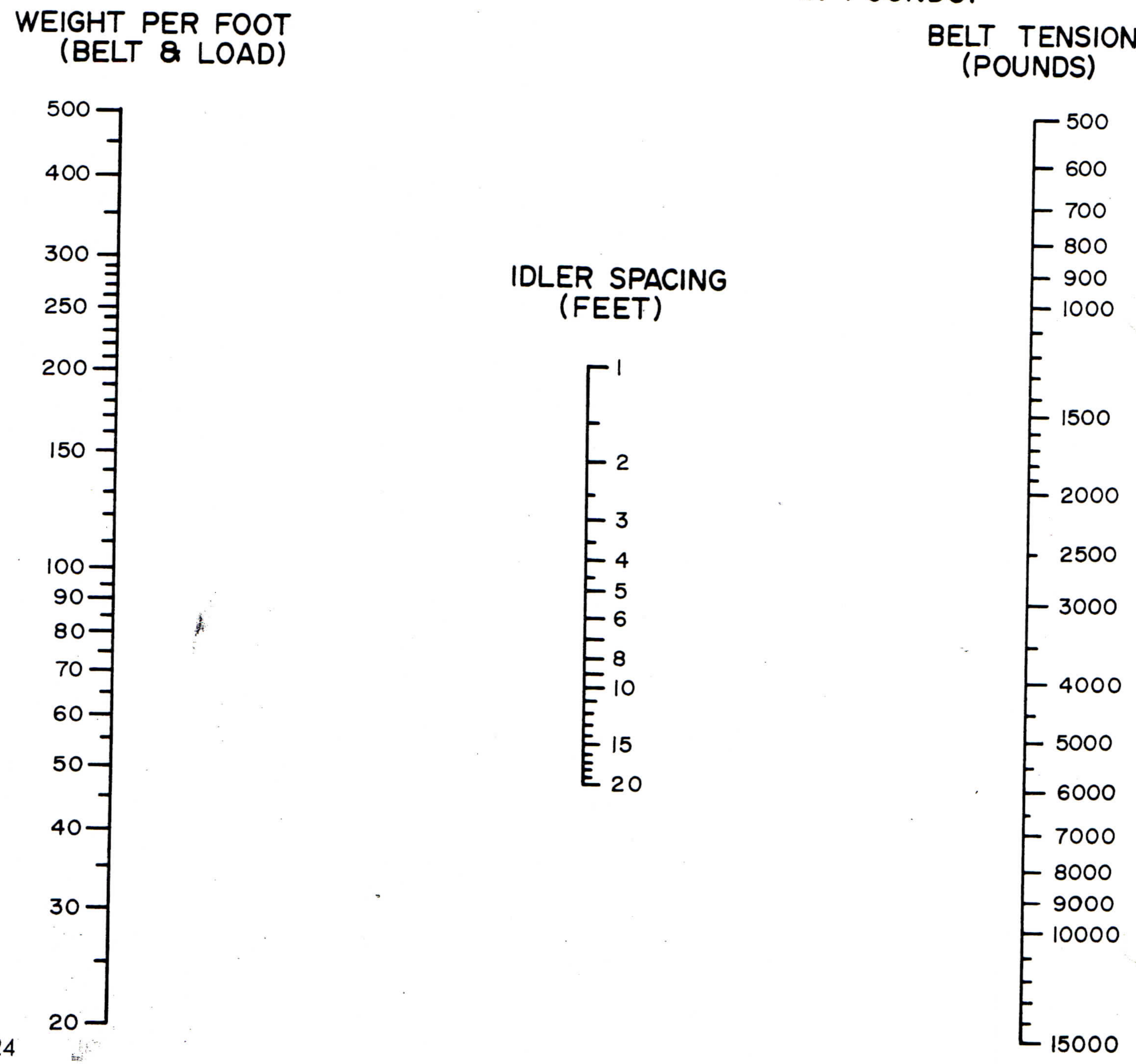
$$\text{SAG} = \frac{\text{WEIGHT} \times \text{SPAN}^2}{8 \times \text{TENSION}}$$

SAG = SAG BETWEEN IDLERS IN FEET. (0.02 OF SPAN FOR THIS CHART)

SPAN = SPACE BETWEEN IDLERS IN FEET.

WEIGHT = WEIGHT IN POUNDS OF BELT AND LOAD PER FOOT OF LENGTH.

TENSION = BELT TENSION BETWEEN IDLERS IN POUNDS.



