THE

MANITOBA

BRIDGE & IRON WORKS

LIMITED

WINNIPEG — CANADA

CATALOGUE

1927

ALBERTA AND BRITISH COLUMBIA
518 Lancaster Building
CALGARY

SASKATCHEWAN
510 Westman Chambers
REGINA

Catalogue "F"

· 1927 ·

Structural and Fabricated

STEEL *and* IRON

FOR

Architects - Contractors - Manufacturers

STEEL STRUCTURES

BUILDINGS—*Offices - Warehouses - Industrial Plants*
BRIDGES—*Railway - Highway - Pontoon - Foot*
TRANSMISSION TOWERS - WATER TANKS

PLATE AND TANK CONSTRUCTION

TANKS *for Gas - Oil - Water - Air*
SPECIAL CATALOGUE FURNISHED ON REQUEST
PLATE WORK—*Bins - Hoppers - Chutes - Stacks*

CASTINGS

GREY IRON - STEEL - SEMI-STEEL

FORGINGS

UPSET RODS - CONTRACTORS' REQUIREMENTS
COMPLETE CONSTRUCTION LINE

COAL MINING EQUIPMENT

TIPPLES - CAR HAULS - SCREENS
AIR-CLEANING EQUIPMENT - PORTABLE CONVEYORS

CONTRACTORS' SUPPLIES

DERRICKS - BUCKETS - DUMP CARS
PILE SHOES AND CAPS - SCRAPERS

TRANSMISSION AND CONVEYING MACHINERY

SPECIAL CATALOGUE FURNISHED ON REQUEST

STOCKS

LARGE STOCKS OF STRUCTURALS, PLATES AND BARS

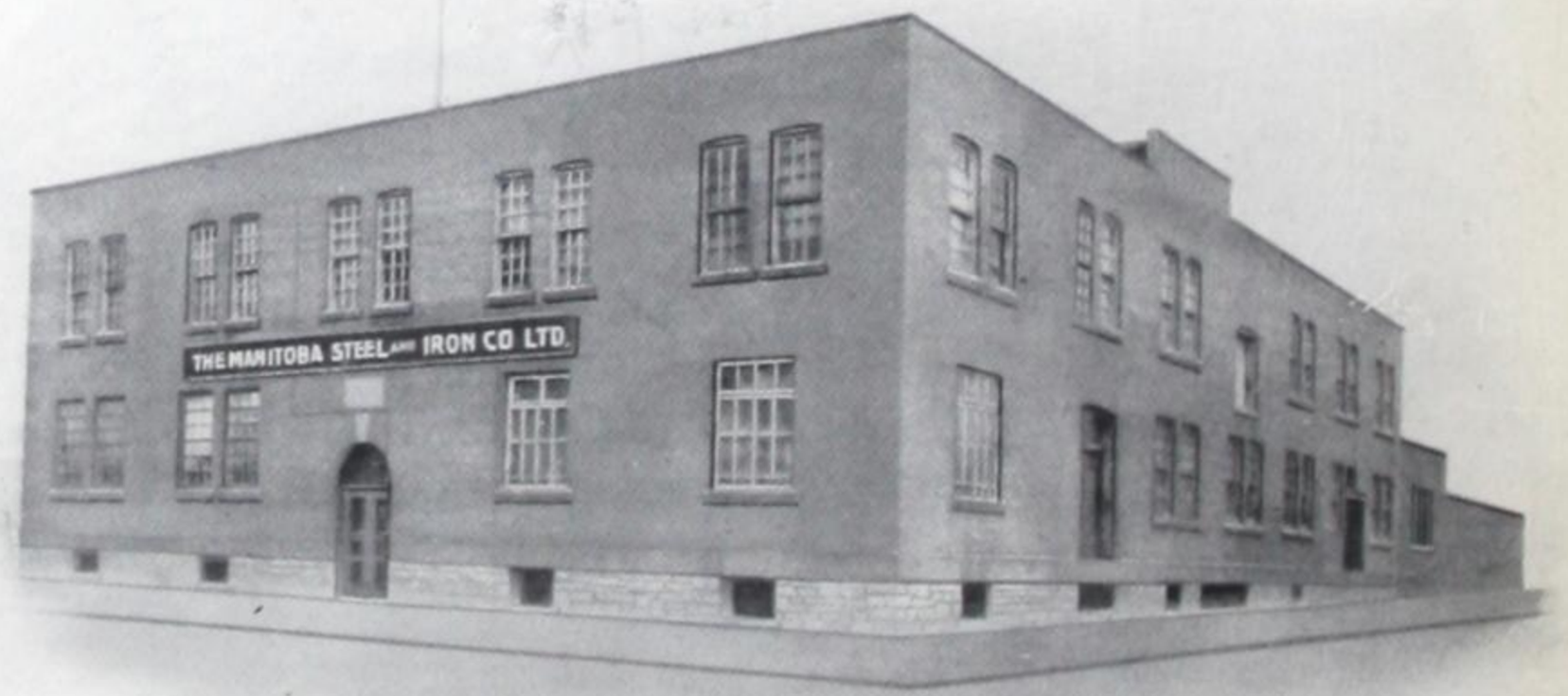
The
MANITOBA BRIDGE & IRON WORKS
Limited

Calgary WINNIPEG Regina

The Leading Steel and Iron

THE MANITOBA BRIDGE AND IRON WORKS PLANT AT WINNIPEG

Structural Steel and Iron for Bridges and Buildings
Steel Tanks and Manufactures of Plate
Mining Equipment Grain Elevator and Transmission Machinery
Grey Iron Castings Forgings and Pressed Work
Railway Frogs, Switches and Crossings



THE MANITOBA STEEL AND IRON CO. WAREHOUSE AT WINNIPEG

Large Stocks of Steel and Iron Bars, Angles, Beams, Channels, Sheets, Plates, Shafting, Boiler Tubes, Bolts, Nuts, Rivets, Reinforcing Steel, Etc.

ron Industry of Western Canada

A Quarter of a Century of Service and Growth is the record of the Manitoba Bridge and Iron Works, Limited. Development from a small beginning twenty-five years ago is shown better by these views of its plants and warehouses than by words.

THE MANITOBA ROLLING MILLS PLANT AT SELKIRK

Capacity: 25,000 Tons per annum of New Billet Basic Open Hearth Steel
Products include Merchant Bars, Forging Bars, Concrete Reinforcing—
Plain and Deformed, Manufacturers' Special Sections.

IN THIS BRIEF SPACE it is impossible to give in detail a picture of our many activities, but the following pages, if carefully studied, will afford the reader many surprises concerning the quality, volume and variety of our products, and the many lines of building and manufacturing in which we are engaged.

The MANITOBA BRIDGE AND IRON WORKS
LIMITED

Plants:
WINNIPEG
AND
SELKIRK

Head Office:
WINNIPEG

Branches:
CALGARY
AND
REGINA

THIS
se
twenty-f
throughc
tional bu
switch, g
the most

Such g
possible
to our ne

Our in
must be
all lines,
in the dif

Branch
our many

As larg
immediat

With su
we feel th
and prob

Announcement

THIS COMPANY, owned and controlled by Western Canadian capital, has been serving its patrons of the West for a quarter of a century. Commencing twenty-five years ago with a foundry, forge, machine and boiler shop, its progress throughout the years has been practically uninterrupted and at this time additional buildings and departments, comprising bridge and structural, frog and switch, galvanizing, tank, bolt and rivet manufacturing all combine to make it the most comprehensive industry of its kind west of Toronto.

Such growth in a few years, despite the post war depression, was only made possible by the production of first-class goods and the rendering of such service to our new patrons as has made them permanent customers.

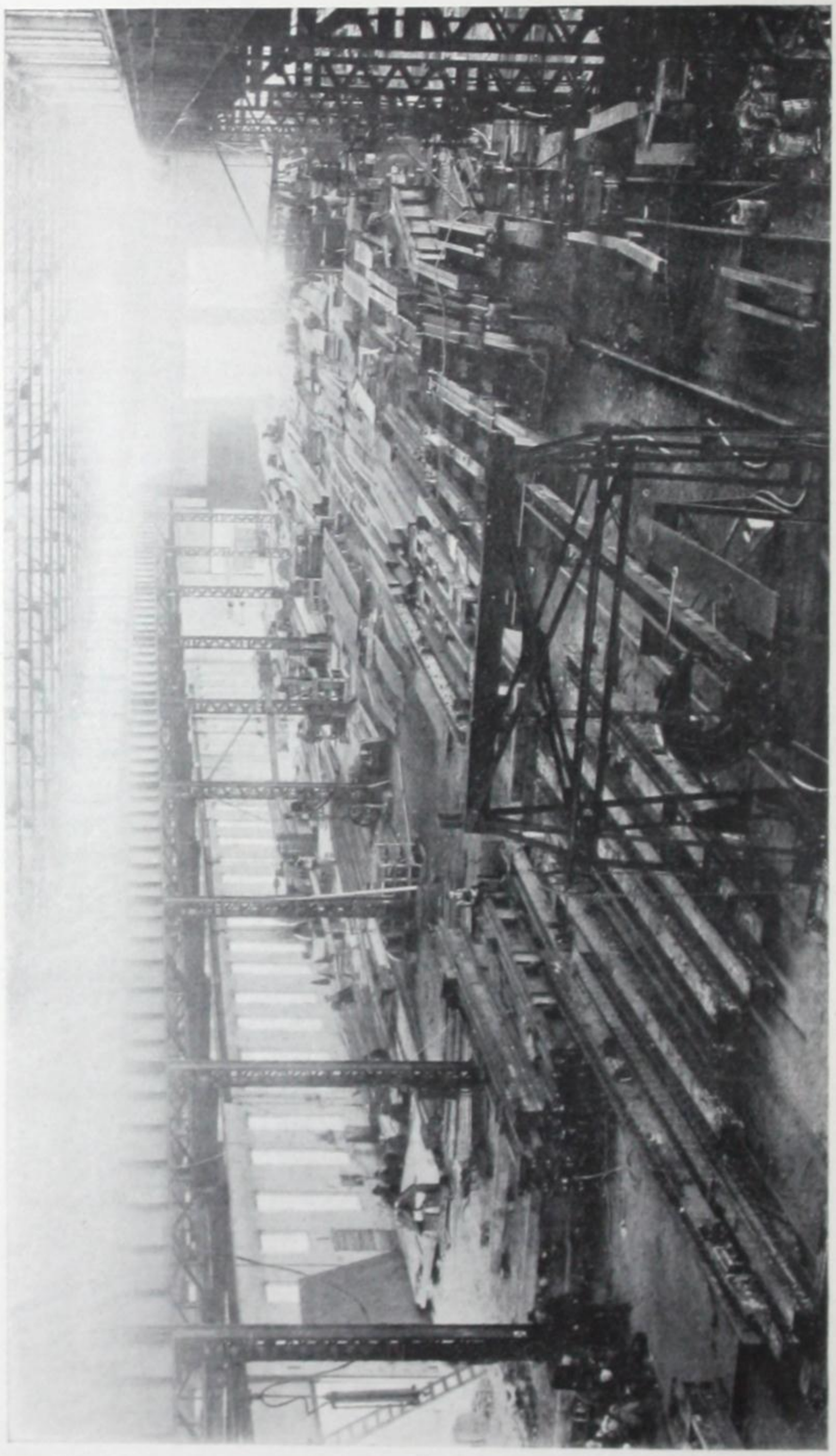
Our interests are so interwoven with the welfare of the whole West that we must be able to advise the trade with respect to the best engineering practice in all lines, and to this end maintain a corps of engineering specialists well versed in the different branches.

Branch offices are maintained at Regina and Calgary for the convenience of our many friends.

As large stocks of various grades of steel are stored at our Winnipeg yards, immediate needs can be satisfied at once.

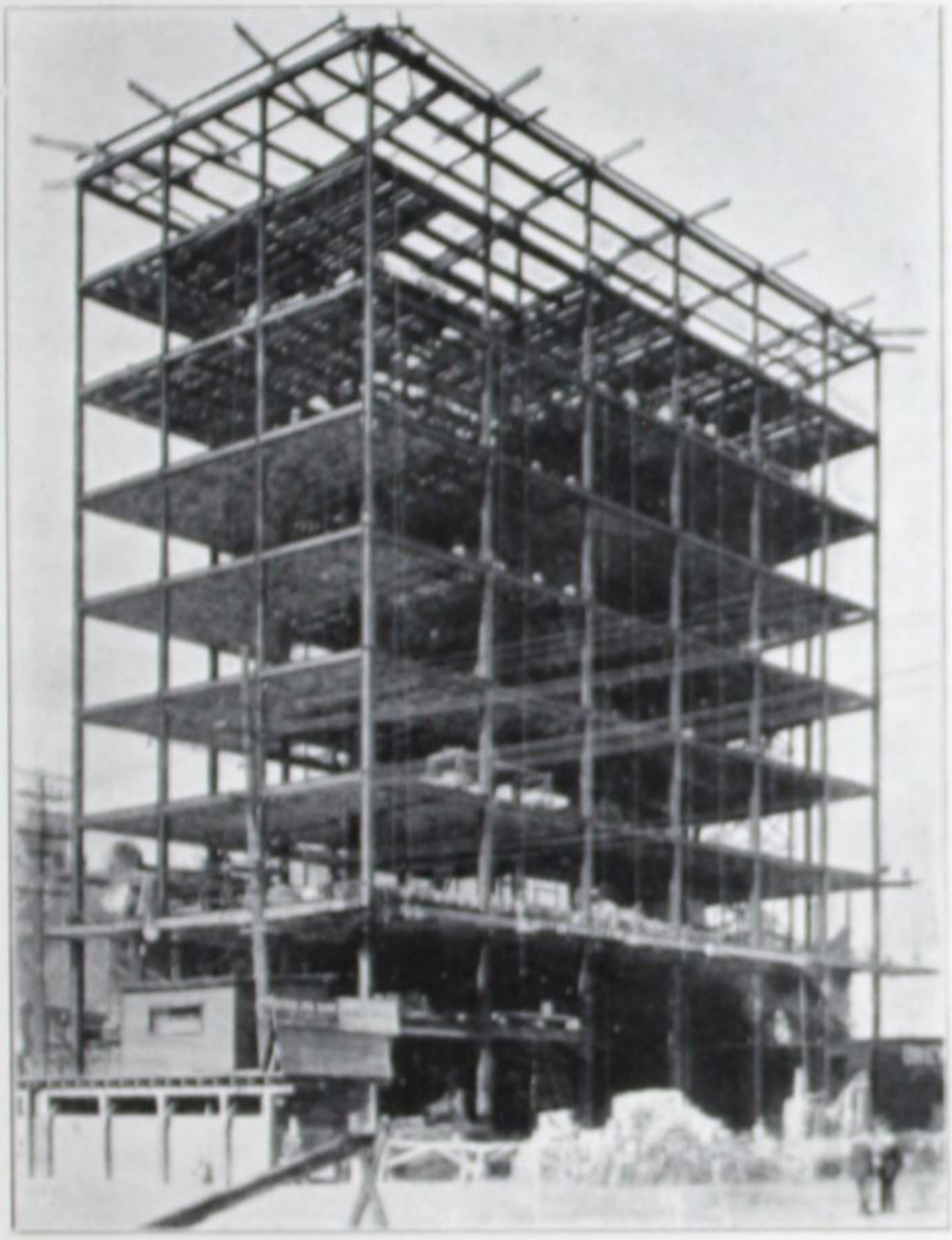
With such a range of manufacturing coupled with capable engineering direction we feel that we are well justified in seeking your business, and invite your inquiries and problems, all of which will be promptly and carefully treated.

THE MANITOBA BRIDGE & IRON WORKS, LIMITED
WINNIPEG



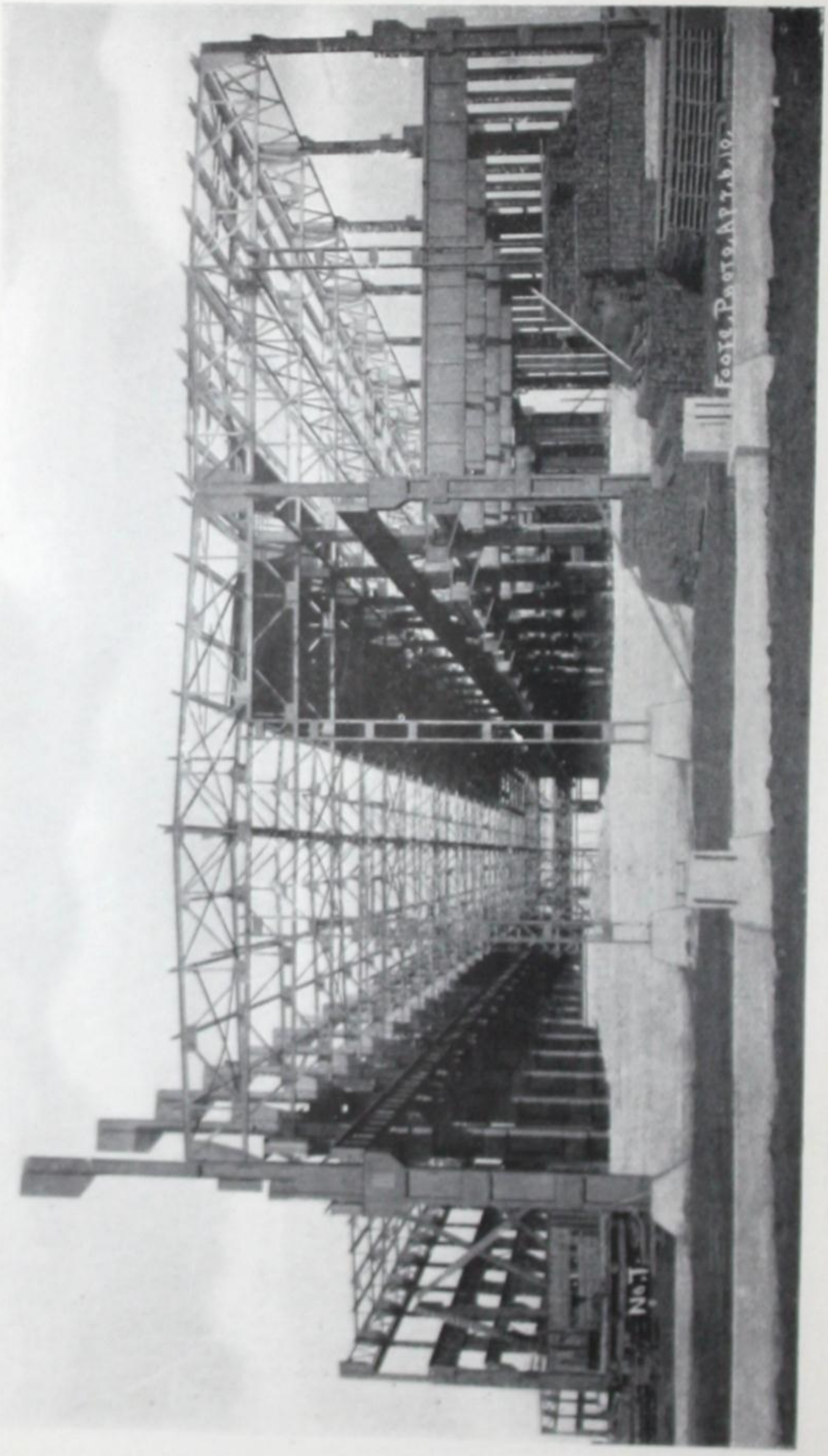
No. 1—Interior of the Structural Shops of the Manitoba Bridge and Iron Works, Limited

STRUCTURAL STEEL WORK



No. 2—Loft Building, in Winnipeg's Business Section, Fabricated and Erected by the Manitoba Bridge and Iron Works, Limited.

The satisfactory service accorded to our customers on contracts which involve the use of structural steel is the result of almost twenty years of specialization in this line, aided by complete equipment to fill the most complicated order.

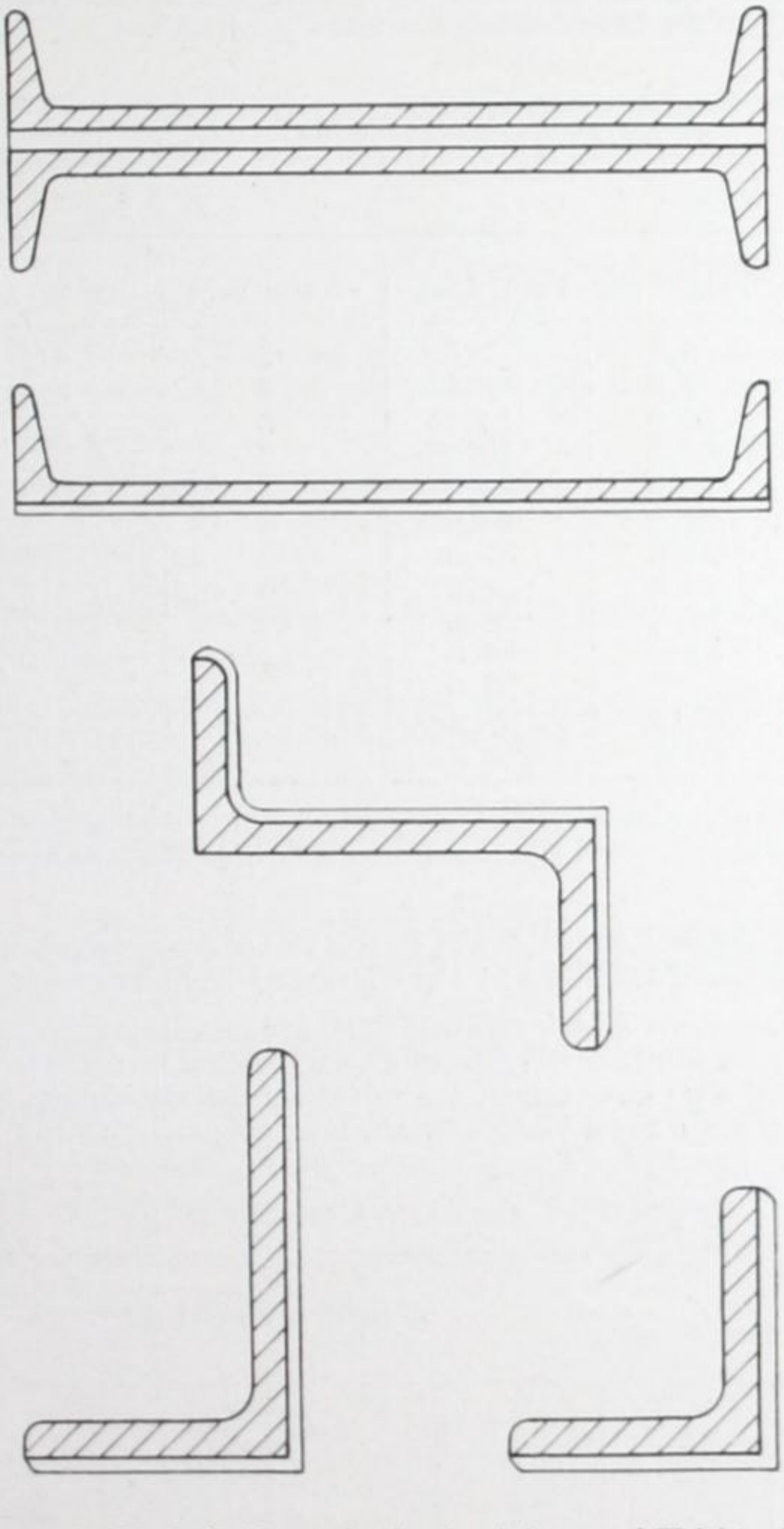


No. 3—Railway Locomotive Shops, Fabricated and Erected by the Manitoba Bridge and Iron Works, Limited

STRUCTURAL STEEL

The steel used in structures is in the form of single sections or in combination of two or more sections.

These sections may be in any of the following shapes: square and round bars, flat bars, plates, channels, angles, I-beams, H-sections, zees and tees. Flat bars more than six or seven inches wide are termed plates.



No. 4—Method of Increasing Sectional Areas and Weights of Structural Shapes.

Structural shapes are rolled to a minimum sectional area and the method of increasing the area and weights is shown in the cuts. The hatched portion represents the minimum section, the blank portion the added areas. In case of channels and beams, the enlargement of the section adds an equal amount to the thickness of the web and width of flanges. In the case of angles and zees the effect is to increase slightly the length of the legs.

Beams and Channels—The properties of standard sections are the same, irrespective of the source of manufacture, but different manufacturers have special sections which they roll for particular purposes. Standard I-beams are rolled in depths of from 3-inch to 24-inch, and channels from 3-inch to 15-inch. Depths of beams are from 3-inch to 10-inch consecutively, then 12-inch, 15-inch, 18-inch, 20-inch and 24-inch. For channels, 3-inch to 10-inch consecutively, then 12-inch and 15-inch. For each depth of beam or channel there are several standard weights.

The sizes usually carried in stock are the minimum weights shown in the tables but in the larger sizes two weights are usually carried.

SECTIONS CARRIED IN STOCK

BEAMS			CHANNELS		
SIZE, IN.	Weight per Foot, Lbs.		SIZE, IN.	Weight per Foot, Lbs.	
3	5.7	7.5	3	4.1	
4	7.7	10.5	4	5.4	
5	10.0	14.75	5	6.7	
6	12.5	17.25	6	8.2	13.0
7	15.3	20.0	7	9.8	17.25
8	18.4	25.5	8	11.5	16.25
9	21.8	30.0	9	13.4	.....
10	25.4	30.0	10	15.3	25.0
12	31.8	40.8	12	20.7	30.0
15	42.9	60.8	15	33.9	50.0
18	54.7	70.0			
20	65.4	81.4			
24	79.9	100.0			

In addition to the above all the sections shown in the tables can be supplied but a reasonable allowance of time must be given to procure sections from the mill.

H-Sections—H-Sections as shown in the tables from 4-inch up to 8-inch are all carried in stock and are rolled by the Carnegie Steel Company.

The larger sizes from 8-inch up to 14-inch are usually carried in stock in their minimum weights and other weights to give a gradual increase in area up to the largest sizes. All sizes over 8-inch are rolled by the Bethlehem Steel Company, although the Carnegie Steel Company are now preparing to roll larger sections.

H-SECTIONS USUALLY CARRIED IN STOCK

NOMINAL SIZE, IN.	Weight per Foot, Lbs.					
4	13.8					
5	18.9					
6		24.1				
8	32*	32.6	34.3*	34.5	37.7*	39.0
10	49	54				
12	64.5	71.5	78.0			
14	83.5	91	99.	114.5		

The large range in weights of the 8-inch section is due to the fact that this size is rolled by both Carnegie Steel Company and Bethlehem, the items marked with an asterisk (*) being Carnegie products, the others Bethlehem.

The Bethlehem Steel Company also roll H-beams in larger weights than shown in all sizes up to 14-inch x 287.5 lbs. per foot but these are only for special conditions. It is usual however, where an extra heavy column is required, to use one of the standard weights and bring it up to the required area by using rivetted cover plates.

Bethlehem Beams and Girders—These differ from manufacturers' standard sections rolled by other manufacturers. The beams have heavier flanges and lighter webs. The girders are the strongest sections rolled, for their depth, but are uneconomical where there is room for a deeper section. Tables showing properties and loading are given in the Bethlehem Handbook.

Angles, Tees and Zees–Angles are carried in stock in all sizes from ½-inch square up to 8-inch square and in all thicknesses from ⅛-inch up to 1-inch both in equal and unequal legs.

Up to 3-inch angles, the thickness varies by 1/16-inches, and weights are carried up to ⅜-inch thick. Over 3-inch to 5-inch, thicknesses are from ¼-inch, to ½-inch, varying by $\frac{1}{16}$-inches.

From 6-inch to 8-inch, the thickness starts at ⅜-inch and varies by ⅛-inches up to ¾-inch. The above variations are those usually carried in stock.

Tees and zees are used only to a limited extent for special purposes and a few of the commoner sizes only are carried in stock.

Notes about Structural Sections—

Flanges of both standard I-beams and channels have a uniform slope of 16-2/3% equivalent to 2 inches per foot.

For I-beams and channels, the enlargement of the section adds a proportional amount to the thickness of the web and the width of the flanges. All other dimensions remain unchanged.

For angles, the enlargement of the section (by separating the rolls) slightly increases the length of the legs.

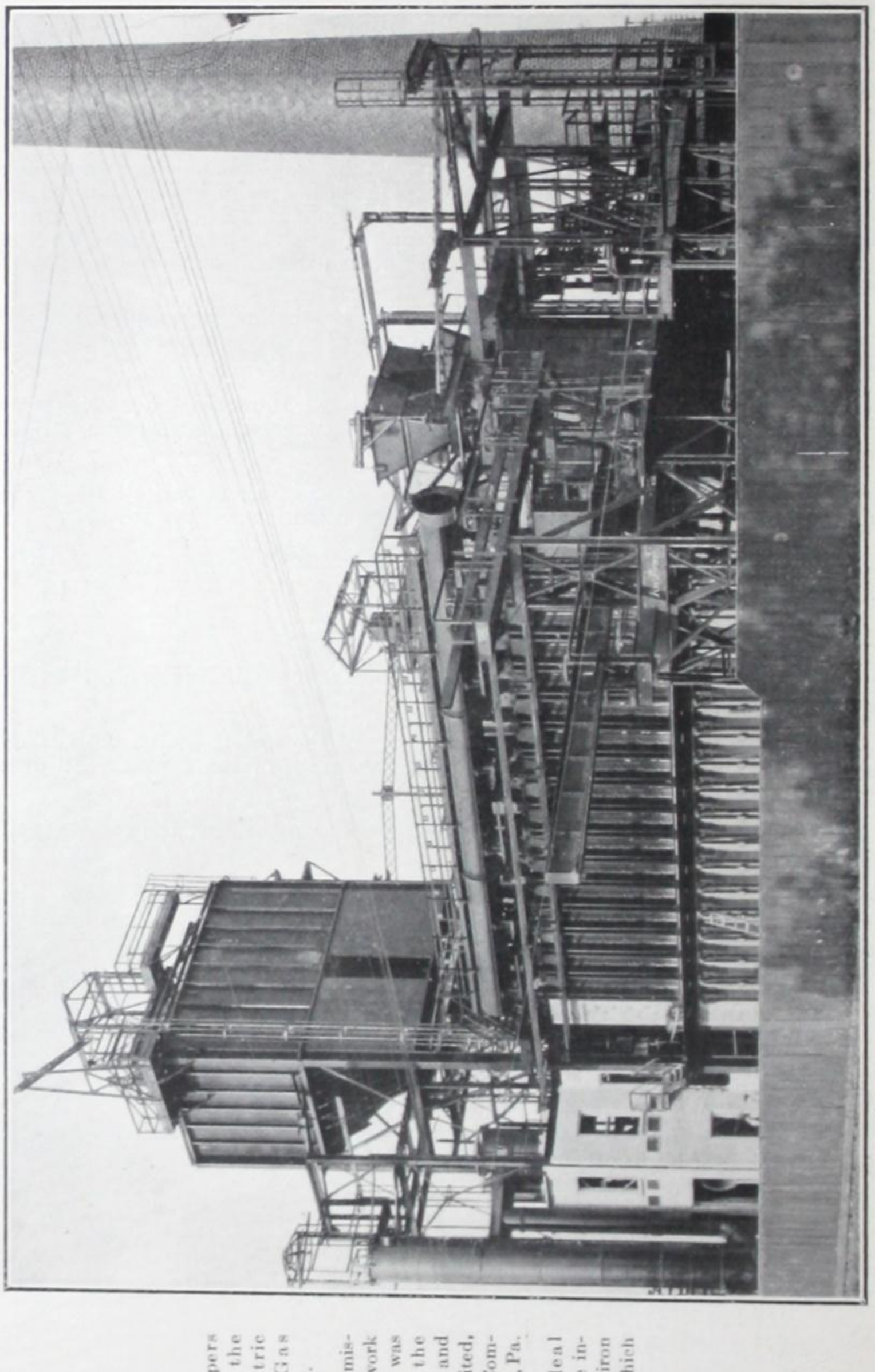
I-beams and channels should be ordered to weights given in the tables. Any weights ordered other than those shown will be furnished and charged for at the next higher weight.

Angles are rolled only to the variation in thickness and weight given in the table.

In ordering, designate either the weight or thickness wanted, but not both.

All structural sections have an allowable variation of 2½% either way from the nominal weight of the section.

All structural sections will be cut to lengths, the extreme variation not exceeding ¾-inch, unless otherwise arranged.



No. 5. — Koppers Coke Plant at the Winnipeg Electric Company's Gas Works, Winnipeg.

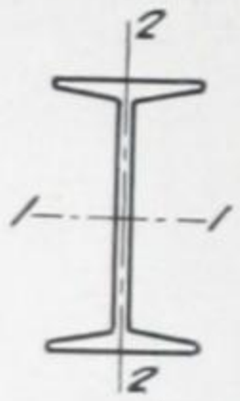
The steel and miscellaneous iron work in this building was fabricated by the Manitoba Bridge and Iron Works, Limited, for the Koppers Company of Pittsburg, Pa.

This is an ideal illustration of the industrial steel and iron fabrication in which we specialize.

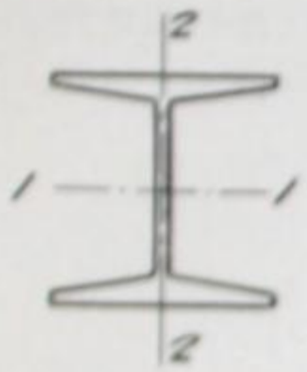
DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL BEAMS

Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2		
					I	r	S	I	r	S
In.	Lbs.	In.²	In.	In.	In.⁴	In.	In.³	In.⁴	In.	In.³
27	90.0	26.34	9.000	0.524	2958.3	10.60	219.1	75.3	1.69	16.7
24	120.0	35.13	8.048	0.798	3010.8	9.26	250.9	84.9	1.56	21.1
	115.0	33.67	7.987	0.737	2940.5	9.35	245.0	82.8	1.57	20.7
	110.0	32.18	7.925	0.675	2869.1	9.44	239.1	80.6	1.58	20.3
	105.9	30.98	7.875	0.625	2811.5	9.53	234.3	78.9	1.60	20.0
	100.0	29.25	7.247	0.747	2371.8	9.05	197.6	48.4	1.29	13.4
	95.0	27.79	7.186	0.686	2301.5	9.08	191.8	47.0	1.30	13.0
	90.0	26.30	7.124	0.624	2230.1	9.21	185.8	45.5	1.32	12.8
	85.0	24.84	7.063	0.563	2159.8	9.33	180.0	44.2	1.33	12.5
	79.9	23.33	7.000	0.500	2087.2	9.46	173.9	42.9	1.36	12.2
	74.2	21.70	9.000	0.476	1950.1	9.48	162.5	61.2	1.68	13.6
21	60.4	17.68	8.250	0.428	1235.5	8.36	117.7	43.5	1.57	10.6
20	100.0	29.20	7.273	0.873	1648.3	7.51	164.8	52.4	1.34	14.4
	95.0	27.74	7.200	0.800	1599.7	7.59	160.0	50.5	1.35	14.0
	90.0	26.26	7.126	0.726	1550.3	7.68	155.0	48.7	1.36	13.7
	85.0	24.80	7.053	0.653	1501.7	7.78	150.2	47.0	1.38	13.3
	81.4	23.74	7.000	0.600	1466.3	7.86	146.6	45.8	1.39	13.1
	75.0	21.90	6.391	0.641	1263.5	7.60	126.3	30.1	1.17	9.4
	70.0	20.42	6.317	0.567	1214.2	7.71	121.4	28.9	1.19	9.2
	65.4	19.08	6.250	0.500	1169.5	7.83	116.9	27.9	1.21	8.9
18	90.0	26.29	7.236	0.796	1256.5	6.91	139.6	51.9	1.40	14.3
	85.0	24.81	7.154	0.714	1216.6	7.00	135.2	49.8	1.42	14.0
	80.0	23.34	7.072	0.632	1176.8	7.10	130.8	47.9	1.43	13.6
	75.6	22.04	7.000	0.560	1141.8	7.20	126.9	46.3	1.45	13.2
	70.0	20.46	6.251	0.711	917.5	6.70	101.9	24.4	1.09	7.8
	65.0	18.98	6.169	0.629	877.7	6.80	97.5	23.4	1.11	7.6
	60.0	17.50	6.087	0.547	837.8	6.92	93.1	22.3	1.13	7.3
	54.7	15.94	6.000	0.460	795.5	7.07	88.4	21.2	1.15	7.1
	48.2	14.09	7.500	0.380	737.1	7.23	81.9	30.0	1.46	8.0
15	75.0	21.85	6.278	0.868	687.2	5.61	91.6	30.6	1.18	9.8
	70.0	20.38	6.180	0.770	659.6	5.69	87.9	28.8	1.19	9.3
	65.0	18.91	6.082	0.672	632.1	5.78	84.3	27.2	1.20	8.9
	60.8	17.68	6.000	0.590	609.0	5.87	81.2	26.0	1.21	8.7
	55.0	16.06	5.738	0.648	508.7	5.63	67.8	17.0	1.03	5.9
	50.0	14.59	5.640	0.550	481.1	5.74	64.2	16.0	1.05	5.7
	45.0	13.12	5.542	0.452	453.6	5.88	60.5	15.0	1.07	5.4
	42.9	12.49	5.500	0.410	441.8	5.95	58.9	14.6	1.08	5.3
	27.3	10.91	6.750	0.332	405.5	6.10	54.1	19.9	1.35	5.9

DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL BEAMS



Depth of Beam	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2		
					I	r	S	I	r	S
In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.	In.^{3}	In.^{4}	In.	In.^{3}
12	55.0	16.04	5.600	0.810	319.3	4.46	53.2	17.3	1.04	6.2
	50.0	14.57	5.477	0.687	301.6	4.55	50.3	16.0	1.05	5.8
	45.0	13.10	5.255	0.565	284.1	4.66	47.3	14.8	1.06	5.5
	40.8	11.84	5.250	0.460	268.9	4.77	44.8	13.8	1.08	5.3
	35.0	10.20	5.078	0.428	227.0	4.72	37.8	10.0	0.99	3.9
	31.8	9.26	5.000	0.350	215.8	4.83	36.0	9.5	1.01	3.8
	27.9	8.15	6.000	0.284	199.4	4.95	33.2	12.6	1.24	4.2
10	40.0	11.69	5.091	0.741	158.0	3.68	31.6	9.4	0.90	3.7
	35.0	10.22	4.944	0.594	145.8	3.78	29.2	8.5	0.91	3.4
	30.0	8.75	4.797	0.447	133.5	3.91	26.7	7.6	0.93	3.2
	25.4	7.38	4.660	0.310	122.1	4.07	24.4	6.9	0.97	3.0
	22.4	6.54	5.500	0.252	113.6	4.17	22.7	9.0	1.17	3.3
9	35.0	10.22	4.764	0.724	111.3	3.30	24.7	7.3	0.84	3.0
	30.0	8.76	4.601	0.561	101.4	3.40	22.5	6.4	0.85	2.8
	25.0	7.28	4.437	0.397	91.4	3.54	20.3	5.6	0.88	2.5
	21.8	6.32	4.330	0.290	84.9	3.67	18.9	5.2	0.90	2.4
8	25.5	7.43	4.262	0.522	68.1	3.03	17.0	4.7	0.80	2.2
	23.0	6.71	4.171	0.441	64.2	3.09	16.0	4.4	0.81	2.1
	20.5	5.97	4.079	0.349	60.2	3.18	15.1	4.0	0.82	2.0
	18.4	5.34	4.000	0.270	56.9	3.26	14.2	3.8	0.84	1.9
	17.5	5.13	5.000	0.220	58.4	3.38	14.6	6.2	1.10	2.5
7	20.0	5.83	3.860	0.450	41.9	2.68	12.0	3.1	0.74	1.6
	17.5	5.09	3.755	0.345	38.9	2.77	11.1	2.9	0.76	1.6
	15.3	4.43	3.660	0.250	36.2	2.86	10.4	2.7	0.78	1.5
6	17.25	5.02	3.565	0.465	26.0	2.28	8.7	2.3	0.68	1.3
	14.75	4.29	3.443	0.343	23.8	2.36	7.9	2.1	0.69	1.2
	12.5	3.61	3.330	0.230	21.8	2.46	7.3	1.8	0.72	1.1
5	14.75	4.29	3.284	0.494	15.0	1.87	6.0	1.7	0.63	1.0
	12.25	3.56	3.137	0.347	13.5	1.95	5.4	1.4	0.63	0.91
	10.0	2.87	3.000	0.210	12.1	2.05	4.8	1.2	0.65	0.82
4	10.5	3.05	2.870	0.400	7.1	1.52	3.5	1.0	0.57	0.70
	9.5	2.76	2.796	0.326	6.7	1.56	3.3	0.91	0.58	0.65
	8.5	2.46	2.723	0.253	6.3	1.60	3.2	0.83	0.58	0.61
	7.7	2.21	2.660	0.190	6.0	1.64	3.0	0.77	0.59	0.58
3	7.5	2.17	2.509	0.349	2.9	1.15	1.9	0.59	0.52	0.47
	6.5	1.88	2.411	0.251	2.7	1.19	1.8	0.51	0.52	0.43
	5.7	1.64	2.330	0.170	2.5	1.23	1.7	0.46	0.53	0.40



DIMENSIONS, WEIGHTS, ELEMENTS AND SAFE LOADS OF

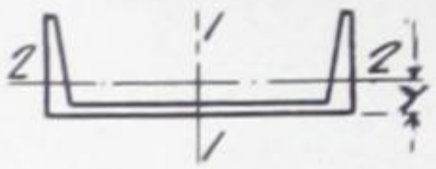
H- AND I-BEAM COLUMNS

Safe Loads in Thousands of Pounds

Allowable fiber stress per square inch:
13,000 pounds for lengths of 60 radii or under, reduced for lengths over 60 radii. Weights do not include details.

Effective Length in Feet	I-Beams					H-Beams							
	8 in.	7 in.	6 in.	5 in.	4 in.	8 in.			6 in.			5 in.	4 in.
	18.4 lb.	15.3 lb.	12.5 lb.	10.0 lb.	7.7 lb.	37.7 lb.	34.3 lb.	32.6 lb.	26.7 lb.	24.1 lb.	22.8 lb.	18.9 lb.	13.8 lb.
3	69.3	57.5	46.9	37.3	**28.5**	143.0	130.0	123.6	100.9	91.1	86.2	71.1	51.9
4	69.3	**56.7**	**44.4**	**33.5**	**24.0**	143.0	130.0	123.6	100.9	91.1	86.2	71.1	51.9
5	**63.3**	**49.9**	**38.3**	**28.2**	**19.5**	143.0	130.0	123.6	100.9	91.1	86.2	71.1	**50.5**
6	**55.7**	**43.1**	*32.3*	**22.9**	*15.2*	143.0	130.0	123.6	100.9	91.1	86.2	71.1	**45.5**
7	**48.1**	**36.2**	**26.2**	*18.9*	*13.0*	143.0	130.0	123.6	100.9	91.1	86.2	**65.6**	**40.4**
8	**40.5**	*30.2*	*22.7*	*16.3*	*10.8*	143.0	130.0	123.6	**95.1**	**86.7**	**82.5**	**60.1**	**35.3**
9	*35.1*	*26.8*	*19.7*	*13.6*	*8.5*	143.0	130.0	123.6	**88.5**	**80.9**	**77.1**	**54.6**	**30.3**
10	*31.3*	*23.4*	*16.7*	*11.0*	*6.3*	**136.9**	**126.0**	**120.5**	**82.0**	**75.1**	**71.7**	**49.1**	*26.6*
11	*27.6*	*19.9*	*13.6*	*8.3*	.....	**129.7**	**119.6**	**114.5**	**75.4**	**69.3**	**66.2**	**43.7**	*24.0*
12	*23.7*	*16.5*	*10.6*	.....	.....	**122.5**	**113.2**	**108.5**	**68.9**	**63.5**	**60.8**	**38.2**	*21.5*
13	*19.9*	*13.1*	.....	.....	.....	**115.3**	**106.8**	**102.5**	**62.4**	**57.6**	**55.4**	*33.5*	*19.0*
14	*16.1*	.....	.....	.....	.....	**108.1**	**100.4**	**96.5**	**55.8**	**51.8**	**49.9**	*32.7*	*16.4*
15	.....	.....	.....	.....	.....	**100.9**	**93.9**	**90.4**	*51.8*	*47.5*	*45.5*	*30.0*	*13.9*
16	.....	.....	.....	.....	.....	**93.7**	**87.5**	**84.4**	*48.5*	*44.6*	*42.7*	*27.3*	.....
17	.....	.....	.....	.....	.....	**86.4**	**81.1**	**78.4**	*45.2*	*41.7*	*40.0*	*24.5*	.....
18	.....	.....	.....	.....	.....	**79.2**	**74.7**	**72.4**	*42.0*	*38.8*	*37.3*	*21.8*	.....
19	.....	.....	.....	.....	.....	*74.5*	*69.2*	*66.5*	*38.7*	*35.9*	*34.6*	*19.1*	.....
20	.....	.....	.....	.....	.....	*70.9*	*66.0*	*63.5*	*35.4*	*33.0*	*31.9*	*16.3*	.....
21	.....	.....	.....	.....	.....	*67.3*	*62.8*	*60.5*	*32.2*	*30.1*	*29.2*	.....	.....
22	.....	.....	.....	.....	.....	*63.7*	*59.6*	*57.5*	*28.9*	*27.2*	*26.5*	.....	.....
23	.....	.....	.....	.....	.....	*60.1*	*56.4*	*54.4*	*25.6*	*24.3*	*23.7*	.....	.....
24	.....	.....	.....	.....	.....	*56.5*	*53.2*	*51.4*	*22.3*	*21.4*	*21.0*	.....	.....
25	.....	.....	.....	.....	.....	*52.9*	*50.0*	*48.4*	.....	.....	.....	.....	.....
26	.....	.....	.....	.....	.....	*49.3*	*46.8*	*45.4*	.....	.....	.....	.....	.....
27	.....	.....	.....	.....	.....	*45.7*	*43.6*	*42.4*	.....	.....	.....	.....	.....
28	.....	.....	.....	.....	.....	*42.1*	*40.4*	*39.4*	.....	.....	.....	.....	.....
29	.....	.....	.....	.....	.....	*38.5*	*37.2*	*36.4*	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	*34.9*	*33.9*	*33.4*	.....	.....	.....	.....	.....
Area, in.^{2}	5.34	4.43	3.61	2.87	2.21	11.00	10.00	9.50	7.76	7.01	6.63	5.47	3.99
$I_{1\text{-}1}$, in.^{4}	56.9	36.2	21.8	12.1	6.0	120.8	115.5	112.8	47.4	45.1	44.0	23.8	10.7
$r_{1\text{-}1}$, in.	3.26	2.86	2.46	2.05	1.64	3.31	3.40	3.45	2.47	2.54	2.58	2.08	1.64
$I_{2\text{-}2}$, in.^{4}	3.8	2.7	1.8	1.2	0.77	36.9	35.1	34.2	15.7	14.7	14.2	7.8	3.6
$r_{2\text{-}2}$, in.	0.84	0.78	0.72	0.65	0.59	1.83	1.87	1.50	1.42	1.45	1.46	1.20	0.95
Weight, Lbs. per Foot	18.4	15.3	12.5	10.0	7.7	37.7	34.3	32.6	26.7	24.1	22.8	18.9	13.8

Safe load values in "light" type are for ratios of l/r not over 60; in "**heavy**" type are for ratios up to 120 l/r; in "*italic*" type are for ratios not over 200 l/r.