NOMOGRAPH FOR DETERMINING

WEIGHT OF MATERIAL PER FOOT OF LENGTH

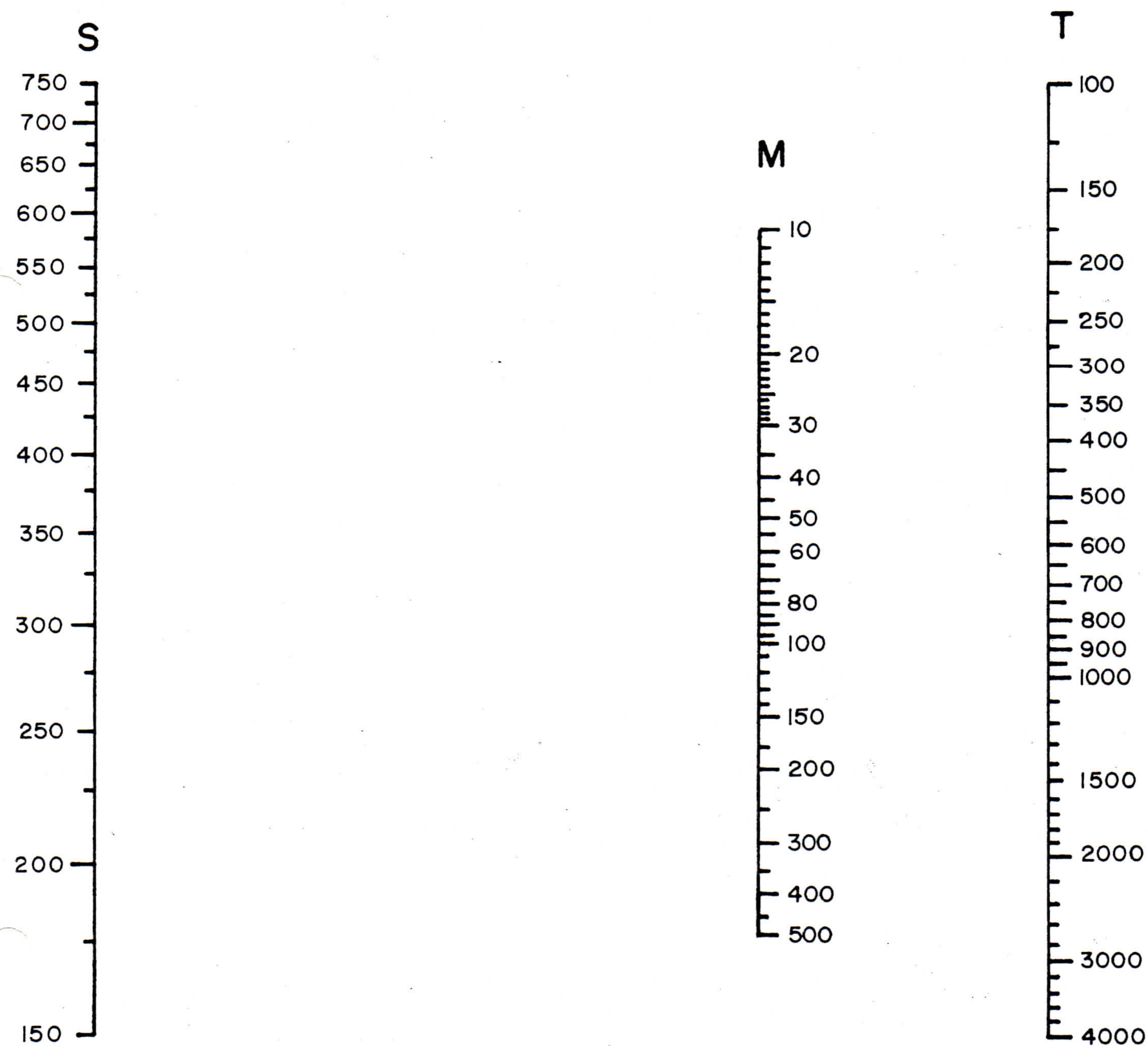
FROM THE NEMA FORMULA

$$M = 33.3 \frac{T}{S}$$

M = AVERAGE LOAD IN POUNDS PER FOOT OF LENGTH.

T = AVERAGE LOAD IN TONS PER HOUR.

S = SPEED OF BELT IN FEET PER MINUTE.