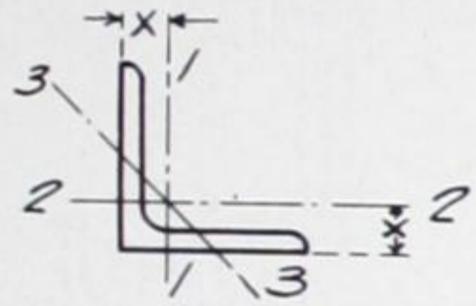


DIMENSIONS, WEIGHTS AND ELEMENTS OF STRUCTURAL CHANNELS

American Standard Sections

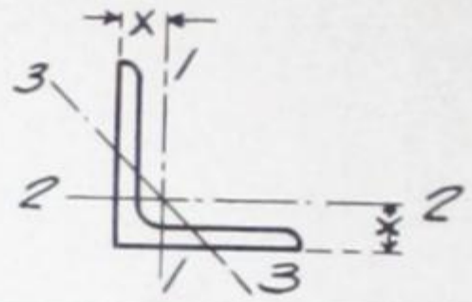
Depth of Channel	Weight per Foot	Area of Section	Width of Flange	Thickness of Web	Axis 1-1			Axis 2-2			
					I	r	S	I	r	S	y
In.	Lbs.	In.^{2}	In.	In.	In.^{4}	In.	In.^{3}	In.^{4}	In.	In.^{3}	In.
15	55.0	16.11	3.814	0.814	429.0	5.16	57.2	12.1	0.87	4.1	0.82
	50.0	14.64	3.716	0.716	401.4	5.24	53.6	11.2	0.87	3.8	0.80
	45.0	13.17	3.618	0.618	373.9	5.33	49.8	10.3	0.88	3.6	0.79
	40.0	11.70	3.520	0.520	346.3	5.44	46.2	9.3	0.89	3.4	0.78
	35.0	10.23	3.422	0.422	318.7	5.58	42.5	8.4	0.91	3.2	0.79
	33.9	9.90	3.400	0.400	312.6	5.62	41.7	8.2	0.91	3.2	0.79
12	40.0	11.73	3.415	0.755	196.5	4.09	32.8	6.6	0.75	2.5	0.72
	35.0	10.26	3.292	0.632	178.8	4.18	29.8	5.9	0.76	2.3	0.69
	30.0	8.79	3.170	0.510	161.2	4.28	26.9	5.2	0.77	2.1	0.68
	25.0	7.32	3.047	0.387	143.5	4.43	23.9	4.5	0.79	1.9	0.68
	20.7	6.03	2.940	0.280	128.1	4.61	21.4	3.9	0.81	1.7	0.70
10	35.0	10.27	3.180	0.820	115.2	3.34	23.0	4.6	0.67	1.9	0.69
	30.0	8.80	3.033	0.673	103.0	3.42	20.6	4.0	0.67	1.7	0.65
	25.0	7.33	2.886	0.526	90.7	3.52	18.1	3.4	0.68	1.5	0.62
	20.0	5.86	2.739	0.379	78.5	3.66	15.7	2.8	0.70	1.3	0.61
	15.3	4.47	2.600	0.240	66.9	3.87	13.4	2.3	0.72	1.2	0.64
9	25.0	7.33	2.812	0.612	70.5	3.10	15.7	3.0	0.64	1.4	0.61
	20.0	5.86	2.648	0.448	60.6	3.22	13.5	2.4	0.65	1.2	0.59
	15.0	4.39	2.485	0.285	50.7	3.40	11.3	1.9	0.67	1.0	0.59
	13.4	3.89	2.430	0.230	47.3	3.49	10.5	1.8	0.67	0.97	0.61
8	21.25	6.23	2.619	0.579	47.6	2.77	11.9	2.2	0.60	1.1	0.59
	18.75	5.49	2.527	0.487	43.7	2.82	10.9	2.0	0.60	1.0	0.57
	16.25	4.76	2.435	0.395	39.8	2.89	9.9	1.8	0.61	0.94	0.56
	13.75	4.02	2.343	0.303	35.8	2.99	9.0	1.5	0.62	0.86	0.56
	11.5	3.36	2.260	0.220	32.3	3.10	8.1	1.3	0.63	0.79	0.58
7	19.75	5.79	2.509	0.629	33.1	2.39	9.4	1.8	0.56	0.96	0.58
	17.25	5.05	2.404	0.524	30.1	2.44	8.6	1.6	0.56	0.86	0.55
	14.75	4.32	2.299	0.419	27.1	2.51	7.7	1.4	0.57	0.79	0.53
	12.25	3.58	2.194	0.314	24.1	2.59	6.9	1.2	0.58	0.71	0.53
	9.8	2.85	2.090	0.210	21.1	2.72	6.0	0.98	0.59	0.63	0.55
6	15.5	4.54	2.279	0.559	19.5	2.07	6.5	1.3	0.53	0.73	0.55
	13.0	3.81	2.157	0.437	17.3	2.13	5.8	1.1	0.53	0.65	0.52
	10.5	3.07	2.034	0.314	15.1	2.22	5.0	0.87	0.53	0.57	0.50
	8.2	2.39	1.920	0.200	13.0	2.34	4.3	0.70	0.54	0.50	0.52
5	11.5	3.36	2.032	0.472	10.4	1.76	4.1	0.82	0.49	0.54	0.51
	9.0	2.63	1.885	0.325	8.8	1.83	3.5	0.64	0.49	0.45	0.48
	6.7	1.95	1.750	0.190	7.4	1.95	3.0	0.48	0.50	0.38	0.49
4	7.25	2.12	1.720	0.320	4.5	1.47	2.3	0.44	0.46	0.35	0.46
	6.25	1.82	1.647	0.247	4.1	1.50	2.1	0.38	0.45	0.32	0.46
	5.4	1.56	1.580	0.180	3.8	1.56	1.9	0.32	0.45	0.29	0.46
3	6.0	1.75	1.596	0.356	2.1	1.08	1.4	0.31	0.42	0.27	0.46
	5.0	1.46	1.498	0.258	1.8	1.12	1.2	0.25	0.41	0.24	0.44
	4.1	1.19	1.410	0.170	1.6	1.17	1.1	0.20	0.41	0.21	0.44

DIMENSIONS, WEIGHTS AND ELEMENTS OF
EQUAL ANGLES



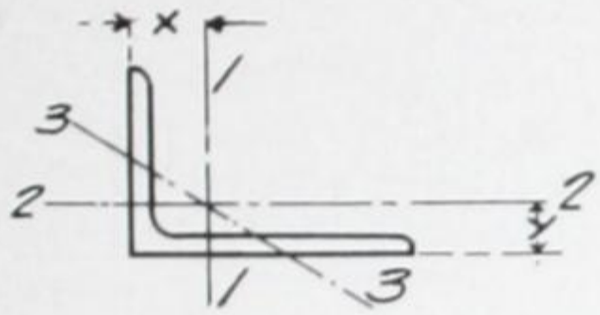
Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2				Axis 3-3
				I	r	S	x	$r^{min.}$
In.	In.	Lbs.	In.²	In.⁴	In.	In.³	In.	In.
8 x 8	1 1/8	56.9	16.73	98.0	2.42	17.5	2.41	1.55
	1 1/16	54.0	15.87	93.5	2.43	16.7	2.39	1.56
	1	51.0	15.00	89.0	2.44	15.8	2.37	1.56
	15/16	48.1	14.12	84.3	2.44	14.9	2.34	1.56
	7/8	45.0	13.23	79.6	2.45	14.0	2.32	1.56
	13/16	42.0	12.34	74.7	2.46	13.1	2.30	1.57
	3/4	38.9	11.44	69.7	2.47	12.2	2.28	1.57
	11/16	35.8	10.53	64.6	2.48	11.2	2.25	1.58
	5/8	32.7	9.61	59.4	2.49	10.3	2.23	1.58
	9/16	29.6	8.68	54.1	2.50	9.3	2.21	1.58
	1/2	26.4	7.75	48.6	2.51	8.4	2.19	1.58
6 x 6	1	37.4	11.00	35.5	1.80	8.6	1.86	1.16
	15/16	35.3	10.37	33.7	1.80	8.1	1.84	1.16
	7/8	33.1	9.73	31.9	1.81	7.6	1.82	1.17
	13/16	31.0	9.09	30.1	1.82	7.2	1.80	1.17
	3/4	28.7	8.44	28.2	1.83	6.7	1.78	1.17
	11/16	26.5	7.78	26.2	1.83	6.2	1.75	1.17
	5/8	24.2	7.11	24.2	1.84	5.7	1.73	1.17
	9/16	21.9	6.43	22.1	1.85	5.1	1.71	1.18
	1/2	19.6	5.75	19.9	1.86	4.6	1.68	1.18
	7/16	17.2	5.06	17.7	1.87	4.1	1.66	1.19
	3/8	14.9	4.36	15.4	1.88	3.5	1.64	1.19
5 x 5	1	30.6	9.00	19.6	1.48	5.8	1.61	0.96
	15/16	28.9	8.50	18.7	1.48	5.5	1.59	0.96
	7/8	27.2	7.98	17.8	1.49	5.2	1.57	0.96
	13/16	25.4	7.47	16.8	1.50	4.9	1.55	0.97
	3/4	23.6	6.94	15.7	1.50	4.5	1.52	0.97
	11/16	21.8	6.40	14.7	1.51	4.2	1.50	0.97
	5/8	20.0	5.86	13.6	1.52	3.9	1.48	0.97
	9/16	18.1	5.31	12.4	1.53	3.5	1.46	0.98
	1/2	16.2	4.75	11.3	1.54	3.2	1.43	0.98
	7/16	14.3	4.18	10.0	1.55	2.8	1.41	0.98
	3/8	12.3	3.61	8.7	1.56	2.4	1.39	0.99
4 x 4	13/16	19.9	5.84	8.1	1.18	3.0	1.29	0.77
	3/4	18.5	5.44	7.7	1.19	2.8	1.27	0.77
	11/16	17.1	5.03	7.2	1.19	2.6	1.25	0.77
	5/8	15.7	4.61	6.7	1.20	2.4	1.23	0.77
	9/16	14.3	4.18	6.1	1.21	2.2	1.21	0.78
	1/2	12.8	3.75	5.6	1.22	2.0	1.18	0.78
	7/16	11.3	3.31	5.0	1.23	1.8	1.16	0.78
	3/8	9.8	2.86	4.4	1.23	1.5	1.14	0.79
	5/16	8.2	2.40	3.7	1.24	1.3	1.12	0.79
	1/4	6.6	1.94	3.0	1.25	1.0	1.09	0.79

DIMENSIONS, WEIGHTS AND ELEMENTS OF
EQUAL ANGLES



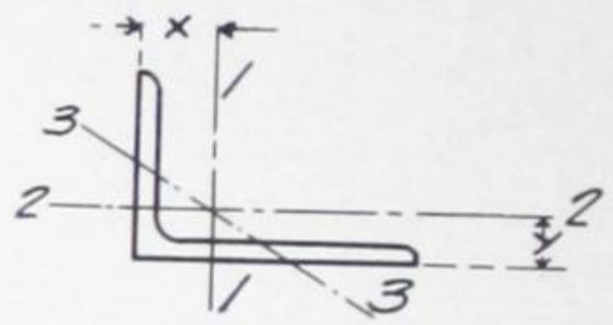
Size	Thickness	Weight per Foot	Area of Section	Axis 1-1 and Axis 2-2				Axis 3-3
				I	r	S	x	$r_{min.}$
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.
$3\frac{1}{2}$ x $3\frac{1}{2}$	$\frac{3}{4}$	16.0	4.69	5.0	1.03	2.1	1.15	0.67
	$\frac{5}{8}$	13.6	3.98	4.3	1.04	1.8	1.10	0.68
	$\frac{1}{2}$	11.1	3.25	3.6	1.06	1.5	1.06	0.68
	$\frac{7}{16}$	9.8	2.87	3.3	1.07	1.3	1.04	0.68
	$\frac{3}{8}$	8.5	2.48	2.9	1.07	1.2	1.01	0.69
	$\frac{5}{16}$	7.2	2.09	2.5	1.08	0.98	0.99	0.69
	$\frac{1}{4}$	5.8	1.69	2.0	1.09	0.79	0.97	0.69
3 x 3	$\frac{5}{8}$	11.5	3.36	2.6	0.88	1.3	0.98	0.57
	$\frac{1}{2}$	9.4	2.75	2.2	0.90	1.1	0.93	0.58
	$\frac{7}{16}$	8.3	2.43	2.0	0.91	0.95	0.91	0.58
	$\frac{3}{8}$	7.2	2.11	1.8	0.91	0.83	0.89	0.58
	$\frac{5}{16}$	6.1	1.78	1.5	0.92	0.71	0.87	0.59
	$\frac{1}{4}$	4.9	1.44	1.2	0.93	0.58	0.84	0.59
$2\frac{1}{2}$ x $2\frac{1}{2}$	$\frac{1}{2}$	7.7	2.25	1.2	0.74	0.73	0.81	0.47
	$\frac{3}{8}$	5.9	1.73	0.98	0.75	0.57	0.76	0.48
	$\frac{5}{16}$	5.0	1.47	0.85	0.76	0.48	0.74	0.49
	$\frac{1}{4}$	4.1	1.19	0.70	0.77	0.39	0.72	0.49
	$\frac{3}{16}$	3.07	0.90	0.55	0.78	0.30	0.69	0.49
	$\frac{1}{8}$	2.08	0.61	0.38	0.79	0.20	0.67	0.50
2 x 2	$\frac{3}{8}$	4.7	1.36	0.48	0.59	0.35	0.64	0.39
	$\frac{5}{16}$	3.92	1.15	0.42	0.60	0.30	0.61	0.39
	$\frac{1}{4}$	3.19	0.94	0.35	0.61	0.25	0.59	0.39
	$\frac{3}{16}$	2.44	0.71	0.28	0.62	0.19	0.57	0.40
	$\frac{1}{8}$	1.65	0.48	0.19	0.63	0.13	0.55	0.40
$1\frac{3}{4}$ x $1\frac{3}{4}$	$\frac{3}{8}$	3.99	1.17	0.31	0.51	0.26	0.57	0.34
	$\frac{5}{16}$	3.39	1.00	0.27	0.52	0.23	0.55	0.34
	$\frac{1}{4}$	2.77	0.81	0.23	0.53	0.19	0.53	0.34
	$\frac{3}{16}$	2.12	0.62	0.18	0.54	0.14	0.51	0.35
	$\frac{1}{8}$	1.44	0.42	0.13	0.55	0.10	0.48	0.35
$1\frac{1}{2}$ x $1\frac{1}{2}$	$\frac{3}{8}$	3.35	0.98	0.19	0.44	0.19	0.51	0.29
	$\frac{5}{16}$	2.86	0.84	0.16	0.44	0.16	0.49	0.29
	$\frac{1}{4}$	2.34	0.69	0.14	0.45	0.13	0.47	0.29
	$\frac{3}{16}$	1.80	0.53	0.11	0.46	0.10	0.44	0.29
	$\frac{1}{8}$	1.23	0.36	0.08	0.46	0.07	0.42	0.30
$1\frac{1}{4}$ x $1\frac{1}{4}$	$\frac{1}{4}$	1.92	0.56	0.08	0.37	0.09	0.40	0.24
	$\frac{3}{16}$	1.48	0.43	0.06	0.38	0.07	0.38	0.24
	$\frac{1}{8}$	1.01	0.30	0.04	0.38	0.05	0.35	0.25
1 x 1	$\frac{1}{4}$	1.49	0.44	0.04	0.29	0.06	0.34	0.19
	$\frac{3}{16}$	1.16	0.34	0.03	0.30	0.04	0.32	0.19
	$\frac{1}{8}$	0.80	0.23	0.02	0.31	0.03	0.30	0.19

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



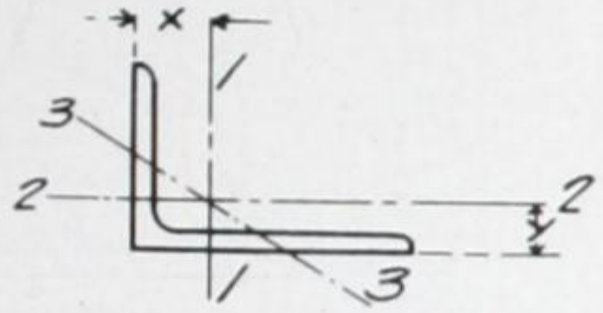
Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	r_{min}
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.^{4}	In.	In.^{3}	In.	In.
8 x 6	1	44.2	13.00	80.8	2.49	15.1	2.65	38.8	1.73	8.9	1.65	1.28
	15/16	41.7	12.25	76.6	2.50	14.3	2.63	36.8	1.73	8.4	1.63	1.28
	7/8	39.1	11.48	72.3	2.51	13.4	2.61	34.9	1.74	7.9	1.61	1.28
	13/16	36.5	10.72	67.9	2.52	12.5	2.59	32.8	1.75	7.4	1.59	1.29
	3/4	33.8	9.94	63.4	2.53	11.7	2.56	30.7	1.76	6.9	1.56	1.29
	11/16	31.2	9.15	58.8	2.54	10.8	2.54	28.6	1.77	6.4	1.54	1.29
	5/8	28.5	8.36	54.1	2.54	9.9	2.52	26.3	1.77	5.9	1.52	1.30
	9/16	25.7	7.56	49.3	2.55	8.9	2.50	24.0	1.78	5.3	1.50	1.30
	1/2	23.0	6.75	44.3	2.56	8.0	2.47	21.7	1.79	4.8	1.47	1.30
	7/16	20.2	5.93	39.2	2.57	7.1	2.45	19.3	1.80	4.2	1.45	1.30
8 x 3½	1	35.7	10.50	66.2	2.51	13.7	3.17	7.8	0.86	3.0	0.92	0.73
	15/16	33.7	9.90	62.9	2.52	12.9	3.14	7.4	0.87	2.9	0.89	0.73
	7/8	31.7	9.30	59.4	2.53	12.2	3.12	7.1	0.87	2.7	0.87	0.73
	13/16	29.6	8.68	55.9	2.54	11.4	3.10	6.7	0.88	2.5	0.85	0.73
	3/4	27.5	8.06	52.3	2.55	10.6	3.07	6.3	0.88	2.3	0.82	0.73
	11/16	25.3	7.43	48.5	2.56	9.8	3.05	5.9	0.89	2.2	0.80	0.73
	5/8	23.2	6.80	44.7	2.57	9.0	3.03	5.4	0.90	2.0	0.78	0.74
	9/16	21.0	6.15	40.8	2.57	8.2	3.00	5.0	0.90	1.8	0.75	0.74
	1/2	18.7	5.50	36.7	2.58	7.3	2.98	4.5	0.91	1.6	0.73	0.74
	7/16	16.5	4.84	32.5	2.59	6.4	2.95	4.1	0.92	1.5	0.70	0.74
7 x 3½	1	32.3	9.50	45.4	2.19	10.6	2.71	7.5	0.89	3.0	0.96	0.74
	15/16	30.5	8.97	43.1	2.19	10.0	2.69	7.2	0.89	2.8	0.94	0.74
	7/8	28.7	8.42	40.8	2.20	9.4	2.66	6.8	0.90	2.6	0.91	0.74
	13/16	26.8	7.87	38.4	2.21	8.8	2.64	6.5	0.91	2.5	0.89	0.74
	3/4	24.9	7.31	36.0	2.22	8.2	2.62	6.1	0.91	2.3	0.87	0.74
	11/16	23.0	6.75	33.5	2.23	7.6	2.60	5.7	0.92	2.1	0.85	0.74
	5/8	21.0	6.17	30.9	2.24	7.0	2.57	5.3	0.93	2.0	0.82	0.75
	9/16	19 1	5.59	28.2	2.25	6.3	2.55	4.9	0.93	1.8	0.80	0.75
	1/2	17.0	5.00	25.4	2.25	5.7	2.53	4.4	0.94	1.6	0.78	0.75
	7/16	15.0	4.40	22.6	2.26	5.0	2.50	4.0	0.95	1.4	0.75	0.76
	3/8	13.0	3.80	19.6	2.27	4.3	2.48	3.5	0.96	1.3	0.73	0.76
6 x 4	1	30.6	9.00	30.8	1.85	8.0	2.17	10.8	1.09	3.8	1.17	0.85
	15/16	28.9	8.50	29.3	1.86	7.6	2.14	10.3	1.10	3.6	1.14	0.85
	7/8	27.2	7.98	27.7	1.86	7.2	2.12	9.8	1.11	3.4	1.12	0.86
	13/16	25.4	7.47	26.1	1.87	6.7	2.10	9.2	1.11	3.2	1.10	0.86
	3/4	23.6	6.94	24.5	1.88	6.2	2.08	8.7	1.12	3.0	1.08	0.86
	11/16	21.8	6.40	22.8	1.89	5.8	2.06	8.1	1.13	2.8	1.06	0.86
	5/8	20.0	5.86	21.1	1.90	5.3	2.03	7.5	1.13	2.5	1.03	0.86
	9/16	18.1	5.31	19.3	1.90	4.8	2.01	6.9	1.14	2.3	1:01	0.87
	1/2	16.2	4.75	17.4	1.91	4.3	1.99	6.3	1.15	2.1	0.99	0.87
	7/16	14.3	4.18	15.5	1.92	3.8	1.96	5.6	1.16	1.8	0.96	0.87
	3/8	12.3	3.61	13.5	1.93	3.3	1.94	4.9	1.17	1.6	0.94	0.88

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



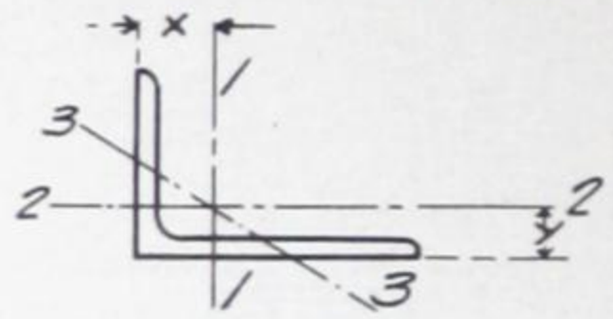
Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r_{min.}$
In.	In.	Lbs.	In.²	In.⁴	In.	In.³	In.	In.⁴	In.	In.³	In.	In.
6 x 3½	1	28.9	8.50	29.2	1.85	7.8	2.26	7.2	0.92	2.9	1.01	0.74
	15/16	27.3	8.03	27.8	1.86	7.4	2.24	6.9	0.93	2.7	0.99	0.74
	7/8	25.7	7.55	26.4	1.87	7.0	2.22	6.6	0.93	2.6	0.97	0.75
	13/16	24.0	7.06	24.9	1.88	6.6	2.20	6.2	0.94	2.4	0.95	0.75
	3/4	22.4	6.56	23.3	1.89	6.1	2.18	5.8	0.94	2.3	0.93	0.75
	11/16	20.6	6.06	21.7	1.89	5.6	2.15	5.5	0.95	2.1	0.90	0.75
	5/8	18.9	5.55	20.1	1.90	5.2	2.13	5.1	0.96	1.9	0.88	0.75
	9/16	17.1	5.03	18.4	1.91	4.7	2.11	4.7	0.96	1.8	0.86	0.75
	1/2	15.3	4.50	16.6	1.92	4.2	2.08	4.3	0.97	1.6	0.83	0.76
	7/16	13.5	3.97	14.8	1.93	3.7	2.06	3.8	0.98	1.4	0.81	0.76
	3/8	11.7	3.42	12.9	1.94	3.3	2.04	3.3	0.99	1.2	0.79	0.77
	5/16	9.8	2.87	10.9	1.95	2.7	2.01	2.9	1.00	1.0	0.76	0.77
5 x 4	7/8	24.2	7.11	16.4	1.52	5.0	1.71	9.2	1.14	3.3	1.21	0.84
	13/16	22.7	6.65	15.5	1.53	4.7	1.68	8.7	1.15	3.1	1.18	0.84
	3/4	21.1	6.19	14.6	1.54	4.4	1.66	8.2	1.15	2.9	1.16	0.84
	11/16	19.5	5.72	13.6	1.54	4.1	1.64	7.7	1.16	2.7	1.14	0.84
	5/8	17.8	5.23	12.6	1.55	3.7	1.62	7.1	1.17	2.5	1.12	0.84
	9/16	16.2	4.75	11.6	1.56	3.4	1.60	6.6	1.18	2.3	1.10	0.85
	1/2	14.5	4.25	10.5	1.57	3.1	1.57	6.0	1.18	2.0	1.07	0.85
	7/16	12.8	3.75	9.3	1.58	2.7	1.55	5.3	1.19	1.8	1.05	0.85
	3/8	11.0	3.23	8.1	1.59	2.3	1.53	4.7	1.20	1.6	1.03	0.86
5 x 3½	7/8	22.7	6.67	15.7	1.53	4.9	1.79	6.2	0.96	2.5	1.04	0.75
	13/16	21.3	6.25	14.8	1.54	4.6	1.77	5.9	0.97	2.4	1.02	0.75
	3/4	19.8	5.81	13.9	1.55	4.3	1.75	5.6	0.98	2.2	1.00	0.75
	11/16	18.3	5.37	13.0	1.56	4.0	1.72	5.2	0.98	2.1	0.97	0.75
	5/8	16.8	4.92	12.0	1.56	3.7	1.70	4.8	0.99	1.9	0.95	0.75
	9/16	15.2	4.47	11.0	1.57	3.3	1.68	4.4	1.00	1.7	0.93	0.75
	1/2	13.6	4.00	10.0	1.58	3.0	1.66	4.0	1.01	1.6	0.91	0.75
	7/16	12.0	3.53	8.9	1.59	2.6	1.63	3.6	1.01	1.4	0.88	0.76
	3/8	10.4	3.05	7.8	1.60	2.3	1.61	3.2	1.02	1.2	0.86	0.76
	5/16	8.7	2.56	6.6	1.61	1.9	1.59	2.7	1.03	1.0	0.84	0.76
5 x 3	13/16	19.9	5.84	14.0	1.55	4.5	1.86	3.7	0.80	1.7	0.86	0.64
	3/4	18.5	5.44	13.2	1.55	4.2	1.84	3.5	0.80	1.6	0.84	0.64
	11/16	17.1	5.03	12.3	1.56	3.9	1.82	3.3	0.81	1.5	0.82	0.64
	5/8	15.7	4.61	11.4	1.57	3.5	1.80	3.1	0.81	1.4	0.80	0.64
	9/16	14.3	4.18	10.4	1.58	3.2	1.77	2.8	0.82	1.3	0.77	0.65
	1/2	12.8	3.75	9.5	1.59	2.9	1.75	2.6	0.83	1.1	0.75	0.65
	7/16	11.3	3.31	8.4	1.60	2.6	1.73	2.3	0.84	1.0	0.73	0.65
	3/8	9.8	2.86	7.4	1.61	2.2	1.70	2.0	0.84	0.89	0.70	0.65
	5/16	8.2	2.40	6.3	1.61	1.9	1.68	1.8	0.85	0.75	0.68	0.66

DIMENSIONS, WEIGHTS AND ELEMENTS OF
UNEQUAL ANGLES



Size	Thickness	Wt. per Foot	Area of Section	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r^{min.}$
In.	In.	Lbs.	In.^{2}	In.^{4}	In.	In.^{3}	In.	In.^{4}	In.	In.^{3}	In.	In.
4½ x 3	¾	17.3	5.06	9.7	1.39	3.4	1.63	3.4	0.82	1.6	0.88	0.64
	11/16	16.0	4.68	9.1	1.39	3.1	1.60	3.2	0.83	1.5	0.85	0.64
	⅝	14.7	4.30	8.4	1.40	2.9	1.58	3.0	0.83	1.4	0.83	0.64
	9/16	13.3	3.90	7.8	1.41	2.6	1.56	2.8	0.85	1.3	0.81	0.64
	½	11.9	3.50	7.0	1.42	2.4	1.54	2.5	0.95	1.1	0.79	0.65
	7/16	10.6	3.09	6.3	1.43	2.1	1.51	2.3	0.85	1.0	0.76	0.65
	⅜	9.1	2.67	5.5	1.44	1.8	1.49	2.0	0.86	0.88	0.74	0.66
	5/16	7.7	2.25	4.7	1.44	1.5	1.47	1.7	0.87	0.75	0.72	0.66
4 x 3½	¾	17.3	5.06	7.3	1.20	2.8	1.34	5.2	1.01	2.1	1.09	0.72
	11/16	16.0	4.68	6.9	1.21	2.6	1.32	4.9	1.02	2.0	1.07	0.72
	⅝	14.7	4.30	6.4	1.22	2.4	1.29	4.5	1.03	1.8	1.04	0.72
	9/16	13.3	3.90	5.9	1.23	2.1	1.27	4.2	1.03	1.7	1.02	0.72
	½	11.9	3.50	5.3	1.23	1.9	1.25	3.8	1.04	1.5	1.00	0.72
	7/16	10.6	3.09	4.8	1.24	1.7	1.23	3.4	1.05	1.3	0.98	0.72
	⅜	9.1	2.67	4.2	1.25	1.5	1.21	3.0	1.06	1.2	0.96	0.73
	5/16	7.7	2.25	3.6	1.26	1.3	1.18	2.6	1.07	1.0	0.93	0.73
4 x 3	¾	16.0	4.69	6.9	1.22	2.7	1.42	3.3	0.84	1.6	0.92	0.64
	11/16	14.8	4.34	6.5	1.22	2.5	1.39	3.1	0.84	1.5	0.89	0.64
	⅝	13.6	3.98	6.0	1.23	2.3	1.37	2.9	0.85	1.4	0.87	0.64
	9/16	12.4	3.62	5.6	1.24	2.1	1.35	2.7	0.86	1.2	0.85	0.64
	½	11.1	3.25	5.0	1.25	1.9	1.33	2.4	0.86	1.1	0.83	0.64
	7/16	9.8	2.87	4.5	1.25	1.7	1.30	2.2	0.87	1.0	0.80	0.64
	⅜	8.5	2.48	4.0	1.26	1.5	1.28	1.9	0.88	0.87	0.78	0.64
	5/16	7.2	2.09	3.4	1.27	1.2	1.26	1.7	0.89	0.74	0.76	0.65
	¼	5.8	1.69	2.8	1.28	1.0	1.24	1.4	0.89	0.60	0.74	0.65
3½ x 3	¾	14.7	4.31	4.7	1.04	2.1	1.21	3.1	0.85	1.5	0.96	0.62
	11/16	13.6	4.00	4.4	1.05	1.9	1.19	3.0	0.86	1.4	0.94	0.62
	⅝	12.5	3.67	4.1	1.06	1.8	1.17	2.8	0.87	1.3	0.92	0.62
	9/16	11.4	3.34	3.8	1.07	1.6	1.15	2.5	0.87	1.2	0.90	0.62
	½	10.2	3.00	3.5	1.07	1.5	1.13	2.3	0.88	1.1	0.88	0.62
	7/16	9.1	2.65	3.1	1.08	1.3	1.10	2.1	0.89	0.98	0.85	0.62
	⅜	7.9	2.30	2.7	1.09	1.1	1.08	1.8	0.90	0.85	0.83	0.62
	5/16	6.6	1.93	2.3	1.10	0.96	1.06	1.6	0.90	0.72	0.81	0.63
	¼	5.4	1.56	1.9	1.11	0.78	1.04	1.3	0.91	0.58	0.79	0.63
3½x2½	⅝	11.5	3.36	3.8	1.07	1.7	1.25	1.6	0.69	0.92	0.75	0.53
	9/16	10.4	3.06	3.6	1.08	1.6	1.23	1.5	0.70	0.84	0.73	0.53
	½	9.4	2.75	3.2	1.09	1.4	1.20	1.4	0.70	0.76	0.70	0.53
	7/16	8.3	2.43	2.9	1.09	1.3	1.18	1.2	0.71	0.68	0.68	0.54
	⅜	7.2	2.11	2.6	1.10	1.1	1.16	1.1	0.72	0.59	0.66	0.54
	5/16	6.1	1.78	2.2	1.11	0.93	1.14	0.94	0.73	0.50	0.64	0.54
	¼	4.9	1.44	1.8	1.12	0.75	1.11	0.78	0.74	0.41	0.61	0.54

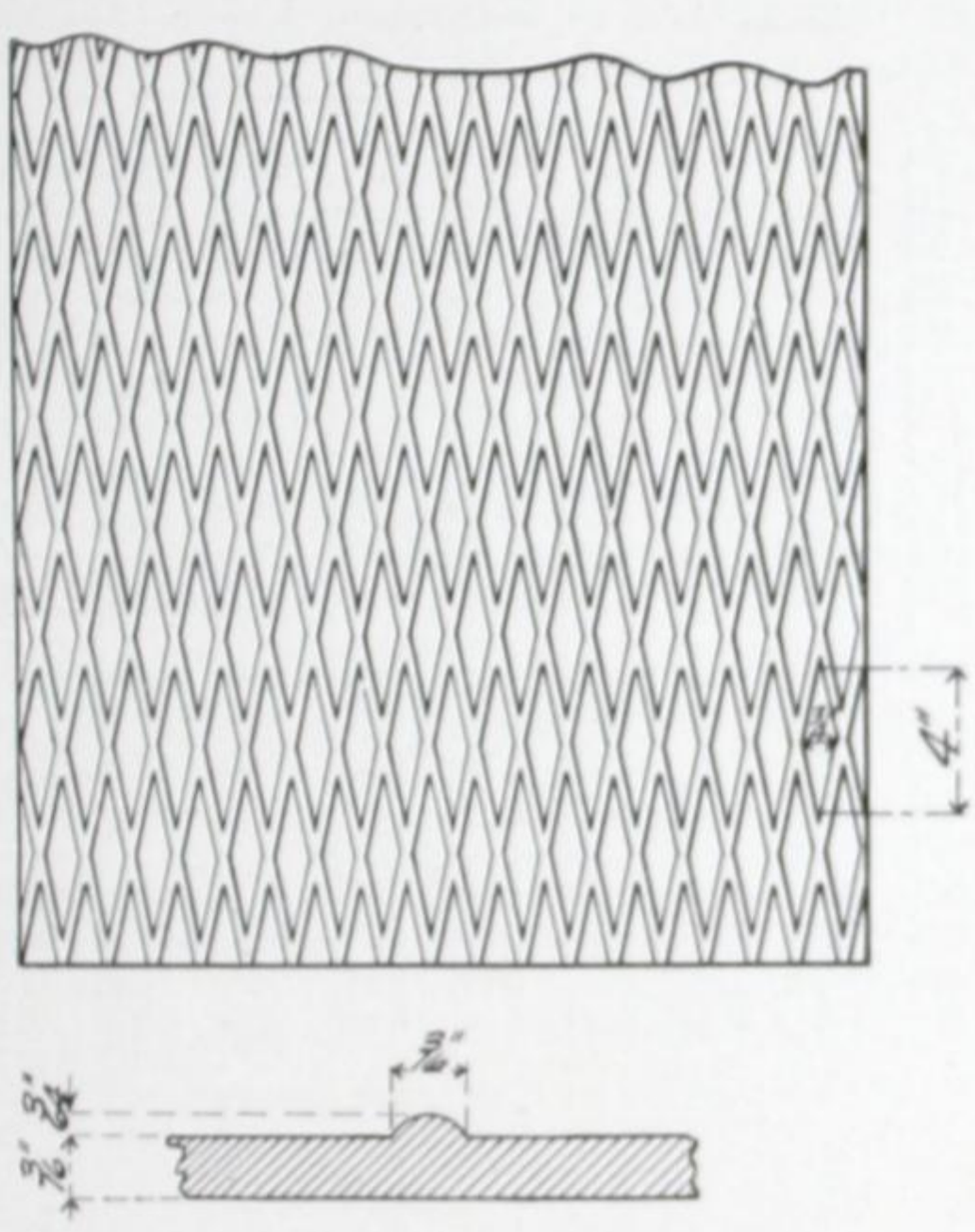
DIMENSIONS, WEIGHTS AND ELEMENTS OF UNEQUAL ANGLES



Size	Thick-ness	Wt. per Foot	Area of Sec-tion	Axis 1-1				Axis 2-2				Axis 3-3
				I	r	S	x	I	r	S	y	$r_{min.}$
In.	In.	Lbs.	In.	In.⁴	In.	In.³	In.	In.⁴	In.	In.³	In.	In.
3 x 2½	½	8.5	2.50	2.1	0.91	1.0	1.00	1.3	0.72	0.74	0.75	0.52
	7/16	7.6	2.21	1.9	0.92	0.93	0.98	1.2	0.73	0.66	0.73	0.52
	3/8	6.6	1.92	1.7	0.93	0.81	0.96	1.0	0.74	0.58	0.71	0.52
	5/16	5.6	1.62	1.4	0.94	0.69	0.93	0.90	0.74	0.49	0.68	0.53
	¼	4.5	1.31	1.2	0.95	0.56	0.91	0.74	0.75	0.40	0.66	0.53
3 x 2	½	7.7	2.25	1.9	0.92	1.0	1.08	0.67	0.55	0.47	0.58	0.43
	7/16	6.8	2.00	1.7	0.93	0.89	1.06	0.61	0.55	0.42	0.56	0.43
	3/8	5.9	1.73	1.5	0.94	0.78	1.04	0.54	0.56	0.37	0.54	0.43
	5/16	5.0	1.47	1.3	0.95	0.66	1.02	0.47	0.57	0.32	0.52	0.43
	¼	4.1	1.19	1.1	0.95	0.54	0.99	0.39	0.57	0.25	0.49	0.43
2½ x 2	½	6.8	2.00	1.1	0.75	0.70	0.88	0.64	0.56	0.46	0.63	0.42
	7/16	6.1	1.78	1.0	0.76	0.62	0.85	0.58	0.57	0.41	0.60	0.42
	3/8	5.3	1.55	0.91	0.77	0.55	0.83	0.51	0.58	0.36	0.58	0.42
	5/16	4.5	1.31	0.79	0.78	0.47	0.81	0.45	0.58	0.31	0.56	0.42
	¼	3.62	1.06	0.65	0.78	0.38	0.79	0.37	0.59	0.25	0.54	0.42
	3/16	2.75	0.81	0.51	0.79	0.29	0.76	0.29	0.60	0.20	0.51	0.43
	1/8	1.86	0.55	0.35	0.80	0.20	0.74	0.20	0.61	0.13	0.49	0.43
2½x1½	5/16	3.92	1.15	0.71	0.79	0.44	0.90	0.19	0.41	0.17	0.40	0.32
	¼	3.19	0.94	0.59	0.79	0.36	0.88	0.16	0.41	0.14	0.38	0.32
	3/16	2.44	0.72	0.46	0.80	0.28	0.85	0.13	0.42	0.11	0.35	0.33
2¼x1½	7/16	5.0	1.45	0.68	0.69	0.48	0.83	0.24	0.41	0.23	0.46	0.32
	3/8	4.4	1.27	0.61	0.69	0.42	0.81	0.21	0.41	0.20	0.44	0.32
	5/16	3.66	1.07	0.53	0.70	0.36	0.79	0.19	0.42	0.17	0.42	0.32
	¼	2.98	0.88	0.44	0.71	0.30	0.77	0.16	0.42	0.14	0.39	0.32
	3/16	2.28	0.67	0.34	0.72	0.23	0.75	0.12	0.43	0.11	0.37	0.33
2 x 1½	3/8	3.99	1.17	0.43	0.61	0.34	0.71	0.21	0.42	0.20	0.46	0.32
	5/16	3.39	1.00	0.38	0.62	0.29	0.69	0.18	0.42	0.17	0.44	0.32
	¼	2.77	0.81	0.32	0.62	0.24	0.66	0.15	0.43	0.14	0.41	0.32
	3/16	2.12	0.62	0.25	0.63	0.18	0.64	0.12	0.44	0.11	0.39	0.32
	1/8	1.44	0.42	0.17	0.64	0.13	0.62	0.09	0.45	0.08	0.37	0.33
2 x 1¼	¼	2.55	0.75	0.30	0.63	0.23	0.71	0.09	0.34	0.10	0.33	0.27
	3/16	1.96	0.57	0.23	0.64	0.18	0.69	0.07	0.35	0.08	0.31	0.27
1¾x1¼	¼	2.34	0.69	0.20	0.54	0.18	0.60	0.09	0.35	0.10	0.35	0.27
	3/16	1.80	0.53	0.16	0.55	0.14	0.58	0.07	0.36	0.08	0.33	0.27
	1/8	1.23	0.36	0.11	0.56	0.09	0.56	0.05	0.37	0.05	0.31	0.27
1½x1¼	5/16	2.59	0.76	0.16	0.45	0.16	0.52	0.10	0.35	0.11	0.40	0.26
	¼	2.13	0.63	0.13	0.46	0.13	0.50	0.08	0.36	0.09	0.38	0.26
	3/16	1.64	0.48	0.10	0.46	0.10	0.48	0.07	0.37	0.07	0.35	0.26

CHECKERED PLATES

These plates are for use in boiler and engine rooms, breweries, for stairways, fire escapes, gutter plates, car platforms, sidewalks, deck plates on ships and every place where a cast iron plate is now used. They are made of the best open hearth steel, and are much stronger than cast iron floor plates, cheaper, and fifty per cent lighter.



No. 6—Checkered Plate, showing Section at Rib

Widths and Maximum Lengths Rolled

Thickness, Inches	Width and Length, Inches			Weight per Square Foot, Pounds
	6 to 11 3/4	12 to 48	48 1/4 to 60	
1/2	120	240	240	21.4
7/16	120	240	240	18.9
3/8	120	240	240	16.3
5/16	120	240	240	13.8
1/4	120	240	240	11.2
3/16	120	180		8.7

The sizes carried in stock are 3/16-inch, 1/4-inch and 5/16-inch. Others are special.

RECTANGULAR UNIVERSAL PLATES—Carbon Steel

UNIVERSAL MILL PLATES, ONE-FOURTH INCH AND OVER, EXTREME SIZES

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										
		48-46	45-41	40-36	35-31	30-26	25-20	19-17	16-15	14-12	11	10-6⅛
¼	10.20						1020	1020	1020	1020	540	540
5/16	12.75	1020	1020	1140	1260	1320	1320	1080	1080	1080	600	600
⅜	15.30	1200	1200	1320	1380	1380	1380	1080	1080	1080	900	840
7/16	17.85	1320	1320	1380	1380	1380	1380	1080	1080	1080	900	840
½	20.40	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
9/16	22.95	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
⅝	25.50	1380	1380	1380	1380	1380	1380	1080	1080	1080	1020	840
¾	30.60	1353	1357	1363	1372	1380	1380	1080	1080	1080	900	840
⅞	35.70	1160	1163	1169	1177	1188	1203	1080	1080	1080	900	840
1	40.80	1015	1018	1023	1030	1039	1052	1080	1080	1080	900	840
1⅛	45.90	903	905	910	916	924	936	1080	1080	1080	840	840
1¼	51.00	812	814	818	824	832	842	1071	1080	1080	840	840
1⅜	56.10	738	740	744	749	756	766	973	1080	1080	840	840
1½	61.20	677	679	682	687	693	702	892	1059	1080	840	840
1⅝	66.30	625	626	629	634	640	648	823	978	1080	840	840
1¾	71.40	580	581	584	588	594	601	765	908	1038	720	720
1⅞	76.50	541	543	545	549	554	561	714	847	968	660	720
2	81.60	507	509	511	515	519	526	669	794	907	600	720

RECTANGULAR AND CIRCULAR PLATES—Carbon Steel

SHEARED PLATES, THREE-SIXTEENTH INCH, EXTREME SIZES

Thickness, Inches	Weight, Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam., In.
		90	84	78	72	70	68	66	64	60	54-24	
3/16	7.65	270	320	345	375	390	400	420	450	470	480	90

RECTANGULAR AND CIRCULAR PLATES—Carbon Steel

SHEARED PLATES, ONE-FOURTH INCH AND OVER, EXTREME SIZES

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam., In.
		128	126	120	114	108	102	96	90	84	78	
1/4	10.20	...	...	...	175	250	280	300	330	375	400	115
5/16	12.75	...	...	240	270	320	360	380	420	440	460	120
3/8	15.30	220	240	270	320	365	380	410	450	500	550	130
7/16	17.85	240	270	300	360	370	410	430	460	510	550	130
1/2	20.40	260	270	320	365	400	450	480	510	550	580	130
9/16	22.95	260	270	330	373	420	470	500	530	570	600	130
5/8	25.50	260	300	350	390	450	500	520	540	600	620	130
11/16	28.05	260	300	360	420	450	500	520	540	600	620	130
3/4	30.60	260	300	360	400	450	490	520	540	600	620	130
13/16	33.15	260	300	340	385	440	490	510	530	600	620	130
7/8	35.70	260	300	330	375	440	480	510	530	600	620	130
1	40.80	250	300	300	340	440	460	500	530	580	600	130
1 1/8	45.90	250	300	300	330	410	440	450	500	550	580	130
1 1/4	51.00	240	270	300	310	380	400	420	490	530	550	130
1 1/2	61.20	220	230	260	280	330	320	340	420	440	480	130
1 3/4	71.40	200	200	220	240	280	270	300	380	380	410	130
2	81.60	180	180	190	210	240	240	260	320	330	360	130
2 1/4	91.80	150	160	170	190	210	210	230	280	295	320	130

Thickness, Inches	Weight Lbs. per Sq. Ft.	Widths and Lengths in Inches										Diam., In.
		72	66	60	54	50	48	42	36	30	24	
1/4	10.20	430	475	525	530	530	530	530	530	530	530	115
5/16	12.75	480	500	560	550	575	575	550	550	550	580	120
3/8	15.30	600	600	620	620	620	620	600	580	600	600	130
7/16	17.85	600	630	630	640	640	640	600	580	600	600	130
1/2	20.40	610	630	630	640	640	640	600	580	630	600	130
9/16	22.95	620	640	640	640	640	640	600	580	630	600	130
5/8	25.50	620	640	640	640	640	640	600	580	600	600	130
11/16	28.05	620	640	640	640	640	640	600	580	600	580	130
3/4	30.60	620	640	640	640	640	640	600	580	600	580	130
13/16	33.15	620	640	640	640	640	640	600	580	570	550	130
7/8	35.70	620	640	640	640	640	640	600	580	550	550	130
1	40.80	600	630	630	640	640	640	580	580	520	530	130
1 1/8	45.90	580	620	620	640	640	640	580	580	520	500	130
1 1/4	51.00	550	600	600	600	600	600	560	560	520	450	130
1 1/2	61.20	530	600	600	600	600	600	540	540	470	430	130
1 3/4	71.40	450	490	550	550	550	550	540	540	430	380	130
2	81.60	400	440	480	500	500	500	500	500	400	350	130
2 1/4	91.80	350	390	420	450	450	450	450	450	300	200	130

WEIGHTS OF FLAT ROLLED STEEL
POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.053	.106	.159	.213	.27	.32	.37	.43	.48	.53	.58	.64	.69	.74	.80	.85
1/2	.106	.213	.319	.425	.53	.64	.74	.85	.96	1.06	1.17	1.28	1.38	1,49	1.59	1.70
3/4	.159	.319	.478	.638	.80	.96	1.12	1.28	1.43	1.59	1.75	1.91	2.07	2.23	2.39	2.55
1	.213	.425	.638	.850	1.06	1.28	1.49	1.70	1.91	2.13	2.34	2.55	2.76	2.98	3.19	3.40
1 1/4	.266	.531	.797	1.063	1.33	1.59	1.86	2.13	2.39	2.66	2.92	3.19	3.45	3.72	3.98	4.25
1 1/2	.319	.638	.956	1.275	1.59	1.91	2.23	2.55	2.87	3.19	3.51	3.83	4.14	4.46	4.78	5.10
1 3/4	.372	.744	1.116	1.488	1.86	2.23	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.21	5.58	5.95
2	.425	.850	1.275	1.700	2 13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.38	6.80
2 1/4	.478	.956	1.434	1.913	2.39	2.87	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.69	7.17	7.65
2 1/2	.531	1.063	1.594	2.125	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50
2 3/4	.584	1.169	1.753	2.338	2.92	3.51	4.09	4.68	5.26	5.84	6.43	7.01	7.60	8.18	8.77	9.35
3	.638	1.275	1.913	2.550	3.19	3.83	4.46	5.10	5.74	6.38	7.01	7.65	8.29	8.93	9.56	10.20
3 1/4	.691	1.381	2.072	2.763	3.45	4.14	4.83	5.53	6.22	6.91	7.60	8.29	8.98	9.67	10.36	11.05
3 1/2	.744	1.488	2.231	2.975	3.72	4.46	5.21	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90
3 3/4	.797	1.594	2.391	3.188	3.98	4.78	5.58	6.38	7.17	7.97	8.77	9.56	10.36	11.16	11.95	12.75
4	.850	1.700	2.550	3.400	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60
4 1/4	.903	1.806	2.709	3.613	4.52	5.42	6.32	7.23	8.13	9.03	9.93	10.84	11.74	12.64	13.55	14.45
4 1/2	.956	1.913	2.869	3.825	4.78	5.74	6.69	7.65	8.61	9.56	10.52	11.48	12.43	13.39	14.34	15.30
4 3/4	1.000	2.019	3.028	4.038	5.05	6.06	7.07	8.08	9.08	10.09	11.10	12.11	13.12	14.13	15.14	16.15
5	1.063	2.125	3.188	4.250	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00
5 1/4	1.116	2.231	3.347	4.463	5.58	6.69	7.81	8.93	10.04	11.16	12.27	13.39	14.50	15.62	16.73	17.85
5 1/2	1.169	2.338	3.506	4.675	5.84	7.01	8.18	9.35	10.52	11.69	12.86	14.03	15.19	16.36	17.53	18.70
5 3/4	1.222	2.444	3.666	4.888	6.11	7.33	8.55	9.78	11.00	12.22	13.44	14.66	15.88	17.11	18.33	19.55
6	1.275	2.550	3.825	5.100	6.38	7.65	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40
6 1/4	1.328	2.656	3.984	5.313	6.64	7.97	9.30	10.63	11.95	13.28	14.61	15.94	17.27	18.59	19.92	21.25
6 1/2	1.381	2.763	4.144	5.525	6.91	8.29	9.67	11.05	12.43	13.81	15,19	16.58	17.96	19.34	20.72	22.10
6 3/4	1.434	2.869	4.303	5,738	7.17	8.61	10.04	11.48	12.91	14.34	15.78	17.21	18.65	20.08	21.52	22.95
7	1.488	2.975	4.463	5.950	7.44	8.93	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80
7 1/4	1.541	3.081	4.622	6.163	7.70	9.24	10.78	12.33	13.87	15.41	16.95	18.49	20.03	21.57	23.11	24.65
7 1/2	1.594	3.188	4.781	6.375	7.97	9.56	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50
7 3/4	1.647	3.294	4.941	6.588	8.23	9.88	11.53	13.18	14.82	16.47	18.12	19.76	21.41	23.06	24.70	26.35
8	1.700	3.400	5.100	6.800	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20
8 1/4	1.753	3.506	5.259	7.013	8.77	10.52	12.27	14.03	15.78	17.53	19.28	21.04	22.79	24.54	26.30	28.05
8 1/2	1.806	3.613	5.419	7.225	9.03	10.84	12.64	14.45	16.26	18.06	19.87	21.68	23.48	25.29	27.09	28.90
8 3/4	1.859	3.719	5.578	7.438	9.30	11.16	13.02	14.88	16.73	18.59	20.45	22.31	24.17	26.03	27.89	29.75
9	1.913	3.825	5.738	7.650	9.56	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60
9 1/4	1,966	3.931	5.897	7.863	9.83	11.79	13.76	15.73	17.69	19.66	21.62	23.59	25.55	27.52	29.48	31.45
9 1/2	2.019	4.038	6.056	8.075	10.09	12.11	14.13	16.15	18.17	20.19	22.21	24.23	26.24	28.26	30.28	32.30
9 3/4	2.072	4.144	6.216	8.288	10.36	12.43	14.50	16.58	18.65	20.72	22.79	24.86	26.93	29.01	31.08	33.15
10	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
10 1/4	2.178	4.356	6.534	8.713	10.89	13.07	15.25	17.43	19.60	21.78	23.96	26,14	28.32	30.49	32.67	34.85
10 1/2	2.231	4.463	6.694	8.925	11.16	13.39	15.62	17.85	20.08	22.31	24.54	26.78	29.01	31.24	33.47	35.70
10 3/4	2.284	4.569	6.853	9.138	11.42	13.71	15.99	18.28	20.56	22.84	25.13	27.41	29.70	31.98	34.27	36.55
11	2.338	4.657	7.013	9.350	11.69	14.03	16.36	18.70	21.04	23.38	25.71	28.05	30.39	32.73	35.06	37.40
11 1/4	2.391	4.781	7.172	9.563	11.95	14.34	16.73	19 13	21.52	23.91	26.30	28.69	31.08	33.47	35.86	38.25
11 1/2	2.444	4.888	7.331	9.775	12.22	14.66	17.11	19.55	21.99	24.44	26.88	29.33	31.77	34.21	36.66	39.10
11 3/4	2.497	4.994	7.491	9.988	12.48	14.98	17.48	19.98	22.47	24.97	27.47	29.96	32.46	34.96	37.45	39.95
12	2.550	5.100	7.650	10.20	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80

WEIGHTS OF FLAT ROLLED STEEL
POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
12½	2.66	5.31	7.97	10.63	13.28	15.94	18.59	21.25	23.91	26.56	29.2	31.9	34.5	37.2	39.8	42.5
13	2.76	5.53	8.29	11.05	13.81	16.58	19.34	22.10	24.86	27.63	30.4	33.2	35.9	38.7	41.4	44.2
13½	2.87	5.74	8.61	11.48	14.34	17.21	20.08	22.95	25.82	28.69	31.6	34.4	37.3	40.2	43.0	45.9
14	2.98	5.95	8.93	11.90	14.88	17.85	20.83	23.80	26.78	29.75	32.7	35.7	38.7	41.7	44.6	47.6
14½	3.08	6.16	9.24	12.33	15.41	18.49	21.57	24.65	27.73	30.81	33.9	37.0	40.1	43.1	46.2	49.3
15	3.19	6.38	9.56	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.1	38.3	41.4	44.6	47.8	51.0
15½	3.29	6.59	9.88	13.18	16.47	19.76	23.06	26.35	29.64	32.94	36.2	39.5	42.8	46.1	49.4	52.7
16	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00	37.4	40.8	44.2	47.6	51.0	54.4
16½	3.51	7.01	10.52	14.03	17.53	21.04	24.54	28.05	31.56	35.06	38.6	42.1	45.6	49.1	52.6	56.1
17	3.61	7.23	10.84	14.45	18.06	21.68	25.29	28.90	32.51	36.13	39.7	43.4	47.0	50.6	54.2	57.8
17½	3.72	7.44	11.16	14.88	18.59	22.31	26.03	29.75	33.47	37.19	40.9	44.6	48.3	52.1	55.8	59.5
18	3.83	7.65	11.48	15.30	19.13	22.95	26.78	30.60	34.43	38.25	42.1	45.9	49.7	53.6	57.4	61.2
18½	3.93	7.86	11.79	15.73	19.66	23.59	27.52	31.45	35.38	39.31	43.2	47.2	51.1	55.0	59.0	62.9
19	4.04	8.08	12.11	16.15	20.19	24.23	28.26	32.30	36.34	40.38	44.4	48.5	52.5	56.5	60.6	64.6
19½	4.14	8.29	12.43	16.58	20.72	24.86	29.01	33.15	37.29	41.44	45.6	49.7	53.9	58.0	62.2	66.3
20	4.25	8.50	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.8	51.0	55.3	59.5	63.8	68.0
20½	4.36	8.71	13.07	17.43	21.78	26.14	30.49	34.85	39.21	43.56	47.9	52.3	56.6	61.0	65.3	69.7
21	4.46	8.93	13.39	17.85	22.31	26.78	32.24	35.70	40.16	44.63	49.1	53.6	58.0	62.5	66.9	71.4
21½	4.57	9.14	13.71	18.28	22.84	27.41	31.98	36.55	41.12	45.69	50.3	54.8	59.4	64.0	68.5	73.1
22	4.68	9.35	14.03	18.70	23.38	28.05	32.73	37.40	42.08	46.75	51.4	56.1	60.8	65.5	70.1	74.8
22½	4.78	9.56	14.34	19.13	23.91	28.69	33.47	38.25	43.03	47.81	52.6	57.4	62.2	66.9	71.7	76.5
23	4.89	9.78	14.66	19.55	24.44	29.33	34.21	39.10	43.99	48.88	53.8	58.7	63.5	68.4	73.3	78.2
23½	4.99	9.99	14.98	19.98	24.97	29.96	34.96	39.95	44.94	49.94	54.9	59.9	64.9	69.9	74.9	79.9
24	5.10	10.20	15.30	20.40	25.50	30.60	35.70	40.80	45.90	51.00	56.1	61.2	66.3	71.4	76.5	81.6
25	5.31	10.63	15.94	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.4	63.8	69.1	74.4	79.7	85.0
26	5.53	11.05	16.58	22.10	27.63	33.15	38.68	44.20	49.73	55.25	60.8	66.3	71.8	77.4	82.9	88.4
27	5.74	11.48	17.21	22.95	28.69	34.43	40.16	45.90	51.64	57.38	63.1	68.9	74.6	80.3	86.1	91.8
28	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55	59.50	65.5	71.4	77.4	83.3	89.3	95.2
29	6.16	12.33	18.49	24.65	30.81	36.98	43.14	49.30	55.46	61.63	67.8	74.0	80.1	86.3	92.4	98.6
30	6.38	12.75	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.1	76.5	82.9	89.3	95.6	102.0
31	6.59	13.18	19.76	26.35	32.94	39.53	46.11	52.70	59.29	65.88	72.5	79.1	85.6	92.2	98.8	105.4
32	6.80	13.60	20.40	27.20	34.00	40.80	47.60	54.40	61.20	68.00	74.8	81.6	88.4	95.2	102.0	108.8
33	7.01	14.03	21.04	28.05	35.06	42.08	49.09	56.10	63.11	70.13	77.1	84.2	91.2	98.2	105.2	112.2
34	7.23	14.45	21.68	28.90	36.13	43.35	50.58	57.80	65.03	72.25	79.5	86.7	93.9	101.2	108.4	115.6
35	7.44	14.88	22.31	29.75	37.19	44.63	52.06	59.50	66.94	74.38	81.8	89.3	96.7	104.1	111.6	119.0
36	7.65	15.30	22.95	30.60	38.25	45.90	53.55	61.20	68.85	76.50	84.2	91.8	99.5	107.1	114.8	122.4
37	7.86	15.73	23.59	31.45	39.31	47.18	55.04	62.90	70.76	78.63	86.5	94.4	102.2	110.1	117.9	125.8
38	8.08	16.15	24.23	32.30	40.38	48.45	56.53	64.60	72.68	80.75	88.8	96.9	105.0	113.1	121.1	129.2
39	8.29	16.58	24.86	33.15	41.44	49.73	58.01	66.30	74.59	82.88	91.2	99.5	107.7	116.0	124.3	132.6
40	8.50	17.00	25.50	34.00	42.50	51.00	59.50	68.00	76.50	85.00	93.5	102.0	110.5	119.0	127.5	136.0
41	8.71	17.43	26.14	34.85	43.56	52.28	60.99	69.70	78.41	87.13	95.8	104.6	113.3	122.0	130.7	139.4
42	8.93	17.85	26.78	35.70	44.63	53.55	62.48	71.40	80.33	89.25	98.2	107.1	116.0	125.0	133.9	142.8
43	9.14	18.28	27.41	36.55	45.69	54.83	63.96	73.10	82.24	91.38	100.5	109.7	118.8	127.9	137.1	146.2
44	9.35	18.70	28.05	37.40	46.75	56.10	65.45	74.80	84.15	93.50	102.9	112.2	121.6	130.9	140.3	149.6
45	9.56	19.13	28.69	38.25	47.81	57.38	66.94	76.50	86.06	95.63	105.2	114.8	124.3	133.9	143.4	153.0
46	9.78	19.55	29.33	39.10	48.88	58.65	68.43	78.20	87.98	97.75	107.5	117.3	127.1	136.9	146.6	156.4
47	9.99	19.98	29.96	39.95	49.94	59.93	69.91	79.90	89.89	99.88	109.9	119.9	129.8	139.8	149.8	159.8
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80	102.0	112.2	122.4	132.6	142.8	153.0	163.2

WEIGHTS OF FLAT ROLLED STEEL

POUNDS PER LINEAL FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
49	10.4	20.8	31.2	41.7	52.1	62.5	72.9	83.3	93.7	104.1	114.5	125.0	135.4	145.8	156.2	166.6
50	10.6	21.3	31.9	42.5	53.1	63.8	74.4	85.0	95.6	106.3	116.9	127.5	138.1	148.8	159.4	170.0
51	10.8	21.7	32.5	43.4	54.2	65.0	75.9	86.7	97.5	108.4	119.2	130.1	140.9	151.7	162.6	173.4
52	11.1	22.1	33.2	44.2	55.3	66.3	77.4	88.4	99.5	110.5	121.6	132.6	143.7	154.7	165.8	176.8
53	11.3	22.5	33.8	45.1	56.3	67.6	78.8	90.1	101.4	112.6	123.9	135.2	146.4	157.7	168.9	180.2
54	11.5	23.0	34.4	45.9	57.4	68.9	80.3	91.8	103.3	114.8	126.2	137.7	149.2	160.7	172.1	183.6
55	11.7	23.4	35.1	46.8	58.4	70.1	81.8	93.5	105.2	116.9	128.6	140.3	151.9	163.6	175.3	187.0
56	11.9	23.8	35.7	47.6	59.5	71.4	83.3	95.2	107.1	119.0	130.9	142.8	154.7	166.6	178.5	190.4
57	12.1	24.2	36.3	48.5	60.6	72.7	84.8	96.9	109.0	121.1	133.2	145.4	157.5	169.6	181.7	193.8
58	12.3	24.7	37.0	49.3	61.6	74.0	86.3	98.6	110.9	123.3	135.6	147.9	160.2	172.6	184.9	197.2
59	12.5	25.1	37.6	50.2	62.7	75.2	87.8	100.3	112.8	125.4	137.9	150.5	163.0	175.5	188.1	200.6
60	12.8	25.5	38.3	51.0	63.8	76.5	89.3	102.0	114.8	127.5	140.3	153.0	165.8	178.5	191.3	204.0
61	13.0	25.9	38.9	51.9	64.8	77.8	90.7	103.7	116.7	129.6	142.6	155.6	168.5	181.5	194.4	207.4
62	13.2	26.4	39.5	52.7	65.9	79.1	92.2	105.4	118.6	131.8	144.9	158.1	171.3	184.5	197.6	210.8
63	13.4	26.8	40.2	53.6	66.9	80.3	93.7	107.1	120.5	133.9	147.3	160.7	174.0	187.4	200.8	214.2
64	13.6	27.2	40.8	54.4	68.0	81.6	95.2	108.8	122.4	136.0	149.6	163.2	176.8	190.4	204.0	217.6
65	13.8	27.6	41.4	55.3	69.1	82.9	96.7	110.5	124.3	138.1	151.9	165.8	179.6	193.4	207.2	221.0
66	14.0	28.1	42.1	56.1	70.1	84.2	98.2	112.2	126.2	140.3	154.3	168.3	182.3	196.4	210.4	224.4
67	14.2	28.5	42.7	57.0	71.2	85.4	99.7	113.9	128.1	142.4	156.6	170.9	185.1	199.3	213.6	227.8
68	14.5	28.9	43.4	57.8	72.3	86.7	101.2	115.6	130.1	144.5	159.0	173.4	187.9	202.3	216.8	231.2
69	14.7	29.3	44.0	58.7	73.3	88.0	102.6	117.3	132.0	146.6	161.3	176.0	190.6	205.3	219.9	234.6
70	14.9	29.8	44.6	59.5	74.4	89.3	104.1	119.0	133.9	148.8	163.6	178.5	193.4	208.3	223.1	238.0
71	15.1	30.2	45.3	60.4	75.4	90.5	105.6	120.7	135.8	150.9	166.0	181.1	196.1	211.2	226.3	241.4
72	15.3	30.6	45.9	61.2	76.5	91.8	107.1	122.4	137.7	153.0	168.3	183.6	198.9	214.2	229.5	244.8
73	15.5	31.0	46.5	62.1	77.6	93.1	108.6	124.1	139.6	155.1	170.6	186.2	201.7	217.2	232.7	248.2
74	15.7	31.5	47.2	62.9	78.6	94.4	110.1	125.8	141.5	157.3	173.0	188.7	204.4	220.2	235.9	251.6
75	15.9	31.9	47.8	63.8	79.7	95.6	111.6	127.5	143.4	159.4	175.3	191.3	207.2	223.1	239.1	255.0
76	16.2	32.3	48.5	64.6	80.8	96.9	113.1	129.2	145.4	161.5	177.7	193.8	210.0	226.1	242.3	258.4
77	16.4	32.7	49.1	65.5	81.8	98.2	114 5	130.9	147.3	163.6	180.0	196.4	212.7	229.1	245.4	261.8
78	16.6	33.2	49.7	66.3	82.9	99.5	116.0	132.6	149.2	165.8	182.3	198.9	215.5	232 1	248.6	265.2
79	16.8	33.6	50.4	67.2	83.9	100.7	117.5	134.3	151.1	167.9	184.7	201.5	218,2	235.0	251.8	268.6
80	17.0	34.0	51.0	68.0	85.0	102.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0
81	17.2	34.4	51.6	68.9	86.1	103.3	120.5	137.7	154.9	172.1	189.3	206.6	223.8	241.0	258.2	275.4
82	17.4	34.9	52.3	69.7	87.1	104.6	122.0	139.4	156.8	174.3	191.7	209.1	226.5	244.0	261.4	278.8
83	17.6	35.3	52.9	70.6	88.2	105.8	123.5	141.1	158.7	176.4	194.0	211.7	229.3	246.9	264.6	282.2
84	17.9	35.7	53.6	71.4	89.3	107.1	125.0	142.8	160.7	178.5	196.4	214.2	232.1	249.9	267.8	285.6
85	18.1	36.1	54.2	72.3	90.3	108.4	126.4	144.5	162.6	180.6	198.7	216.8	234.8	252.9	270.9	289.0
86	18.3	36.6	54.8	73.1	91.4	109.7	127.9	146.2	164.5	182.8	201.0	219.3	237 6	255.9	274.1	292 4
87	18.5	37.0	55.5	74.0	92.4	110.9	129.4	147.9	166.4	184.9	203.4	221.9	240.3	258.8	277.3	295.8
88	18.7	37.4	56.1	74.8	93.5	112.2	130.9	149.6	168.3	187.0	205.7	224.4	243.1	261.8	280.5	299.2
89	18.9	37.8	56.7	75.7	94.6	113.5	132.4	151.3	170.2	189.1	208.0	227.0	245.9	264.8	283.7	302.6
90	19.1	38.3	57.4	76.5	95.6	114.8	133.9	153.0	172.1	191.3	210.4	229.5	248.6	267.8	286.9	306.0
91	19.3	38.7	58.0	77.4	96.7	116.0	135.4	154.7	174.0	193.4	212.7	232.1	241.4	270.7	290.1	309.4
92	19.6	39.1	58.7	78.2	97.8	117.3	136.9	156.4	176.0	195.5	215.1	234.6	254.2	273.7	293.3	312.8
93	19.8	39.5	59.3	79.1	98.8	118.6	138.3	158.1	177.9	197.6	217.4	237.2	256.9	276.7	296.4	316.2
94	20.0	40.0	59.9	79.9	99.9	119.9	139.8	159.8	179.8	199.8	219.7	239.7	259.7	279.7	299.6	319.6
95	20.2	40.4	60.6	80 8	100.9	121.1	141.3	161.5	181.7	201.9	222.1	242.3	262.4	282.6	302.8	323.0
96	20.4	40.8	61.2	81.6	102.0	122.4	142.8	163.2	183.6	204.0	224.4	244.8	265.2	285.6	306.0	326.4
97	20.6	41.2	61.8	82.5	103.1	123.7	144.3	164.9	185.5	206.1	226.7	247.4	268.0	288.6	309.2	329.8
98	20.8	41.7	62.5	83.3	104.1	125.0	145.8	166.6	187.4	208.3	229.1	249.9	270.7	291.6	312.4	333.2
99	21.0	42.1	63.1	84.2	105.2	126.2	147.3	168.3	189.3	210.4	231.4	252.5	373.5	294.5	315.6	336.6
100	21.3	42.5	63.8	85.0	106.3	127.5	148.8	170.0	191.3	212.5	233.8	255.0	276.3	297.5	318.8	340.0

A.S.C.E. RAILS AND LIGHT RAILS

No. 7—Section of Steel Rail

Steel railway rails in all sizes and weights, new and relaying, available for reasonable delivery. Fish plates, bolts, spikes, frogs, switches and switch stands supplied.

Weight per Yard, Lbs.	Height of Rail, In. *a*	Base of Rail In. *b*	Width of Bult, In. *c*	Length of Fplice Bar, In.	Size of Bolt, In.	Size of Spike, In.	Weight of One Rail Joint, Lbs.		
60	4 1/2	4	2 5/8	24	1/4 x 3 1/4	3 1/2 x 5/8	40 92	2 59	43 50
55	4 3/8	4 3/8	2 1/4	24	1/4 x 3 1/4	3 1/2 x 5/8	28 80	2 91	33 81
50	3 7/8	3 7/8	2 1/4	24	1/4 x 3 1/4	3 1/2 x 5/8	25 50	2 78	28 28
45	3 11/16	3 11/16	2	20	1/4 x 3	3 1/2 x 5/8	18 75	2 72	21 47
40	3 1/2	3 1/2	1 7/8	20	1/4 x 2 7/8	3 x 1/2	16 10	2 66	18 76
35	3 3/8	3 3/8	1 3/4	16 1/2	1/4 x 2 1/2	4 1/2 x 1/2	12 10	1 60	13 70
30	3 1/4	3 1/4	1 5/8	16 1/2	1/4 x 2 1/2	4 x 1/2	10 45	1 60	12 05
25	2 3/4	2 3/4	1 1/2	16 1/2	1/2 x 2 1/4	4 x 1/2	5 70	.86	6 56
20	2 1/2	2 1/2	1 1/4	16 1/2	1/2 x 2	3 1/2 x 1/2	4 86	.83	5 69
16	2 1/4	2 1/4	1 1/4	16 1/2	1/2 x 1 3/4	3 1/2 x 1/2	4 36	.80	5 16
14	2 1/8	2 1/8	1 1/8	16 1/2	1/2 x 1 3/4	3 x 1/2	3 44	.80	4 24
12	2	2	1	16 1/2	1/2 x 1 3/4	3 x 1/2	3 44	.80	4 24
10	1 3/4	1 3/4	1	16	1/4 x 1 1/2	2 1/2 x 1/2	2 60	.45	3 05
8	1 5/8	1 5/8	1	16	1/4 x 1 1/2	2 1/2 x 1/2	2 00	.45	2 45

MERCHANT BARS

We own and operate at Selkirk, Manitoba, our own Steel Plant comprised of a basic open hearth furnace of twenty tons capacity per heat (80 tons daily) and three rolling mills, a 9-inch, a 12-inch and a 16-inch.

The furnace is of the basic type as in this kind it is possible to produce steel of uniform quality from a wider range of raw material. Fuel oil is used to generate the high temperatures necessary for melting and refining.

All the rolling mills are of the Belgian type, driven by electric motors of 500, 350 and 800 h.p. capacity.

Round

Square

Flat

Band

Half-Round

No. 8—Types of Merchant Bars

The refined molten steel from the open hearth furnace is poured into ingots, each ingot being marked with its respective heat number. Our laboratory makes a careful analysis of each heat and this information is recorded in the office for future reference. The records will therefore show in a moment the physical properties of all of the steel which we have on hand at any time and from these we draw those suitable to customer's specifications as orders are received.

If suitable qualities are not available from storage, the furnace is operated on the grade required to enable completion of the orders as required.

We are able to supply steel to any of the standard specifications and over a period of years have enjoyed the confidence of our customers who all agree as to the uniformity and workability of the bars which we supply.

Merchant grades in both high and extremely low carbons have been supplied for all of the manufacturing processes at present being carried on in Western Canada and we can furnish any of these grades in rounds, squares, flats, bands, half rounds and ovals within the following limits:

ROUNDS
HALF ROUNDS } —From $\frac{3}{8}$ inch diameter up to and including 3 inch diameter.

SQUARES—From $\frac{3}{8}$ inch square up to and including 3-inch square.

FLATS—From $\frac{3}{16}$ inch x $\frac{3}{8}$ inch up to and including $1\frac{1}{2}$ inch x 6 inch.

BANDS—From $\frac{3}{4}$ inch to 3 inch in width, and $\frac{1}{8}$ inch thick.

SQUARE AND ROUND BARS
WEIGHTS AND AREAS

Size, Inches	Weight, Lbs. per Foot		Area, Square Inches		Size Inches	Weights, Lbs. per Foot		Area, Square Inches	
	□	○	□	○		□	○	□	○
0					3	30.60	24.03	9.000	7.069
1/16	.013	.010	.0039	.0031	1/16	31.89	25.05	9.379	7.366
1/8	.053	.042	.0156	.0123	1/8	33.20	26.08	9.766	7.670
3/16	.120	.094	.0352	.0276	3/16	34.54	27.13	10.160	7.980
1/4	.213	.167	.0625	.0491	1/4	35.91	28.21	10.563	8.296
5/16	.332	.261	.0977	.0767	5/16	37.31	29.30	10.973	8.618
3/8	.478	.376	.1406	.1105	3/8	38.73	30.42	11.391	8.946
7/16	.651	.511	.1914	.1503	7/16	40.18	31.55	11.816	9.281
1/2	.850	.668	.2500	.1963	1/2	41.65	32.71	12.250	9.621
9/16	1.076	.845	.3164	.2485	9/16	43.15	33.89	12.691	9.968
5/8	1.328	1.043	.3906	.3068	5/8	44.68	35.09	13.141	10.321
11/16	1.607	1.262	.4727	.3712	11/16	46.23	36.31	13.598	10.680
3/4	1.913	1.502	.5625	.4418	3/4	47.81	37.55	14.063	11.045
13/16	2.245	1.763	.6602	.5185	13/16	49.42	38.81	14.535	11.416
7/8	2.603	2.044	.7656	.6013	7/8	51.05	40.10	15.016	11.793
15/16	2.988	2.347	.8789	.6903	15/16	52.71	41.40	15.504	12.177
1	3.400	2.670	1.0000	.7854	4	54.40	42.73	16.000	12.566
1/16	3.838	3.015	1.1289	.8866	1/16	56.11	44.07	16.504	12.962
1/8	4.303	3.380	1.2656	.9940	1/8	57.85	45.44	17.016	13.364
3/16	4.795	3.766	1.4102	1.1075	3/16	59.62	46.83	17.535	13.772
1/4	5.313	4.172	1.5625	1.2272	1/4	61.41	48.23	18.063	14.186
5/16	5.857	4.600	1.7227	1.3530	5/16	63.23	49.66	18.598	14.607
3/8	6.428	5.049	1.8906	1.4849	3/8	65.08	51.11	19.141	15.033
7/16	7.026	5.518	2.0664	1.6230	7/16	66.95	52.58	19.691	15.466
1/2	7.650	6.008	2.2500	1.7671	1/2	68.85	54.07	20.250	15.904
9/16	8.301	6.519	2.4414	1.9173	9/16	70.78	55.59	20.816	16.349
5/8	8.978	7.051	2.6406	2.0739	5/8	72.73	57.12	21.391	16.800
11/16	9.682	7.604	2.8477	2.2365	11/16	74.71	58.67	21.973	17.257
3/4	10.413	8.178	3.0625	2.4053	3/4	76.71	60.25	22.563	17.721
13/16	11.170	8.773	3.2852	2.5802	13/16	78.74	61.85	23.160	18.190
7/8	11.953	9.388	3.5156	2.7612	7/8	80.80	63.46	23.766	18.665
15/16	12.763	10.024	3.7539	2.9483	15/16	82.89	65.10	24.379	19.147
2	13.600	10.681	4.0000	3.1416	5	85.00	66.76	25.000	19.635
1/16	14.463	11.359	4.2539	3.3410	1/16	87.14	68.44	25.629	20.129
1/8	15.353	12.058	4.5156	3.5466	1/8	89.30	70.14	26.266	20.629
3/16	16.270	12.778	4.7852	3.7583	3/16	91.49	71.86	26.910	21.135
1/4	17.213	13.519	5.0625	3.9761	1/4	93.71	73.60	27.563	21.648
5/16	18.182	14.280	5.3477	4.2000	5/16	95.96	75.36	28.223	22.166
3/8	19.178	15.062	5.6406	4.4301	3/8	98.23	77.15	28.891	22.691
7/16	20.201	15.866	5.9414	4.6664	7/16	100.53	78.95	29.566	23.221
1/2	21.250	16.690	6.2500	4.9087	1/2	102.85	80.78	30.250	23.758
9/16	22.326	17.534	6.5664	5.1572	9/16	105.20	82.62	30.941	24.301
5/8	23.428	18.400	6.8906	5.4119	5/8	107.58	84.49	31.641	24.850
11/16	24.557	19.287	7.2227	5.6727	11/16	109.98	86.38	32.348	25.406
3/4	25.713	20.195	7.5625	5.9396	3/4	112.41	88.29	33.063	25.967
13/16	26.895	21.123	7.9102	6.2126	13/16	114.87	90.22	33.785	26.535
7/8	28.103	22.072	8.2656	6.4918	7/8	117.35	92.17	34.516	27.109
15/16	29.338	23.042	8.6289	6.7771	15/16	119.86	94.14	35.254	27.688

For weights of flats, see pages 18 to 20.

SQUARE AND ROUND BARS
WEIGHTS AND AREAS

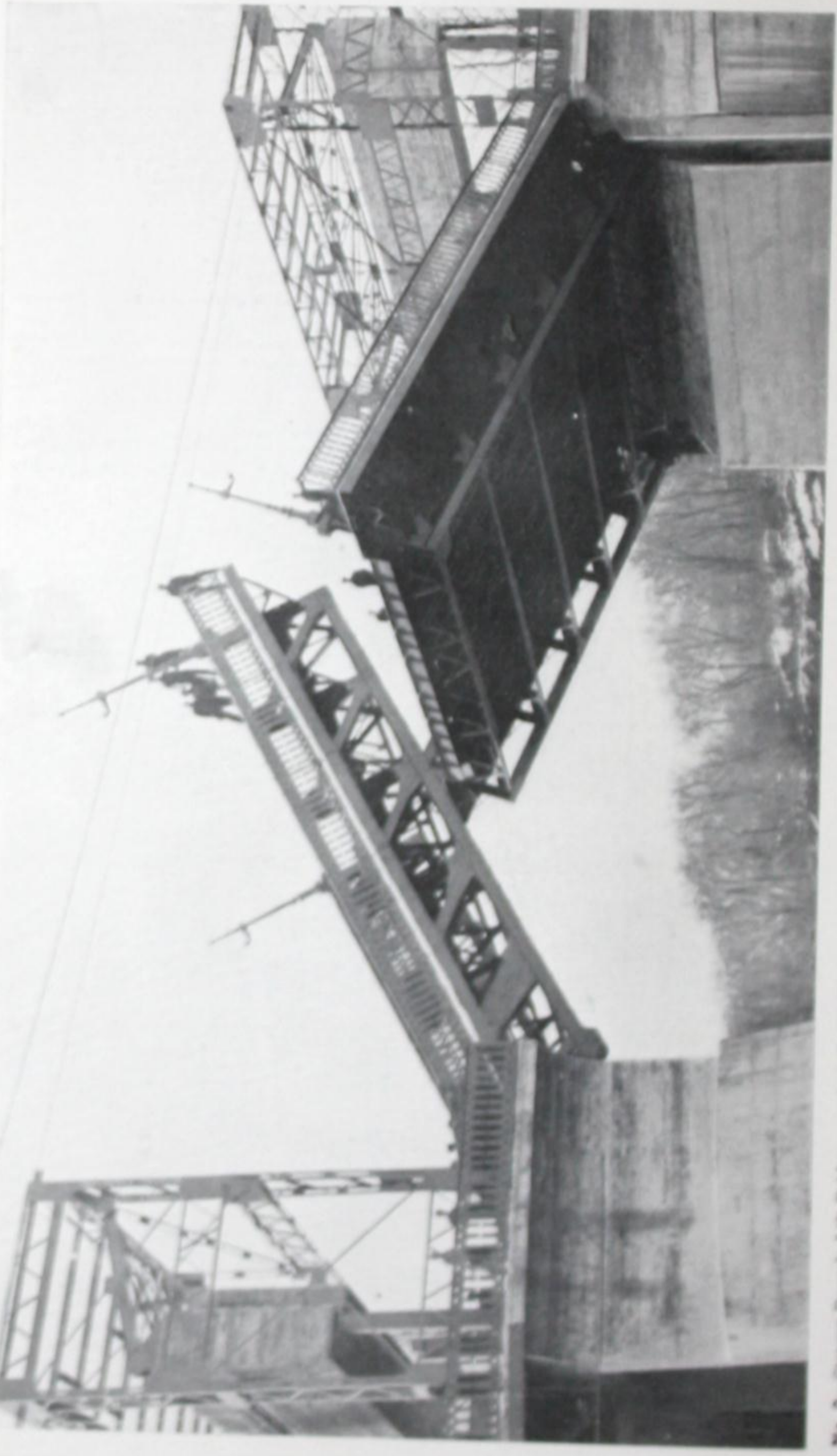
Size, Inches	Weight, Lbs. per Foot		Area, Square Inches		Size, Inches	Weight, Lbs. per Foot		Area, Square Inches	
	□	○	□	○		□	○	□	○
6	122.40	96.13	36.000	28.274	9	275.40	216.30	81.000	63.617
1/16	124.96	98.15	36.754	28.866	1/16	279.24	219.31	82.129	64.504
1/8	127.55	100.18	37.516	29.465	1/8	283.10	222.35	83.266	65.397
3/16	130.17	102.23	38.285	30.069	3/16	286.99	225.41	84.410	66.296
1/4	132.81	104.31	39.063	30.680	1/4	290.91	228.48	85.563	67.201
5/16	135.48	106.41	39.848	31.296	5/16	294.86	231.58	86.723	68.112
3/8	138.18	108.53	40.641	31.919	3/8	298.83	234.70	87.891	69.029
7/16	140.90	110.66	41.441	32.548	7/16	302.83	237.84	89.066	69.953
1/2	143.65	112.82	42.250	33.183	1/2	306.85	241.00	90.250	70.882
9/16	146.43	115.00	43.066	33.824	9/16	310.90	244.18	91.441	71.818
5/8	149.23	117.20	43.891	34.472	5/8	314.98	247.38	92.641	72.760
11/16	152.06	119.43	44.723	35.125	11/16	319.08	250.61	93.848	73.708
3/4	154.91	121.67	45.563	35.785	3/4	323.21	253.85	95.063	74.662
13/16	157.79	123.93	46.410	36.450	13/16	327.37	257.12	96.285	75.622
7/8	160.70	126.22	47.266	37.122	7/8	331.55	260.40	97.516	76.589
15/16	163.64	128.52	48.129	37.800	15/16	335.76	263.71	98.754	77.561
7	166.60	130.85	49.000	38.485	10	340.00	267.04	100.000	78.540
1/16	169.59	133.19	49.879	39.175	1/16	344.26	270.38	101.254	79.525
1/8	172.60	135.56	50.766	39.871	1/8	348.55	273.75	102.516	80.516
3/16	175.64	137.95	51.660	40.574	3/16	352.87	277.14	103.785	81.513
1/4	178.71	140.36	52.563	41.282	1/4	357.21	280.55	105.063	82.516
5/16	181.81	142.79	53.473	41.997	5/16	361.58	283.99	106.348	83.525
3/8	184.93	145.24	54.391	42.718	3/8	365.98	287.44	107.641	84.541
7/16	188.07	147.71	55.316	43.445	7/16	370.40	290.91	108.941	85.563
1/2	191.25	150.21	56.250	44.179	1/2	374.85	294.41	110.250	86.590
9/16	194.45	152.72	57.191	44.918	9/16	379.33	297.92	111.566	87.624
5/8	197.68	155.26	58.141	45.664	5/8	383.83	301.46	112.891	88.664
11/16	200.93	157.81	59.098	46.415	11/16	388.36	305.02	114.223	89.710
3/4	204.21	160.39	60.063	47.173	3/4	392.91	308.59	115.563	90.763
13/16	207.52	162.99	61.035	47.937	13/16	397.49	312.19	116.910	91.821
7/8	210.85	165.60	62.016	48.707	7/8	402.10	315.81	118.266	92.886
15/16	214.21	168.24	63.004	49.483	15/16	406.74	319.45	119.629	93.957
8	217.60	170.90	64.000	50.265	11	411.40	323.11	121.000	95.033
1/16	221.01	173.58	65.004	51.054	1/16	416.09	326.80	122.379	96.116
1/8	224.45	176.29	66.016	51.849	1/8	420.80	330.50	123.766	97.205
3/16	227.92	179.01	67.035	52.649	3/16	425.54	334.22	125.160	98.301
1/4	231.41	181.75	68.063	53.456	1/4	430.31	337.97	126.563	99.402
5/16	234.93	184.52	69.098	54.269	5/16	435.11	341.73	127.973	100.510
3/8	238.48	187.30	70.141	55.088	3/8	439.93	345.52	129.391	101.623
7/16	242.05	190.11	71.191	55.914	7/16	444.78	349.33	130.816	102.743
1/2	245.65	192.93	72.250	56.745	1/2	449.65	353.16	132.250	103.869
9/16	249.28	195.78	73.316	57.583	9/16	454.55	357.00	133.691	105.001
5/8	252.93	198.65	74.391	58.426	5/8	459.48	360.87	135.141	106.139
11/16	256.61	201.54	75.473	59.276	11/16	464.43	364.76	136.598	107.284
3/4	260.31	204.45	76.563	60.132	3/4	469.41	368.68	138.063	108.434
13/16	264.04	207.38	77.660	60.994	13/16	474.42	372.61	139.535	109.591
7/8	267.80	210.33	78.766	61.863	7/8	479.45	376.56	141.016	110.754
15/16	271.59	213.31	79.879	62.737	15/16	484.51	380 54	142.504	111.923
					12	489.60	384.53	144.000	113.098

For weights of flats, see pages 18 to 20.

DIMENSIONS AND WEIGHTS OF
SMALL CHANNELS FOR REINFORCING

SIZE	Weight per Foot, Pounds	SIZE	Weight per Foot, Pounds
½ x ½ x 13 ga.	.80	1½ x ½ x ⅛ in.	1.38
½ x ½ x ⅛ in.	.96	1½ x ½ x ¼ in.	1.82
¾ x ½ x ⅛ in.	.83	2 x ⅝ x ⅛ in.	1.70
1 x ½ x ⅛ in.	.69	2 x ½ x ⅛ in.	2.16
1 x ½ x ¼ in.	.94	2 x 1 x ⅛ in.	2.40
1½ x ½ x ⅛ in.	1.06	2½ x ½ x ⅛ in.	2.27
1½ x ½ x ¼ in.	1.12		

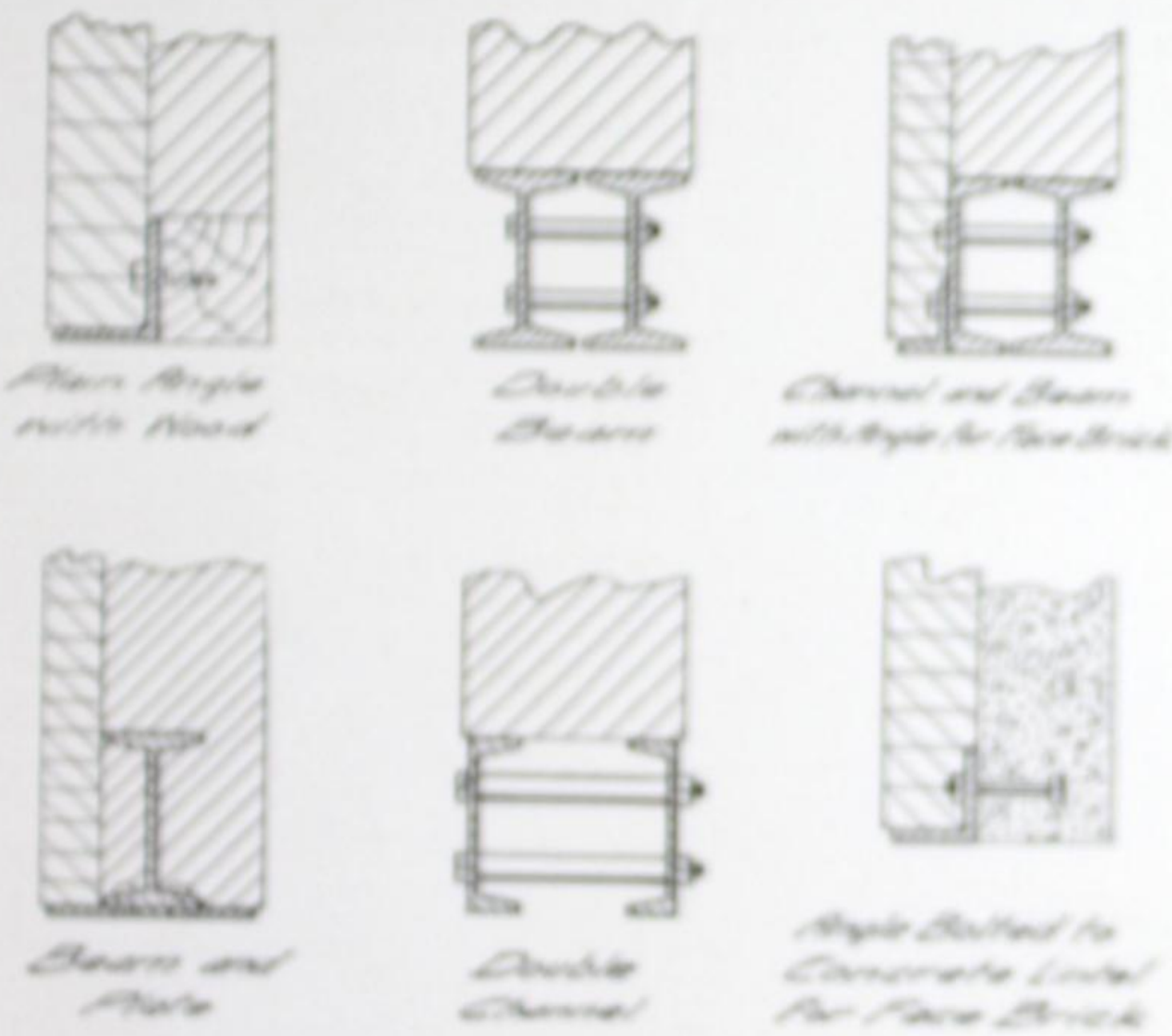
We carry a large stock of small channels for furring and sheeting in reinforced concrete work. For reinforced concrete design see pages 168 to 171. Bars for reinforcing are discussed on page 183.