WEIGHTS OF ROTATING PARTS FOR BELT CONVEYOR CALCULATIONS

	Roll Diameter		2-5/8"	4"		5"		6"	
BW	Type	Wall	#7 Ga.	#9 Ga.	#7 Ga.	#9 Ga.	#7 Ga.	#7 Ga.	1/4"
30"	Carrying	Each	5.262	6.728	7.834	8.342	9.747		
		Set of 3	15.786	20.184	23.502	25.026	29.241		
	Return	Each	17.306	22.225	26.177	27.687	32.671		
36"	Carrying	Each	6.107	7.814	9.121	9.707	11.355	14.588	19.557
		Set of 3	18.321	23.442	27.363	29.121	34.065	43.764	58.671
	Return	Each	19.820	25.460	30.006	31.723	37.456	45.902	63.238
42"	Carrying	Each	6.961	8.913	10.421	11.078	12.981	16.539	22.279
		Set of 3	20.883	26.739	31.263	33.234	38.943	49.617	66.837
	Return	Each	22.333	28.694	33.833	35.758	42.239	51.641	71.245
48"	Carrying	Each	7.775	9.961	11.662	12.386	14.531	18.398	24.876
		Set of 3	23.325	29.883	34.986	37.158	43.593	55.194	74.628
	Return	Each	24.846	31.927	37.661	39.793	47.023	57.380	79.271
54"	Carrying	Each	8.620	11.048	12.948	13.742	16.138	20.327	27.564
		Set of 3	25.860	33.144	38.844	41.226	48.414	60.981	82.692
	Return	Each	27.360	35.162	41.489	43.829	51.807	63.120	87.210
60"	Carrying	Each		12.122	14.219	15.082	17.727	22.232	30.223
		Set of 3		36.366	42.657	45.246	53.181	66.696	90.669
	Return	Each		38.396	45.317	47.863	56.591	68.860	95.261
66"	Carrying	Each				16.422	19.315	24.139	32.881
		Set of 3				49.266	57.945	72.417	98.643
	Return	Each				51.899	61.375	74.600	103.268
72"	Carrying	Each						26.066	35.570
		Set of 3						78.198	106.710
	Return	Each						80.339	111.466

PROCEDURE FOR SETTING RELIEF VALVES AND PRESSURE SWITCHES
FOR
BT-1 POWER PAK

When unit is full of oil, hosed and wired properly, follow this procedure:

1. First, check pump for proper rotation by starting unit and stopping just to note rotation only.

2. Then, increase both pressure switches to at least 200 PSI above highest relief valve setting desired.

3. Adjust main relief valve pressure to 100 PSI above highest relief valve pressure desired. 1000 PSI in the following example.

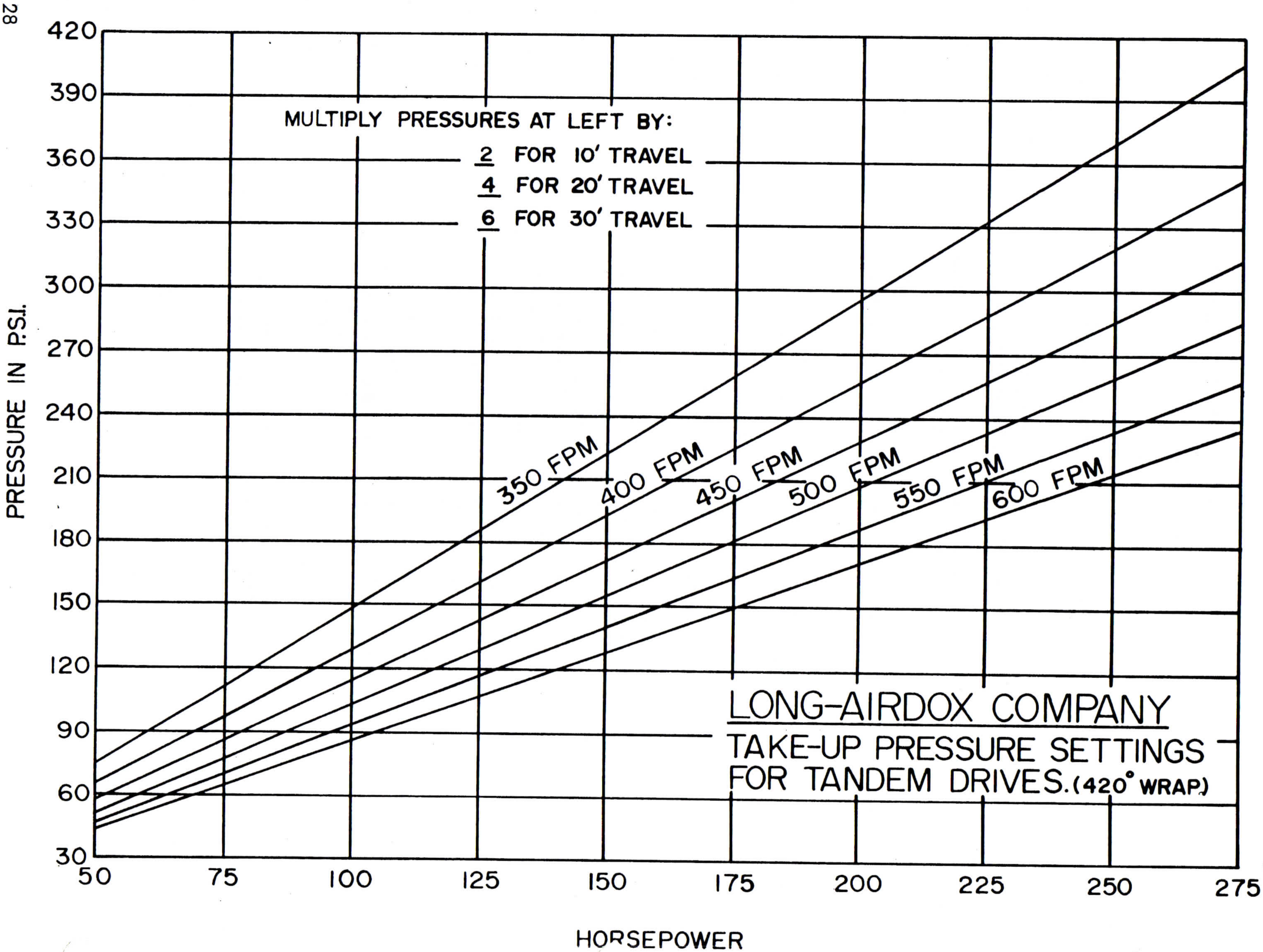
The following settings are typical of an 800 PSI working pressure:

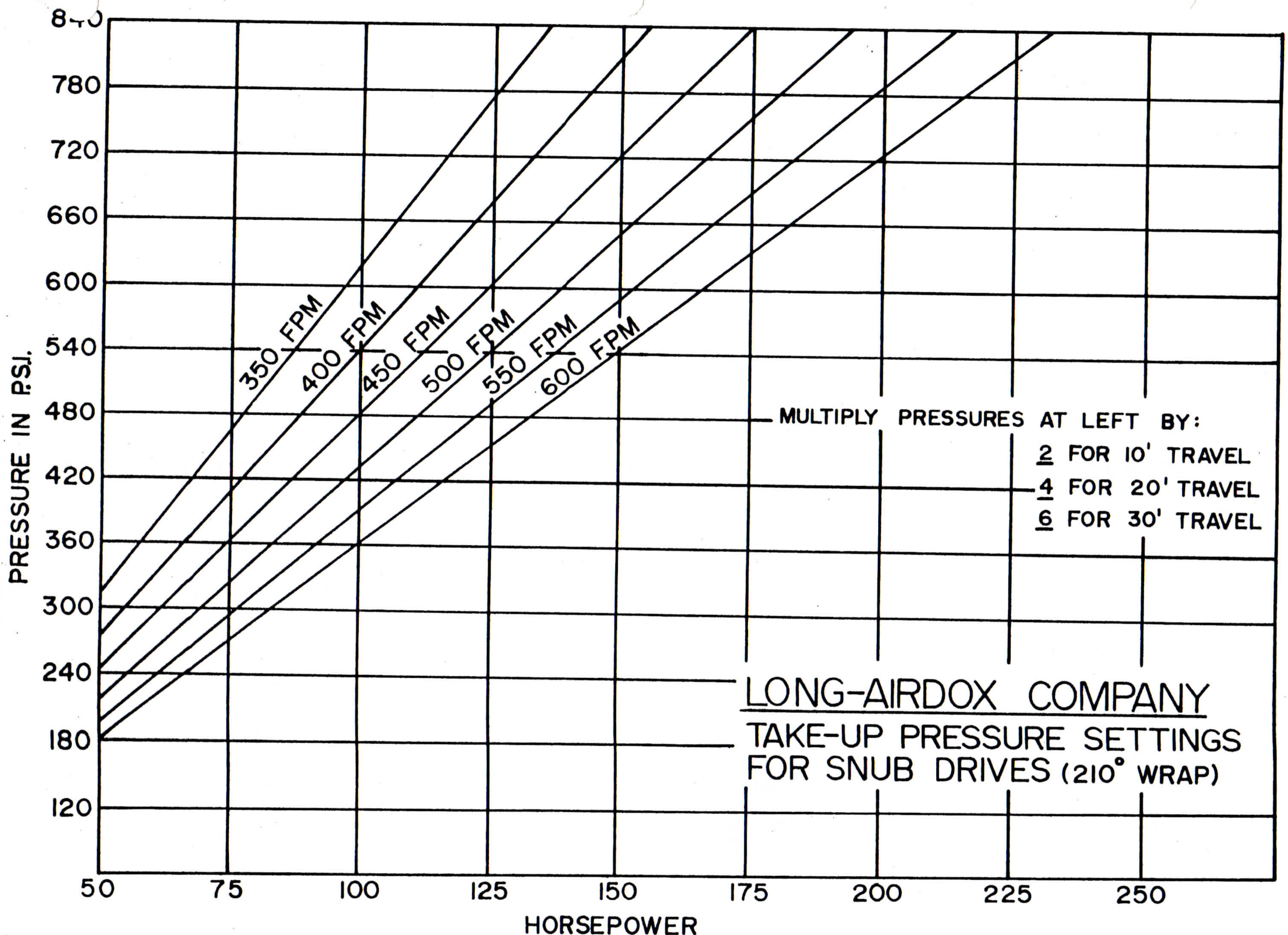
4. Push control valve handle in and adjust RV10 relief (valve on side of manifold) pressure to 900 PSI and lock adjusting nut in place.