No. 9—Strauss Bascule Lift Bridge over Assiniboine River at Osborne Street, Winnipeg. Fabricated and Erected by the Manitoba Bridge and Iron Works, Limited.

LINTELS

In determining the loads imposed on lintels, the clear width of opening, thickness of wall, material of which constructed, and whether any weight except the wall above is carried, must be taken into consideration. If the wall is solid, with no window openings above the lintel, the wall will arch and carry a great deal of load to the adjoining wall which supports the lintel, without coming on the lintel. The portion for which the lintel should be designed would be a triangle whose height will be one-half the span. This is true only when the adjoining wall is sufficient to take the thrust due to the arch effect.



No. 10—Types of Steel Lintels

Each individual case must stand on its own merits and the lintel be designed accordingly. If the loads are underestimated, cracks are liable to appear in walls.

The diagrams above illustrate some different types of steel lintels. Lintels made of cast iron are not in general use in present-day construction, although we have a number of patterns, and can supply cast iron lintels if desired.

FLOORS AND FLOOR LOADS

Kinds of Loads.—Two kinds of loads are carried by structures. Live loads consist of the weight of machinery, merchandise, persons or other moving objects, or of cranes or other handling devices and their loads, the support of which is the purpose of the structure, including also wind stresses. Dead loads consist of the actual weight of the structure itself with the walls, floors, partitions, roofs, and all other permanent construction and fixtures. The dead loads stress the structure at all times and it must, therefore, be proportioned to sustain them at all times without reduction. The live loads may be taken at their full values or reduced in accordance with the probabilities that the structure as a whole or its principal members will not be subject at all times to the full theoretical live loading.

Dead Loads.—The permanent load should be calculated from known weights per unit of the material composing floors, partitions, walls, or other permanent construction. The weight assumed for the steel frame itself should be checked after the sections are determined and then the sizes readjusted if necessary.

Live Loads.—Live loads vary with the character of the structures. In buildings they consist of uniform loads per square foot of floor area, concentrated loads such as heavy safes, which may be applied at any point of the floor, and uniform loads per lineal foot of beams or girders. The load which produces the maximum bending moment or reaction is to be used in proportioning sections. The floor system between beams must of course be of sufficient strength to transmit any concentrated load to the beam.

In cities the minimum live loads to be used on the various classes of buildings are fixed by public ordinances, and are given on page 31 for the principal cities of the United States in accordance with the most recent building laws, which are intended to cover general conditions and do not include machinery or other concentrations. If such concentrations, like safes, armatures, generators, or printing presses, occur on floors, special provision should be made for them in the floor framing. Flat roofs of buildings which may be loaded with people, should be treated the same as floors and the same uniform live loads used as given in the table for dwellings, hotels or assembly rooms.

Reduced Live Loads.—Floor beams in buildings should be computed to sustain floor by floor the full live and dead loads. It is not probable that all the floors will be fully loaded at all times, and, therefore, good practice permits a reduction of the theoretical live load in the computations of column sections. See pages 54 and 55.

BEARING PLATES

In the case where beams rest on walls, the table on page 51 gives sizes and thicknesses which depend on the end reaction, length of bearing and safe unit pressure for the different constructions of walls, and the dimensions given are for beams of usual spans.

MINIMUM LIVE LOADS FOR FLOORS AND ROOFS IN POUNDS PER SQUARE FOOT

By Building Laws of Various U.S. Cities.

Description of Building	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Floors for Rooms									
Apartments and Dwellings	40	40	70	50	50	70	60	50	40
Asylums, Hospitals, etc.	100	50	70	50	50			70	40
Detention Buildings, etc.	100	50			50	80			60
Factories:									
Light manufacture	120	100	120	100	125		125	125	100
Heavier manufacture			150	150	250		175		150
Hotels, Lodging Houses	40	50	70	50	50	70	60	70	40
Office Buildings, etc.	60	50	100	*100	*75	*70	*75	*70	*50
Public Buildings:									
Municipal Buildings	100				75	100			100
Churches	100	100	120	75	100	80	75	125	100
Libraries, Museums	100				100	125		200	
Theaters	100	100	120	100	100	80	75	125	100
Schools, Colleges, etc.	75	75		75	50	70	75	70	60
Stores, light goods	120	100	120	100	125	*100	125	125	100
" heavier goods			150	150	250		175		150
Warehouses			150	150	250		250	200	150
Floors for Assembly Halls									
Auditoriums, fixed seats	100	100	120	100	100	80	75	125	100
" movable seats	100	100	120	100	100	125	125	125	100
Armories, Dance Halls, etc.	100	100			100	150		150	150
Miscellaneous									
Garages, Stables	120	100		100	150	150	100		75
Corridors, Hallways	100	100		100	75	70			100
Stairways, Fire Escapes	100	100		100	75	100			100
Sidewalks	300				250	200	200		300
Roofs:									
Flat, slope up to 20° (1/3)	40	25	†30	20	40	35	40	30	25
Steep, slope over 20° (1/3)	30	25	†30		25	30	20	30	25
Wind Pressure	30	20	†30	30	20	20	30	25	20

*First floors: St. Louis, 100; Boston, 125; Cleveland, 125; Baltimore, 130; Cincinnati, 100.

†Wind pressure for high buildings in built-up districts: 25 lbs. at tenth storey, 2½ lbs. less for each storey below and 2½ lbs. more for each storey above, up to 55 lbs.

EXPLANATION OF
TABLES OF SAFE LOADS

The following tables give the greatest safe load (uniformly distributed over the entire length) which the steel shapes used as beams will carry.

These loads include the weight of the beam, which must be deducted to obtain the net load.

The loads given are based on a fiber stress of 16,000 pounds per square inch, and are entirely reliable for ordinary conditions where loads are quiescent, as in buildings.

For fluctuating loads causing vibration, especially if the beams are long as compared to their depth, the tabular loads should be reduced one-fifth; for rapidly moving loads, or where loads are suddenly applied with slight impact, the tabular loads should be reduced one-third.

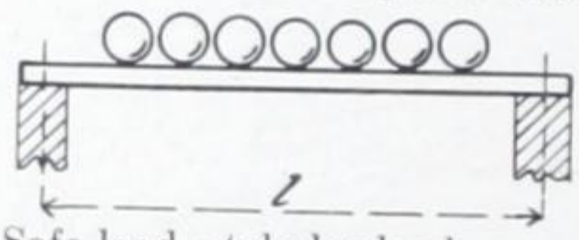
It is assumed that the beams are stiffened sideways to prevent buckling in the compression flange, otherwise tabular load must be reduced as follows.

Unbraced Length of Beam	Proportion to be used	Unbraced Length of Beam	Proportion to be used
10×flange width	Full tabular load	30×flange width	63% tabular load
15×flange width	91% tabular load	35×flange width	53% tabular load
20×flange width	81% tabular load	40×flange width	44% tabular load
25×flange width	72% tabular load	45×flange width	

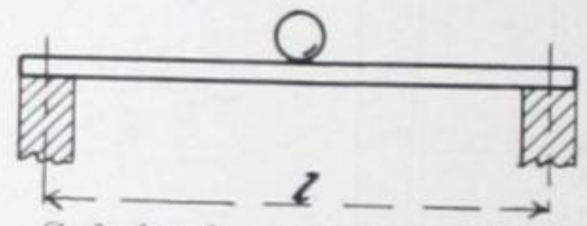
In many cases deflection will govern. The allowable deflection for plastered ceilings is 1/360 of the span. The deflection will be reduced in the same ratio as the load on the beam.

The bending moments and deflections of beams under various systems of loading are given below:

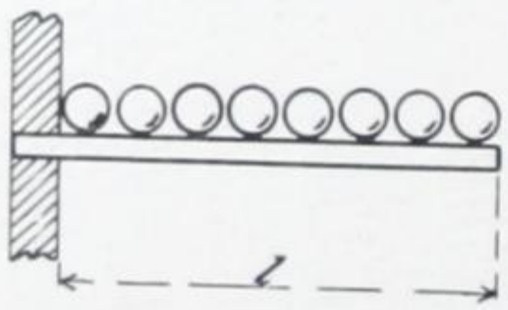
W = total load. l = length of beam. M = maximum bending moment.



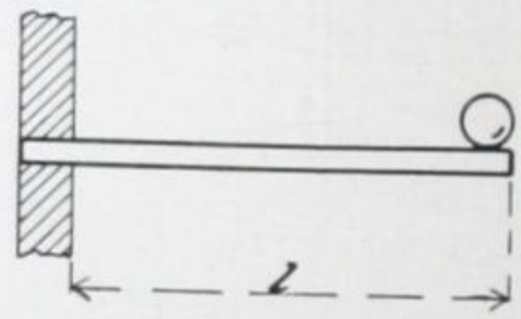
Safe load = tabular load.
M at center = 1/8 Wl.
Deflection as in tables.



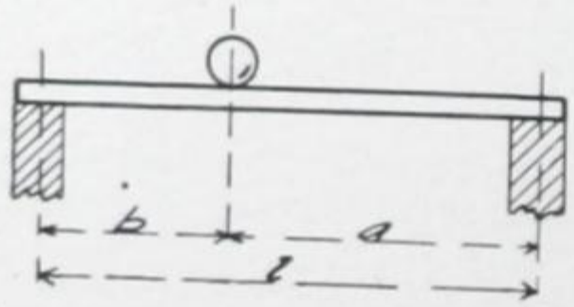
Safe load = 1/2 tabular load.
M = 1/4 Wl.
Deflection = .8 tabular deflection.



Safe load = 1/4 tabular load.
M = 1/2 Wl.
Deflection = 2.4 tabular deflection.

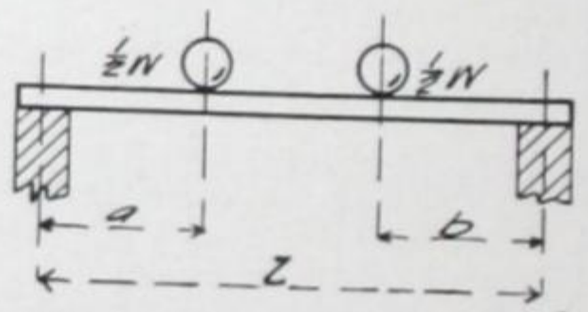


Safe load = 1/8 tabular load.
M at point of support = W.
Deflection = 3.2 tabular deflection.



Safe load = tabular load $\times \frac{l^2}{8ab}$

$M = \frac{Wab}{l}$



Safe load = tabular load $\times \frac{l}{4a}$

M between loads = 1/2 Wa.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress 16,000 Pounds per Square Inch

Depth of Beam	Depth and Weight of Section																	
	24 Ins.	24 Ins.	20 Ins.												18 Ins.		15 Ins.	
	80 lbs.	100 lbs.	90 lbs.	85 lbs.	80 lbs.	75 lbs.	70 lbs.	65 lbs.	60 lbs.	55 lbs.	50 lbs.	45 lbs.	42.5 lbs.	40 lbs.	70 lbs.	55 lbs.	60 lbs.	42 lbs.
5	160	200	144	136	128	120	112	104	96	88	80	72	68	64	112	88	96	67.2
6	133	167	120	113	107	100	93	87	80	73	67	60	57	53	93	73	80	56
7	114	143	103	97	91	86	80	74	69	63	57	51	49	46	80	63	69	48
8	100	125	90	85	80	75	70	65	60	55	50	45	43	40	70	55	60	42
9	89	111	80	75	71	67	62	58	53	49	44	40	38	36	62	49	53	37
10	80	100	72	68	64	60	56	52	48	44	40	36	34	32	56	44	48	34
11	73	91	65	62	58	55	51	47	44	40	36	33	31	29	51	40	44	31
12	67	83	60	57	53	50	47	43	40	37	33	30	28	27	47	37	40	28
13	62	77	55	52	49	46	43	40	37	34	31	28	26	25	43	34	37	26
14	57	71	51	49	46	43	40	37	34	31	29	26	24	23	40	31	34	24
15	53	67	48	45	43	40	37	35	32	29	27	24	23	21	37	29	32	22
16	50	63	45	43	40	38	35	33	30	28	25	23	21	20	35	28	30	21
17	47	59	42	40	38	35	33	31	28	26	24	21	20	19	33	26	28	20
18	44	56	40	38	36	33	31	29	27	25	22	20	19	18	31	25	27	19
19	42	53	38	36	34	32	30	28	25	23	21	19	18	17	30	23	25	18
20	40	50	36	34	32	30	28	26	24	22	20	18	17	16	28	22	24	17
21	38	48	34	32	30	29	27	25	23	21	19	17	16	15	27	21	23	16
22	36	45	33	31	29	27	25	24	22	20	18	16	15	14	25	20	22	15
23	35	43	31	30	28	26	24	23	21	19	17	16	15	14	24	19	21	14
24	33	42	30	28	27	25	23	22	20	18	17	15	14	13	23	18	20	14

Loads in "Heavy" type will produce maximum allowable shear in webs.
Loads in "Italic" type will produce excessive deflections.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections												Coefficient of Deflection
	20-Inch								18-Inch				
	100 lbs.	95 lbs.	90 lbs.	85 lbs.	81.4 lbs.	75 lbs.	70 lbs.	65.4 lbs.	90 lbs.	85 lbs.	80 lbs.	75.6 lbs.	
	349.2	**320.0**	**290.4**	.....	.....	**256.4**	**226.8**	.....	**286.6**	**257.0**	.....	.....	
6	293.0	284.4	275.6	**261.2**	**240.0**	224.6	215.9	**200.0**	248.2	240.3	**227.5**	**201.6**	0.60
7	251.2	243.8	236.2	228.8	223.4	192.5	185.0	178.2	212.7	205.9	199.2	193.3	0.81
8	219.8	213.3	206.7	200.2	195.5	168.5	161.9	155.9	186.2	180.2	174.3	169.2	1.06
9	195.4	189.6	183.8	178.0	173.8	149.7	143.9	138.6	165.5	160.2	155.0	150.4	1.34
10	175.8	170.6	165.4	160.2	156.4	134.8	129.5	124.7	148.9	144.2	139.5	135.3	1.66
11	159.9	155.1	150.3	145.6	142.2	122.5	117.7	113.4	135.4	131.1	126.7	123.0	2.00
12	146.5	142.2	137.8	133.5	130.3	112.3	107.9	104.0	124.1	120.2	116.2	112.8	2.38
13	135.2	131.2	127.2	123.2	120.3	103.7	99.6	96.0	114.5	110.9	107.3	104.1	2.80
14	125.6	121.9	118.1	114.4	111.7	96.3	92.5	89.1	106.4	103.0	99.6	96.7	3.24
15	117.2	113.7	110.3	106.8	104.3	89.9	86.3	83.2	99.3	96.1	93.0	90.2	3.72
16	109.9	106.6	103.4	100.1	97.8	84.2	81.0	78.0	93.1	90.1	87.2	84.6	4.24
17	103.4	100.4	97.3	94.2	92.0	79.3	76.2	73.4	87.6	84.8	82.0	79.6	4.78
18	97.7	94.8	91.9	89.0	86.9	74.9	72.0	69.3	82.7	80.1	77.5	75.2	5.36
19	92.5	89.8	87.0	84.3	82.3	70.9	68.2	65.7	78.4	75.9	73.4	71.2	5.98
20	87.9	85.3	82.7	80.1	78.2	67.4	64.8	62.4	74.5	72.1	69.7	67.7	6.62
21	83.7	81.3	78.8	76.3	74.5	64.2	61.7	59.4	70.9	68.7	66.4	64.4	7.30
22	79.9	77.6	75.2	72.8	71.1	61.3	58.9	56.7	67.7	65.5	63.4	61.5	8.01
23	76.4	74.2	71.9	69.7	68.0	58.6	56.3	54.2	64.7	62.7	60.6	58.8	8.76
24	73.3	71.1	68.9	66.7	65.2	56.2	54.0	52.0	62.1	60.1	58.1	56.4	9.53
25	70.3	68.3	66.2	64.1	62.6	53.9	51.8	49.9	59.6	57.7	55.8	54.1	10.35
26	67.6	65.6	63.6	61.6	60.2	51.8	49.8	48.0	57.3	55.4	53.6	52.0	11.19
27	65.1	63.2	61.2	59.3	57.9	49.9	48.0	46.2	55.2	53.4	51.6	50.1	12.07
28	62.8	60.9	59.0	57.2	55.9	48.1	46.3	44.6	53.2	51.5	49.8	48.3	12.98
29	60.6	58.8	57.0	55.2	53.9	46.5	44.7	43.0	51.4	49.7	48.1	46.7	13.92
30	58.6	56.9	55.1	53.4	52.1	44.9	43.2	41.6	49.6	48.1	46.5	45.1	14.90
31	56.7	55.0	53.4	51.7	50.5	43.5	41.8	40.2	48.5	46.5	45.0	43.7	15.91
32	54.9	53.3	51.7	50.1	48.9	42.1	40.5	39.0	46.0	45.1	43.6	42.3	16.95
33	53.3	51.7	50.1	48.5	47.4	40.8	39.2	37.8	45.1	43.7	42.3	41.0	18.03
34	51.7	50.2	48.6	47.1	46.0	39.6	38.1	36.7	43.8	42.4	41.0	39.8	19.13
35	50.2	48.8	47.2	45.8	44.7	38.5	37.0	35.6	42.5	41.2	39.9	38.7	20.28
36	48.8	47.4	45.9	44.5	43.4	37.4	36.0	34.7	41.4	40.0	38.7	37.6	21.45
37	47.5	46.1	44.7	43.3	42.3	36.4	35.0	33.7	*40.2*	*39.0*	*37.7*	*36.6*	22.66
38	46.3	44.9	43.5	42.1	41.2	35.5	34.1	32.8	*39.2*	*37.9*	*36.7*	*35.6*	23.90
39	45.1	43.8	42.4	41.1	40.1	34.6	33.2	32.0	.....	.....	.....	.....	25.18
40	44.0	42.7	41.3	40.0	39.1	33.7	32.4	31.2					26.48
41	*42.9*	*41.6*	*40.3*	*39.1*	*38.1*	*32.9*	*31.6*	*30.4*	.....	.....	.....	.....	27.82
42	*41.9*	*40.6*	*39.4*	*38.1*	*37.2*	*32.1*	*30.8*	*29.7*	.....	.....	.....	.....	29.20

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections,

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections													Deflection in Inches for Uniform Load
	15-Inch					15-Inch								
	70 lbs.	55 lbs.	60 lbs.	50.7 lbs.	40.2 lbs.	75 lbs.	70 lbs.	55 lbs.	60.8 lbs.	55 lbs.	50 lbs.	45 lbs.	42.9 lbs.	
4	256 0	226 4				260 4				194 4				0 17
5	217 1	208 0				244 3	231 0	201 8	177 0	161 2	146 0	126 8		0 27
6			196 0	165 6		195 1	197 6	174 8	171 2	144 7	130 0	120 0		0 41
7	161 2	173 4	163 1	117 1	136 8	167 0							123 8	
8	155 3	144 5	141 8	134 7	124 6	146 2	136 4	120 6	144 4	120 6	114 1	107 2	114 7	0 37
9	151 8	140 1	124 1	117 0	109 2	129 7	134 0	120 4	123 7	103 3	97 7	92 1	89 7	0 47
10	151 0	130 0	124 1	117 0	109 2	123 2	117 0	112 3	108 3	90 4	85 1	80 6	78 3	1 00
11	129 6	111 6	110 3	104 6	97 1	109 6	116 2	99 3	95 2	80 4	75 9	71 7	69 8	1 14
12	108 7	104 0	99 3	94 3	87 6	97 7	93 3	89 3	86 0	72 3	68 4	64 2	62 8	1 26
13	99 9	94 0	90 3	85 7	79 6	88 9	85 3	81 7	78 7	65 9	62 3	58 8	57 1	1 40
14	92 8	86 7	83 7	79 6	73 8	81 3	78 1	74 9	72 2	60 4	57 0	53 7	52 4	1 53
15	86 7	80 0	78 4	73 1	67 2	75 2	72 2	69 1	66 5	55 6	52 6	49 6	48 3	1 67
16	77 7	74 9	73 4	67 3	62 4	68 8	67 0	64 2	61 8	51 7	48 9	46 1	44 9	1 79
17	73 1	69 4	66 2	63 4	58 2	64 3	62 1	59 8	57 7	48 2	45 6	43 0	41 9	2 02
18	68 0	65 0	63 1	58 9	54 0	61 1	58 6	56 2	54 1	45 2	42 9	40 3	39 3	2 14
19	64 4	61 2	58 6	55 1	51 4	57 1	55 2	52 9	50 9	42 6	40 3	37 9	37 0	2 26
20	60 8	57 9	55 3	52 4	48 6	54 3	52 1	49 9	48 1	40 3	38 1	35 9	34 9	2 39
21	57 7	54 9	52 4	49 6	46 1	51 4	49 4	47 3	45 6	38 1	36 1	34 0	33 1	2 51
22	54 9	52 3	49 9	47 3	43 9	48 9	47 0	45 0	43 4	36 3	34 4	32 4	31 5	2 64
23	52 3	49 9	47 6	45 1	41 9	46 6	44 8	42 9	41 4	34 6	32 8	30 9	30 1	2 76
24	50 1	47 8	45 6	43 2	40 1	44 6	42 9	41 1	39 6	33 1	31 4	29 6	28 8	2 89
25	48 1	45 9	43 8	41 5	38 6	42 8	41 2	39 5	38 0	31 8	30 1	28 4	27 6	3 02
26	46 3	44 1	42 1	39 9	37 1	41 2	39 6	38 0	36 6	30 6	29 0	27 3	26 6	3 14
27	44 6	42 5	40 6	38 4	35 8	39 7	38 2	36 6	35 2	29 5	27 9	26 3	25 6	3 27
28	43 0	41 0	39 1	37 0	34 5	38 3	36 8	35 3	33 9	28 4	26 9	25 3	24 7	3 39
29	41 6	39 6	37 8	35 8	33 3	37 0	35 6	34 1	32 8	27 5	26 0	24 5	23 8	3 52
30	40 2	38 3	36 6	34 6	32 2	35 8	34 4	33 0	31 7	26 6	25 2	23 7	23 0	3 64
31	38 9	37 1	35 4	33 5	31 2	34 6	33 3	31 9	30 7	25 7	24 3	22 9	22 3	3 77
32	37 8	36 0	34 4	32 5	30 3	33 6	32 3	31 0	29 8	24 9	23 6	22 2	21 6	3 89
33	36 7	35 0	33 4	31 6	29 4	32 6	31 4	30 1	28 9	24 2	22 9	21 6	21 0	4 02
34	35 7	34 0	32 5	30 7	28 6	31 7	30 5	29 3	28 1	23 5	22 3	21 0	20 4	4 14
35	34 7	33 1	31 6	29 9	27 8	30 8	29 7	28 5	27 3	22 9	21 7	20 4	19 8	4 27
36	33 8	32 2	30 8	29 1	27 1	30 0	28 9	27 7	26 6	22 2	21 1	19 8	19 3	4 39
37	32 9	31 4	30 0	28 3	26 4	29 2	28 1	27 0	25 9	21 6	20 5	19 3	18 8	4 52
38	32 1	30 6	29 3	27 6	25 7	28 5	27 4	26 3	25 2	21 0	20 0	18 8	18 3	4 64

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections													Coefficient of Deflection
	15 in.	12-Inch							10-Inch					
	37.3 lbs.	55 lbs.	50 lbs.	45 lbs.	40.8 lbs.	35 lbs.	31.8 lbs.	27.9 lbs.	40 lbs.	35 lbs.	30 lbs.	25.4 lbs.	22.4 lbs.	
		194.4	.....	.....	.....	.....	.....	.....	**148.2**	**118.8**	.....	.....	.....	
3	.....	189.2	**164.9**	**135.6**	.....	**102.7**	.....	.....	112.4	103.7	**89.4**	.....	.....	0.15
4	.....	141.9	134.1	126.3	**110.4**	100.9	**84.0**	.....	84.3	77.7	71.2	**62.0**	**50.4**	0.27
5	.....	113.5	107.2	101.0	95.6	80.7	76.7	.....	67.4	62.2	57.0	52.1	48.5	0.41
	99.6	.....	.....	.....	.....	.....	.....	**68.2**	.....	.....	.....	.....	.....	
6	96.1	94.6	89.4	84.2	79.7	67.3	63.9	59.1	56.2	51.8	47.5	43.4	40.4	0.60
7	82.4	81.1	76.6	72.1	68.3	57.6	54.8	50.6	48.1	44.4	40.7	37.2	34.6	0.81
8	72.1	71.0	67.0	63.1	59.8	50.5	48.0	44.3	42.1	38.9	35.6	32.6	30.3	1.06
9	64.1	63.1	59.6	56.1	53.1	44.9	42.6	39.4	37.5	34.6	31.6	28.9	26.9	1.34
10	57.7	56.8	53.6	50.5	47.8	40.4	38.4	35.5	33.7	31.1	28.5	26.0	24.2	1.66
11	52.4	51.6	48.7	45.9	43.5	36.7	34.9	32.2	30.6	28.3	25.9	23.7	22.0	2.00
12	48.1	47.3	44.7	42.1	39.8	33.6	32.0	29.5	28.1	25.9	23.7	21.7	20.2	2.38
13	44.4	43.7	41.2	38.8	36.8	31.0	29.5	27.3	25.9	23.9	21.9	20.0	18.6	2.80
14	41.2	40.6	38.3	36.1	34.2	28.8	27.4	25.3	24.1	22.2	20.3	18.6	17.3	3.24
15	38.4	37.8	35.7	33.7	31.9	26.9	25.6	23.6	22.5	20.7	19.0	17.4	16.2	3.72
16	36.0	35.5	33.5	31.6	29.9	25.2	24.0	22.2	21.1	19.4	17.8	16.3	15.1	4.24
17	33.9	33.4	31.5	29.7	28.1	23.7	22.6	20.9	19.8	18.3	16.8	15.3	14.3	4.78
18	32.0	31.5	29.8	28.1	26.6	22.4	21.3	19.7	18.7	17.3	15.8	14.5	13.5	5.36
19	30.4	29.9	28.2	26.6	25.2	21.2	20.2	18.7	17.7	16.4	15.0	13.7	12.8	5.98
20	28.8	28.4	26.8	25.3	23.9	20.2	19.2	17.7	16.9	15.5	14.2	13.0	12.1	6.62
21	27.5	27.0	25.5	24.0	22.8	19.2	18.3	16.9	*16.1*	*14.8*	*13.6*	*12.4*	*11.5*	7.30
22	26.2	25.8	24.4	23.0	21.7	18.3	17.4	16.1	*15.3*	*14.1*	*12.9*	*11.8*	*11.0*	8.01
23	25.1	24.7	23.3	22.0	20.8	17.5	16.7	15.4	.....	.....	.....	.....	.....	8.76
24	24.0	23.7	22.3	21.0	19 9	16.8	16.0	14.8	.....	.....	.....	.....	.....	9.53
25	23.1	*22.7*	*21.4*	*20.2*	*19.1*	*16.1*	*15.3*	*14.2*	.....	.....	.....	.....	.....	10.35
26	22.2	*21.8*	*20.6*	*19.4*	*18.4*	*15.5*	*14.8*	*13.6*	.....	.....	.....	.....	.....	11.19
27	21.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.07
28	20.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.98
29	19.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.92
30	19.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.90
31	*18.6*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.91
32	*18.0*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.95

Loads in **"heavy"** type will produce maximum allowable shear in webs.
Loads in *"italic"* type will produce excessive deflections.

BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections												Distance between Centres of Supports in Feet
	9-Inch				8-Inch					7-Inch			
	25 lbs.	20 lbs.	15 lbs.	13.8 lbs.	17.5 lbs.	18 lbs.	20.5 lbs.	16.4 lbs.	17.5 lbs.	20 lbs.	17.5 lbs.	15.3 lbs.	
3	130 3	107 9			86 1	79 6	66 8			63 9	48 3		
4	97 8	80 1	71 5	62 3	64 5	59 8	50 1	43 3		47 11	36 2	26 8	3 - 10
5	78 2	64 1	57 2	49 10	51 7	47 8	40 1	34 7	26 7	38 4	28 11	21 5	4 - 0
6	65 2	53 5	47 8	41 7	43 1	39 10	33 5	28 11	22 3	31 11	24 1	17 10	4 - 6
7	55 10	45 10	40 11	35 8	36 11	34 1	28 8	24 9	19 1	27 5	20 8	15 4	4 - 9
8	48 11	40 1	35 9	31 3	32 3	29 10	25 1	21 8	16 8	23 11	18 1	13 5	5 - 0
9	43 6	35 6	31 9	27 10	28 8	26 6	22 3	19 4	14 11	21 3	16 1	12 0	5 - 3
10	39 2	32 1	28 8	25 1	25 11	23 11	20 1	17 5	13 5	19 2	14 6	10 9	5 - 6
11	35 7	29 2	26 2	22 10	23 6	21 9	18 3	15 10	12 3	17 5	13 3	9 11	5 - 9
12	32 8	26 9	24 0	21 0	21 8	20 1	16 10	14 7	11 4	16 1	12 2	9 2	6 - 0
13	30 3	24 9	22 2	19 5	20 2	18 7	15 7	13 6	10 6	14 11	11 4	8 6	6 - 3
14	28 1	23 0	20 7	18 1	18 9	17 4	14 6	12 7	9 10	13 11	10 6	7 11	6 - 6
15	26 3	21 6	19 4	17 0	17 8	16 4	13 8	11 11	9 3	13 1	9 11	7 5	6 - 9
16	24 8	20 3	18 2	16 0	16 8	15 5	13 0	11 3	8 9	12 4	9 4	7 0	7 - 0
17	23 4	19 2	17 2	15 1	15 10	14 7	12 4	10 8	8 4	11 9	8 11	6 8	7 - 3
18	22 2	18 2	16 4	14 4	15 0	13 11	11 9	10 3	8 0	11 3	8 6	6 4	7 - 6
19	21 1	17 3	15 6	13 8	14 3	13 3	11 3	9 10	7 8	10 9	8 2	6 1	7 - 9
20	20 1	16 5	14 10	13 1	13 7	12 8	10 9	9 5	7 4	10 4	7 10	5 10	8 - 0
21	19 3	15 8	14 2	12 6	13 1	12 2	10 4	9 1	7 1	9 11	7 6	5 7	8 - 3
22	18 5	15 0	13 6	12 0	12 6	11 8	10 0	8 8	6 10	9 6	7 3	5 5	8 - 6
23	17 8	14 5	13 0	11 6	12 0	11 3	9 8	8 5	6 7	9 2	7 0	5 3	8 - 9
24	17 1	13 10	12 6	11 1	11 6	10 10	9 4	8 2	6 5	8 10	6 9	5 1	9 - 0
25	16 5	13 5	12 1	10 8	11 2	10 6	9 1	7 11	6 3	8 7	6 7	4 11	9 - 3
26	15 11	13 0	11 8	10 4	10 10	10 2	8 9	7 8	6 1	8 4	6 4	4 9	9 - 6
27	15 4	12 6	11 4	10 0	10 5	9 10	8 6	7 6	5 11	8 1	6 2	4 7	9 - 9
28	14 10	12 1	10 11	9 8	10 1	9 6	8 3	7 3	5 9	7 10	6 0	4 5	10 - 0
29	14 4	11 9	10 8	9 5	9 9	9 3	8 0	7 1	5 7	7 7	5 10	4 4	10 - 3
30	13 10	11 4	10 4	9 2	9 6	9 0	7 9	6 11	5 5	7 4	5 8	4 2	10 - 6
31	13 4	11 0	10 0	8 11	9 3	8 9	7 7	6 9	5 4	7 2	5 6	4 1	10 - 9
32	12 11	10 8	9 9	8 8	9 0	8 6	7 5	6 7	5 2	6 11	5 4	3 11	11 - 0
33	12 6	10 3	9 5	8 5	8 9	8 4	7 3	6 5	5 1	6 9	5 3	3 10	11 - 3
34	12 1	9 11	9 2	8 2	8 6	8 1	7 1	6 3	4 11	6 7	5 1	3 9	11 - 6
35	11 8	9 8	8 11	7 11	8 3	7 11	6 11	6 1	4 10	6 5	4 11	3 8	11 - 9
36	11 4	9 4	8 8	7 9	8 0	7 8	6 9	6 0	4 8	6 3	4 10	3 7	12 - 0

Span in Feet	Depth and Weight of Sections												Distance between Centres of Supports in Feet
	6-Inch			5-Inch			4-Inch				3-Inch		
	17.25 lbs.	14.75 lbs.	12.5 lbs.	14.75 lbs.	12.25 lbs.	10 lbs.	10.5 lbs.	9.5 lbs.	9.5 lbs.	7.7 lbs.	7.5 lbs.	6.5 lbs.	5.7 lbs.	
3	55 8			40 4	34 7		32 8	26 1	20 3		20 9			
4	41 3	41 2	27 6	32 1	26 4	21 9	24 6	19 7	15 2	16 2	15 8	10 1	9 11	3 - 0
5	33 0	32 11	22 1	25 8	21 1	17 6	19 8	15 9	12 2	13 0	12 7	8 1	7 11	4 - 0
6	27 6	27 5	18 4	21 5	17 7	14 7	16 5	13 2	10 1	10 10	10 6	6 9	6 7	5 - 0
7	23 7	23 6	15 9	18 4	15 1	12 6	14 1	11 4	8 8	9 4	9 1	5 10	5 9	6 - 0
8	20 8	20 7	13 10	16 1	13 2	11 0	12 4	9 11	7 7	8 2	7 11	5 2	5 1	7 - 0
9	18 5	18 4	12 4	14 3	11 8	9 9	11 0	8 10	6 10	7 4	7 1	4 7	4 6	8 - 0
10	16 7	16 6	11 1	12 10	10 6	8 10	9 11	7 11	6 2	6 7	6 5	4 2	4 1	9 - 0
11	15 2	15 1	10 1	11 8	9 7	8 1	9 1	7 3	5 8	6 1	5 11	3 10	3 9	10 - 0
12	13 11	13 10	9 3	10 10	8 11	7 5	8 4	6 9	5 3	5 7	5 5	3 6	3 5	11 - 0
13	12 10	12 9	8 6	10 0	8 2	6 10	7 9	6 3	4 11	5 2	5 0	3 3	3 2	12 - 0
14	11 10	11 9	7 11	9 3	7 7	6 5	7 3	5 10	4 7	4 10	4 8	3 0	2 11	13 - 0
15	11 0	10 11	7 4	8 7	7 2	6 0	6 9	5 6	4 4	4 6	4 4	2 10	2 8	14 - 0
16	10 3	10 2	6 10	8 1	6 9	5 8	6 5	5 2	4 1	4 3	4 1	2 7	2 6	15 - 0
17	9 8	9 7	6 6	7 8	6 5	5 4	6 1	4 11	3 10	4 0	3 10	2 5	2 4	16 - 0
18	9 2	9 1	6 1	7 3	6 1	5 1	5 9	4 8	3 8	3 9	3 7	2 3	2 2	17 - 0
19	8 8	8 7	5 9	6 11	5 9	4 11	5 6	4 5	3 6	3 6	3 5	2 2	2 1	18 - 0
20	8 3	8 2	5 6	6 7	5 6	4 8	5 3	4 3	3 4	3 4	3 3	2 1	2 0	19 - 0
21	7 10	7 9	5 3	6 4	5 3	4 6	5 0	4 0	3 2	3 2	3 1	2 0	1 11	20 - 0
22	7 6	7 5	5 0	6 0	5 0	4 4	4 10	3 11	3 1	3 0	2 11	1 11	1 10	21 - 0
23	7 2	7 1	4 9	5 9	4 9	4 2	4 8	3 9	3 0	2 11	2 10	1 10	1 9	22 - 0
24	6 10	6 9	4 7	5 6	4 7	4 0	4 6	3 8	2 11	2 10	2 9	1 9	1 8	23 - 0
25	6 7	6 6	4 5	5 4	4 5	3 11	4 4	3 7	2 10	2 9	2 8	1 8	1 7	24 - 0
26	6 4	6 3	4 3	5 2	4 3	3 10	4 2	3 6	2 9	2 8	2 7	1 7	1 6	25 - 0

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "italic" type will produce excessive deflections.

H - BEAMS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Pending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections								Coefficients of Deflection
	8-Inch			6-Inch			5-Inch	4-Inch	
	37.7 lb.	34.3 lb.	32.6 lb.	26.7 lb.	24.1 lb.	22.8 lb.	18.9 lb.	13.8 lb.	
	.....	.....	.....	.....	.....	.....	.....	**25.0**	
3	.....	.....	.....	**52.5**	.....	.....	**31.3**	19.0	0.15
4	**80.0**	.....	.....	42.1	**37.5**	.....	25.4	14.3	0.27
5	64.4	**60.0**	.....	33.7	32.1	**30.0**	20.3	11.4	0.41
6	53.7	51.4	**50.0**	28.1	26.7	26.1	16.9	9.5	0.60
7	46.0	44.0	43.0	24.1	22.9	22.3	14.5	8.1	0.81
8	40.3	38.5	37.6	21.1	20.1	19.6	12.7	7.1	1.06
9	35.8	34.2	33.4	18.7	17.8	17.4	11.3	*6.3*	1.34
10	32.2	30.8	30.1	16.8	16.0	15.6	10.1	*5.7*	1.66
11	29.3	28.0	27.3	15.3	14.6	14.2	*9.2*	.....	2.00
12	26.8	25.7	25.1	14.0	13.4	13.0	*8.5*		2.38
13	24.8	23.7	23.1	*13.0*	*12.3*	*12.0*	.....	.....	2.80
14	23.0	22.0	21.5	*12.0*	*11.5*	*11.2*	.....	.....	3.24
15	21.5	20.5	20.1	.....	.....	.....	.....	.....	3.72
16	20.1	19.3	18.8	.....	.....	.....	.....	.....	4.24
17	*18.9*	*18.1*	*17.7*	.....	.....	.....	.....	.....	4.78
18	*17.9*	*17.1*	*16.7*	.....	.....	.....	.....	.....	5.36

Loads in **"heavy"** type will produce maximum allowable shear in webs.
Loads in *"italic"* type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections												Coefficient of Deflection
	15-Inch						13-Inch						
	55 lbs.	50 lbs.	45 lbs.	40 lbs.	35 lbs.	33.9 lbs.	50 lbs.	45 lbs.	40 lbs.	37 lbs.	35 lbs.	31.8 lbs.	
	244.2	**214.8**	**185.4**	.....	.....	.....	**204.6**	**175.0**	.....	.....	.....	.....	
3	203.4	190.4	177.2	**156.0**	**126.6**	**120.0**	171.2	159.8	**145.6**	**127.9**	**116.2**	**97.5**	0.15
4	152.5	142.8	132.9	123.1	113.3	111.1	128.4	119.8	111.3	106.2	102.8	97.4	0.27
5	122.0	114.3	106.3	98.5	90.7	88.9	102.7	95.9	89.1	85.0	82.3	77.9	0.41
6	101.7	95.2	88.6	82.1	75.6	74.1	85.6	79.9	74.2	70.8	68.6	65.0	0.60
7	87.1	81.6	75.9	70.3	64.7	63.5	73.3	68.4	63.6	60.6	58.8	55.7	0.81
8	76.3	71.4	66.5	61.6	56.7	55.6	64.2	59.9	55.7	53.1	51.4	48.7	1.06
9	67.8	63.5	59.1	54.7	50.4	49.4	57.1	53.2	49.5	47.2	45.7	43.3	1.34
10	61.0	57.1	53.2	49.3	45.3	44.5	51.3	47.9	44.5	42.5	41.1	39.0	1.66
11	55.5	51.9	48.3	44.8	41.2	40.4	46.7	43.6	40.5	38.6	37.4	35.4	2.00
12	50.9	47.6	44.3	41.1	37.7	37.0	42.8	39.9	37.1	35.4	34.3	32.5	2.38
13	47.0	44.0	40.9	37.9	34.9	34.2	39.5	36.9	34.3	32.7	31.6	30.0	2.80
14	43.6	40.8	38.0	35.2	32.4	31.8	36.7	34.2	31.8	30.3	29.4	27.8	3.24
15	40.7	38.1	35.5	32.8	30.2	29.6	34.2	31.9	29.7	28.3	27.4	26.0	3.72
16	38.1	35.7	33.2	30.8	28.3	27.8	32.1	30.0	27.8	26.6	25.7	24.4	4.24
17	35.9	33.6	31.3	29.0	26.7	26.1	30.2	28.2	26.2	25.0	24.2	22.9	4.78
18	33.9	31.7	29.5	27.4	25.2	24.7	28.5	26.6	24.7	23.6	22.9	21.7	5.36
19	32.1	30.1	28.0	25.9	23.9	23.4	27.0	25.2	23.4	22.4	21.6	20.5	5.98
20	30.5	28.6	26.6	24.6	22.7	22.2	25.7	24.0	22.3	21.2	20.6	19.5	6.62
21	29.1	27.2	25.3	23.5	21.6	21.2	24.5	22.8	21.2	20.2	19.6	18.6	7.30
22	27.7	26.0	24.2	22.4	20.6	20.2	23.3	21.8	20.2	19.3	18.7	17.7	8.01
23	26.5	24.8	23.1	21.4	19.7	19.3	22.3	20.8	19.4	18.5	17.9	16.9	8.76
24	25.4	23.8	22.2	20.5	18.9	18.5	21.4	20.0	18.6	17.7	17.1	16.2	9.53
25	24.4	22.9	21.3	19.7	18.1	17.8	20.5	19.2	17.8	17.0	16.5	15.6	10.35
26	23.5	22.0	20.5	18.9	17.4	17.1	19.8	18.4	17.1	16.3	15.8	15.0	11.19
27	22.6	21.2	19.7	18.2	16.8	16.5	*19.4*	*17.7*	*16.5*	*15.7*	*15.2*	*14.4*	12.07
28	21.8	20.4	19.0	17.6	16.2	15.9	*18.3*	*17.1*	*15.9*	*15.2*	*14.7*	*13.9*	12.98
29	21.0	19.7	18.3	17.0	15.6	15.3	.....	.....	.....	.....	.....	.....	13.92
30	20.3	19.0	17.7	16.4	15.1	14.8	.....	.....	.....	.....	.....	.....	14.90
31	*19.7*	*18.4*	*17.2*	*15.9*	*14.6*	*14.3*							15.91
32	*19.1*	*17.9*	*16.6*	*15.4*	*14.2*	*13.9*	.....	.....	.....	.....	.....	.....	16.95

Loads in **"heavy"** type will produce maximum allowable shear in webs.
Loads in *"italic"* type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections										Coefficient of Deflection
	12-Inch					10-Inch					
	40 lbs.	35 lbs.	30 lbs.	25 lbs.	20.7 lbs.	35 lbs.	30 lbs.	25 lbs.	20 lbs.	15.3 lbs.	
	181.2					**164.0**	**134.6**	**105.2**			
2	174.7	**151.7**	**122.4**	**92.9**		122.9	109.8	96.8	**75.8**	**48.0**	0.07
3	116.4	105.9	95.5	85.0	**67.2**	81.9	73.2	64.5	55.8	47.6	0.15
4	87.3	79.5	71.7	63.8	56.9	61.4	54.9	48.4	41.8	35.7	0.27
5	69.9	63.6	57.3	51.0	45.5	49.2	43.9	38.7	33.5	28.5	0.41
6	58.2	53.0	47.8	42.5	38.0	41.0	36.6	32.3	27.9	23.8	0.60
7	49.9	45.4	40.9	36.4	32.5	35.1	31.4	27.6	23.9	20.4	0.81
8	43.7	39.7	35.8	31.9	28.5	30.7	27.5	24.2	20.9	17.8	1.06
9	38.8	35.3	31.8	28.3	25.3	27.3	24.4	21.5	18.6	15.9	1.34
10	34.9	31.8	28.7	25.5	22.8	24.6	22.0	19.4	16.7	14.3	1.66
11	31.7	28.9	26.1	23.2	20.7	22.3	20.0	17.6	15.2	13.0	2.00
12	29.1	26.5	23.9	21.3	19.0	20.5	18.3	16.1	13.9	11.9	2.38
13	26.9	24.5	22.0	19.6	17.5	18.9	16.9	14.9	12.9	11.0	2.80
14	25.0	22.7	20.5	18.2	16.3	17.6	15.7	13.8	12.0	10.2	3.24
15	23.3	21.2	19.1	17.0	15.2	16.4	14.6	12.9	11.2	9.5	3.72
16	21.8	19.9	17.9	15.9	14.2	15.4	13.7	12.1	10.5	8.9	4.24
17	20.6	18.7	16.9	15.0	13.4	14.5	12.9	11.4	9.9	8.4	4.78
18	19.4	17.7	15.9	14.2	12.7	13.7	12.2	10.7	9.3	7.9	5.36
19	18.4	16.7	15.1	13.4	12.0	12.9	11.6	10.2	8.8	7.5	5.98
20	17.5	15.9	14.3	12.8	11.4	12.3	11.0	9.7	8.4	7.1	6.62
21	16.6	15.1	13.6	12.1	10.8	*11.7*	*10.5*	*9.2*	*8.0*	*6.8*	7.30
22	15.9	14.4	13.0	11.6	10.4	*11.2*	*10.0*	*8.8*	*7.6*	*6.5*	8.01
23	15.2	13.8	12.5	11.1	9.9						8.76
24	14.6	13.2	11.9	10.6	9.5						9.53
25	*14.0*	*12.7*	*11.5*	*10.2*	*9.1*						10.35
26	*13.4*	*12.2*	*11.0*	*9.8*	*8.8*						11.19

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

CHANNELS

ALLOWABLE UNIFORM LOAD IN THOUSANDS OF POUNDS

Maximum Bending Stress: 16,000 Pounds per Square Inch

Span in Feet	Depth and Weight of Sections															Coefficient of Deflection
	9-Inch				8-Inch					7-Inch						
	25 lbs.	20 lbs.	15 lbs.	13.4 lbs.	21.25 lbs.	18.75 lbs.	16.25 lbs.	13.75 lbs.	11.5 lbs.	19.75 lbs.	17.25 lbs.	14.75 lbs.	12.25 lbs.	9.8 lbs.		
	110.2	**80.6**	.....	.....	**92.6**	**77.9**	**63.2**	**48.5**	.....	**88.1**	**73.4**	**58.7**	**44.0**	.....		
2	83.6	71.8	**51.3**	**41.4**	63.5	58.3	53.0	47.8	**35.2**	50.4	45.8	41.2	36.7	**29.4**		0.07
3	55.7	47.8	40.0	37.4	42.3	38.8	35.3	31.9	28.7	33.6	30.5	27.5	24.4	21.4		0.15
4	41.8	35.9	30.0	28.0	31.7	29.1	26.5	23.9	21.5	25.2	22.9	20.6	18.3	16.1		0.27
5	33.4	28.7	24.0	22.4	25.4	23.3	21.2	19.1	17.2	20.2	18.3	16.5	14.7	12.9		0.41
6	27.9	23.9	20.0	18.7	21.2	19.4	17.7	15.9	14.4	16.8	15.3	13.7	12.2	10.7		0.60
7	23.9	20.5	17.2	16.0	18.1	16.6	15.1	13.7	12.3	14.4	13.1	11.7	10.5	9.2		0.81
8	20.9	17.9	15.0	14.0	15.9	14.6	13.3	11.9	10.8	12.6	11.4	10.3	9.2	8.0		1.06
9	18.6	16.0	13.3	12.5	14.1	12.9	11.8	10.6	9.6	11.2	10.2	9.2	8.2	7.1		1.34
10	16.7	14.4	12.0	11.2	12.7	11.7	10.6	9.6	8.6	10.1	9.2	8.2	7.3	6.4		1.66
11	15.2	13.1	10.9	10.2	11.5	10.6	9.6	8.7	7.8	9.2	8.3	7.5	6.7	5.8		2.00
12	13.9	12.0	10.0	9.3	10.6	9.7	8.8	8.0	7.2	8.4	7.6	6.9	6.1	5.4		2.38
13	12.9	11.0	9.2	8.6	9.8	9.0	8.2	7.4	6.6	7.8	7.0	6.3	5.6	4.9		2.80
14	11.9	10.3	8.6	8.0	9.1	8.3	7.6	6.8	6.2	7.2	6.5	5.9	5.2	4.6		3.24
15	11.1	9.6	8.0	7.5	8.5	7.8	7.1	6.4	5.7	*6.7*	*6.1*	*5.5*	*4.9*	*4.3*		3.72
16	10.4	9.0	7.5	7.0	7.9	7.3	6.6	6.0	5.4	*6.3*	*5.7*	*5.2*	*4.6*	*4.0*		4.24
17	9.8	8.4	7.1	6.6	*7.5*	*6.9*	*6.2*	*5.6*	*5.1*	.....	.....	.....	.....	.....		4.78
18	9.3	8.0	6.7	6.2	*7.1*	*6.5*	*5.9*	*5.3*	*4.8*	.....	.....	.....	.....	.....		5.36
19	*8.8*	*7.6*	*6.3*	*5.9*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		5.98
20	*8.4*	*7.2*	*6.0*	*5.6*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		6.62

Span in Feet	Depth and Weight of Sections															Coefficient of Deflection
	6-Inch				5-Inch			4-Inch			3-Inch					
	15.5 lbs.	13 lbs.	10.5 lbs.	8.2 lbs.	11.5 lbs.	9 lbs.	6.7 lbs.	7.25 lbs.	6.25 lbs.	5.4 lbs.	6 lbs.	5 lbs.	4.1 lbs.			
	.....	.....	.....	.....	**47.2**	.....	.....	**25.6**	.....	.....	**21.4**	**15.5**	.....			
1	**67.1**	**52.4**	**37.7**	**24.0**	44.2	**32.5**	**19.0**	24.3	**19.8**	**14.4**	14.7	13.0	**10.2**			0.02
2	34.6	30.7	26.8	23.1	22.1	18.8	15.8	12.1	11.1	10.1	7.3	6.5	5.8			0.07
3	23.1	20.5	17.8	15.4	14.7	12.5	10.5	8.1	7.4	6.7	4.9	4.3	3.9			0.15
4	17.3	15.3	13.4	11.6	11.0	9.4	7.9	6.1	5.5	5.1	3.7	3.3	2.9			0.27
5	13.8	12.3	10.7	9.2	8.8	7.5	6.3	4.9	4.4	4.1	2.9	2.6	2.3			0.41
6	11.5	10.2	8.9	7.7	7.4	6.3	5.3	4.0	3.7	3.4	2.4	2.2	1.9			0.60
7	9.9	8.8	7.6	6.6	6.3	5.4	4.5	3.5	3.2	2.9	*2.1*	*1.9*	*1.7*			0.81
8	8.6	7.7	6.7	5.8	5.5	4.7	4.0	3.0	2.8	2.5	*1.8*	*1.6*	*1.5*			1.06
9	7.7	6.8	5.9	5.1	4.9	4.2	3.5	*2.7*	*2.5*	*2.2*	.....	.....	.....			1.34
10	6.9	6.1	5.4	4.6	4.4	3.8	3.2	*2.4*	*2.2*	*2.0*	.....	.....	.....			1.66
11	6.3	5.6	4.9	4.2	*4.0*	*3.4*	*2.9*	.....	.....	.....	.....	.....	.....			2.00
12	5.8	5.1	4.5	3.9	*3.7*	*3.1*	*2.6*	.....	.....	.....	.....	.....	.....			2.38
13	*5.3*	*4.7*	*4.1*	*3.6*	.....	.....	.....	.....	.....	.....	.....	.....	.....			2.80
14	*4.9*	*4.4*	*3.8*	*3.3*	.....	.....	.....	.....	.....	.....	.....	.....	.....			3.24

Loads in "**heavy**" type will produce maximum allowable shear in webs.
Loads in "*italic*" type will produce excessive deflections.

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Neutral Axis Parallel to Either Leg

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×8 ×1	51.00	.....	84240	56160	42120	33700	28080	24070	21060	18720	16850	15320	**14040**	**12960**	**12030**	**11230**
7/8	45.00	.....	74740	49840	37370	29900	24920	21360	18690	16610	14950	13590	**12460**	**11500**	**10680**	**9970**
3/4	38.90	.....	64980	43320	32490	25990	21660	18570	16250	14440	13000	11820	**10830**	**10000**	**9280**	**8660**
5/8	32.70	.....	54940	36620	27470	21980	18310	15700	13740	12210	10990	9990	**9160**	**8450**	**7850**	**7330**
1/2	26.40	89240	44620	29760	22310	17850	14880	12750	11160	9920	8930	8110	**7440**	**6870**	**6380**	**5950**
6 ×6 × 7/8	33.10	81440	40720	27150	20360	16290	13570	11630	10180	9050	**8140**	**7400**	**6790**	**6260**	**5820**	*5430*
3/4	28.70	71180	35540	23690	17770	14220	11850	10150	8890	7900	**7110**	**6460**	**5920**	**5470**	**5080**	*4740*
5/8	24.20	60340	30170	20120	15090	12070	10060	8620	7540	6710	**6030**	**5490**	**5030**	**4640**	**4310**	*4020*
1/2	19.60	49220	24610	16400	12300	9840	8200	7030	6150	5470	**4920**	**4470**	**4100**	**3790**	**3520**	*3280*
3/8	14.90	37640	18820	12550	9410	7530	6270	5380	4700	4180	**3760**	**3420**	**3140**	**2900**	**2690**	*2510*
5 ×5 × 3/4	23.60	48320	24160	16100	12080	9660	8050	6900	6040	**5360**	**4830**	**4390**	**4020**	*3710*	*3450*	*3220*
5/8	20.00	41140	20570	13710	10280	8230	6860	5880	5140	**4570**	**4110**	**3740**	**3430**	*3160*	*2940*	*2740*
1/2	16.20	33660	16830	11220	8410	6730	5610	4810	4210	**3740**	**3370**	**3060**	**2800**	*2590*	*2400*	*2240*
3/8	12.30	25820	12910	8610	6460	5170	4310	3690	3230	**2780**	**2580**	**2350**	**2150**	*1990*	*1850*	*1720*
4 ×4 × 5/8	15.70	25620	12810	8540	6410	5130	4270	3660	**3200**	**2850**	**2560**	**2330**	*2140*	*1970*	*1830*	*1710*
1/2	12.80	21060	10530	7020	5270	4210	3510	3010	**2630**	**2340**	**2110**	**1910**	*1760*	*1620*	*1500*	*1400*
3/8	9.80	16240	8120	5420	4060	3250	2710	2320	**2030**	**1810**	**1620**	**1480**	*1350*	*1250*	*1160*	*1080*
5/16	8.20	13740	6870	4580	3430	2750	2290	1960	**1720**	**1530**	**1370**	**1250**	*1140*	*1060*	*980*	*920*

For lengths in "light" type, deflection will be less than 3/16"; in **"heavy"** type, more than 3/16"; in *"italic"* type more than 3/8".

STANDARD STEEL ANGLES

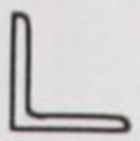
SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Neutral Axis Parallel to Either Leg

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Equal Leg Angles



Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Neutral Axis Parallel to Either Leg

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches		Weight per Foot	Distance between Supports in Feet													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3½×3½×	½	11.10	15880	7940	5290	3970	3180	2650	2270	**1098**	**1760**	*1590*	*1440*	*1320*	*1220*	*1130*	*1060*
	⅜	8.50	12280	6140	4100	3070	2460	2050	1760	**1540**	**1370**	*1239*	*1120*	*1020*	*950*	*880*	*820*
	¼	5.80	8640	4320	2880	2160	1720	1440	1230	**1080**	**960**	*860*	*780*	*720*	*660*	*610*	*570*
3 ×3 ×	½	9.40	11440	5720	3810	2860	2290	1910	**1630**	**1430**	**1270**	*1140*	*1040*	*950*	.....	.....	.....
	⅜	7.20	8880	4440	2960	2220	1780	1480	**1270**	**1110**	**990**	*890*	*810*	*740*	.....	.....	.....
	5/16	6.10	7540	3770	2510	1890	1510	1260	**1080**	**940**	**840**	*750*	*690*	*630*	.....	.....	.....
	¼	4.90	6160	3080	2050	1540	1230	1030	**880**	**770**	**680**	*620*	*560*	*510*	.....	.....	.....
2¾×2¾×	½	8.50	9480	4740	3160	2370	1900	1580	**1360**	**1190**	*1050*	*950*	*860*	*790*	.....	.....	.....
	5/16	5.60	6280	3140	2090	1570	1260	1050	**900**	**790**	*700*	*630*	*570*	*520*	.....	.....	.....
	3/16	3.39	3940	1970	1310	980	790	660	**560**	**490**	*440*	*390*	*360*	*330*	.....	.....	.....
2½×2½×	⅜	5.90	6040	3020	2010	1510	1210	1010	**860**	**760**	*670*	*600*	*550*	*500*	.....	.....	.....
	3/16	3.07	3220	1610	1080	810	650	540	**460**	**400**	*360*	*320*	*290*	*270*	.....	.....	.....
2¼×2¼×	⅜	5.30	4820	2410	1610	1210	960	**800**	**690**	*600*	*540*	*480*	*440*	*400*	.....	.....	.....
	3/16	2.75	2600	1300	870	650	520	**430**	**370**	*320*	*290*	*260*	*240*	*220*	.....	.....	.....
2 ×2 ×	⅜	4.70	3740	1870	1250	940	750	**620**	**540**	*470*	*420*	*370*	.....	.....	.....	.....	.....
	3/16	2.44	2040	1020	680	510	410	**340**	**290**	*250*	*230*	*200*	.....	.....	.....	.....	.....

For lengths in "light" type, deflection will be less than 3/16"; in **"heavy"** type, more than 3/16": in *"italic"* type, more than ⅜".

STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×6 ×¾	33.80	.....	62220	41480	31110	24890	20740	17770	15550	13820	12440	11310	**10370**	**9570**	**8880**	**8290**
⅝	28.50	.....	52620	35080	26310	21050	17540	15040	13150	11690	10520	9570	**8770**	**8090**	**7510**	**7010**
½	23.00	85480	42740	28490	21370	17090	14250	12210	10680	9500	8550	7770	**7120**	**6570**	**6100**	**5700**
7 ×3½×⅝	21.00	74280	37140	24760	18570	14850	12380	10610	9280	8250	7430	**6750**	**6190**	**5710**	**5310**	*4950*
½	17.00	60560	30280	20180	15140	12120	10100	8650	7570	6730	6060	**5510**	**5050**	**4660**	**4330**	*4040*
⅜	13.00	46180	23090	15390	11540	9230	7690	6590	5770	5130	4610	**4190**	**3840**	**3550**	**3290**	*3070*
6 ×4 ×⅝	20.00	56640	28320	18880	14160	11330	9440	8090	7080	6290	**5660**	**5150**	**4720**	**4360**	*4050*	*3780*
½	16.20	46240	23120	15410	11560	9250	7710	6600	5780	5140	**4620**	**4200**	**3850**	**3560**	*3300*	*3080*
⅜	12.30	35400	17700	11800	8850	7080	5900	5060	4420	3930	**3540**	**3220**	**2950**	**2720**	*2530*	*2360*
6 ×3½×⅝	18.90	55340	27670	18450	13840	11070	9220	7910	6920	6150	**5530**	**5030**	**4610**	**4260**	*3950*	*3690*
½	15.30	45200	22600	15060	11300	9040	7530	6460	5650	5020	**4520**	**4110**	**3770**	**3480**	*3230*	*3010*
⅜	11.70	34600	17300	11540	8650	6920	5770	4940	4330	3850	**3460**	**3150**	**2880**	**2660**	*2470*	*2310*
5 ×4 ×½	14.50	32560	16280	10850	8140	6510	5430	4650	4070	**3620**	**3260**	**2960**	**2710**	*2500*	*2330*	*2170*
⅜	11.00	25000	12500	8330	6250	5000	4170	3570	3120	**2780**	**2500**	**2270**	**2080**	*1920*	*1790*	*1670*
5 ×3½×½	13.60	31860	15930	10620	7960	6370	5310	4550	3980	**3540**	**3190**	**2900**	**2650**	*2450*	*2280*	*2120*
5/16	8.70	20640	10320	6880	5160	4130	3440	2950	2580	**2290**	**2060**	**1880**	**1720**	*1590*	*1470*	*1380*
5 ×3 ×½	12.80	31020	15510	10340	7760	6210	5170	4430	3880	**3450**	**3100**	**2820**	**2590**	*2390*	*2220*	*2070*
5/16	8.20	20120	10160	6710	5030	4020	3350	2870	2520	**2240**	**2010**	**1830**	**1680**	*1550*	*1440*	*1340*

For lengths in **"heavy"** type, the deflection will be greater than 3/16"; in *"italic"* type, greater than ⅜".

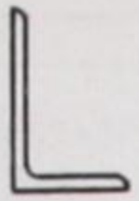
STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.



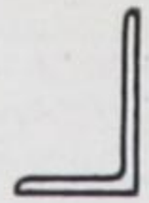
STANDARD STEEL ANGLES

SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Long Leg Vertical

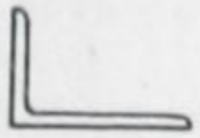
For safe loads and deflections under various systems of loading, see explanation on page 32.



Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4½×3 ×½	11.90	25320	12660	8440	6330	5060	4220	3620	3170	**2810**	**2530**	**2300**	*2110*	*1950*	*1810*	*1690*
5/16	7.70	16420	8210	5470	4100	3280	2730	2340	2050	**1820**	**1640**	**1490**	*1360*	*1260*	*1170*	*1090*
4 ×3½×½	11.90	20640	10320	6880	5160	4130	3440	2950	**2580**	**2290**	**2060**	**1880**	*1720*	*1590*	*1470*	*1380*
5/16	7.70	13480	6740	4490	3370	2690	2250	1920	**1680**	**1500**	**1350**	**1220**	*1120*	*1040*	*960*	*900*
4 ×3 ×½	11.10	20140	10070	6710	5040	4030	3360	2880	**2520**	**2240**	**2010**	**1830**	*1680*	*1550*	*1440*	*1340*
5/16	7.20	13160	6580	4390	3290	2630	2190	1880	**1640**	**1460**	**1320**	**1200**	*1100*	*1010*	*940*	*880*
3½×3 ×½	10.20	15500	7750	5170	3880	3100	2580	2220	**1940**	**1720**	**1550**	*1410*	*1290*	*1190*	*1110*	*1030*
¼	5.40	8420	4210	2800	2100	1680	1400	1200	**1050**	**930**	**840**	*760*	*700*	*640*	*600*	*560*
3½×2½×½	9.40	15060	7530	5020	3760	3010	2510	2150	**1880**	**1670**	**1510**	*1370*	*1250*	*1160*	*1080*	*1000*
¼	4.90	8040	4020	2680	2010	1610	1340	1150	**1010**	**890**	**800**	*730*	*670*	*620*	*570*	*540*
3 ×2½×⅜	6.60	8640	4320	2880	2160	1730	1440	**1230**	**1080**	**960**	*860*	*790*	*720*	*660*	*620*	.....
¼	4.50	5980	2990	2000	1500	1200	1000	**860**	**750**	**670**	*600*	*540*	*500*	*460*	*430*	.....
3 ×2 ×⅜	5.90	8340	4170	2780	2080	1670	1390	**1190**	**1040**	**930**	*830*	*760*	*690*	.....	.....	.....
¼	4.10	5780	2890	1930	1440	1160	960	**830**	**720**	**640**	*580*	*530*	*480*	.....	.....	.....

For lengths in **"heavy"** type, the deflection will be greater than 3/16"; in *"italic"* type greater than ⅜".

STANDARD STEEL ANGLES



SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Short Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8 ×6 ×¾	33.80	73840	36920	24610	18460	14770	12310	10550	9320	8200	7380	**6710**	**6150**	**5680**	**5270**	*4920*
⅝	28.50	62680	31340	20890	15670	12530	10440	8950	7830	6960	6260	**5690**	**5220**	**4820**	**4470**	*4170*
½	23.00	55080	27540	18360	12770	10210	8510	7290	6380	5670	5100	**4640**	**4250**	**3920**	**3640**	*3400*
7 ×3½×⅝	21.00	21040	10520	7010	5260	4210	3510	3010	**2630**	**2340**	**2100**	**1910**	*1750*	*1620*	*1500*	*1400*
½	17.00	17280	8640	5760	4320	3460	2880	2470	**2160**	**1920**	**1730**	**1570**	*1440*	*1330*	*1230*	*1150*
⅜	13.00	13970	6980	4650	3490	2790	2320	1990	**1740**	**1550**	**1390**	**1270**	*1160*	*1070*	*990*	*930*
6 ×4 ×⅝	20.00	27040	13520	9020	6760	5410	4510	3860	3380	**3010**	**2700**	**2460**	*2250*	*2080*	*1930*	*1800*
½	16.20	22200	11100	7400	5550	4440	3700	3170	2770	**2470**	**2220**	**2020**	*1850*	*1710*	*1590*	*1480*
⅜	12.30	17100	8550	5700	4280	3420	2850	2440	2140	**1900**	**1710**	**1550**	*1430*	*1320*	*1220*	*1140*
6 ×3½×⅝	18.90	20680	10340	6890	5170	4140	3450	2950	**2580**	**2300**	**2070**	**1880**	*1720*	*1590*	*1480*	*1380*
½	15.30	17000	8500	5670	4250	3400	2830	2430	**2120**	**1890**	**1700**	**1550**	*1420*	*1310*	*1210*	*1130*
⅜	11.70	13140	6570	4380	3280	2630	2190	1880	**1640**	**1460**	**1310**	**1190**	*1090*	*1010*	*940*	*870*
5 ×4 ×½	14.50	21720	10860	7240	5430	4340	3620	3100	2710	**2410**	**2170**	**1970**	*1810*	*1670*	*1550*	*1450*
⅜	11.00	16740	8370	5580	4180	3350	2790	2390	2090	**1860**	**1670**	**1520**	*1390*	*1290*	*1200*	*1120*
5 ×3½×½	13.60	16640	8320	5550	4160	3330	2770	2380	**2080**	**1850**	**1660**	*1510*	*1390*	*1280*	*1190*	.....
5/16	8.70	10900	5450	3630	2720	2180	1820	1560	**1360**	**1210**	**1090**	*900*	*910*	*840*	*780*	.....
5 ×3 ×½	12.80	12220	6110	4070	3060	2440	2040	1750	**1530**	**1360**	**1220**	*1110*	*1020*	*940*	*870*	.....
5/16	8.20	8040	4020	2680	2010	1610	1340	1150	**1000**	**890**	**800**	*730*	*670*	*620*	*570*	.....

For lengths in **"heavy"** type, the deflection will be greater than $\frac{3}{16}$"; in *"italic"* type greater than $\frac{3}{8}$".

STANDARD STEEL ANGLES

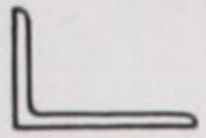
SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles

Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

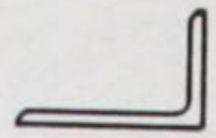
Short Leg Vertical

For safe loads and deflections under various systems of loading, see explanation on page 32.

STANDARD STEEL ANGLES



SAFE LOADS IN POUNDS UNIFORMLY DISTRIBUTED—For Unequal Leg Angles



Safe loads are figured for a fiber stress of 16,000 pounds per square inch, and include the weight of angle.

Short Leg Vertical

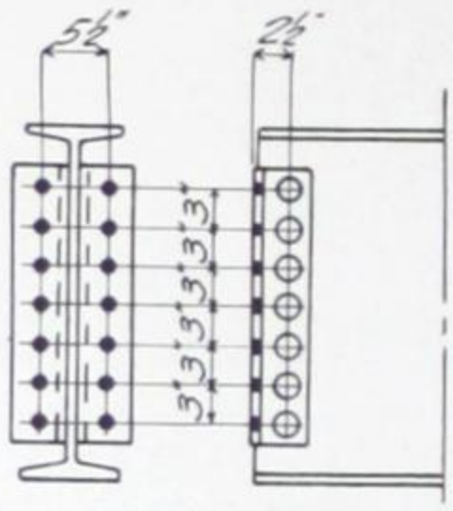
For safe loads and deflections under various systems of loading, see explanation on page 32.

Size of Angle, Inches	Weight per Foot	Distance between Supports in Feet.														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4½×3 ×½	11.90	12080	6040	4020	3020	2410	2010	1720	**1510**	**1340**	**1210**	*1100*	*1010*	*930*	*860*	.....
5/16	7.70	8106	4050	2700	2020	1620	1350	1150	**1010**	**900**	**810**	*730*	*670*	*620*	*570*	.....
4 ×3½×½	11.90	16180	8090	5390	4040	3240	2700	2310	**2020**	**1800**	**1620**	*1470*	*1350*	*1240*	*1160*	.....
5/16	7.70	10600	5300	3530	2650	2120	1770	1510	**1320**	**1180**	**1060**	*960*	*880*	*820*	*760*	.....
4 ×3 ×½	11.10	11900	5950	3960	2970	2380	1980	1700	**1490**	**1320**	**1190**	*1080*	*990*	*910*	*850*	.....
5/16	7.20	7840	3920	2610	1960	1570	1310	1120	**980**	**870**	**780**	*710*	*650*	*600*	*560*	.....
3½×3 ×½	10.20	11680	5840	3900	2920	2340	1950	1670	**1460**	**1300**	*1170*	*1060*	*970*	*900*	*830*	.....
¼	5.40	7700	3850	2570	1930	1540	1280	1100	**960**	**860**	*770*	*700*	*640*	*590*	*550*	.....
3½×2½×½	9.40	8100	4050	2700	2030	1620	1350	**1160**	**1010**	**900**	*810*	*740*	*680*	.....	.....	.....
¼	4.90	4400	2200	1460	1100	880	730	**630**	**550**	**490**	*440*	*400*	*370*	.....	.....	.....
3 ×2½×⅜	6.60	6200	3100	2060	1550	1240	1030	**880**	**770**	**690**	*620*	*560*	*520*	.....	.....	.....
¼	4.50	4320	2160	1440	1080	860	720	**620**	**540**	**480**	*430*	*390*	*360*	.....	.....	.....
3 ×2 ×⅜	5.90	3960	1980	1320	990	790	**660**	**570**	**500**	*440*	*400*	*360*	*330*	.....	.....	.....
¼	4.10	2780	1390	920	690	550	**460**	**400**	**350**	*310*	*280*	*250*	*230*	.....	.....	.....

For lengths in **"heavy"** type, the deflection will be greater than 3/16"; in *"italic"* type greater than 3/8".

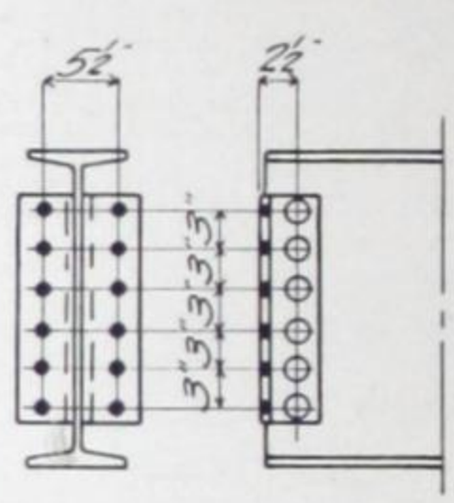
STANDARD BEAM CONNECTIONS

27-INCH



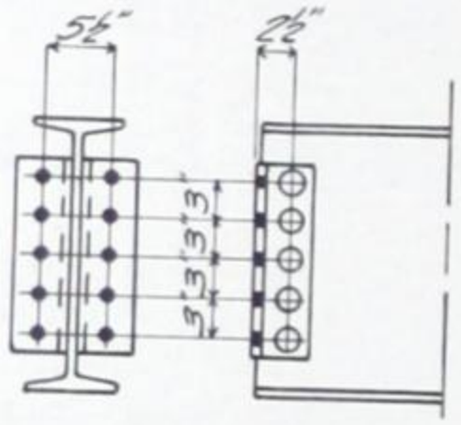
2 Angles 4″ x 4″ x ½″ x 1′-8½″
Weight 46 lbs.

24-INCH



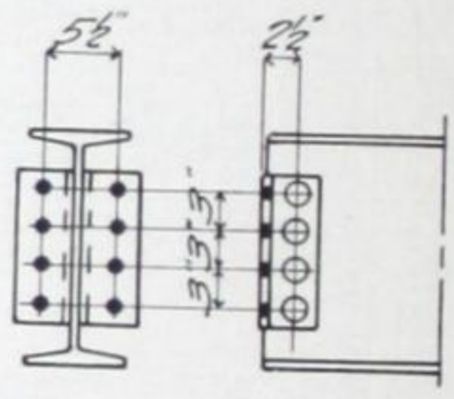
2 Angles 4″ x 4″ x ⅜″ x 1′-5½″
Weight 30 lbs.

21- and 20-INCH



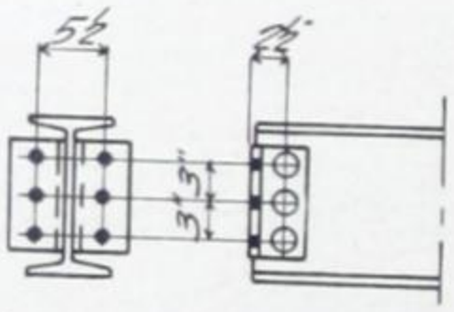
2 Angles 4″ x 4″ x ⅜″ x 1′-2½″
Weight 25 lbs.

18- and 15-INCH



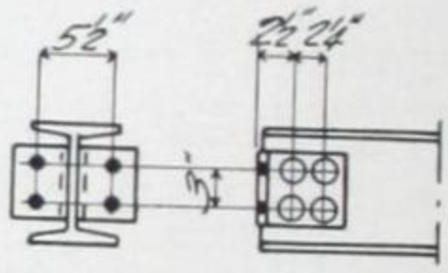
2 Angles 4″ x 4″ x ⅜″ x 0′-11½″
Weight 20 lbs.

12-INCH



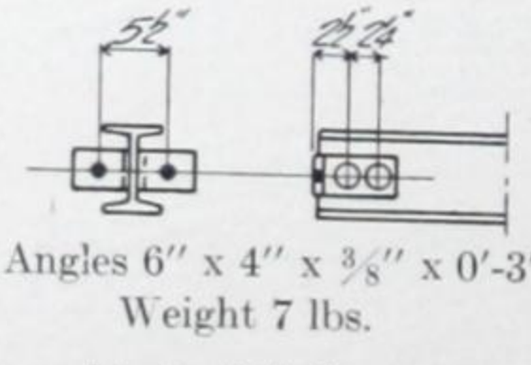
2 Angles 4″ x 4″ x ⅜″ x 0′-8½″
Weight 15 lbs.

10-, 9- and 8-INCH



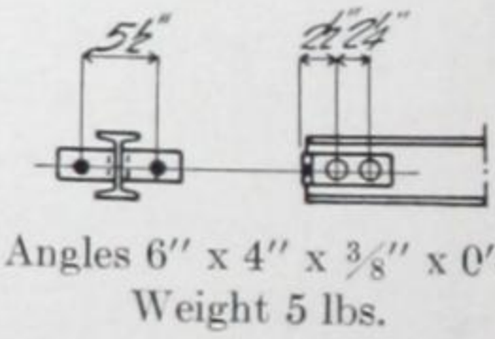
2 Angles 6″ x 4″ x ⅜″ x 0′-5½″
Weight 13 lbs.

7-, 6- and 5-INCH



2 Angles 6″ x 4″ x ⅜″ x 0′-3″
Weight 7 lbs.

4- and 3-Inch



2 Angles 6″ x 4″ x ⅜″ x 0′-2″
Weight 5 lbs.

Rivets and bolts ¾″ diameter.

Weights given are for ¾-inch shop rivets and angle connections; about 20 per cent should be added for field rivets or bolts.

LIMITING VALUES OF CONNECTIONS

FOR UNIFORMLY LOADED BEAMS

I-Beam		Strength of Web Connection with ¾" Shop Rivets.		Strength of Outstanding Legs of Connection Angles with ¾" Field Rivets.	Minimum Span of Beam in feet.	"t" in inches
Depth in inches	Weight in lbs. per foot	Bearing in lbs.	Double Shear in lbs.	Single Shear in lbs.		
24	100.	.....	63,600	53,040	19.9	5/8
..	79.9	56,250	.....	53,040	17.5	5/8
20	81.4	.....	42,400	35,360	22.1	5/8
..	65.4	37,500	.....	35,360	17.6	5/8
18	70.	.....	42,400	35,360	15.5	5/8
..	54.7	34,500	.....	35,360	13.7	5/8
15	81.3	.....	42,400	35,360	16.0	5/8
..	42.9	30,750	.....	35,360	10.2	9/16
12	55.	.....	31,800	26,520	10.8	5/8
..	31.8	19,665	.....	26,520	9.8	7/16
10	40.	.....	42,400	17,680	9.6	5/8
..	25.4	23,250	.....	17,680	7.4	5/8
9	35.	.....	42,400	17,680	7.5	5/8
.	21.8	21,750	.....	17,680	5.7	5/8
8	25.5	40,575	.....	17,680	5.2	5/8
.	18.4	20,250	.....	17,680	4.3	5/8
7	15.3	9,415	.....	8,840	6.3	5/8
6	12.5	8,665	.....	8,840	4.5	5/8
5	10.	7,915	.....	8,840	3.2	9/16
4	7.7	7,125	.....	8,840	2.2	1/2
3	5.7	6,375	.....	8,840	1.4	7/16

t = web thickness, for bearing if beams frame opposite, to develop strength of connection angles.

ALLOWABLE UNIT STRESSES IN POUNDS PER SQUARE INCH:

Single Shear

Shop rivets—12,000 Field rivets—10,000

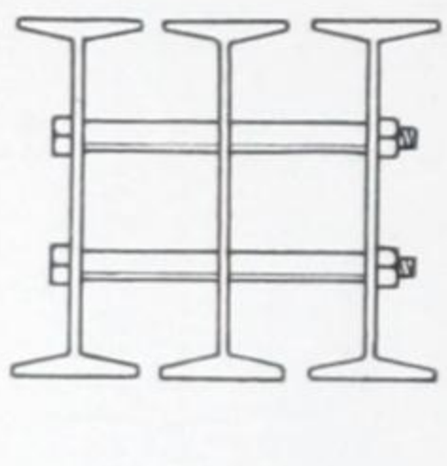
Bearing

Shop rivets—25,000 Field rivets—20,000

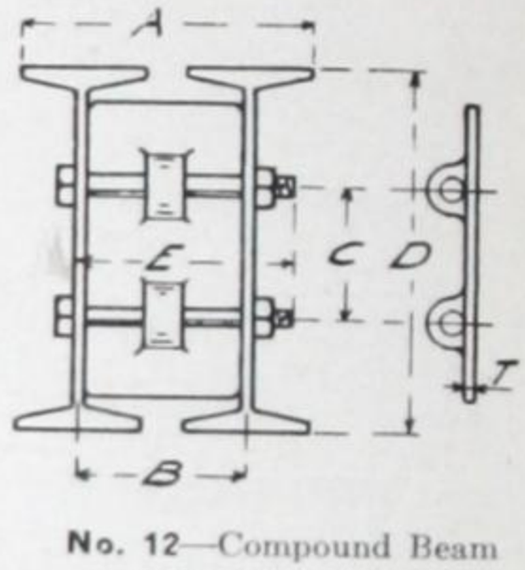
BEAM SEPARATORS

Beam separators may be cast iron separators, pipe separators, or sometimes steel channels.

Pipe separators are used in many cases owing to their convenience of adjustment to any necessary size. Channels are limited in use, owing to the fact that they are obtainable only in exact inch sizes. Specifications for cast iron separators are given in the table below.



No. 11—Compound Beam with Pipe Separators



No. 12—Compound Beam with Cast Iron Separator

SPECIFICATIONS FOR CAST IRON SEPARATORS

	BEAMS				SEPS.		BOLTS		
	D In.	Weight, Ft., Lbs	A In.	B In.	T In.	Weight, Lbs.	C In.	E In.	Wt., Polts & Nuts, Lbs.
ONE-BOLT SEPARATORS	3	5.7	$5\frac{5}{16}$	3	$\frac{3}{8}$	1.1	...	4	.95
	4	7.7	$5\frac{7}{8}$	$3\frac{1}{4}$	$\frac{3}{8}$	1.6	...	$4\frac{1}{2}$	1.01
	5	10.0	$6\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{8}$	2.0	...	$4\frac{3}{4}$	1.04
	6	12.5	$7\frac{5}{16}$	4	$\frac{1}{2}$	3.3	...	$5\frac{1}{4}$	1.11
	7	15.3	$7\frac{7}{8}$	$4\frac{1}{4}$	$\frac{1}{2}$	3.9	...	$5\frac{1}{2}$	1.14
	8	18.4	$8\frac{1}{2}$	$4\frac{1}{2}$	$\frac{1}{2}$	4.7	...	$5\frac{3}{4}$	1.17
	9	21.8	$9\frac{5}{16}$	5	$\frac{1}{2}$	5.9	...	$6\frac{1}{4}$	1.23
	10	25.4	$9\frac{7}{8}$	$5\frac{1}{4}$	$\frac{1}{2}$	6.8	...	$6\frac{1}{2}$	1.26
	12	31.8	$10\frac{3}{4}$	$5\frac{3}{4}$	$\frac{1}{2}$	8.8	...	7	1.32
	12	40.8	$11\frac{1}{4}$	6	$\frac{1}{2}$	8.9	...	$7\frac{1}{2}$	1.38
TWO-BOLT SEPARATORS	12	31.8	$10\frac{3}{4}$	$5\frac{3}{4}$	$\frac{1}{2}$	9.5	$6\frac{1}{2}$	7	2.64
	12	40.8	$11\frac{1}{4}$	6	$\frac{1}{2}$	9.5	$6\frac{1}{2}$	$7\frac{1}{2}$	2.76
	15	42.9	$11\frac{3}{4}$	$6\frac{1}{4}$	$\frac{1}{2}$	12.5	7	$7\frac{3}{4}$	2.82
	15	60.8	$12\frac{3}{4}$	$6\frac{3}{4}$	$\frac{1}{2}$	13.0	7	$8\frac{1}{4}$	2.95
	15	65.	$13\frac{5}{8}$	$7\frac{1}{4}$	$\frac{1}{2}$	13.2	7	9	3.13
	18	54.7	$12\frac{3}{4}$	$6\frac{3}{4}$	$\frac{5}{8}$	19.8	9	$8\frac{1}{4}$	2.95
	20	65.4	$13\frac{1}{4}$	7	$\frac{5}{8}$	22.9	10	$8\frac{1}{2}$	3.01
	20	81.4	$14\frac{3}{4}$	$7\frac{3}{4}$	$\frac{5}{8}$	24.6	10	$9\frac{1}{4}$	3.19
	24	79.9	$14\frac{3}{4}$	$7\frac{3}{4}$	$\frac{5}{8}$	30.3	12	$9\frac{1}{4}$	3.19

Dimensions given in above table refer to cut No. 12. Square head bolts, $\frac{3}{4}$-inch diameter, with nuts are used. Lengths and weights of separator bolts in above table are for girders composed of two beams of minimum section as shown.

STEEL BEARING PLATES

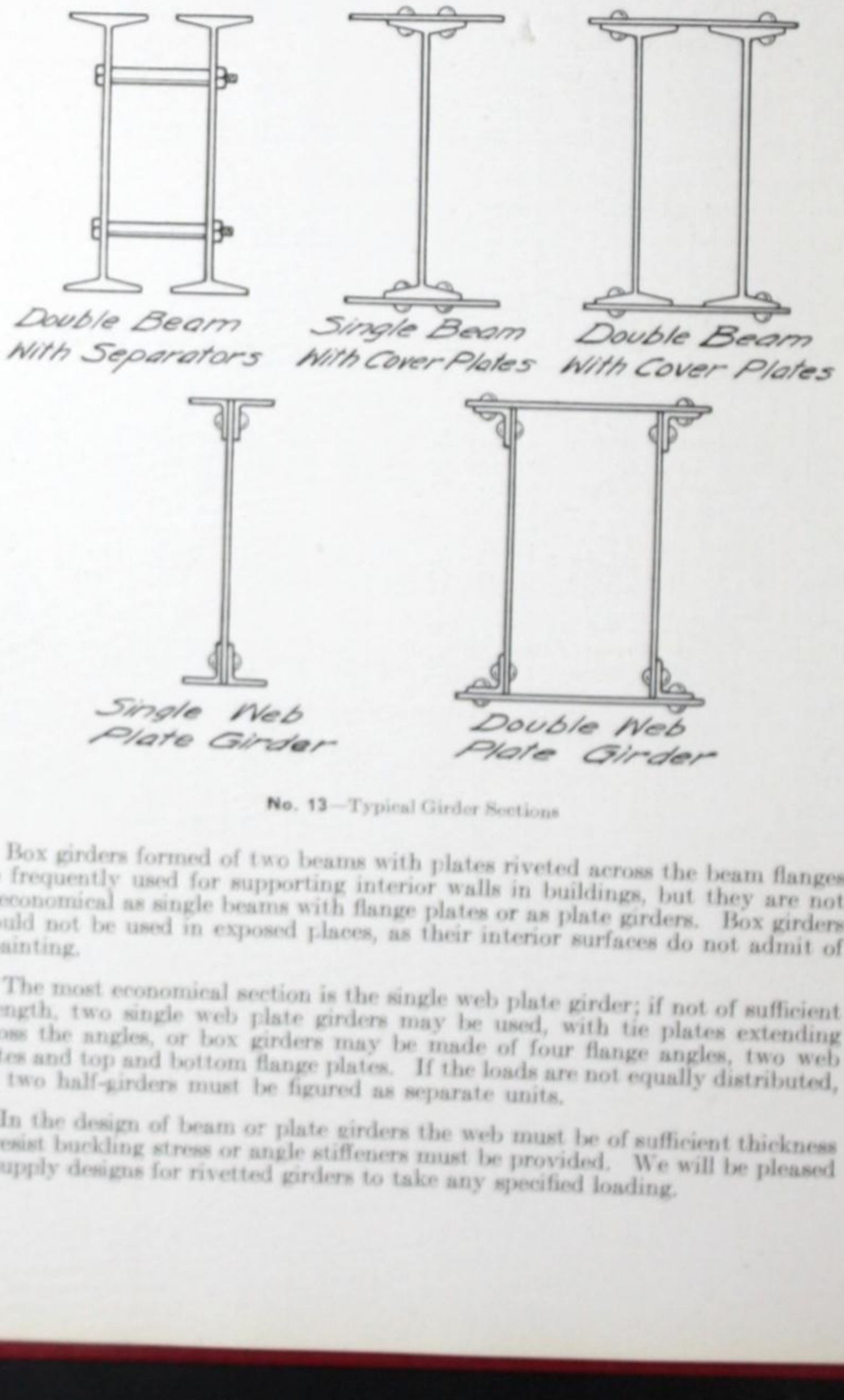
BEAM		Wall Bearing, Inches	Size in inches	Weight in Pounds	Common brick with lime mortar. 100 lbs. per sq. in. bearing pressure		Hard common select-brick, mortar 1 part Portland cement, 1 lime, 3 torpedo sand. 175 lbs. per sq. in. bearing pressure.		Portland cement concrete 1-2-4 mix. Machine mixed. 400 lbs. per sq. in. bearing pressure.		Common Size C. I. Bearing Plates	
Depth, In.	Wt., Lbs., per Ft.				Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Safe Load in 1000 lbs. on one Plate	Limiting Span in feet and inches	Size in inches	Weight including 2 per cent for overweight
24	79.9	16	16x16x1	73	25.6	36′ 0″	44.8	20′ 9″	67.3	13′ 6″	16x16x2	136
20	65.4	16	16x16x1	73	25.6	24′ 6″	44.8	14′ 0′	60.5	10′ 3″	16x16x1¾	119
18	54.7	16	16x16x1	73	25.6	18′ 6″	44.8	10′ 6″	54.8	8′ 6″	16x16x1¾	119
15	42.9	12	12x16x¾	41	19.2	16′ 0″	20.9	15′ 0″	20.9	15′ 0″	12x16x1¼	64
12	31.8	12	12x12x¾	31	14.4	13′ 3″	25.2	7′ 6″	35.3	5′ 3″	12x12x1¼	48
10	25.4	8	8x12x⅝	17	9.6	13′ 6″	14.9	8′ 9″	14.9	8′ 9″	8x12x1	25
9	21.8	8	8x12x⅝	17	9.6	10′ 6″	13.6	7′ 6″	13.6	7′ 6″	8x12x1	25
8	18.4	8	8x8x⅝	12	6.4	11′ 9″	11.2	6′ 9″	25.6	3′ 0″	8x8x1	17
7	15.3	8	8x8x⅝	12	6.4	8′ 9″	11.2	4′ 9″	25.6	3′ 0″	8x8x1	17
6	12.5	6	6x6x½	5	3.6	10′ 9″	6.3	6′ 3″	14.4	2′ 0″	6x6x¾	7
5	10	6	6x6x½	5	3.6	7′ 0″	6.3	4′ 0″	14.4	2′ 0″	6x6x¾	7

BEAM AND PLATE AND ANGLE GIRDERS

Where single rolled beams are insufficient to carry the loads, the required capacity may be obtained by various methods.