5. Now set power pak pressure switch at 800 PSI high and 700 PSI low. The high setting is set by loosening the jam nut on top of the pressure switch and turning adjusting screw clockwise to increase the pressure or counter clockwise to decrease the pressure. To set the differential pressure, remove the front cover and turn the adjusting screw in the recessed hole to achieve the desired low setting. Setting on belt interconnect switch will be 600 PSI or 100 PSI lower than power pak pressure switch. Retighten jam nut and replace cover.

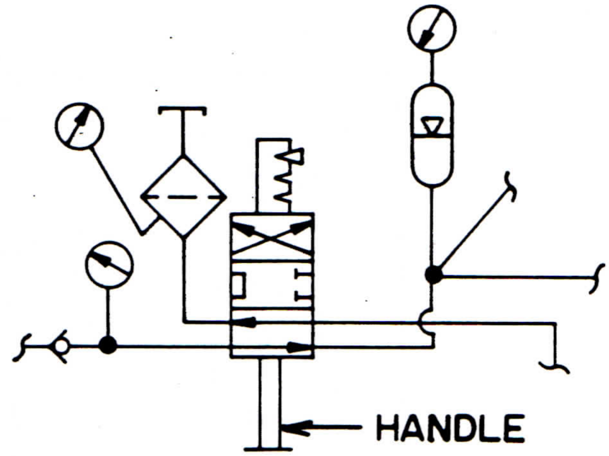
6. To check power pak, push control handle in and let unit run, check cut-off pressure, next bleed pressure off slowly by pulling handle to you until unit cuts in and check pressure. Reading should be 100 PSI less than cut-off pressure. Now unit should be ready for service.

Note: Accumulator should be charged with dry nitrogrn to 400 PSI. (Nitrogen charge should be approximately half of operating pressure.)

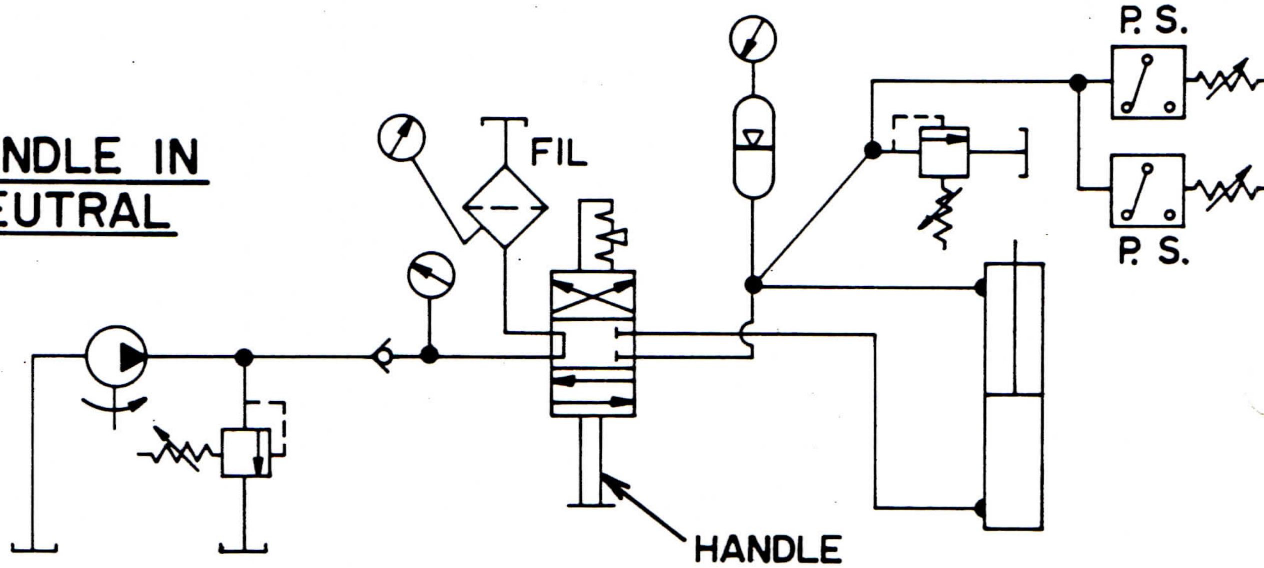

LONG-AIRDOX COMPANY
TAKE-UP PRESSURE SETTINGS FOR TANDEM DRIVES. (420° WRAP)
MULTIPLY PRESSURES AT LEFT BY:
2 FOR 10' TRAVEL
4 FOR 20' TRAVEL
6 FOR 30' TRAVEL
350 FPM
400 FPM
450 FPM
500 FPM
550 FPM
600 FPM
PRESSURE IN P.S.I.
420
390
360
330
300
270
240
210
180
150
120
90
60
30
HORSEPOWER
50
75
100
125
150
175
200
225
250
275