Two beams, connected with bolts and cast iron separators, or, for greater rigidity, with rivetted plate and angle separators, can be used. The total strength of these is twice that of the single beam provided that the loads are applied equally on the two sections, otherwise their strength must be computed separately.

Single beam girders with plates rivetted on top and bottom are often more economical than two beams connected with separators.



No. 13—Typical Girder Sections

Box girders formed of two beams with plates riveted across the beam flanges are frequently used for supporting interior walls in buildings, but they are not as economical as single beams with flange plates or as plate girders. Box girders should not be used in exposed places, as their interior surfaces do not admit of repainting.

The most economical section is the single web plate girder; if not of sufficient strength, two single web plate girders may be used, with tie plates extending across the angles, or box girders may be made of four flange angles, two web plates and top and bottom flange plates. If the loads are not equally distributed, the two half-girders must be figured as separate units.

In the design of beam or plate girders the web must be of sufficient thickness to resist buckling stress or angle stiffeners must be provided. We will be pleased to supply designs for rivetted girders to take any specified loading.

FOUNDATIONS

Foundation Loads.—Footings should be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible, and the dead loads carried by the footings should include the actual weight of the superstructure and foundations down to the bottom of the footing. The live load should be assumed to be the same as the live load in the lowest tier of columns or in the footings under walls. The area of the footing is determined by dividing the total load by the unit resistance of the soil. From the area thus calculated all the other footings of the building are proportioned according to the ratios of their respective dead loads only. In no case should the load per square foot under any portion of any footing due to the combined dead, live and wind loads, exceed the safe sustaining power of the soil upon which the footing rests.

Bearing Power of Soils.—The bearing power of a soil depends upon the character of the soil, its freedom from water, and its lateral support. The downward pressure of the surrounding soil prevents lateral displacement of the material under the foundation and adds materially to the bearing power of treacherous soils.

The allowable pressures given in the table below may be used as an aid to the judgment in determining on a safe load for a foundation. However, no important foundations should be built without making careful soundings and bearing tests.

A soil incapable of supporting the required loads may have its supporting power increased (1) by increasing the depth of the foundation; (2) by draining the site; (3) by compacting the soil; (4) by adding a layer of sand or gravel; (5) by using grillages to increase the bearing area; (6) by driving piles through the soft stratum, or far enough into it to support the loads.

When foundations are placed on sand, gravel or clay, it is usually only necessary to dig a trench and start the foundation below frost. If the soil is somewhat yielding or if the load is heavy, the foundation should be carried to a greater depth, or the footing should be made wider than for greater depths.

The placing of three or four reinforcing rods continuous around wall footings is advantageous as it prevents the common cracking in foundation walls due to unequal settlement caused by the fact that soil is not uniform in any area.

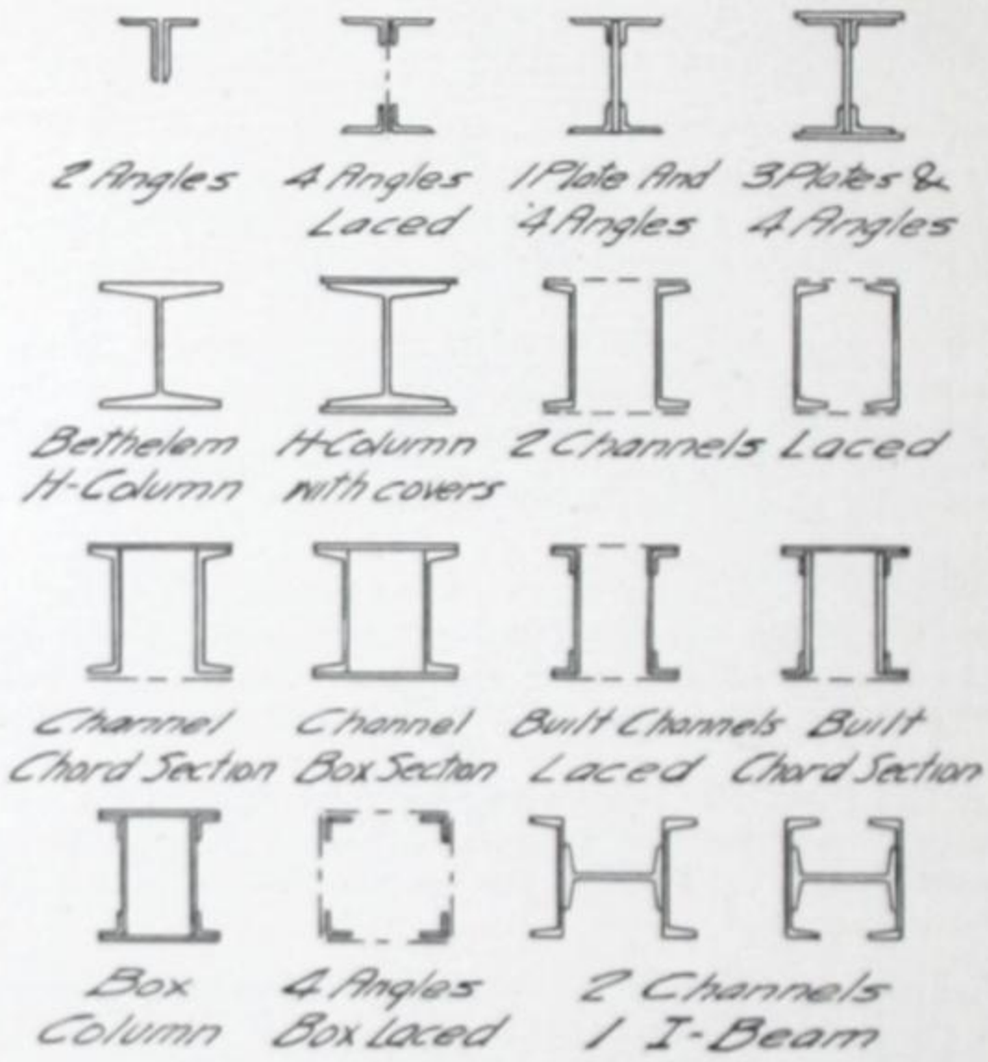
Allowable Foundation Pressures.—The following unit pressures for foundations have been proposed by Schneider in "Structural Design of Buildings":

MAXIMUM FOUNDATION PRESSURES

Kind of Material	Tons per Square Foot
Alluvial Soils	.5
Soft clay	1
Ordinary clay and dry sand mixed with clay	2
Dry sand and dry clay	3
Hard clay and firm, coarse sand	4
Firm, coarse sand and gravel	6
Rock	5 to 200

STEEL COLUMNS

Form and Size of Section.—Important as it may be to have the metal of the column section distributed as far as possible from the neutral axis, that is with as large a radius of gyration as possible, considerations of ease in fabrication and simplicity in connections are of greater weight. The economical column section is not that which affords the least weight of metal in the shaft, but that which, with a reasonable radius of gyration, provides the least weight of member, shaft and details with the minimum amount of riveting. Modern practice therefore, eliminates earlier forms of construction which represented the minimum amount of metal for the maximum radius of gyration, such, for example, as the column composed of three I-beams or one I-beam and two channels placed either with the flanges in or the flanges out. The Z-bar column has also fallen into disuse likewise a number of patented sections. The column sections should be of such size as to permit ready framing of beams and girders thereto and so



No. 14—Common Forms of Cross Section for Steel Columns and Struts.

placed in the construction as to permit the simplest details. Experience indicates that eight inches is the smallest desirable dimension in ordinary building work, For struts and light loads, smaller angle columns are still in use, while H-beams are excellent for such purposes. I-beams and single angles may be used with economy where the conditions of lengths and loading permit.

Design.—Column loads to be calculated in the design of ordinary columns for buildings are dead loads, including snow loads, and live loads. There are other loads such as impact, wind load etc., which are for particular cases and need not be considered here. The dead load is the load produced by the weight of floors, curtain walls, roof, steel etc., and can be accurately calculated. The live load depends on the use of which the building is to be put, and includes the weight of persons, furniture, goods and equipment. In determining the loads due to occupancy of stores and office buildings considerable judgment must be exercised. Since it is very improbable that the full live load will be imposed on all floors simultaneously, the loads used in calculating the strength of floor beams may be reduced for the calculation of column stresses.

For columns carrying more than five floors, live loads may be reduced as follows:

For roof and top floor, no reduction.

For each succeeding floor a reduction of 5% until 50% is reached, which load shall be used for all succeeding floors. This reduction does not apply for warehouses, which are likely to be loaded on all floors simultaneously.

Radius of Gyration.—As the strength of a column depends on its ability to resist flexural stress, the moment of inertia of its cross section is an important factor in the determination of its carrying capacity. For the purpose of computation, however, it is much more convenient to use the radius of gyration which depends on the moment of inertia.

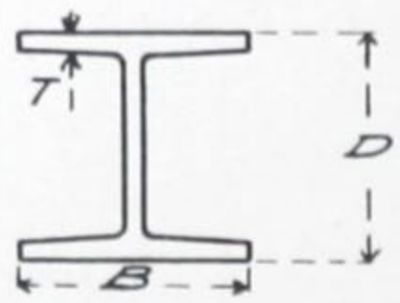
Ratio of Slenderness.—The ratio of slenderness is ratio of the unsupported length of a compression member to its radius of gyration, generally the least radius excepting when the unsupported length of a column is rigidly braced in such a manner as to prevent deflection of the column in the direction which corresponds to the least radius of gyration. Columns, excepting those of square or circular section, have two principal radii of gyration. It is, therefore, necessary to determine the radii of gyration of such columns and to use the proper ratio of slenderness in any particular case. The unsupported length of a compression member should never exceed 200 times its least radius of gyration. The following are generally recognized as the upper limits of the value of l/r where l = unsupported length in inches and r = least radius of gyration.

For lateral struts carrying wind stresses only, in buildings	150 to 200
For lateral struts carrying wind stresses only, in bridges	120 to 150
For columns in buildings with quiescent loads	120 to 150
For compression members in bridges	100 to 120

Explanation of Tables.—The tables which immediately follow give the safe loads in thousands of pounds on H-beam columns which, in the light of experience, are most desirable for use in ordinary building construction. In addition to the safe loads, they give least radii of gyration areas of sections, and weights in pounds per foot. For safe loads on I-beam columns and Carnegie H-sections, see page 9. For Bethlehem sections, see pages 56 to 59.

Combined Bending and Compression Stresses.—It is assumed in the tables that the loads are direct and equally distributed over the cross section of the column or balanced on opposite sides thereof. In the case of beams carried on brackets or other forms of eccentric loading, bending stresses are produced which should be taken into consideration and the column sections so proportioned that the combined fiber stresses do not exceed the allowable axial compressive stresses.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
8 In. H COLUMNS—SQUARE ENDS



Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.

Weight of Section, Lbs. per Foot	Dimensions, Inches D	T	B	Area of Section, Square Inches	Least Radius of Gyration, Inches	UNSUPPORTED LENGTH OF COLUMNS 8 Ft.	9 Ft.	10 Ft.	11 Ft.	12 Ft.	13 Ft.	14 Ft.	15 Ft.	16 Ft.	17 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	Weight of Section, Lbs. per Foot
32.0	7⅞	7/16	8.00	9.17	1.98	59.7	59.7	58.1	56.5	55.0	53.5	52.0	50.4	48.9	47.4	45.9	42.8	**39.7**	**36.7**		32.0
34.5	8	½	8.00	10.17	2.01	66.1	66.1	64.7	63.0	61.3	59.7	58.0	56.3	54.6	53.0	51.3	48.0	**44.6**	**41.3**	**38.0**	34.5
39.0	8⅛	9/16	8.04	11.50	2.03	74.8	74.8	73.3	71.4	69.6	67.7	65.8	64.0	62.1	60.2	58.4	54.6	**50.9**	**47.1**	**43.4**	39.0
43.5	8¼	5/8	8.08	12.83	2.04	83.4	83.4	81.9	79.8	77.7	75.7	73.6	71.5	69.4	67.4	65.3	61.1	**57.0**	**52.8**	**48.7**	43.5
48.0	8⅜	11/16	8.12	14.18	2.05	92.2	92.2	90.6	88.3	86.1	83.8	81.5	79.2	76.9	74.6	72.4	67.8	**63.2**	**58.7**	**54.1**	48.0
53.0	8½	¾	8.16	15.53	2.07	101.0	101.0	99.5	97.0	94.5	92.1	89.6	87.1	84.6	82.2	79.7	74.7	**69.8**	**64.8**	**59.9**	53.0
57.5	8⅝	13/16	8.20	16.90	2.08	109.9	109.9	108.4	105.7	103.0	100.3	97.7	95.0	92.3	89.6	86.9	81.6	**76.2**	**70.9**	**65.5**	57.5
62.0	8¾	⅞	8.24	18.27	2.09	118.8	118.8	117.3	114.4	111.5	108.7	105.8	102.9	100.0	97.1	94.2	88.5	**82.7**	**76.9**	**71.2**	62.0
67.0	8⅞	15/16	8.28	19.66	2.11	127.8	127.8	126.5	123.5	120.4	117.3	114.2	111.2	108.1	105.0	101.9	95.8	89.6	**83.5**	**77.3**	67.0
71.5	9	1	8.32	21.05	2.12	136.8	136.8	135.6	132.4	129.1	125.8	122.5	119.2	116.0	112.7	109.4	102.9	96.3	**89.8**	**83.2**	71.5
76.5	9⅛	1 1/16	8.36	22.46	2.13	146.0	146.0	144.9	141.4	137.9	134.4	131.0	127.5	124.0	120.5	117.0	110.1	103.1	**96.2**	**89.2**	76.5
81.0	9¼	1⅛	8.39	23.78	2.14	154.6	154.6	153.6	149.9	146.2	142.6	138.9	135.2	131.6	127.9	124.2	116.9	109.6	**102.2**	**94.9**	81.0
85.5	9⅜	1 3/16	8.43	25.20	2.16	163.8	163.8	163.1	159.3	155.4	151.6	147.7	143.9	140.0	136.1	132.3	124.6	116.9	**109.2**	**101.5**	85.5
90.5	9½	1¼	8.47	26.64	2.17	173.2	173.2	172.6	168.6	164.5	160.5	156.4	152.4	148.3	144.3	140.2	132.1	124.0	**115.9**	**107.8**	90.5

Loads in "light" type are for lengths less than 125 radii; loads in "**heavy**" type are for lengths greater than 125 radii.

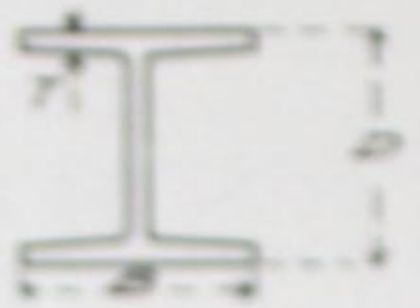
For loads on Carnegie 4″ to 8″ H columns, see page 9.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
10 In. H-COLUMNS—SQUARE ENDS

For loads on Carnegie 4" to 8" H columns, see page 9.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
10 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.

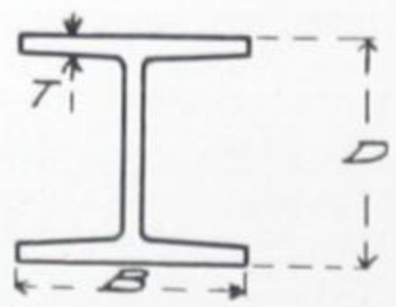


Weight of Section, Lbs. per Foot.	Dimensions, Inches D	T	B	Area of Section, Square Inches	Least Radius of Gyration, Inches	UNSUPPORTED LENGTH OF COLUMNS 10 Ft.	11 Ft.	12 Ft.	13 Ft.	14 Ft.	15 Ft.	16 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	28 Ft.	30 Ft.	32 Ft.	Weight of Section, Lbs. per Foot.
49.0	9 1/4	△	9.97	14.37	2.49	93.5	93.5	92.1	90.2	88.3	86.3	84.5	80.7	76.9	73.1	69.3	65.4	**61.6**	**57.8**	**54.0**	49.0
54.0	10	1/4	10.00	15.91	2.51	103.4	103.4	102.2	100.1	98.0	95.9	93.8	89.6	85.4	81.3	77.1	72.9	**68.7**	**64.5**	**60.3**	54.0
60.5	10 1/4	1/2	10.04	17.67	2.53	114.2	114.2	113.1	111.0	109.0	106.9	104.8	100.6	96.4	92.3	88.1	83.9	**79.8**	**75.6**	**71.4**	60.5
65.5	10 1/2	5/8	10.08	19.23	2.54	125.0	125.0	123.9	122.1	121.0	118.9	116.8	112.6	108.5	104.3	100.2	96.0	**91.9**	**87.7**	**83.5**	65.5
71.0	10 1/2	3/4	10.12	20.91	2.56	135.9	135.9	134.8	133.2	131.6	129.5	127.4	123.3	119.2	115.0	110.9	106.8	**102.6**	**98.5**	**94.3**	71.0
77.0	10 1/2	7/8	10.16	22.59	2.57	146.8	146.8	145.8	144.3	142.8	140.7	138.7	134.6	130.5	126.4	122.3	118.2	**114.1**	**110.0**	**105.9**	77.0
82.5	10 1/2	1	10.20	24.29	2.58	157.8	157.8	157.8	157.8	155.8	153.8	151.8	147.8	143.8	139.8	135.8	131.8	**127.8**	**123.8**	**119.8**	82.5
88.5	10 1/2	1 1/8	10.24	25.99	2.59	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9	**168.9**	**168.9**	**168.9**	88.5
94.0	10 1/4	1 1/4	10.28	27.71	2.61	180.1	180.1	180.1	180.1	180.1	180.1	180.1	180.1	180.1	180.1	180.1	180.1	**180.1**	**180.1**	**180.1**	94.0
99.5	11	1 1/4	10.31	29.32	2.62	190.6	190.6	190.6	190.6	190.6	190.6	190.6	190.6	190.6	190.6	190.6	190.6	**190.6**	**190.6**	**190.6**	99.5
105.5	11 1/4	1 3/8	10.35	31.06	2.64	201.9	201.9	201.9	201.9	201.9	201.9	201.9	201.9	201.9	201.9	201.9	201.9	**201.9**	**201.9**	**201.9**	105.5
111.5	11 1/4	1 1/2	10.39	32.80	2.65	213.2	213.2	213.2	213.2	213.2	213.2	213.2	213.2	213.2	213.2	213.2	213.2	**213.2**	**213.2**	**213.2**	111.5
117.5	11 1/4	1 5/8	10.43	34.55	2.66	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	**224.4**	**224.4**	**224.4**	117.5
123.5	11 1/4	1 3/4	10.47	36.32	2.67	236.1	236.1	236.1	236.1	236.1	236.1	236.1	236.1	236.1	236.1	236.1	236.1	**236.1**	**236.1**	**236.1**	123.5

Loads in "light" type are for lengths less than 120 radii; loads in "**heavy**" type are for lengths greater than 120 radii.

SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
12 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.

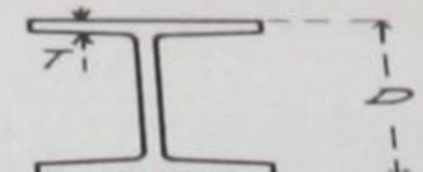


Weight of Section, Lbs. per Foot.	Dimensions, Inches D	T	B	Area of Section, Square Inches.	Least Radius of Gyration, Inches.	UNSUPPORTED LENGTH OF COLUMNS 12 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	28 Ft.	30 Ft.	32 Ft.	34 Ft.	36 Ft.	38 Ft.	Weight of Section, Lbs. per Foot.
64.5	11 3/4	5/8	11.92	19.00	2.98	123.5	123.5	122.5	118.3	114.1	109.9	105.7	101.5	97.3	93.1	88.9	**84.7**	**80.5**	**76.3**	.....	64.5
71.5	11 7/8	11/16	11.96	20.96	3.00	136.2	136.2	135.4	130.8	126.2	121.6	117.0	112.4	107.8	103.1	98.5	**93.9**	**89.3**	**84.7**	.....	71.5
78.0	12	3/4	12.00	22.94	3.01	149.1	149.1	148.3	143.3	138.3	133.2	128.2	123.2	118.1	113.1	108.1	**103.0**	**98.0**	**93.0**	.....	78.0
84.5	12 1/8	13/16	12.04	24.92	3.03	162.0	162.0	161.4	155.9	150.5	145.1	139.7	134.2	128.8	123.4	117.9	**112.5**	**107.1**	**101.7**	.....	84.5
91.5	12 1/4	7/8	12.08	26.92	3.04	175.0	175.0	174.5	168.6	162.8	156.9	151.1	145.2	139.4	133.5	127.7	**121.9**	**116.0**	**110.2**	**104.3**	91.5
98.5	12 3/8	15/16	12.12	28.92	3.06	188.0	188.0	187.7	181.5	175.2	169.0	162.8	156.5	150.3	144.0	137.8	**131.6**	**125.3**	**119.1**	**112.8**	98.5
105.0	12 1/2	1	12.16	30.94	3.07	201.1	201.1	201.0	194.3	187.7	181.0	174.4	167.7	161.1	154.4	147.8	**141.1**	**134.4**	**127.8**	**121.1**	105.0
112.0	12 5/8	1 1/16	12.20	32.96	3.08	214.2	214.2	214.2	207.2	200.1	193.1	186.0	178.9	171.9	164.8	157.7	150.7	**143.6**	**136.6**	**129.5**	112.0
118.5	12 3/4	1 1/8	12.23	34.87	3.10	226.7	226.7	226.7	219.6	212.1	204.7	197.3	189.9	182.5	175.0	167.6	160.2	**152.8**	**145.3**	**137.9**	118.5
125.5	12 7/8	1 3/16	12.27	36.91	3.11	239.9	239.9	239.9	232.6	224.8	217.0	209.1	201.3	193.5	185.6	177.8	170.0	**162.1**	**154.3**	**146.5**	125.5
132.5	13	1 1/4	12.31	38.97	3.13	253.3	253.3	253.3	246.0	237.8	229.6	221.4	213.2	204.9	196.7	188.5	180.3	**172.1**	**163.9**	**155.6**	132.5
139.5	13 1/8	1 5/16	12.35	41.03	3.14	266.7	266.7	266.7	259.3	250.6	242.0	233.4	224.8	216.1	207.5	198.9	190.3	**181.6**	**173.0**	**164.4**	139.5
146.5	13 1/4	1 3/8	12.39	43.10	3.15	280.2	280.2	280.2	272.6	263.5	254.5	245.5	236.4	227.4	218.4	209.3	200.3	**191.3**	**182.3**	**173.2**	146.5
153.5	13 3/8	1 7/16	12.43	45.19	3.16	293.7	293.7	293.7	286.0	276.6	267.1	257.7	248.3	238.8	229.4	219.9	210.5	**201.1**	**191.6**	**182.2**	153.5
161.0	13 1/2	1 1/2	12.47	47.28	3.18	307.3	307.3	307.3	299.7	289.9	280.1	270.3	260.5	250.7	240.9	231.0	221.2	**211.4**	**201.6**	**191.8**	161.0

Loads in "light" type are for lengths less than 125 radii; loads in **"heavy"** type are for lengths greater than 125 radii.

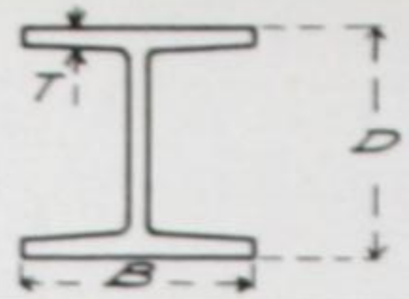
SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
14 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.



SAFE LOADS, IN TONS OF 2000 LBS., FOR
BETHLEHEM ROLLED STEEL
14 In. H-COLUMNS—SQUARE ENDS

Allowable stress per square inch:
13,000 lbs. for lengths under 55 radii. 16,000—55-l/r for lengths over 55 radii.

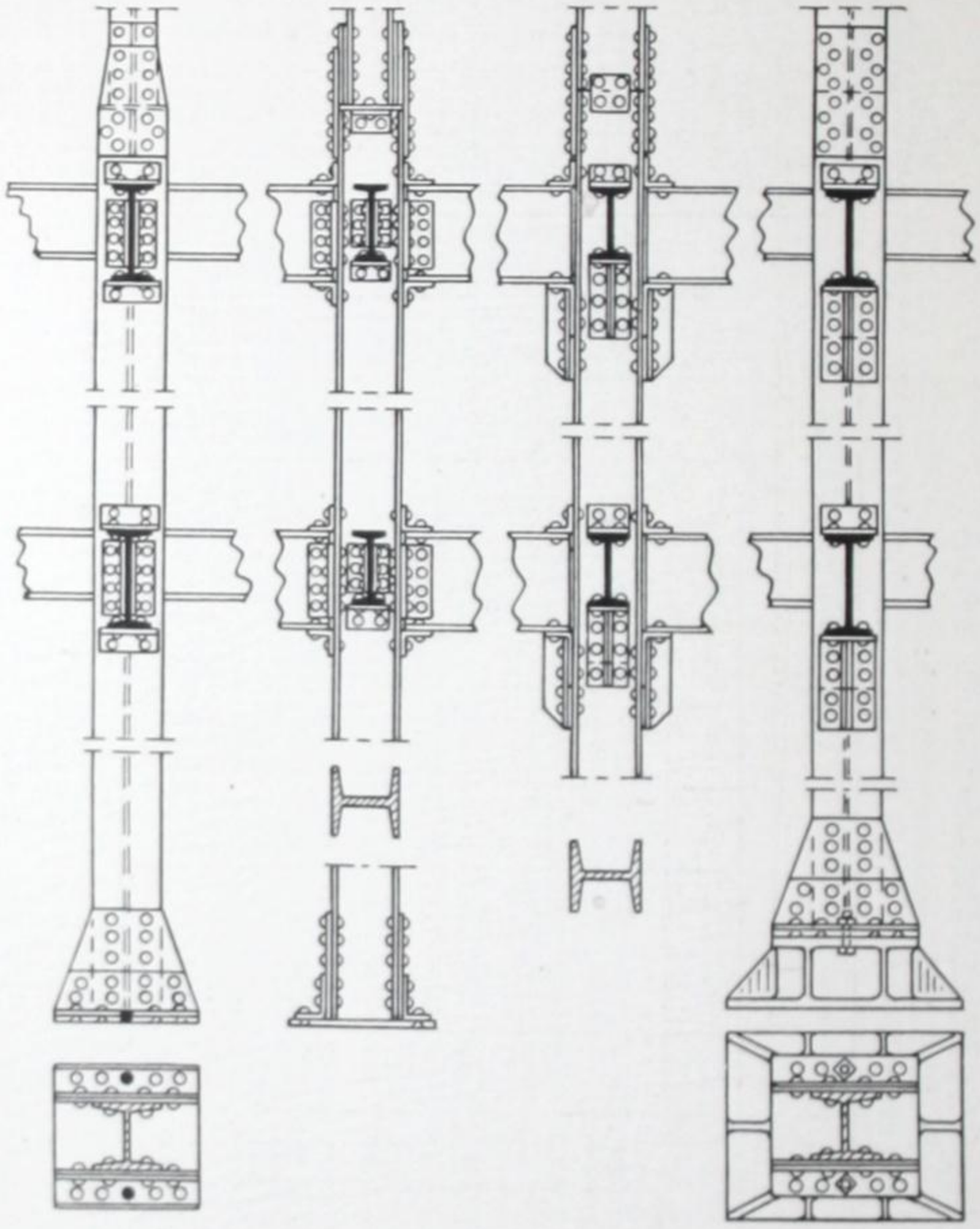


Weight of Section, Lbs. per Foot	Dimensions, Ins. D	T	B	Area of Section, Square Inches	Least radius of Gyration, Inches	UNSUPPORTED LENGTH OF COLUMNS 10 Ft.	12 Ft.	14 Ft.	16 Ft.	18 Ft.	20 Ft.	22 Ft.	24 Ft.	26 Ft.	28 Ft.	30 Ft.	32 Ft.	36 Ft.	40 Ft.	44 Ft.	Weight of Section, Lbs. per Foot
83.5	13¾	11/16	13.92	24.46	3.47	159.0	159.0	159.0	158.5	153.8	149.2	144.5	139.9	135.2	130.5	125.9	121.2	111.9	**102.6**	.....	83.5
91.0	13⅞	¾	13.96	26.76	3.49	173.9	173.9	173.9	173.9	168.5	163.4	158.4	153.3	148.2	143.2	138.1	133.1	122.9	**112.8**	.....	91.0
99.0	14	11/16	14.00	29.06	3.50	188.9	188.9	188.9	188.6	183.2	177.7	172.2	166.7	161.2	155.8	150.3	144.8	133.8	**122.9**	**111.9**	99.0
106.5	14⅛	⅞	14.04	31.38	3.52	204.0	204.0	204.0	204.0	198.1	192.2	186.3	180.4	174.6	168.7	162.8	156.9	145.1	**133.4**	**121.6**	106.5
114.5	14¼	11/16	14.08	33.70	3.53	219.1	219.1	219.1	219.1	212.9	206.6	200.3	194.0	187.7	181.4	175.1	168.8	156.2	**143.6**	**131.0**	114.5
122.5	14⅜	1	14.12	36.04	3.55	234.3	234.3	234.3	234.3	228.0	221.3	214.6	207.9	201.2	194.5	187.8	181.1	167.7	**154.3**	**140.9**	122.5
130.5	14½	1 1/16	14.16	38.38	3.56	249.5	249.5	249.5	249.5	243.0	235.9	228.8	221.7	214.5	207.4	200.3	193.2	179.0	**164.7**	**150.5**	130.5
138.0	14⅝	1⅛	14.19	40.59	3.58	263.8	263.8	263.8	263.8	257.4	249.9	242.4	234.9	227.4	220.0	212.5	205.0	190.0	**175.1**	**160.1**	138.0
146.0	14¾	1 3/16	14.23	42.95	3.59	279.2	279.2	279.2	279.2	272.5	264.6	256.7	248.9	241.0	233.1	225.2	217.3	201.5	**185.7**	**170.0**	146.0
154.0	14⅞	1¼	14.27	45.33	3.61	294.7	294.7	294.7	294.7	288.1	279.8	271.5	263.2	254.9	246.6	238.3	230.0	213.5	**196.9**	**180.3**	154.0
162.0	15	1 5/16	14.31	47.71	3.62	310.1	310.1	310.1	310.1	303.4	294.7	286.0	277.3	268.6	259.9	251.2	242.5	225.1	**207.7**	**190.3**	162.0
170.5	15⅛	1⅜	14.35	50.11	3.64	325.7	325.7	325.7	325.7	319.0	309.9	300.8	291.7	282.6	273.5	264.4	255.3	237.1	**218.9**	**200.7**	170.5
178.5	15¼	1⅜	14.39	52.51	3.65	341.3	341.3	341.3	341.3	334.6	325.1	315.6	306.1	296.6	287.1	277.6	268.1	249.1	**230.1**	**211.1**	178.5
186.5	15⅜	1½	14.43	54.92	3.66	357.0	357.0	357.0	357.0	350.3	340.4	330.5	320.6	310.7	300.8	290.9	281.0	261.2	**241.4**	**221.6**	186.5
195.0	15½	1 7/16	14.47	57.35	3.68	372.8	372.8	372.8	372.8	366.1	355.8	345.5	335.2	324.9	314.6	304.3	294.0	273.4	**252.8**	**232.2**	195.0
203.5	15⅝	1⅝	14.51	59.78	3.69	388.6	388.6	388.6	388.6	381.9	371.2	360.5	349.8	339.1	328.4	317.7	307.0	285.6	**264.2**	**242.8**	203.5
211.0	15¾	1 11/16	14.54	62.07	3.70	403.5	403.5	403.5	403.5	396.9	385.8	374.8	363.7	352.6	341.6	330.5	319.4	297.3	**275.1**	**253.0**	211.0
219.5	15⅞	1¾	14.58	64.52	3.71	419.4	419.4	419.4	419.4	412.9	410.5	390.0	378.5	367.1	355.6	344.1	332.6	309.7	**286.8**	**263.8**	219.5
227.5	16	1 13/16	14.62	66.98	3.72	435.4	435.4	435.4	435.4	429.0	417.2	405.3	393.4	381.6	369.7	357.8	345.9	322.2	**298.5**	**274.8**	227.5
236.0	16⅛	1⅞	14.66	69.45	3.74	451.4	451.4	451.4	451.4	445.2	433.0	420.7	408.4	396.2	383.9	371.6	359.4	334.8	**310.3**	**285.8**	236.0
244.5	16¼	1 15/16	14.70	71.94	3.75	467.6	467.6	467.6	467.6	461.5	448.9	436.2	423.6	410.9	398.2	385.6	372.9	347.6	**322.2**	**296.9**	244.5
253.0	16⅜	2	14.74	74.43	3.76	483.3	483.3	483.3	483.3	477.9	464.8	451.8	438.7	425.7	412.6	399.6	386.5	360.4	**334.3**	**308.1**	253.0
261.5	16½	2 1/16	14.78	76.93	3.77	500.0	500.0	500.0	500.0	494.4	480.9	467.4	454.0	440.5	427.1	413.6	400.2	373.3	**346.4**	**319.5**	261.5
270.0	16⅝	2⅛	14.82	79.44	3.79	516.4	516.4	516.4	516.4	510.9	497.0	483.2	469.3	455.5	441.6	427.8	413.9	386.3	**358.6**	**330.9**	270.0
278.5	16¾	2 3/16	14.86	81.97	3.80	532.8	532.8	532.8	532.8	527.6	513.3	499.1	484.8	470.6	456.3	442.1	427.8	399.4	**370.9**	**342.4**	278.5
287.5	16⅞	2¼	14.90	84.50	3.81	549.3	549.3	549.3	549.3	544.3	529.6	515.0	500.4	485.7	471.1	456.4	441.8	412.5	**383.3**	**354.0**	287.5

Loads in "light" type are for lengths less than 125 radii; loads in "**heavy**" type are for lengths greater than 125 radii.

STEEL COLUMN DETAILS

Steel columns are usually made long enough to extend two stories in height in one section. At all joints splice plates should be provided connecting the two sections. The joints are faced and a good bearing insured, only sufficient splice being used to take care of the bending moment at the point and to hold the parts in position.



No. 15—Types of H-Column and Base Details

The use of column caps should be avoided if possible. The beams or trusses connecting to columns should generally be rivetted to the webs or flanges with connection angles and not set on the top of a cap plate. It is necessary to put a base on a column large enough to distribute the loads to the masonry footings. This base may be built up of rolled shapes and plates; or a cast iron or cast steel sub-base may be interposed between the column base proper and the masonry. In some cases a grillage of beams and concrete is used for distributing the load over the soil; this has its advantages as it eliminates deep excavation and large masses of concrete.

CAST IRON COLUMNS

Cast iron columns are suitable only for small buildings of non-fireproof construction. They offer greater resistance to fire than unprotected steel columns, and occupy a minimum of space in the building; but cast iron is not as reliable as steel and should not be used where there is eccentric loading.

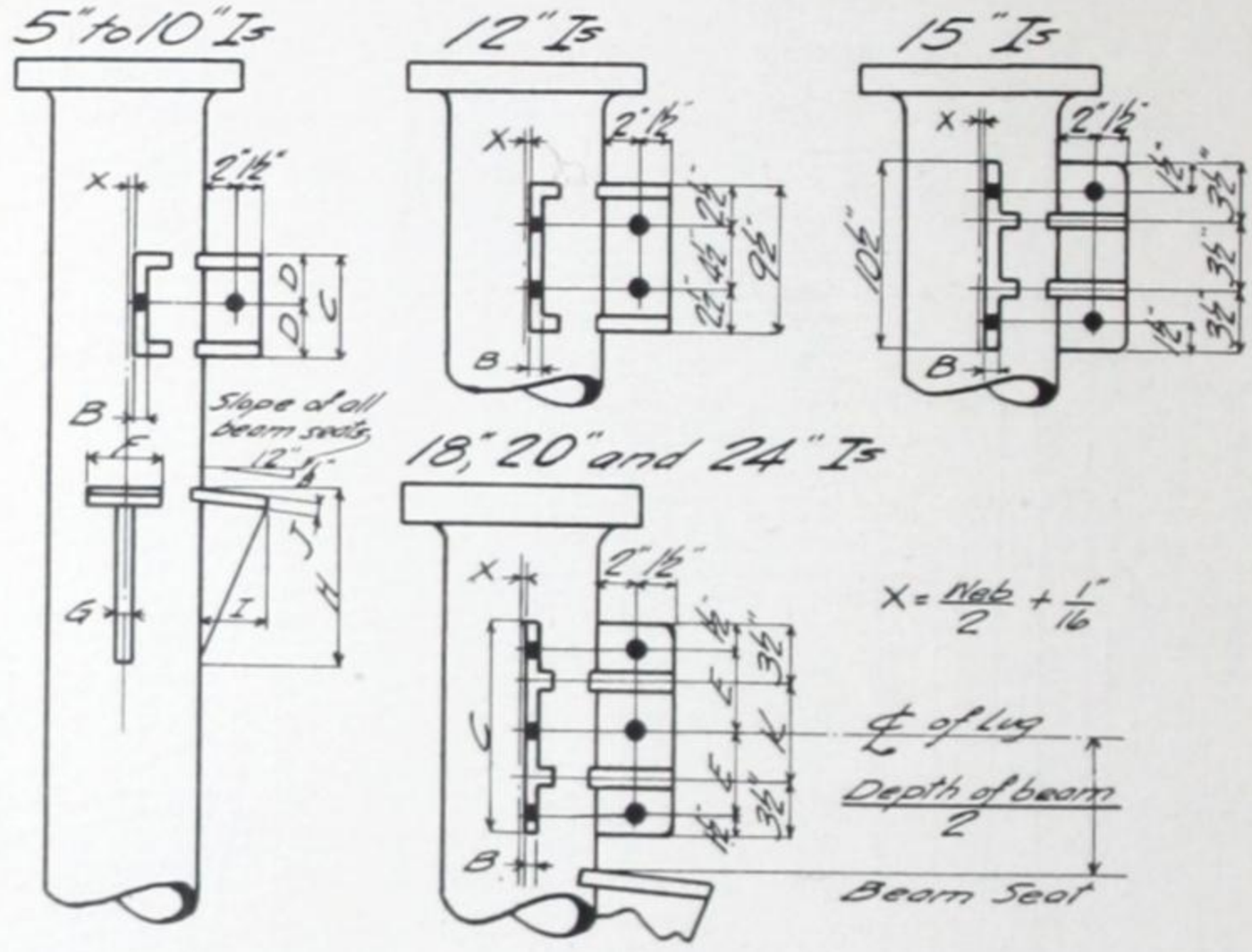
SAFE LOADS IN TONS OF 2,000 POUNDS FOR HOLLOW ROUND CAST IRON COLUMNS WITH SQUARE ENDS

Diam. In.	Thickness, In.	LENGTH OF COLUMN IN FEET										Area, Metal, In.	Wt. per Foot of Length
		6	8	10	12	14	16	18	20	22	24		
5	3/4	39	34	29	24	....	....	....	....	....	....	10.0	31.3
	7/8	45	38	32	27	....	....	....	....	....	....	11.3	35.3
5 1/2	3/4	46	40	35	30	26	....	....	....	....	....	11.2	35.0
	7/8	52	46	40	34	29	....	....	....	....	....	12.7	39.7
6	3/4	52	47	41	36	31	27	24	....	....	....	12.4	38.7
	7/8	60	53	47	41	36	31	27	....	....	....	14.1	44.0
	1	66	59	52	45	39	34	30	....	....	....	15.7	49.0
7	3/4	65	60	54	48	43	38	34	....	....	....	14.7	46.0
	7/8	74	68	62	55	49	43	38	....	....	....	16.8	52.6
	1	83	76	68	61	54	48	43	....	....	....	18.8	58.9
8	3/4	78	72	67	61	55	50	45	40	36	33	17.1	53.4
	7/8	89	83	76	70	63	57	51	46	41	37	19.6	61.2
	1	100	93	86	79	71	64	58	52	47	42	22.0	68.7
9	7/8	103	98	91	85	80	71	65	59	54	49	22.3	69.8
	1	117	110	103	95	90	80	73	67	61	55	25.1	78.5
	1 1/8	129	122	114	105	99	89	81	74	67	61	27.8	87.0
10	7/8	118	112	106	100	93	86	79	73	67	62	25.1	78.4
	1	133	127	120	112	105	97	89	82	76	69	28.3	88.4
	1 1/8	147	141	133	125	116	107	99	91	84	77	31.4	98.0
	1 1/4	161	154	146	136	127	118	109	100	92	84	34.4	107.4
11	1	149	143	137	129	122	114	106	98	91	85	31.4	98.2
	1 1/8	165	159	152	144	135	126	118	109	101	94	34.9	109.1
	1 1/4	182	175	167	158	148	139	129	120	111	103	38.3	119.7
	1 3/8	197	190	181	171	161	151	140	130	121	112	41.6	129.9
12	1 1/8	184	178	171	163	154	146	137	128	120	112	38.4	120.1
	1 1/4	202	195	188	179	170	160	150	141	132	123	42.2	131.9
	1 3/8	220	212	204	194	184	174	163	153	143	133	45.9	143.4
	1 1/2	237	229	220	210	199	187	176	165	154	144	49.5	154.6

Cast Iron Column Bases—Cast iron column bases can be supplied to suit all sizes and loadings of columns. A large range of patterns are carried in stock.

CAST IRON COLUMN DETAILS

In the usual forms of connection of girders and beams to cast iron columns, the beam rests on the bracket-shelf, as shown in No. 16 below, and is bolted to the lug through the web. Connections should be designed with a bracket directly below the web of a single beam, or below both webs on a double beam. The bracket-shelf should be given a slope of $\frac{1}{8}$-inch to the foot away from the column so that the load cannot be applied at the edge of the shelf when the beam is deflected under its load.



No. 16—Standard Cast Iron Column Connections

DIMENSIONS FOR STANDARD CAST IRON COLUMN CONNECTIONS

Size Beam In.	B In.	C In.	D In.	E In.	F In.	G In.	H In.	I In.	J In.	K In.	Max. Load Lbs.	Weight Bracket Lbs.
5	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	4	$\frac{3}{4}$	5	$3\frac{1}{2}$	$\frac{7}{8}$	....	9000	8.50
6	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	$4\frac{1}{2}$	$\frac{7}{8}$	5	$3\frac{1}{2}$	1	....	9000	9.50
7	$\frac{5}{8}$	3	$1\frac{1}{2}$	....	$4\frac{1}{2}$	$\frac{7}{8}$	5	$3\frac{1}{2}$	1	....	9000	9.50
8	$\frac{3}{4}$	4	2	....	$4\frac{1}{2}$	1	6	4	1	....	12000	13.75
9	$\frac{3}{4}$	4	2	....	5	$1\frac{1}{8}$	$7\frac{1}{4}$	4	$1\frac{1}{4}$	....	17000	16.00
10	$\frac{3}{4}$	4	2	....	5	$1\frac{1}{8}$	$7\frac{1}{4}$	4	$1\frac{1}{4}$	....	17000	16.00
12	$\frac{3}{4}$	....	....	....	6	$1\frac{1}{8}$	$9\frac{1}{4}$	4	$1\frac{1}{4}$	....	23000	24.00
15	$\frac{7}{8}$	....	....	....	$6\frac{1}{2}$	$1\frac{1}{4}$	$10\frac{1}{4}$	4	$1\frac{1}{4}$	....	33000	29.00
18	1	12	....	$4\frac{1}{2}$	$6\frac{1}{2}$	$1\frac{1}{2}$	$10\frac{1}{2}$	4	$1\frac{1}{2}$	5	34000	37.00
20	1	13	....	5	7	$1\frac{1}{2}$	$11\frac{1}{2}$	4	$1\frac{1}{2}$	6	38000	40.50
24	1	15	....	6	$7\frac{1}{2}$	$1\frac{1}{2}$	$13\frac{1}{2}$	4	$1\frac{1}{2}$	8	45000	46.50

All holes cored for $\frac{3}{4}$-inch bolts.
Loads on brackets must not exceed loads shown in column marked maximum load.

SAFE LOADS IN THOUSANDS OF POUNDS FOR STANDARD PIPE COLUMNS

Nominal Size, In.	15	16
External Dia. In.	16.000	17.000

STANDARD PIPE COLUMNS

Steel pipe columns are frequently used for light loads where the loads are quiescent and there is no probability of side thrust. The caps and bases of these are usually loose cast iron with a cross projection which fits inside the pipe. The pipes are machined; also the part of the base or cap where the pipe bears.

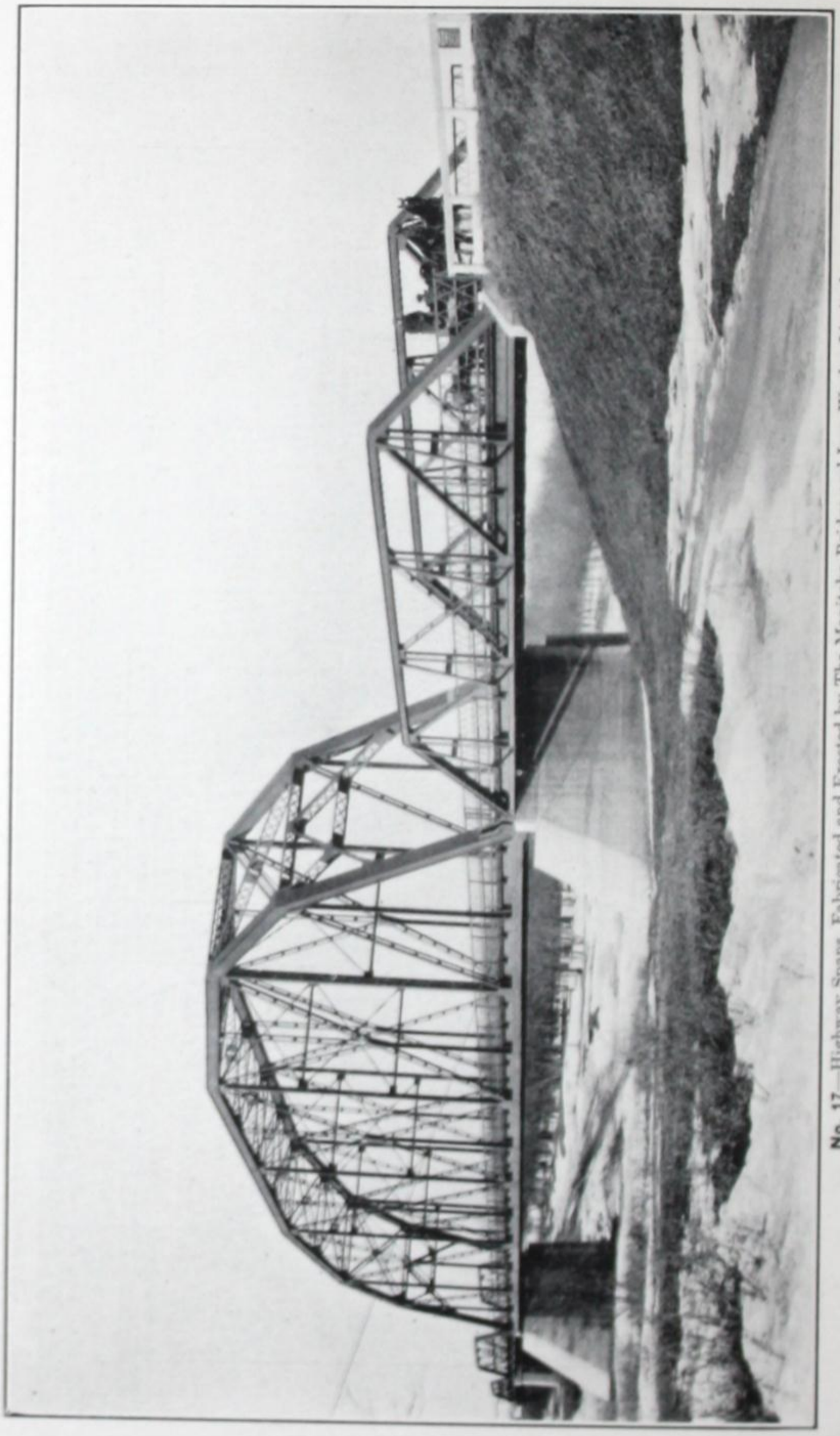
SAFE LOADS IN THOUSANDS OF POUNDS FOR STANDARD PIPE COLUMNS

Nominal Size, In.		15	14	13	12	11	10	9	8	7	6	5	4½	4	3½	3	2½	2	1½
External Dia. In. / Thickness, In.		16.000 .375	15.000 .375	14.000 .375	12.750 .375	11.750 .375	10.750 .365	9.625 .342	8.625 .322	7.625 .301	6.625 .280	5.563 .258	5.000 .247	4.500 .237	4.000 .226	3.500 .216	2.875 .203	2.375 .154	1.900 .145
Effective Length in feet	5	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	34.8	29.0	**21.6**	**12.2**	**7.5**
	6	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	34.8	**28.6**	**19.4**	**10.6**	**6.0**
	7	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	41.2	**34.1**	**26.3**	**17.3**	**9.0**	*5.0*
	8	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	48.0	**40.1**	**31.7**	**24.0**	**15.1**	*7.4*	*4.2*
	9	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	55.9	**46.4**	**37.6**	**29.3**	**21.7**	**12.9**	*6.6*	*3.5*
	10	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	**54.2**	**43.8**	**35.1**	**26.9**	**19.4**	*11.4*	*5.8*	*2.7*
	11	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	72.5	**51.5**	**41.2**	**32.6**	**24.5**	**17.1**	*10.3*	*5.0*	
	12	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	90.1	**70.2**	**48.7**	**38.5**	**30.0**	**22.1**	*15.2*	*9.2*	*4.1*	
	13	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	**89.9**	**67.3**	**46.0**	**35.9**	**27.5**	**19.7**	*14.0*	*8.1*	*3.3*	
	14	239.3	224.0	208.7	189.5	174.2	154.8	129.6	109.2	**86.7**	**64.3**	**43.2**	**33.3**	**25.0**	*18.0*	*12.9*	*7.0*		
	15	239.3	224.0	208.7	189.5	174.2	154.8	129.6	**108.1**	**83.5**	**61.3**	**40.5**	**30.6**	**22.5**	*16.8*	*11.7*	*6.0*		
	16	239.3	224.0	208.7	189.5	174.2	154.8	129.6	**104.7**	**80.3**	**58.3**	**37.7**	**28.0**	*21.1*	*15.6*	*10.6*			
	17	239.3	224.0	208.7	189.5	174.2	154.8	**127.5**	**101.3**	**77.1**	**55.3**	**35.0**	*25.6*	*19.8*	*14.4*	*9.4*			
	18	239.3	224.0	208.7	189.5	174.2	154.8	**123.9**	**97.8**	**73.9**	**52.3**	**32.2**	*24.3*	*18.6*	*13.2*	*8.3*			
	19	239.3	224.0	208.7	189.5	174.2	**152.4**	**120.3**	**94.4**	**70.7**	**49.4**	*29.8*	*23.0*	*17.3*	*12.0*	*7.1*			
	20	239.3	224.0	208.7	189.5	174.2	**148.5**	**116.6**	**91.0**	**67.5**	**46.4**	*28.4*	*21.7*	*16.0*	*10.8*				
	21	239.3	224.0	208.7	189.5	**170.7**	**144.6**	**113.0**	**87.6**	**64.3**	**43.4**	*27.0*	*20.3*	*14.8*	*9.6*				
	22	239.3	224.0	208.7	**189.1**	**166.7**	**140.7**	**190.3**	**84.1**	**61.1**	**40.4**	*25.7*	*19.0*	*13.5*	*8.4*				
	23	239.3	224.0	208.7	**185.1**	**162.7**	**136.8**	**105.7**	**80.7**	**57.8**	*38.3*	*24.3*	*17.7*	*12.3*					
	24	239.3	224.0	208.7	**181.1**	**158.7**	**132.9**	**102.0**	**77.3**	**54.6**	*36.8*	*22.9*	*16.4*	*11.0*					
	25	239.3	224.0	**205.0**	**177.1**	**154.7**	**129.0**	**98.4**	**73.8**	**51.4**	*35.3*	*21.6*	*15.1*	*9.7*					
	26	239.3	**223.4**	**201.0**	**173.1**	**150.7**	**125.1**	**94.7**	**70.4**	*48.4*	*33.8*	*20.2*	*13.8*						
	27	239.3	**219.4**	**197.0**	**169.1**	**146.7**	**121.3**	**91.1**	**67.0**	*46.7*	*32.3*	*18.8*	*12.4*						
	28	**237.9**	**215.4**	**193.0**	**165.1**	**142.7**	**117.4**	**87.5**	**63.5**	*45.1*	*30.8*	*17.4*	*11.1*						
	29	**233.9**	**211.4**	**189.0**	**161.1**	**138.7**	**113.5**	**83.8**	**60.1**	*43.5*	*29.3*	*16.1*							
	30	**229.9**	**207.4**	**185.0**	**157.1**	**134.7**	**109.6**	**80.2**	*57.7*	*41.9*	*27.8*	*14.7*							
Area, in.²		18.41	17.23	16.05	14. 58	13.40	11.91	9.97	8.40	6.93	5.58	4.30	3.69	3.17	2.68	2.23	1.70	1.08	0.80
I, in.⁴		562.1	461.0	372.8	279.3	217.0	160.7	107.6	72.5	46.5	28.1	15.2	10.4	7.23	4.79	3.02	1.53	0.666	0.310
r, in.		5.526	5.172	4.819	4.377	4.024	3.674	3.284	2.938	2.592	2.245	1.878	1.683	1.510	1.337	1.164	0.947	0.787	0.623
Weight, lb./ft.		62.58	58.57	54.57	49.56	45.56	40.48	33.91	28.55	23.54	18.97	14.62	12.54	10.79	9.11	7.58	5.79	3.65	2.72

Allowable Fiber Stress per square inch, 13,000 pounds for lengths of 60 radii or under, reduced for length over 60 radii; see Construction Specifications.

Weights do not include details.

Safe loads in "light" type are for ratios of l/r not over 60; in **"heavy"** type, for ratios up to 120 l/r; in *"italic"* type, for ratios not over 200 l/r.



No. 17—Highway Spans, Fabricated and Erected by The Manitoba Bridge and Iron Works, Limited

BRIDGES

Years of experience in designing, fabricating and erecting steel bridges of all types permit us to assure satisfaction in even the most difficult undertakings in this line.

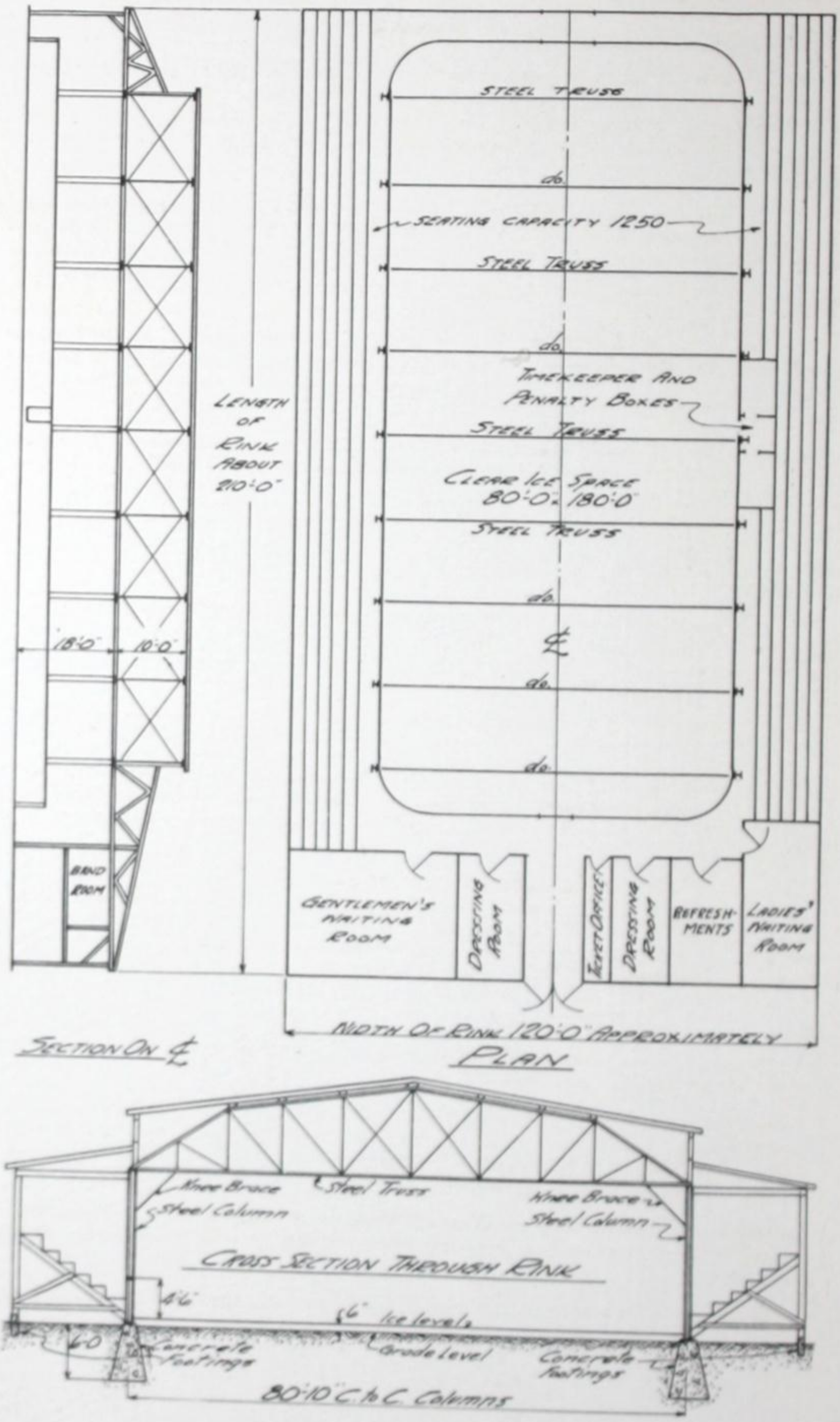
For both the Canadian Pacific Railway and the Canadian National Railways we have constructed numerous railway bridges throughout the western provinces.

For the Canadian Pacific we fabricated and erected the viaduct over the Bow River on the Suffield-Kipp branch, the bridges on that company's line to Drumheller, Alta. and on their line through southern Saskatchewan, as well as on the main line in British Columbia. We have also built bridges on the Kettle Valley Railway at the coast.

For the Canadian National Railways, we fabricated and erected all the bridges on the Calgary-Edmonton line and many others throughout the West and as far east as Port Arthur. On page 159 is illustrated a railway bridge on the Canadian National cut-off at Dona, Ont., fabricated and erected by us.

In the construction of highway bridges our record is no less imposing. Every province of Western Canada has numerous evidences of the creditable work of our organization. The Morris bridge, recently erected by us at Morris, Man., is an excellent example of fine workmanship in handling a difficult contract. Its center span is an unusual piece of work, measuring 356 feet from center to center of bearings. Views of the span and of the steel work may be seen on pages 64 and 145.

We also construct movable opening bridges and, of these, two examples are the Osborne bridge, over the Assiniboine, shown on page 28, and the Lockport bridge, over the locks. Both are Strauss bascule spans, fabricated and erected by us.



No. 18—Typical Enclosed Skating and Hockey Rink

RINKS

The problem of providing an outlet for the energy of the youthful members of a community during the long months of Canadian winter finds solution in the enclosed rink. Skating, hockey and curling rinks are an acknowledged necessity, in towns throughout Western Canada, from the standpoint of health as well as recreation.

On the opposite page appears plan and section of a type of enclosed rink which has proved popular and which we have supplied for various towns in Manitoba, Saskatchewan and Alberta.

The size of rink illustrated is 210 feet by 120 feet, with a clear ice space to conform to hockey regulations, 80 feet by 180 feet. The plan allows of a seating capacity for more than 1250 persons, as well as ample space for dressing and waiting rooms, refreshment booth and box office.

No provision is made in this design for end seating, but this can be arranged by putting in an extra truss at the end, and framing to suit. If so desired, a further extension can be made at the sides for the accommodation of a curling rink; or the seats at one side may be replaced by curling surface.

The design shown illustrates a type of combination steel-and-wood construction. In any rink, the most difficult and expensive portion is the truss-work. The advantages of steel trusses over those of wooden construction are more than sufficient to offset the slight increase in cost.

Shrinkage, in a wooden truss, whether framed or arched, increases with the length of time the truss has been in position. This shrinkage causes distortion in the members and warping in the truss itself. These defects are communicated to the roof covering, resulting in leakage, and necessitating continuous repairs.

With steel truss-work, there is a minimum of such difficulty and inconvenience—a sound roof is the result.

In the plan shown on the opposite page, the columns are placed inside the rail so that the truss span may be the shortest possible. In the case of larger rinks the columns may be located in the wall so that there is no obstruction to the view.

The column footings are concrete carried below frost level. Steel columns of 8 x 8-inch H-section are used for carrying the roof trusses, although in some cases 12 x 12-inch timber posts are used. The latter are rather large, and obstruct the view to some extent, but they may be placed back about the middle of the seating. This gives a rather good and economical layout, the saving on the columns helping to balance the extra cost of lengthening the trusses.

The ends of the trusses are framed up in timber so that a row of windows can be put in along the sides, obviating the objectionable necessity of roof skylights, which are so hard to keep watertight.

The roof is made up of timber purlins and 2 x 4-inch or 2 x 6-inch jack rafters, covered with shiplap and prepared roofing: in some cases, corrugated iron is used. The sides are either timber framing or corrugated sheeting. The seating accommodation is framed in timber.

Roof loading conditions in Western Canada are taken into consideration in designing the trusses, which have all necessary rod bracing to take care of wind loads, etc.

The design shown is only one of many we have supplied. We will be pleased to submit designs to suit any required size and conditions on request.

TRUSSES

Roof Trusses—A roof truss is a frame work designed to support the roof covering over large spans, avoiding the use of interior columns. They form a structure of compression and tension members and produce vertical reactions under vertical loads; the total load of the roof, that is, the weight of the truss, purlins, roof covering, ceiling, and often also the snow and wind load, is usually considered a uniformly distributed load, equally divided between the two supports and producing equal and vertical end reactions.

The purlins usually rest on the upper chord of the truss, transmitting to the latter the load of the roof covering, the wind and snow load, that of the jack rafter and their own, and are often so arranged as to carry the dead load directly to the truss joints or panel points to avoid transverse stresses. The distance between two consecutive joints of the top chord is the panel length, the distance between two adjacent trusses the bay length.

The transverse strength of the sheathing or of the corrugated iron used for the roof covering generally determines the spaces between the jack rafters or the purlins. These purlins or rafters are small steel shapes, such as beams, channels and angles, or wooden beams, if the roof is not of fireproof construction.

The design and selection of the covering depends on local conditions as to snow load, wind load, etc.

Forms of trusses in common use, with rigid bearing supports, are shown by No. 19 on page 70. A large number of different styles of trusses are used, the character of the building deciding the correct style of truss. The diagram shown on page 70 will serve to illustrate the trusses in most general use in building construction.

Snow Loads—Snow load varies according to location and slope of roof. Up to slopes of 20 degrees, the snow load should be taken around 25 pounds per square foot of horizontal roof area, reducing by one pound per degree of slope up to 45 degrees, where no snow load need be considered. Regard should also be given to the possibility of partial snow load with local concentration.

Wind Loads—Wind loads also vary with local conditions and with the slope of the roof. When not fixed by building by-laws, they are usually taken as acting horizontally at 40 pounds per square foot on vertical surfaces of greatly-exposed structures and 30 pounds on less-exposed structures. On inclined surfaces, only the normal components of the wind pressure need be considered. The following table gives the normal wind pressure on sloping roofs for a horizontal pressure of 30 pounds per square foot.

NORMAL WIND PRESSURE, IN POUNDS PER SQUARE FOOT

Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds	Slope, Degrees	Pressure per Square Foot, Pounds
5	5.19	20	18.37	35	25.90	50	28.97
10	10.11	25	21.51	40	27.29	55	29.41
15	14.55	30	24.00	45	28.28	60	29.69

For other pressures than 30 pounds per square foot, the values given above change in proportion. For slopes over 60 degrees the values assumed for horizontal pressure are applied.

Combined Roof Loads—Where the roof loads are not fixed by building laws, ordinary roofs up to 80 feet span should carry the following minimum loads per square foot of exposed surface, applied vertically to provide for dead, wind and snow loads.

MINIMUM ROOF LOADS, IN POUNDS PER SQUARE FOOT

Roof Covering		Roof Load per Square Foot, Pounds
Gravel or Composition Roofing	on boards, flat slope, 1 to 6 or less	50
	on boards, steep slope, more than 1 to 6	45
	on 3 inch flat tile or cinder concrete	60
Corrugated sheeting on boards or purlins		40
Slate	on boards or purlins	50
	on 3 inch flat tile or cinder concrete	65
Tile on steel purlins		55
Glass		45

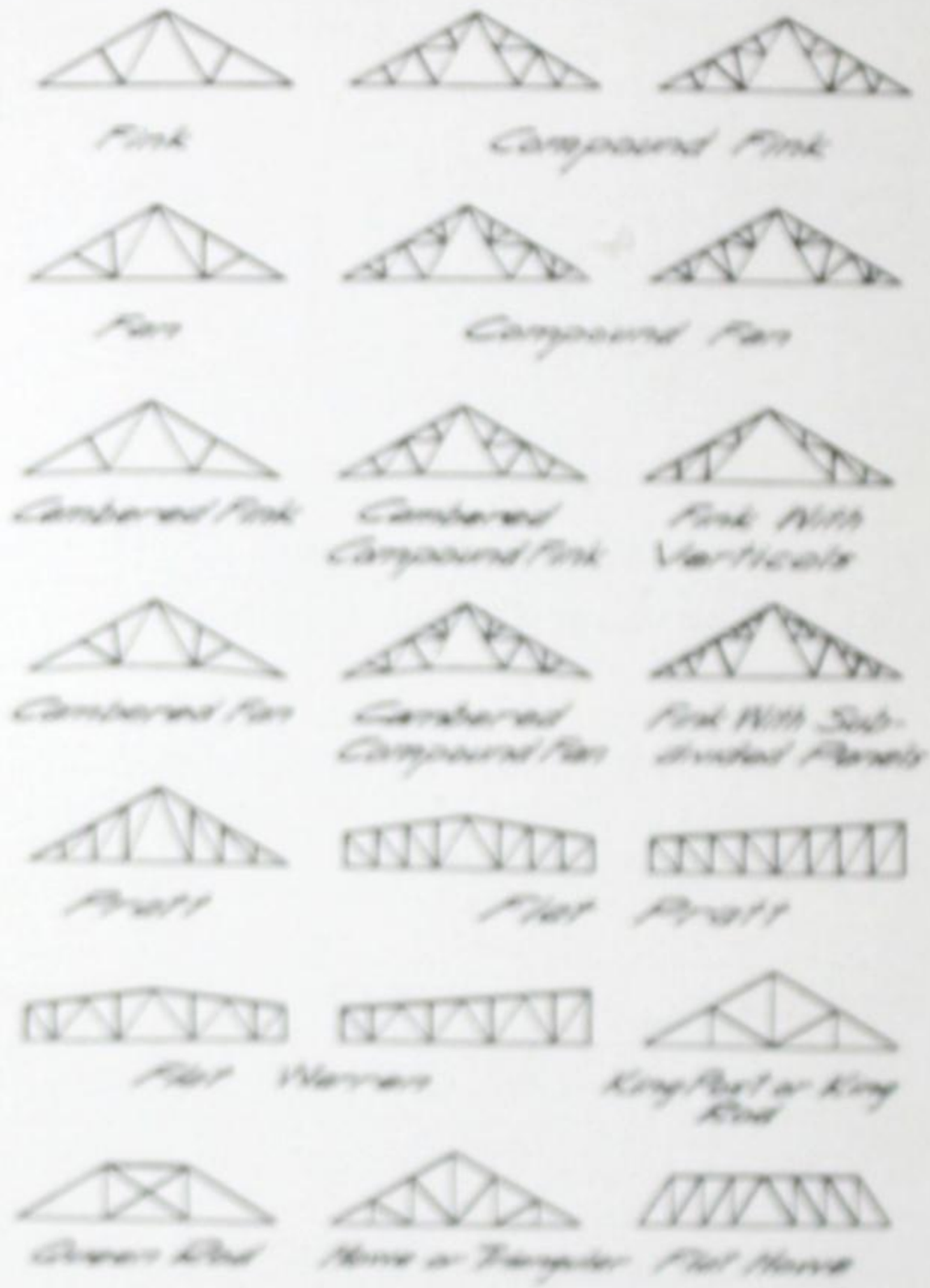
For roofs in climates where no snow is likely to occur, reduce these loads by 10 pounds per square foot, but no roof or any part thereof should be designed for a total live and dead load less than 40 pounds per square foot.

APPROXIMATE WEIGHT OF ROOFING MATERIAL

Roofing Material	Weight per Square Foot, Pounds
Copper, No. 22 B. W. G.	1¼
Corrugated galvanized iron, No. 20 B. W. G.	2¼
Corrugated galvanized iron, No. 26 B. W. G.	1¼
Felt, 2 layers	½
Felt and asphalt or coal-tar	2
Glass, ¼ inch thick	1¾
Lath and plaster ceiling	6–8
Lead, ¼ inch thich	7½
Mackite, 1 inch thick, with plaster	10
Sheathing, hemlock, 1 inch thick	2
Sheathing, white pine, spruce, 1 inch thick	2¼–2½
Sheathing, yellow pine, 1 inch thick	3½
Shingles, 6x18 inches, 6 inches to weather	2
Skylight, glass ⅛ to ½ inch, including frame	4–10
Slag roof, 4-ply, with cement and sand	4
Slate, ¼ inch thick, 3 inch double lap	4½
Slate, ⅛ inch thick, 3 inch double lap	6¼
Terneplate, IC	½
Terneplate, IX	½
Tiles (plain), 10½x6¼x¾ inches, 5¼ inches to weather	18
Tiles (Spanish), 14½x10½ inches, 7¼ inches to weather	8½
Zinc, No. 20 B. W. G.	1½

Form of Trusses—A great variety of trusses are used in building construction the form depending on the character of the building.

The trusses in No. 19 are so arranged that the compression members are the shortest members while the tension members are longest. The last four types are for combination wood and rods, for which they are well adapted. The flat type are well adapted for tar and gravel covering and it is only necessary to give them enough slope for proper drainage.



No. 19—Forms of Trusses in Common Use, where Supported by Rigid Bearings

Comparative estimates of cost, made by comparing the total cost of roof trusses of the usual span for various spacing indicate that for spans up to 50 feet the most economical spacing is about 15 feet for light loads or about ⅓ the span.

The spans of from 50 feet to 100 feet the spacing should be about ¼ the span for the shorter spans and about 1-5 the span for the longer spans or from 15 feet to 20 feet. In many cases local conditions govern and determine the spacing of the trusses regardless of the economic conditions.

Bracing for a roof supported on rigid walls cannot be calculated definitely and the designer must use his judgement, based on past experience, as to the position form and amount required to give a stiff roof.

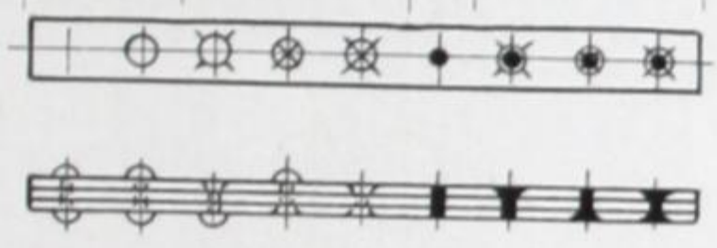
Roof trusses supported on steel columns allow of the approximate determination of stresses in bracing, and generally every third or fourth pair of trusses should be rigidly braced with diagonals placed on the plane of the top and bottom chords of the trusses. The compression between trusses being taken by lines of struts running continuously the length of the building.

DETAILS FOR PUNCHING AND RIVETTING

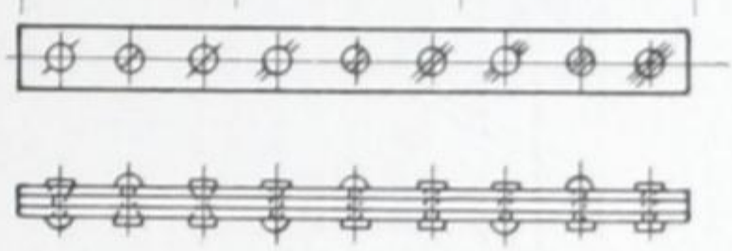
Dimensions in Inches

CONVENTIONAL SIGNS FOR RIVETTING

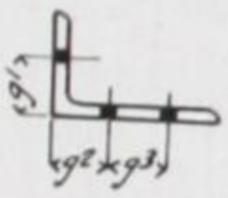
Shop Rivets				Field Rivets			
Two full heads	Countersunk and Chipped			Two full heads	Countersunk and Chipped		
	Near Side	Far Side	Both Sides		Near Side	Far Side	Both Sides



Shop Rivets								
Countersunk but not chipped Max. Height, 1/16"			Flattened to 1/4" high 1/2" and 5/8" Rivets			Flattened to 3/8 high 3/4", 7/8", 1" Rivets		
Near Side	Far Side	Both Sides	Near Side	Far Side	Both Sides	Near Side	Far Side	Both Sides



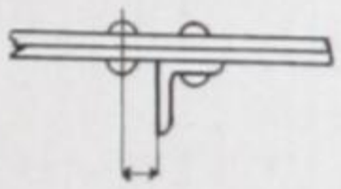
GAUGES FOR ANGLES



Leg	8	7	6	5	4	3½	3	2½	2	1¾	1½	1⅜	1¼	1	¾
g1	4½	4	3½	3	2½	2	1¾	1⅜	1⅛	1	⅞	⅞	¾	⅝	½
g2	3	2½	2½	2											
g3	3	3	2¼	1¾											
Max. rivet	1⅛	1	⅞	⅞	⅞	⅞	⅞	¾	⅝	½	⅜	⅜	⅜	¼	¼

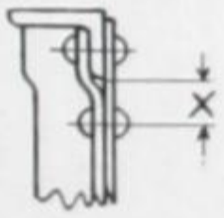
For column details, 6" leg (½ inch thick or less) against column shaft, g2 = 1¾", g3 = 3".
For diagonal angles, etc., gauge in middle, where riveted leg equals or exceeds 3" for ¾" rivets 3½" for ⅞" rivets.
Use special gauges to adapt work to multiple punch, or to secure desirable details.

CLEARANCE FOR WEB RIVETTING



Size Rivet	Min.	Std.
⅝	⅞	1⅛
¾	1	1¼
⅞	1⅛	1⅜
1	1¼	1½
1⅛	1⅜	1⅝

RIVETS IN CRIMPED ANGLES

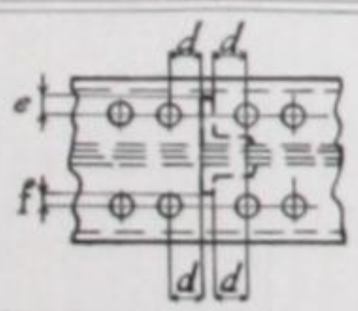


Distance X should be 1½ inches, plus the thickness of chord angles, but never less than 2 inches.

STANDARD RIVET DIES

Size Rivet	Diam. of Die
⅝	2
¾	2¼
⅞	2½
1	2¾
1⅛	3

CLEARANCE FOR COVER PLATE RIVETTING

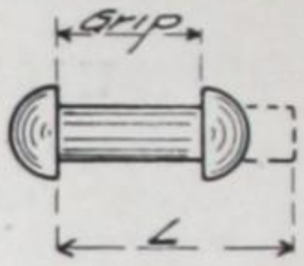


e	½	1	1½	2	2½	3	3½	4	½	5	5½	6
d	2½	2⅝	2¾	2¾	2⅞	2⅞	3	3⅛	3⅛	3¼	3¼	3⅜
f	0	½	1	1½	2	2½						
d	2½	2¼	2⅛	2	1½	0						

RIVETS

RIVET LENGTHS AND APPROXIMATE WEIGHTS PER HUNDRED FOR VARIOUS GRIPS

Weights given are for rivets before driving.

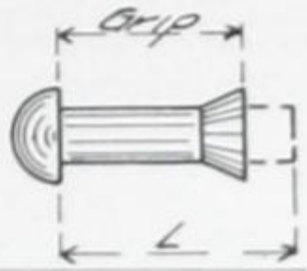


	½-Inch		⅝-Inch		¾-Inch		⅞-Inch		1-Inch	
Grip, In.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.
½	1½	14.2	1¾	26.3	1⅞	37.1	2	56.7	2⅛	86.3
⅝	1⅝	14.8	1⅞	27.4	2	38.6	2⅛	58.8	2¼	88.8
¾	1¾	15.5	2	28.5	2⅛	40.1	2¼	60.9	2⅜	91.9
⅞	1⅞	16.2	2⅛	29.6	2¼	41.8	2⅜	63.1	2½	94.6
1	2	16.9	2¼	30.6	2⅜	43.3	2½	65.2	2⅝	97.4
1⅛	2⅛	17.6	2⅜	31.7	2½	44.9	2⅝	67.3	2¾	100.2
1¼	2¼	18.3	2½	32.8	2⅝	46.5	2¾	69.6	2⅞	103.0
1⅜	2⅜	19.0	2⅝	33.9	2¾	48.0	2⅞	71.6	3	105.0
1½	2⅝	20.4	2⅞	36.1	3	51.2	3⅛	75.8	3¼	111.3
1⅝	2¾	21.1	3	37.2	3⅛	52.7	3¼	78.0	3⅜	114.1
1¾	3	22.5	3¼	39.4	3⅜	55.8	3½	82.2	3⅝	119.7
1⅞	3⅛	23.2	3⅜	40.4	3½	57.4	3⅝	84.4	3¾	122.4
2	3¼	23.9	3½	41.5	3⅝	59.0	3¾	86.5	3⅞	125.1
2⅛	3⅜	24.6	3⅝	42.6	3¾	60.5	3⅞	88.6	4	128.0
2¼	3½	25.3	3¾	43.7	3⅞	62.1	4	90.8	4⅛	130.8
2⅜	3⅝	26.0	3⅞	44.8	4	63.7	4⅛	92.9	4¼	133.6
2½	3¾	26.7	4	45.9	4⅛	65.2	4¼	95.0	4⅜	136.4
2⅝	3⅞	27.4	4⅛	47.0	4¼	66.8	4⅜	97.1	4½	139.0
2¾	4	28.1	4¼	48.0	4⅜	78.4	4½	99.3	4⅝	141.9
2⅞	4⅛	28.7	4⅜	49.1	4½	69.9	4⅝	101.4	4¾	145.0
3	4⅜	30.1	4⅝	51.3	4¾	73.1	4⅞	105.6	5	150.0
3⅛	4½	30.8	4¾	52.4	4⅞	74.6	5	107.8	5⅛	153.0
3¼	4⅝	31.5	4⅞	53.5	5	76.2	5⅛	109.9	5¼	155.8
3⅜	4¾	32.2	5	54.6	5⅛	77.8	5¼	112.0	5⅜	158.6
3½	4⅞	32.9	5⅛	55.6	5¼	79.3	5⅜	114.2	5½	161.4
3⅝	5	33.6	5¼	56.7	5⅜	80.9	5½	116.3	5⅝	164.2
3¾	5⅛	34.3	5⅜	57.8	5½	82.4	5⅝	118.4	5¾	167.0
3⅞	5¼	35.0	5½	58.9	5⅝	84.0	5¾	120.6	5⅞	169.7
4	5⅜	35.7	5⅝	60.0	5¾	85.6	5⅞	122.7	6	172.5
4⅛	5⅝	36.8	5⅞	62.2	6	88.6	6⅛	126.9	6¼	178.1
4¼	5¾	37.8	6	63.3	6⅛	90.3	6¼	129.1	6⅜	180.9
4⅜	6	39.2	6¼	65.5	6⅜	93.4	6½	133.3	6⅝	186.5
4½	6⅛	39.9	6⅜	66.6	6½	95.1	6⅝	135.4	6¾	189.2
4⅝	6¼	40.6	6½	67.6	6⅝	96.5	6¾	137.6	6⅞	192.0
4¾	6⅜	41.3	6⅝	68.7	6¾	98.1	6⅞	139.7	7	194.8
4⅞	6½	42.0	6¾	69.8	6⅞	99.7	7	141.9	7⅛	197.6
5	6⅝	42.7	6⅞	70.9	7	101.12	7⅛	144.0	7¼	200.3
5⅛	.....	.....	.....	.....	7⅛	102.8	7¼	146.1	7⅜	203.1
5¼	.....	.....	.....	.....	7¼	104.4	7⅜	148.2	7½	205.9
5⅜	.....	.....	.....	.....	7⅜	105.9	7½	150.4	7⅝	208.7
5½	.....	.....	.....	.....	7⅝	108.9	7¾	154.7	7⅞	214.3
5⅝	.....	.....	.....	.....	7¾	111.0	7⅞	156.8	8	217.0
5¾	.....	.....	.....	.....	7⅞	112.5	8	159.0	8⅛	219.8
5⅞	.....	.....	.....	.....	8	114.0	8⅛	161.1	8¼	222.6
6	.....	.....	.....	.....	8⅛	115.5	8¼	163.2	8⅜	224.5

RIVETS

RIVET LENGTHS AND APPROXIMATE WEIGHTS PER HUNDRED FOR VARIOUS GRIPS

Weights given are for rivets before driving.



	½-Inch		⅝-Inch		¾-Inch		⅞-Inch		1-Inch	
Grip, In.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.	L, In.	Weight per 100, Lbs.
½	1⅛	12.2	1¼	22.0	1¼	29.3	1⅜	46.1	1⅜	69.6
⅝	1¼	12.8	1⅜	23.1	1⅜	30.9	1½	48.2	1½	72.2
¾	1⅜	13.4	1½	24.1	1½	32.4	1⅝	50.3	1⅝	74.6
⅞	1½	14.2	1⅝	25.2	1⅝	34.0	1¾	52.5	1¾	77.7
1	1⅝	14.8	1¾	26.3	1¾	35.5	1⅞	54.6	1⅞	80.7
1⅛	1¾	15.5	1⅞	27.4	1⅞	37.1	2	56.7	2	83.3
1¼	1⅞	16.2	2	28.5	2	38.6	2⅛	58.8	2⅛	86.3
1⅜	2	16.9	2⅛	29.6	2⅛	40.1	2¼	61.0	2¼	88.8
1⅝	2¼	18.3	2⅜	31.7	2½	44.9	2½	65.2	2⅝	97.4
1¾	2½	19.7	2⅝	33.9	2¾	48.0	2¾	69.5	2⅞	103.0
1⅞	2⅝	20.4	2¾	35.0	2⅞	49.6	2⅞	71.6	3	105.0
2	2¾	21.1	2⅞	36.1	3	51.2	3	73.7	3⅛	108.5
2⅛	2⅞	21.8	3	37.2	3⅛	52.7	3⅛	75.9	3¼	111.3
2¼	3	22.5	3⅛	38.3	3¼	54.3	3¼	78.0	3⅜	114.1
2⅜	3⅛	23.2	3¼	39.4	3⅜	55.8	3⅜	80.1	3½	116.9
2½	3¼	23.9	3⅜	40.4	3½	57.4	3½	82.3	3⅝	119.7
2⅝	3⅜	24.6	3½	41.5	3⅝	59.0	3⅝	84.4	3¾	122.4
2¾	3½	25.3	3⅝	42.6	3¾	60.5	3¾	86.5	3⅞	125.1
2⅞	3⅝	26.0	3¾	43.7	3⅞	62.1	3⅞	88.6	4	128.0
3	3⅞	27.4	4	45.9	4	63.7	4⅛	92.9	4¼	133.6
3⅛	4	28.1	4⅛	47.0	4⅛	65.2	4¼	95.0	4⅜	136.4
3¼	4⅛	28.7	4¼	48.0	4¼	66.8	4⅜	97.2	4½	139.0
3⅜	4¼	29.4	4⅜	49.1	4⅜	68.4	4½	99.3	4⅝	141.9
3½	4⅜	30.1	4½	50.2	4½	69.9	4⅝	101.4	4¾	145.0
3⅝	4½	30.8	4⅝	51.3	4⅝	71.5	4¾	103.5	4⅞	147.5
3¾	4⅝	31.5	4¾	52.4	4¾	73.1	4⅞	105.7	5	150.0
3⅞	4¾	32.2	4⅞	53.5	4⅞	74.6	5	107.8	5⅛	153.0
4	4⅞	32.9	5	54.6	5	76.2	5⅛	109.9	5¼	155.8
4⅛	5⅛	34.3	5¼	56.7	5¼	79.3	5⅜	114.2	5½	161.4
4¼	5¼	35.0	5⅜	57.8	5⅜	80.9	5½	116.3	5⅝	164.2
4⅜	5½	36.4	5⅝	60.0	5⅝	84.0	5⅝	118.4	5¾	167.0
4½	5⅝	37.1	5¾	61.1	5¾	85.6	5¾	120.6	5⅞	169.7
4⅝	5¾	37.8	5⅞	62.2	5⅞	87.1	5⅞	122.7	6	172.5
4¾	5⅞	38.5	6	63.3	6	88.6	6	124.8	6⅛	175.3
4⅞	6	39.2	6⅛	64.4	6⅛	90.3	6⅛	126.9	6¼	178.1
5	6⅛	39.9	6¼	65.5	6¼	91.8	6¼	129.1	6⅜	180.9
5⅛	.....	.....	.....	.....	6⅜	93.4	6⅜	131.2	6½	184.0
5¼	.....	.....	.....	.....	6½	95.1	6½	133.4	6⅝	186.5
5⅜	.....	.....	.....	.....	6⅝	96.5	6⅝	135.5	6¾	189.2
5½	.....	.....	.....	.....	6⅞	99.7	6⅞	139.8	7	194.8
5⅝	.....	.....	.....	.....	7	101.2	7	142.0	7⅛	197.6
5¾	.....	.....	.....	.....	7⅛	102.8	7⅛	144.1	7¼	200.3
5⅞	.....	.....	.....	.....	7¼	104.4	7¼	146.2	7⅜	203.1
6	.....	.....	.....	.....	7⅜	105.9	7⅜	148.3	7½	205.9

RIVETS

SHEARING AND BEARING VALUES

⅜-INCH RIVETS—Area .1104 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	770	880	990	1100	1210	1320
	Double Shear per Rivet, Lbs.	1540	1760	1980	2200	2420	2640
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. ⅛	660	750	840	940	1030	1130
	3/16	980	1130	1270	1410	1550	1690
	¼	1310	1500	1690	1880	2060	2250
	5/16	**1640**	**1880**	**2110**	**2340**	**2580**	**2810**
	⅜	**1910**	**2250**	**2530**	**2810**	**3090**	**3380**

½-INCH RIVETS—Area .1963 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	1370	1570	1770	1960	2160	2360
	Double Shear per Rivet, Lbs.	2750	3140	3530	3930	4320	4710
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. 3/16	1310	1500	1690	1880	2060	2250
	¼	1750	2000	2250	2500	2750	3000
	5/16	2190	2500	2810	3130	3440	3750
	⅜	2630	3000	3380	3750	4130	4500
	7/16	**3060**	**3500**	**3940**	**4380**	**4810**	**5250**
	½	**3500**	**4000**	**4500**	**5000**	**5500**	**6000**

⅝-INCH RIVETS—Area .3068 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	2150	2450	2760	3070	3370	3680
	Double Shear per Rivet, Lbs.	4300	4910	5520	6140	6750	7360
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. 3/16	1640	1880	2110	2340	2580	2810
	¼	2190	2500	2810	3130	3440	3750
	5/16	2730	3130	3520	3910	4300	4690
	⅜	3280	3750	4220	4690	5160	5630
	7/16	3830	4380	4920	5470	6020	6560
	½	**4380**	**5000**	**5630**	**6250**	**6880**	**7500**
	9/16	**4920**	**5630**	**6330**	**7030**	**7730**	**8440**
	⅝	**5470**	**6250**	**7040**	**7810**	**8590**	**9380**

Values in "**heavy**" type are greater than double shear.