840
780
720
660
600
540
480
420
360
300
240
180
120
PRESSURE IN P.S.I.
50
75
100
125
150
175
200
225
250
HORSEPOWER
350 FPM
400 FPM
450 FPM
500 FPM
550 FPM
600 FPM
MULTIPLY PRESSURES AT LEFT BY:
2 FOR 10' TRAVEL
4 FOR 20' TRAVEL
6 FOR 30' TRAVEL
LONG-AIRDOX COMPANY
TAKE-UP PRESSURE SETTINGS
FOR SNUB DRIVES (210° WRAP)

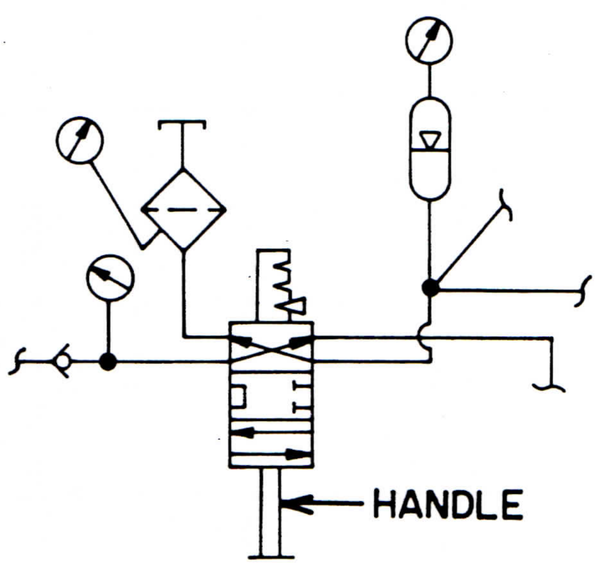
HANDLE IN



HANDLE IN NEUTRAL



HANDLE OUT



BT-1 POWER PAC

TRAJECTORY OF DISCHARGE

When designing discharge chutes, it may be desirable to determine the trajectory of discharged material. This can be done by graphical means, as shown in the following diagrams.

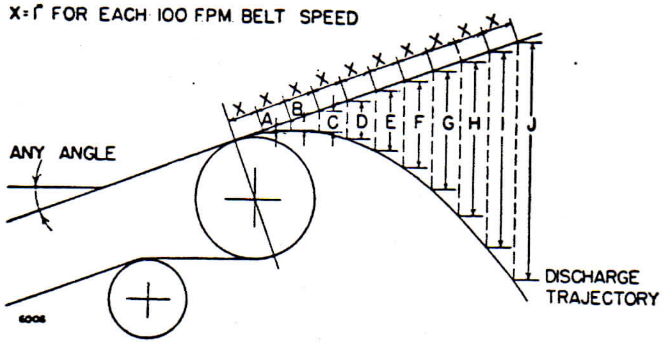


DIAGRAM NO. 1

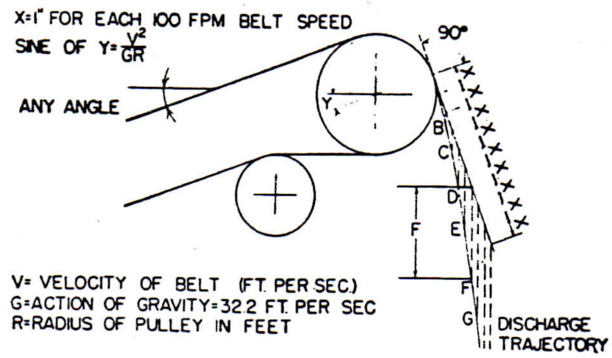


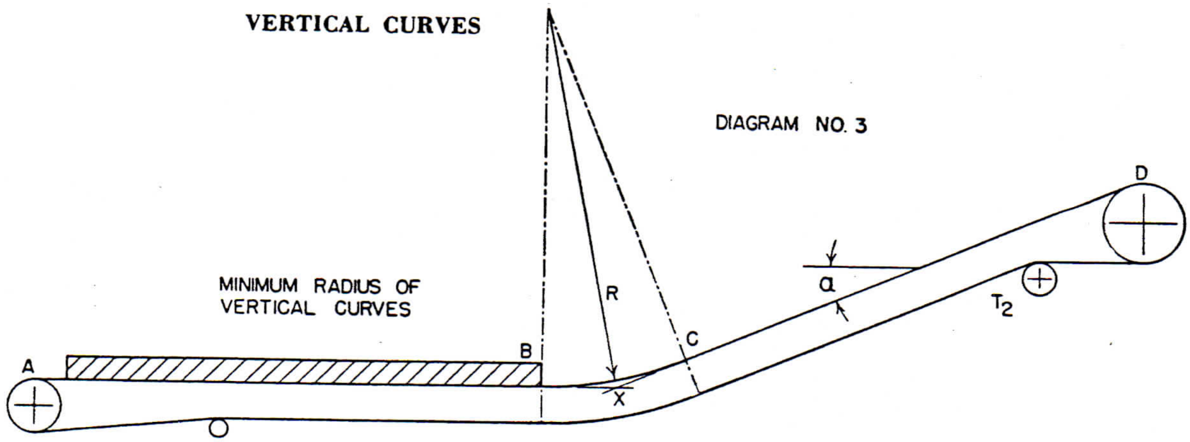
DIAGRAM NO. 2

LENGTH OF VERTICAL DROP IN INCHES

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
½	2	4⅜	7¾	12	17½	23½	31	39	48	58½	69½	81½	94½	108½

In charting the discharge trajectory of a conveyor having a belt speed of more than 300 F.P.M., use Diagram No. 1. If belt speed is less than 300 F.P.M. or the diameter of discharge pulley is small, it may be necessary, at times, to find the highest point at which material can be discharged. In this case, use Diagram No. 2.

VERTICAL CURVES



A. Starting Radius—Tight Side

1. Compute operating tight side tension Tx at Intersecting point X as follows:
   (a) Compute H. P. of conveyor loaded from tail pulley to point X, then compute effective tension Ex at point X, neglecting curve of belt.
   (b) Compute H. P. and effective tension E and slack side tension T_2 at head pulley for entire conveyor loaded from tail to head pulley.
   From (a) and (b), $Tx = Ex + T_2$
2. Approximate starting radius $R = \frac{2Tx}{w}$ where w = wt. of belt in lbs. per lineal foot.
3. Should determination of a more exact starting radius be required, establish the location of B using the above approximate radius.
   (c) Compute H. P. of Conveyor loaded from tail pulley to point B, then compute effective tension E_b at point B.
   From (c) and (b), $T_b = E_b + T_2$
4. Starting Radius $R = \frac{2T_b}{w}$

   This formula will give results that should prevent the belt from lifting off the curve during starting with across the line starting equipment. If this feature is not important the radius may be decreased.

B. Radius of return belt: $R = \frac{T_2}{w}$

Total HP vs. Belt Speed and Maximum Belt Tension
Single Motor Drives

"TE" Max. Belt Tension	50 HP 8250	75 HP 12375	100 HP 16500	125 HP 20625	150 HP 24750	200 HP 33000	250 HP 41250	300 HP 49500	350 HP 57750
200'/Min.	T-17H T-21 T-21H T-25 T-25H T-21XH	T-21XH							
Max. Belt Tension	5500	8250	11000	13750	16500	22000	27500	33000	38600
300'/Min.	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17H T-21 T-21H T-25H T-21XH	T-17H T-21H T-25H T-21XH	T-21XH					
Max. Belt Tension	4125	6187	8250	10312	12375	16500	20625	24750	28900
400'/Min.	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17H T-21 T-21H T-25H T-21XH	T-17H T-21H T-25H T-21XH	T-21XH	T-21XH			
Max. Belt Tension	3300	4950	6600	8250	9900	13200	16500	19800	23100
500'/Min.	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17 T-17H T-21 T-21H T-25 T-25H T-21XH	T-17H T-21 T-21H T-25H T-21XH	T-17H T-21H T-25H T-21XH	T-21XH			

Total HP vs. Belt Speed and Maximum Belt Tension
Single Motor Drives

		50 HP	75 HP	100 HP	125 HP	150 HP	200 HP	250 HP	300 HP	350 HP
	Max. Belt Tension	2250	4125	5500	6875	8250	11000	13750	16500	19270
600'/Min.		T-17	T-17	T-17						
		T-17H	T-17H	T-17H	T-17H	T-17H	T-17H			
		T-21	T-21	T-21	T-21	T-21				
		T-21H	T-21H	T-21H	T-21H	T-21H	T-21H			
		T-25	T-25	T-25	T-25					
		T-25H	T-25H	T-25H	T-25H	T-25H				
		T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	T-21XH		
	Max. Belt Tension	2375	3535	4714	5892	7071	9428	11785	14142	16500
700'/Min.		T-17	T-17	T-17	T-17					
		T-17H	T-17H	T-17H	T-17H	T-17H	T-17H			
		T-21	T-21	T-21	T-21	T-21				
		T-21H	T-21H	T-21H	T-21H	T-21H	T-21H			
		T-25	T-25	T-25	T-25	T-25				
		T-25H	T-25H	T-25H	T-25H	T-25H	T-25H			
		T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	T-21XH	

Total HP vs. Belt Speed and Maximum Belt Tension
Dual Motor Drives

	HP (Total)	50	100	150	200	250	300	400
	* Max. Belt Tension	8250	16500	24750	33000	41250	49500	66000
200'/Min		DT-25H						
		DT-21H						
		DT-25HS						
		DT-21XH						
		DT-25XH	DT-25XH					
		DT-30H	DT-30H					
		DT-36H	DT-36H					
	* Max. Belt Tension	5500	11000	16500	22000	27500	33000	44000
300'/Min.		DT-25H						
		DT-21H	DT-21H					
		DT-25HS	DT-25HS					
		DT-21XH	DT-21XH					
		DT-25XH	DT-25XH	DT-25XH				
		DT-30H	DT-30H	DT-30H				
		DT-36H	DT-36H	DT-36H	DT-36H			
	* Max. Belt Tension	4125	8250	12375	16500	20625	24750	33000
400'/Min.		DT-25H	DT-25H					
		DT-21H	Dt-21H					
		DT-25HS	DT-25HS					
		DT-21XH	DT-21XH	DT-21XH				
		DT-25XH	DT-25XH	DT-25XH	DT-25XH			
		DT-30H	DT-30H	DT-30H	DT-30H			
		DT-36H	DT-36H	DT-36H	DT-36H	DT-36H		
	* Max. Belt Tension	3300	6600	9900	13200	16500	19800	26400
500'/Min.		DT-25H	DT-25H					
		DT-21H	DT-21H	DT-21H				
		DT-25HS	DT-25HS	DT-25HS				
		DT-21XH	DT-21XH	DT-21XH	DT-21XH			
		DT-25XH	DT-25XH	DT-25XH	DT-25XH	DT-25XH		
		DT-30H	DT-30H	DT-30H	DT-30H	DT-30H		
		DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	

Total HP vs. Belt Spe and Maximum Belt Tension
Dual Motor Drives

	* Max. Belt Tension	2250	5500	8250	11000	13750	16500	22000
600'/Min.		DT-25H	DT-25H	DT-25H				
		DT-21H	DT-21H	DT-21H	DT-21H			
		DT-25HS	DT-25HS	DT-25HS	DT-25HS			
		DT-21XH	DT-21XH	DT-21XH	DT-21XH	DT-21XH		
		DT-25XH	DT-25XH	DT-25XH	DT-25XH	DT-25XH	DT-25XH	
		DT-30H	DT-30H	DT-30H	DT-30H	DT-30H	DT-30H	
		DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	DT-36H
	* Max. Belt Tension	2375	4714	7071	9428	11785	14142	18850
700'/Min.		DT-25H	DT-25H	DT-25H				
		DT-21H	DT-21H	DT-21H	DT-21H			
		DT-25HS	DT-25HS	DT-25HS	DT-25HS	DT-25HS		
		DT-21XH	DT-21XH	DT-21XH	DT-21XH	DT-21XH	DT-21XH	
		DT-25XH	DT-25XH	DT-25XH	DT-25XH	DT-25XH	DT-25XH	
		DT-30H	DT-30H	DT-30H	DT-30H	DT-30H	DT-30H	
		DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	DT-36H	DT-36H

* Each Strand

Type Head	Per Drawing
DT-25H	R-28363
DT-21H	R-28494
DT-25HS	D-28272
DT-21XH	R-28824
DT-25XH	R-28539
DT-30H	R-28055
DT-36H	R-28731

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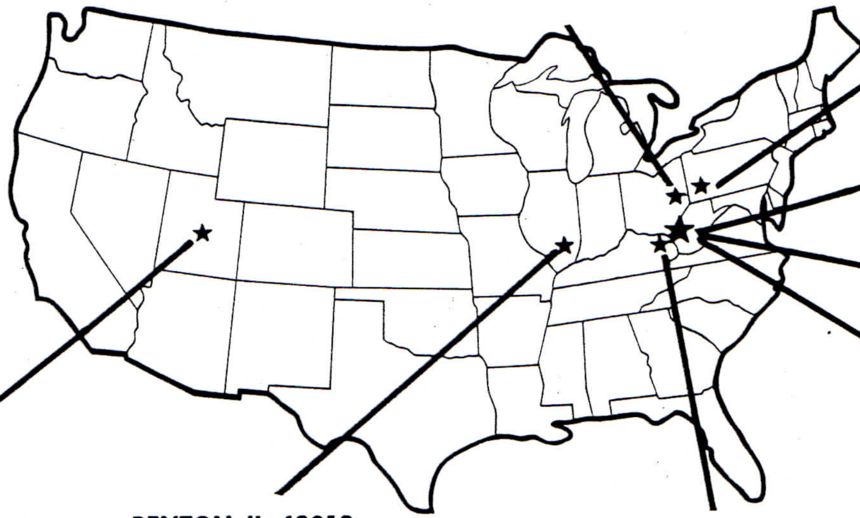

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