RIVETS

SHEARING AND BEARING VALUES

¾-INCH RIVETS—Area .4418 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	3090	3530	3980	4420	4860	5300
	Double Shear per Rivet, Lbs.	6190	7070	7950	8840	9720	10600
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. ¼	*2630*	*3000*	*3380*	*3750*	*4130*	*4500*
	5/16	3280	3750	4220	4690	5160	5630
	⅜	3940	4500	5060	5630	6190	6750
	7/16	4590	5250	5910	6560	7220	7880
	½	5250	6000	6750	7500	8250	9000
	9/16	5910	6750	7590	8440	9280	10130
	⅝	**6560**	**7500**	**8440**	**9380**	**10310**	**11250**

⅞-INCH RIVETS—Area .6013 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	4210	4810	5410	6010	6610	7220
	Double Shear per Rivet, Lbs.	8420	9620	10820	12030	13230	14430
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. ¼	*3060*	*3500*	*3940*	*4380*	*4810*	*5250*
	5/16	*3830*	*4380*	*4920*	*5470*	*6020*	*6560*
	⅜	4590	5250	5910	6560	7220	7880
	7/16	5360	6130	6890	7660	8420	9190
	½	6130	7000	7880	8750	9630	10500
	9/16	6890	7880	8860	9840	10830	11810
	⅝	7660	8750	9840	10940	12030	13130
	11/16	**8420**	**9630**	**10830**	**12030**	**13230**	**14430**

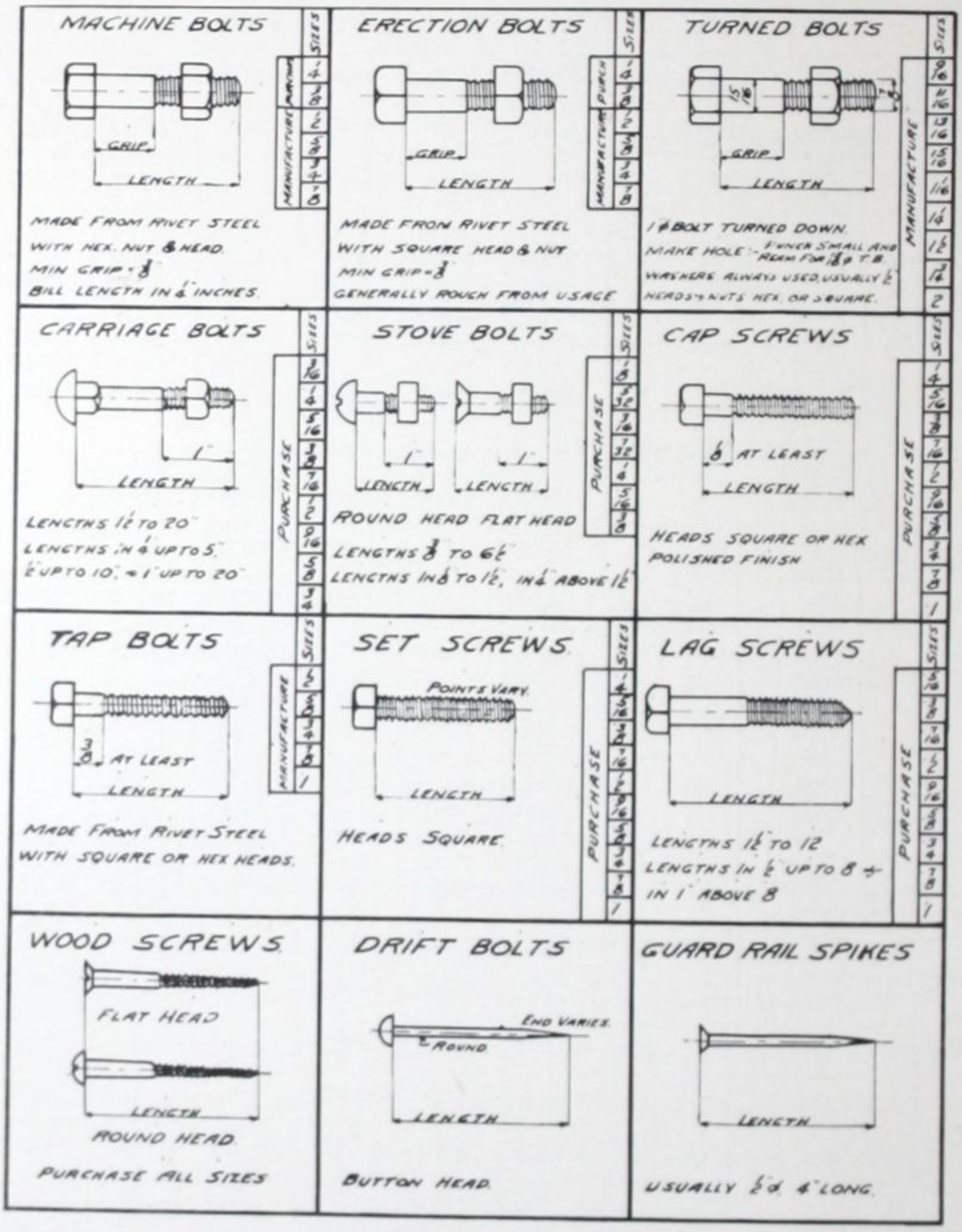
1-INCH RIVETS—Area .7854 Square Inch

Shear	Unit, Lbs. per Sq. In.	7000	8000	9000	10000	11000	12000
	Single Shear per Rivet, Lbs.	5500	6280	7070	7850	8640	9420
	Double Shear per Rivet, Lbs.	11000	12570	14140	15710	17280	18850
Bearing	Unit, Lbs. per Sq. In.	14000	16000	18000	20000	22000	24000
	Thickness, In. ¼	*3500*	*4000*	*4500*	*5000*	*5500*	*6000*
	5/16	*4380*	*5000*	*5630*	*6250*	*6880*	*7500*
	⅜	*5250*	*6000*	*6750*	*7500*	*8250*	*9000*
	7/16	6130	7000	7880	8750	9630	10500
	½	7000	8000	9000	10000	11000	12000
	9/16	7880	9000	10130	11250	12380	13500
	⅝	8750	10000	11250	12500	13750	15000
	11/16	9630	11000	12380	13750	15130	16500
	¾	10500	12000	13500	15000	16500	18000
	13/16	**11380**	**13000**	**14630**	**16250**	**17880**	**19500**

Values in "*italic*" type are less than single shear.
Values in "**heavy**" type are greater than double shear.

BOLTS AND SCREWS

The illustration below shows the more common types of bolts and screws in general use. It should prove useful, as discussion often arises concerning the differences between certain types.

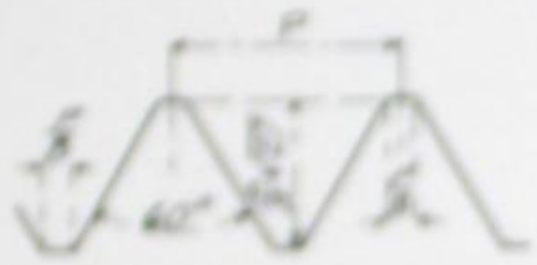


No. 20—Types of Bolts and Screws

Information as to sizes, lengths and finishes of the bolts and screws shown above is given in the text of the accompanying pages of this section.

MACHINE BOLTS

The rules used for shape of thread, number of threads per inch, and sizes for heads and nuts, are those commonly known as U. S. Standard, as follows:



No. 21—Shape of Thread

Short diameter of rough nut or rough head is equal to one and a half times the diameter of bolt, plus 1/8". Thickness of rough nut equals diameter of bolt. Thickness of rough head equals one half the short diameter of head.

Dimensions of Heads and Nuts

Diameter of Bolt	Threads per Inch	Area at Root of Thread	Round	Head			Nut			Diameter of Bolt
				Hexagonal	Hex. or Square	Square	Square	Hex. or Square	Hexagonal	
¼	20	.027	¼	⅜	⅜	⅜	⅜	⅜	⅜	¼
⅜	16	.068	⅜	9/16	9/16	9/16	9/16	9/16	9/16	⅜
½	13	.126	½	¾	¾	¾	¾	¾	¾	½
⅝	11	.202	⅝	15/16	15/16	15/16	15/16	15/16	15/16	⅝
¾	10	.302	¾	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	¾
⅞	9	.419	⅞	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	⅞
1	8	.551	1	1½	1½	1½	1½	1½	1½	1
1⅛	7	.693	1⅛	1¾	1¾	1¾	1¾	1¾	1¾	1⅛
1¼	7	.890	1¼	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	1¼
1⅜	6	1.054	1⅜	2	2	2	2	2	2	1⅜
1½	6	1.294	1½	2⅛	2⅛	2⅛	2⅛	2⅛	2⅛	1½
1¾	5½	1.515	1¾	2⅝	2⅝	2⅝	2⅝	2⅝	2⅝	1¾
2	4½	1.746	2	3	3	3	3	3	3	2
2¼	4½	2.410	2¼	3⅜	3⅜	3⅜	3⅜	3⅜	3⅜	2¼
2½	4	3.020	2½	3¾	3¾	3¾	3¾	3¾	3¾	2½
2¾	4	3.715	2¾	4⅛	4⅛	4⅛	4⅛	4⅛	4⅛	2¾
3	4	4.520	3	4½	4½	4½	4½	4½	4½	3
3¼	4	5.428	3¼	4⅞	4⅞	4⅞	4⅞	4⅞	4⅞	3¼
3½	4	6.388	3½	5¼	5¼	5¼	5¼	5¼	5¼	3½
3¾	4	7.441	3¾	5⅝	5⅝	5⅝	5⅝	5⅝	5⅝	3¾
4	4	8.589	4	6	6	6	6	6	6	4
4¼	4	9.831	4¼	6⅜	6⅜	6⅜	6⅜	6⅜	6⅜	4¼
4½	4	11.166	4½	6¾	6¾	6¾	6¾	6¾	6¾	4½
4¾	4	12.595	4¾	7⅛	7⅛	7⅛	7⅛	7⅛	7⅛	4¾
5	4	14.118	5	7½	7½	7½	7½	7½	7½	5
5¼	4	15.733	5¼	7⅞	7⅞	7⅞	7⅞	7⅞	7⅞	5¼
5½	4	17.442	5½	8¼	8¼	8¼	8¼	8¼	8¼	5½
5¾	4	19.244	5¾	8⅝	8⅝	8⅝	8⅝	8⅝	8⅝	5¾
6	4	21.139	6	9	9	9	9	9	9	6

BOLTS WITH SQUARE HEADS AND NUTS

WEIGHT IN POUNDS PER 100 BOLTS

Length Under Head, Inches	Diameter of Bolt, Inches								
	¼	5/16	⅜	7/16	½	⅝	¾	⅞	1
1	4	7	11	15	22	37	56		
1¼	4	7	11	16	23	39	59		
1½	5	8	12	17	24	41	62		
1¾	5	8	13	18	26	43	64		
2	5	9	14	19	27	45	67	101	144
2¼	6	9	15	20	28	47	71	104	150
2½	6	10	15	21	30	49	74	109	155
2¾	6	10	16	22	31	51	77	113	161
3	7	11	17	24	33	54	80	117	167
3½	7	12	18	25	35	58	86	126	178
4	8	13	20	28	38	62	92	134	189
4½	9	14	21	30	41	66	98	142	198
5	10	15	23	32	43	71	104	151	209
5½	10	16	25	34	46	75	111	159	220
6	11	17	26	36	49	79	117	168	232
6½			28	38	52	84	123	176	243
7			29	40	55	88	129	185	254
7½			31	42	57	92	136	193	265
8			32	45	60	97	142	202	276
9			34	49	65	105	154	218	298
10				53	71	114	167	235	320
12				61	82	131	192	269	364
14					93	148	217	303	409
Per Inch Additional	1.4	2.2	3.1	4.3	5.6	8.7	12.5	17.0	22.3

SQUARE NUTS AND BOLT HEADS

WEIGHTS IN POUNDS FOR ONE HEAD AND ONE NUT

Diameter of Bolt, Inches	1¼	1½	1¾	2	2½	3
Square Head and Nut ...	2.05	3.51	5.48	8.08	15.5	26.2
Weight of Shank per Inch	.3477	.5007	.6815	.8900	1.391	2.003

BOLTS WITH HEXAGONAL HEADS AND NUTS

WEIGHT IN POUNDS PER 100 BOLTS

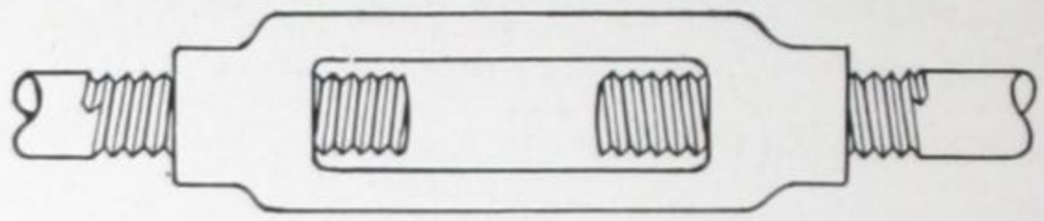
Length Under Head, Inches	Diameter of Bolt, Inches					Length Under Head, Inches	Diameter of Bolt, Inches				
	½	⅝	¾	⅞	1		½	⅝	¾	⅞	1
1	19	33	52			8	58	92	137	194	264
1¼	20	34	54			8½	60	96	143	202	274
1½	22	36	57			9	63	100	149	210	285
1¾	23	38	60			9½	66	105	156	219	296
2	24	40	63	93	132	10	68	109	162	227	307
2¼	26	43	66	97	137	10½	71	114	168	236	318
2½	27	45	69	101	143	11	74	118	174	244	329
2¾	29	47	72	105	148	11½	77	122	181	253	341
3	30	49	75	109	154	12	80	127	187	261	352
3¼	31	51	78	114	160	12½	82	131	193	270	363
3½	33	54	82	118	165	13	85	135	199	278	374
3¾	34	56	85	122	171	13½	88	139	206	287	385
4	35	58	88	126	176	14	91	144	212	295	396
4¼	37	60	90	130	180	14½	93	148	218	304	407
4½	38	62	94	134	186	15	96	152	225	312	418
4¾	39	64	97	138	191	15½	99	157	231	321	430
5	41	66	100	143	197	16	102	161	237	329	441
5¼	42	68	103	147	202	16½	105	165	243	338	452
5½	44	71	106	151	208	17	107	170	250	346	463
5¾	45	73	109	156	213	17½	110	174	256	355	474
6	46	75	112	160	219	18	113	177	262	364	485
6¼	48	77	115	164	225	18½	116	183	268	372	496
6½	49	79	119	168	230	19	119	187	275	381	507
6¾	51	81	122	173	236	19½	121	191	281	389	519
7	52	84	125	177	241	20	124	196	287	398	530
7¼	53	86	128	181	247						
7½	55	88	131	185	252						
7¾	56	90	134	190	258						
Per Inch Additional	5.6	8.7	12.5	17.0	22.3	Per Inch Additional	5.6	8.7	12.5	17.0	22.3

HEXAGONAL NUTS AND BOLT HEADS

WEIGHTS IN POUNDS FOR ONE HEAD AND ONE NUT

Diameter of Bolt, Inches	1¼	1½	1¾	2	2½	3
Hexagon Head and Nut.	1.73	2.95	4.61	6.79	13.0	22.0
Weight of Shank per Inch	.3477	.5007	.6815	.8900	1.391	2.003

DROP-FORGED STEEL STANDARD TURNBUCKLES



No. 22—Stand rd Turnbuckle

These Turnbuckles are drop-forged from the bar, are free from welds and seams, thus making them absolutely reliable and giving a tensile strength of 60,000 pounds or more per square inch.

Diameter of Stub Ends, Inches	Opening between Heads, Inches	Length of Buckle With Ends, Inches	Weights			
			With Stub		Without Stub	
			Lb.	Oz.	Lb.	Oz.
1/2	6	22	1	8	0	12
5/8	6	22	2	8	1	2
3/4	6	23	3	8	1	6
7/8	6	24	4	8	2	0
1	6	25	6	8	2	14
1 1/8	6	25	8	8	3	8
1 1/4	6	26	10	12	5	0
1 3/8	6	27	13	0	6	0
1 1/2	6	27	16	0	7	0
1 5/8	6	28	19	0	8	12
1 3/4	6	28	21	8	10	0
1 7/8	6	29	26	8	12	8
2	6	29	30	8	14	0
2 1/4	6	30	45	0	19	0

Larger sizes can be supplied but are not carried in stock. Turnbuckles with longer length between heads can also be furnished.

SQUARE WROUGHT WASHERS

Size Square, Inches	Thickness, Inches	Size of Hole, Inches	Size of Bolt, Inches	Average Number per100 Pounds
1 1/2	1/8	7/16	3/8	1,300
1 3/4	1/8	1/2	7/16	1,100
2	3/16	9/16	1/2	500
2 1/4	3/16	11/16	5/8	390
2 1/4	1/4	23/32	5/8	315
2 1/4	3/16	13/16	3/4	426
2 1/4	3/16	3/4	47/64	409
2 1/2	1/4	27/32	3/4	250
3	1/4	13/16	3/4	166
3	1/4	31/32	7/8	165
3 1/2	3/8	1-3/32	1	87
4	3/8	1 1/4	1 1/8	65
4 1/2	3/8	1 3/8	1 1/4	48
5	3/8	1 1/2	1 3/8	40
6	3/8	1 5/8	1 1/2	28
6	3/8	1 7/8	1 3/4	24
6	3/8	2 1/8	2	21

These can be supplied either black hot galvanized or electric galvanized.

SQUARE PLATE WASHERS

Heavy plate washers are furnished in large numbers for all classes of structural work. As we always carry a large stock of plates of all sizes and thicknesses, these washers can be turned out very promptly. When ordering always state width, length and thickness of plate, also size of bolt hole.

CUT, PRESSED OR PLATE WASHERS

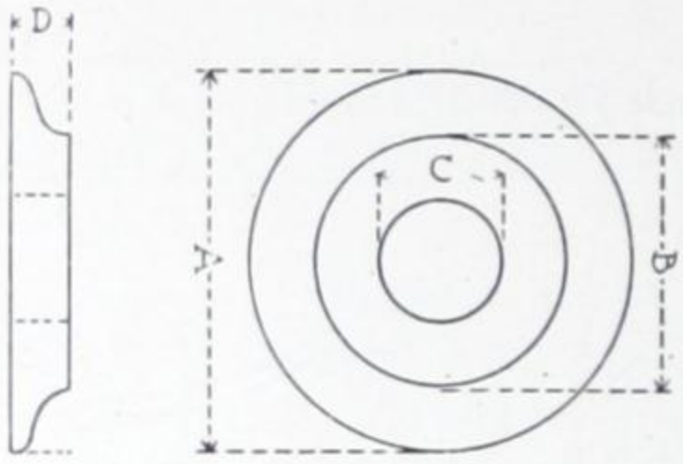
We can supply from stock standard cut, pressed or plate washers in the sizes tabulated below for cut round washers.

SPECIFICATIONS FOR CUT ROUND WASHERS

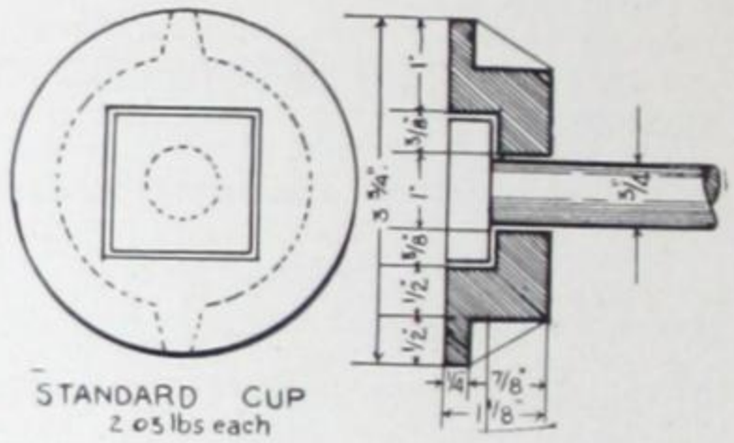
Outside Diameter In.	Size of Hole In.	Thickness Wire Gauge No.	Size of Bolt In.	Average Number in 100 lbs.
9/16	1/4	18	3/16	39,400
3/4	5/16	16	1/4	15,000
7/8	3/8	16	5/16	11,250
1	7/16	14	3/8	6,800
1 1/4	1/2	13	7/16	4,300
1 3/8	9/16	12	1/2	2,600
1 1/2	5/8	12	9/16	2,250
1 3/4	11/16	10	5/8	1,300
1 3/4	3/4	10	11/16	1,580
2	11/16	10	3/4	1,010
2	7/8	10	11/16	1,110
2 1/4	11/16	9	7/8	860
2 1/2	1 1/16	9	1	625
2 1/2	1 1/8	9	1 1/16	670
2 3/4	1 1/4	9	1 1/8	520
2 3/4	1 5/16	9	1 1/8	570
3	1 3/8	9	1 1/4	400
3 1/4	1 1/2	8	1 3/8	300
3 1/2	1 5/8	8	1 1/2	280
3 3/4	1 3/4	8	1 5/8	240
4	1 7/8	8	1 3/4	215
4 1/4	2	8	1 7/8	190
4 1/2	2 1/8	8	2	175

CAST IRON WASHERS

We can supply on short notice standard cast washers in the sizes tabulated below. Pressed washers, are referred to on page 81. Cup washers, as shown by No. 24 below, and cast iron separators, for use in timber bridge construction, are obtainable in all sizes and patterns.



No. 23—Standard Cast "Ogee" Washer.



No. 24—Cast Iron Cup Washer

DIMENSIONS AND WEIGHTS OF STANDARD CAST WASHERS

Diameter of Bolt, Inch	A	B	C	D	Weight in Pounds
1/2	2 5/8	1 3/4	9/16	5/8	1/2
5/8	3	1 7/8	11/16	3/4	3/4
3/4	3 1/4	2 1/8	13/16	7/8	1 1/4
7/8	3 3/4	2 1/2	15/16	7/8	1 1/2
1	4	2 3/4	1 1/16	1 1/8	2 1/2
1 1/8	4 3/4	2 3/4	1 3/16	1 1/8	3
1 1/4	6	3	1 5/16	1 3/8	5 3/4
1 1/2	6 1/4	3 1/4	1 5/8	1 1/2	6
1 3/4	7 1/4	3 3/4	1 7/8	1 3/4	9 1/2
2	8 1/4	4 1/4	2 1/8	2	17 1/4

The letters A, B, C, D refer to illustration No. 23 above.

SASH WEIGHTS

Our facilities for manufacturing sash weights are exceptional and we sell large numbers of them in Winnipeg and throughout Western Canada.

Send list of sizes wanted and we will quote you prices.

No. 25 (At Left)—Cast Iron Sash Weights

STRUCTURAL TIMBER

In building construction, timber is used for the ordinary class of a building of a non-fireproof nature. Where it is desired to reduce the fire risk to a minimum and yet not go to the expense of fireproof construction, mill construction type is used.

Mill construction consists in disposing the timber and plank in heavy solid masses so as to expose the least number of corners and projections to fire. The columns are large-sized squared timbers with steel post caps and bases, heavy timbers supporting a solid laminated floor.

Details of steel hangers, post bases and caps, etc., which we manufacture for use with timber construction, are given on pages 89 to 96.

The strength of structural timbers depends upon the kind of wood, the age of the tree, the time of the year in which it was felled, the method of sawing, the character of the seasoning and therewith its moisture content, the proportion of heartwood to sapwood and the proportion of knots to clear wood.

The tables give the average practice as represented by the building laws, and may, therefore, be used as they stand for ordinary building work executed with the commercial grades of timber, such as can be purchased in the open market, and are the usual qualities used in Western building construction.

The safe loads include the weight of the beams and are computed on the assumption that the beams are braced against lateral deflection. These tables also give minimum and maximum spans and coefficients of deflection.

The maximum safe loads as limited by the allowable shearing stresses along horizontal axes of beams have been calculated from the formula:

$$\text{Maximum safe load} = \frac{8}{3} \times \text{area of section} \times \text{safe unit stress for longitudinal shear.}$$

These limits, indicated also by horizontal lines in the tables, should not be exceeded to avoid failure of the beam in horizontal direction of the grain of the wood.

The theoretical deflection in the center of the span for uniformly distributed and permanently applied loads is obtained from the coefficients of deflection by dividing the depth of the beam, in inches, into the corresponding coefficient; the result obtained only approximates the actual deflection, as the modulus of elasticity varies with the moisture content of the wood.

The deflection of beams intended to carry plastered ceilings should not exceed 1/360 of the span; the table gives the maximum spans for this limit, for uniformly distributed and permanently applied loads.

For loads concentrated in the center of the span, use one-half the values for the tabular loads and four-fifths of the coefficients of deflection.

TIMBER COLUMNS

The safe load tables of wooden columns which follow, based upon the working unit stresses adopted by the American Railway Engineering Association, give the allowable direct compressive loads for square and round columns.

The safe loads of rectangular columns may be found from the safe loads of square columns by direct proportion of areas, using the safe load unit stress of the square column whose side is equal to the least side of the rectangular section.

The following table gives the safe load in pounds per square inch of sectional area for ratios of

$$\frac{l}{d} = \frac{\text{effective length of column, in inches}}{\text{least side or diameter, in inches}},$$

ranging between limits of 15 and 30.

Unit Working Stresses in Pounds per Square Inch

$\frac{l}{d}$	Longleaf Pine	Douglas Fir	Spruce	Tamarack	Red Cedar,	Norway Pine
	1300× (1—l/d60)	1200× (1—l/d60)	1100× (1—l/d60)	1000× (1—l/d60)	900× (1—l/d60)	800× (1—l/d60)
15	975	900	825	750	675	600
16	953	880	807	733	660	587
17	931	860	788	717	645	573
18	910	840	770	700	630	560
19	888	820	752	683	615	547
20	867	800	733	667	600	533
21	845	780	715	650	585	520
22	823	760	697	633	570	507
23	802	740	678	617	555	493
24	780	720	660	600	540	480
25	758	700	642	583	525	467
26	737	680	623	567	510	553
27	715	660	605	550	495	440
28	693	640	587	533	480	427
29	672	620	568	517	465	413
30	650	600	550	500	450	400

SQUARE TIMBER COLUMNS
SAFE LOADS IN THOUSANDS OF POUNDS

	Lgth. Feet	Side of Square, Inches								
		4	6	8	10	12	14	16	18	20
LONGLEAF PINE WHITE OAK 1300 (1—1/60d)		**15.6**								
	5	15.6								
	6	14.6								
	7	13.5	**35.1**							
	8	12.5	34.3							
	9	11.4	32.8	**62.4**						
	10	10.4	31.2	62.4						
	11		29.6	60.3						
	12		28.1	58.2	**97.5**					
	14		25.0	54.1	93.6	**140.4**				
	16			49.9	88.4	137.3	**191.1**			
	18			45.8	83.2	131.0	189.3	**249.6**		
	20			41.6	78.0	124.8	182.0	249.6	**315.9**	**390.0**
DOUGLAS FIR WESTERN HEMLOCK 1200 (1—1/60d)		**14.4**								
	5	14.4								
	6	13.4								
	7	12.5	**32.4**							
	8	11.5	31.7							
	9	10.6	30.2	**57.6**						
	10	9.6	28.8	57.6						
	11		27.4	55.7						
	12		25.9	53.8	**90.0**					
	14		23.0	49.9	86.4	**129.6**				
	16			46.1	81.6	126.7	**176.4**			
	18			42.2	76.8	121.0	174.7	**230.4**		
	20			38.4	72.0	115.2	168.0	230.4	**291.6**	**360.0**
SHORTLEAF PINE SPRUCE 1100 (1—1/60d)		**13.2**								
	5	13.2								
	6	12.3								
	7	11.4	**29.7**							
	8	10.6	29.0							
	9	9.7	27.7	**52.8**						
	10	8.8	26.4	52.8						
	11		25.1	51.0						
	12		23.8	49.3	**82.5**					
	14		21.1	45.8	79.2	**118.8**				
	16			42.2	74.8	116.2	**161.7**			
	18			38.7	70.4	110.9	160.2	**211.2**		
	20			35.2	66.0	105.6	154.0	211.2	**267.3**	**330.0**
WHITE PINE TAMARACK 1000 (1—1/60d)		**12.0**								
	5	12.0								
	6	11.2								
	7	10.4	**27.0**							
	8	9.6	26.4							
	9	8.8	25.2	**48.0**						
	10	8.0	24.0	48.0						
	11		22.8	46.4						
	12		21.6	44.8	**75.0**					
	14		19.2	41.6	72.0	**108.0**				
	16			38.4	68.0	105.6	**147.0**			
	18			35.2	64.0	100.8	145.6	**192.0**		
	20			32.0	60.0	96.0	140.0	192.0	**243.0**	**300.0**

Loads in "**heavy**" type above horizontal lines are the maximum allowable safe loads

RECTANGULAR TIMBER BEAMS
ONE INCH THICK
MAXIMUM SAFE LOADS AND LIMITING SPANS

	Species of Timber	Depth of Beam, Inches											
		2	4	6	8	10	12	14	16	18	20	22	24
Max. Safe Loads Lbs.	Douglas Fir	293	587	880	1173	1467	1760	2053	2347	2640	2933	3227	3520
	Spruce.....	187	373	560	747	933	1120	1307	1493	1680	1867	2053	2240
Min. Spans, Feet	Douglas Fir	1.8	3.6	5.5	7.3	9.1	10.9	12.8	14.6	16.4	18.2	20.0	21.9
	Spruce.....	2.4	4.9	7.1	9.5	11.9	14.3	16.7	19.0	21 4	23.8	26.2	28.6

MAXIMUM SPANS IN FEET
For Deflections = 1/360 Span

Species of Timber	Depth of Beam, Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
Douglas Fir.....	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.7
Spruce.....	1.5	2.9	4.4	5.8	7.3	8.7	10.2	11.6	13.1	14.6	16.0	17.5

COEFFICIENT OF DEFLECTION FOR PERMANENT LOADS

Span, Feet	Douglas Fir	Spruce	Span, Feet	Douglas Fir	Spruce	Span, Feet	Douglas Fir	Spruce
1	0.05	0.05	15	10.74	10.31	29	40.14	38.52
2	0.19	0.18	16	12.22	11.73	30	42.96	41.22
3	0.43	0.41	17	13.79	13.24	31	45.87	44.01
4	0.76	0.73	18	15.47	14.84	32	48.88	46.90
5	1.19	1.15	19	17.23	16.53	33	51.98	49.88
6	1.72	1.65	20	19.09	18.32	34	55.18	52.95
7	2.34	2.24	21	21.05	20.20	35	58.47	56.11
8	3.06	2.93	22	23.10	22.17	36	61.86	59.36
9	3.87	3.71	23	25.25	24.23	37	65.34	62.70
10	4.77	4.58	24	27.49	26.38	38	68.92	66.14
11	5.78	5.54	25	29.83	28.63	39	72.60	69.66
12	6.87	6.60	26	32.27	30.96	40	76.37	73.28
13	8.07	7.74	27	34.80	33.39			
14	9.36	8.98	28	37.42	35.91			

RECTANGULAR TIMBER BEAMS—DOUGLAS FIR

ONE INCH THICK

ALLOWABLE UNIFORM LOAD IN POUNDS

Maximum Bending Stress, 1200 Pounds per Square Inch

Span in Feet	Depth of Beam in Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
	293											
2	267											
3	178	**587**										
4	133	533										
5	107	427										
			880									
6	89	356	800									
7	76	305	686	**1173**								
8	67	267	600	1067								
9		237	533	948	**1467**							
10		213	480	853	1333							
						1760						
11		194	436	776	1212	1745						
12		178	400	711	1111	1600	**2053**					
13			369	656	1026	1477	2010					
14			343	610	952	1371	1867	**2347**				
15			320	569	889	1280	1742	2276				
16			300	533	833	1200	1633	2133	**2640**			
17				502	784	1129	1537	2008	2541			
18				474	741	1067	1452	1896	2400	**2933**		
19				449	702	1011	1375	1796	2274	2807	**3227**	
20				427	667	960	1307	1707	2160	2667	3227	
21					635	914	1244	1625	2057	2540	3073	**3520**
22					606	873	1188	1552	1964	2424	2933	3491
23					580	835	1136	1484	1878	2319	2806	3339
24					556	800	1089	1422	1800	2222	2689	3200
25						768	1045	1365	1728	2133	2581	3072
26						738	1005	1313	1662	2051	2482	2954
27						711	968	1264	1600	1975	2390	2844
28						686	933	1219	1543	1905	2305	2743
29							901	1177	1490	1839	2225	2648
30							871	1138	1440	1778	2151	2560
31							843	1101	1394	1720	2082	2477
32							817	1067	1350	1667	2017	2400
33								1034	1309	1616	1956	2327
34								1004	1271	1569	1898	2259
35								975	1234	1524	1844	2194
36								948	1200	1481	1793	2133
37									1168	1441	1744	2076
38									1137	1404	1698	2021
39									1108	1368	1655	1969
40									1080	1333	1613	1920

Loads in "**heavy**" type indicate the limit for resistance to shear in the horizontal direction of the grain.

RECTANGULAR TIMBER BEAMS—SPRUCE

ONE INCH THICK

ALLOWABLE UNIFORM LOAD IN POUNDS

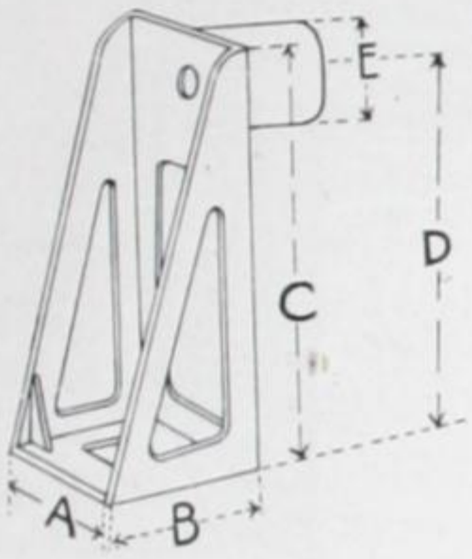
Maximum Bending Stress, 1000 Pounds per Square Inch

Span in Feet	Depth of Beam in Inches											
	2	4	6	8	10	12	14	16	18	20	22	24
2	**187**											
3	148											
4	111	**373**										
5	89	356										
6	74	296										
7	63	254	**560**									
8	56	222	500									
9		198	444	**747**								
10		178	400	711								
11		162	364	646	**933**							
12		148	333	593	926							
13			308	547	855							
14			286	508	794	**1120**						
15			267	474	741	1067						
16			250	444	694	1000	**1307**					
17				418	654	941	1281					
18				395	617	889	1210					
19				374	585	842	1146	**1493**				
20				356	556	800	1089	1422				
21					529	762	1037	1354	**1680**			
22					505	727	990	1293	1636			
23					483	696	947	1237	1565	**1867**		
24					463	667	907	1185	1500	1852		
25						640	871	1138	1440	1778		
26						615	838	1094	1385	1709	**2053**	
27						593	807	1053	1333	1646	1992	
28						571	778	1016	1286	1587	1921	**2240**
29							751	981	1241	1533	1854	2207
30							726	948	1200	1481	1793	2133
31							703	918	1161	1434	1735	2065
32							681	889	1125	1389	1681	2000
33								862	1091	1347	1630	1939
34								837	1059	1307	1582	1882
35								813	1029	1270	1537	1829
36								790	1000	1235	1494	1778
37									973	1201	1453	1730
38									947	1169	1415	1684
39									923	1140	1379	1641
40									900	1111	1344	1600

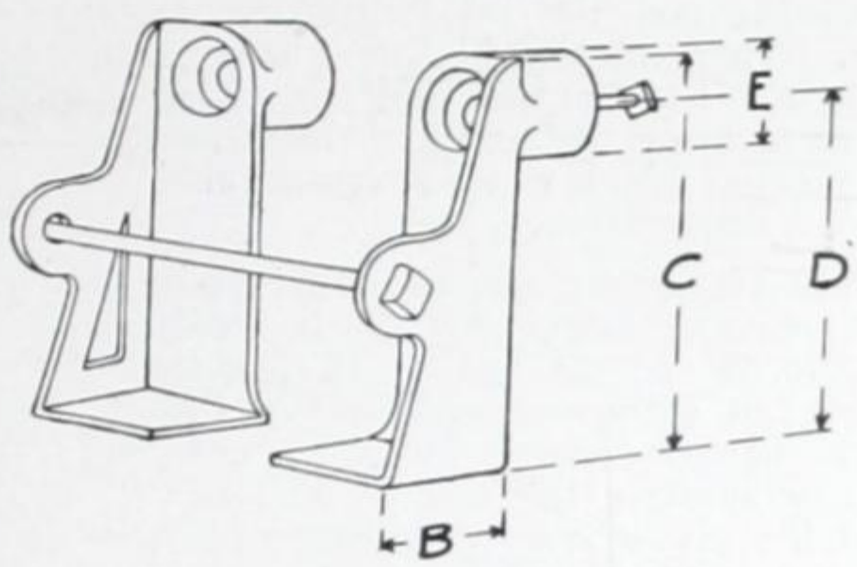
Loads in "**heavy**" type indicate the limit for resistance to shear in the horizontal direction of the grain

JOIST HANGERS

The old method of framing by mortise and tenon is obsolete. The use of joist hangers reduces joist-shrinkage to a minimum. Building construction experts find that all headers six feet long or over should be carried on joist hangers, while all framing in warehouses and first-class buildings should be done by means of means of joist hangers.



No. 26—Duplex Joist Hanger



No. 27—Duplex Joist Hangers, in Pairs

SPECIFICATIONS FOR DUPLEX JOIST HANGERS

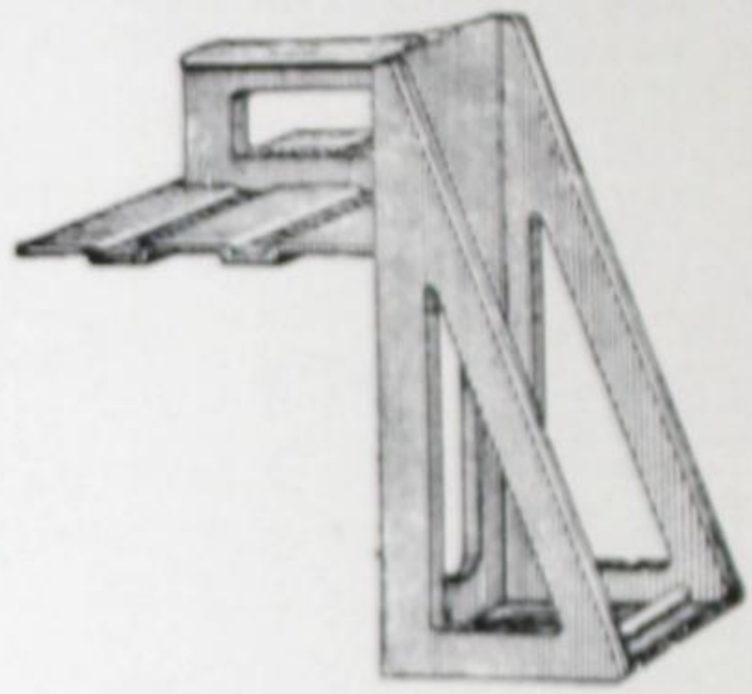
No.	Dimensions, Inches					Length Lug, In.	Carries Joist, Sizes, In.	Ship. Wt., Lbs.
	A	B	C	D	E			
10	2	3	5¾	5	1½	1¾	2 x 6 to 2 x 10	2¼
14	2	3	8	7	1¾	2	2 x 12 to 2 x 16	3⅓
15	3	3	5¾	5	1⅝	2¼	3 x 6 to 3 x 10	2¾
18	2½	3	8	7	1¾	2½	2½ x 6 to 2½ x 16	3½
20	4	3	5¾	5	1¾	2	4 x 6 to 4 x 10	3
21	3	3	8	7	1⅞	2½	3 x 12 to 3 x 14	3
21X	3	3	10	9	1⅞	2½	3 x 16 to 3 x 20	4¾
28	4	3½	8¼	7	1⅜	2¾	4 x 12 to 4 x 14	4½
28X	4	3½	10	9	2⅜	2⅞	4 x 16 to 4 x 20	7½
53	5	3½	8¼	7	2⅜	3	5 x 8 to 5 x 16	5½
16	6	3½	6	5	2	2¾	6 x 6 to 6 x 9	4
60	6	3½	8¼	7	2⅜	3	6 x 10 to 6 x 12	6⅓
60X	6	4	9½	8	2⅜	3	6 x 14 to 6 x 16	8¾
80	8	4	8¼	7	2⅜	3¼	8 x 8 to 8 x 12	10½
90	8	4	9½	8	2⅜	3	8 x 16 to 8 x 18	14
35R 35L		3¾	8¼	7	2⅜	3¼	8 x 8 to 8 x 14 10 x 10 to 10 x 14	9½ pr.
75R 75L		4¼	11½	10	2⅞	3½	10 x 16 to 10 x 18	19½ pr.

Nos. 35 R and L and 75 R and L are used in pairs as shown in illustration No. 27 above. Weights of these are per pair, without bolts.

WALL HANGERS

In a warehouse intended to be constructed on slow burning principle the floor beams and girders should be anchored to and supported by the walls in such a way that in case the beams are burnt through, the ends may fall without injuring the wall, and where large timbers are used provision should be made against the possibility of dry rot. When the wall hanger is used no hole is left in the wall and the saving of six inches in the length of the timber is effected which in some cases would be a consideration.

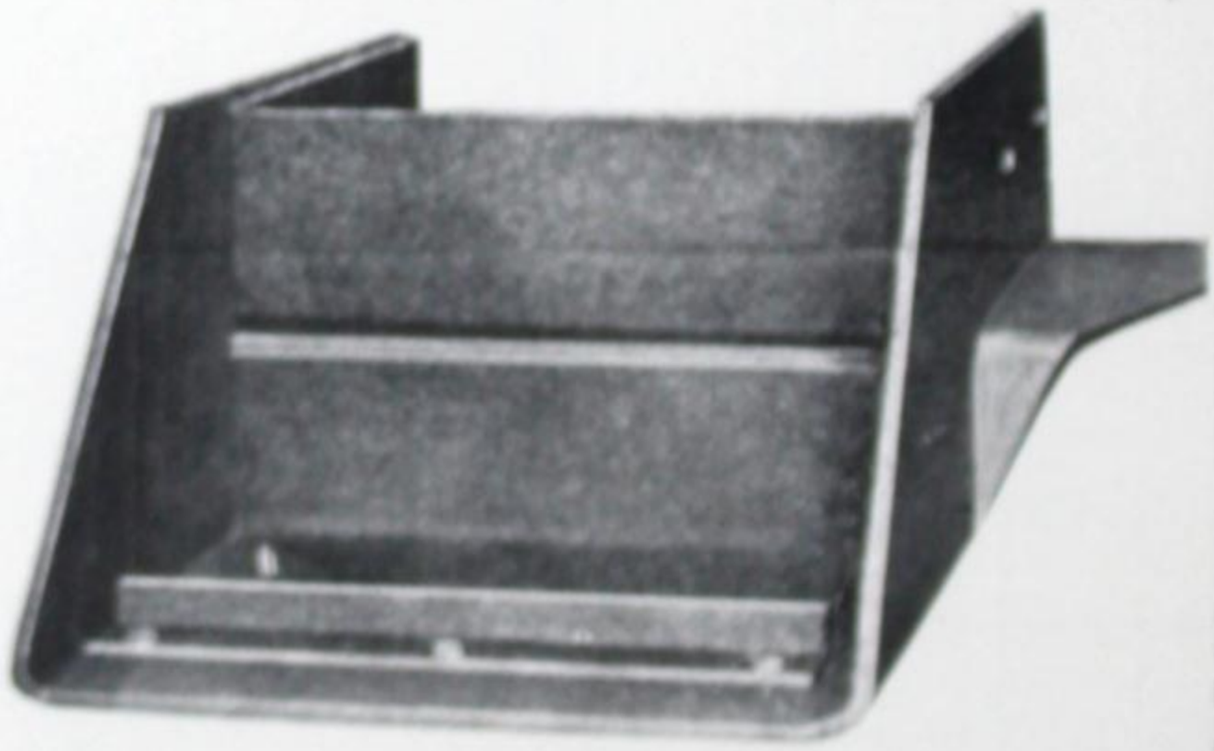
The Duplex hanger, an ideal hanger for general construction use, is shown by No. 28, on the right. In heavier work, an extra durable type of this style hanger, shown below is used. Tables showing the size of joist carried by each size of wall hanger, and shipping weights of hangers, are given herewith.



No. 28—Duplex Wall Hanger

No.	Carries Joist, Size, In.	Shipping Weight, Lbs.	No.	Carries Joist, Size, In.	Shipping Weight, Lbs.
100	2 x 6 to 2 x 12	2¼	280	4 x 12 to 4 x 18	6¾
140	2 x 14 to 2 x 18	3½	500	5 x 8 to 5 x 16	10
150	3 x 6 to 3 x 12	4	600	6 x 8 to 6 x 16	11½
210	3 x 14 to 3 x 18	5¼	800	8 x 8 to 8 x 14	13¾
200	4 x 6 to 4 x 10	3½	1000	10 x 10 to 10 x 12	18

For heavy mill construction work, the extra heavy steel wall hanger shown by No. 29 herewith is highly adaptable. It is provided with a plate that has eight inches of bearing on the wall and the bearing of the timbers on the hangers is also eight inches.



No. 29—Extra Heavy Duplex Wall Hanger

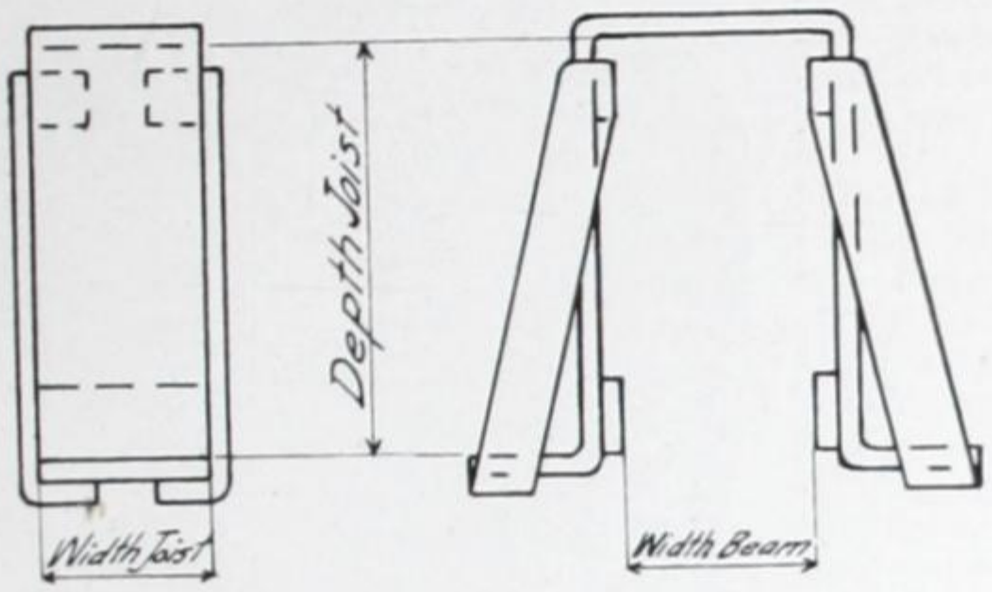
Wall hangers made from stirrups should not be used for heavy beams.

We carry all sizes of this extra heavy wall hanger in stock; the tables below show the size of joist carried by each size of wall hanger.

No.	Carries Joist, Size, In.	Shipping Weight, Lbs.	No.	Carries Joist, Size, In.	Shipping Weight, Lbs.
800	8 x 14 to 8 x 18	24	1400	14 x 14 to 14 x 18	55
1000	10 x 14 to 10 x 18	45	1600	16 x 16 to 16 x 20	58
1200	12 x 14 to 12 x 18	52			

WELDED HANGERS

The welded style of hanger combines strength and durability with economy in cost.

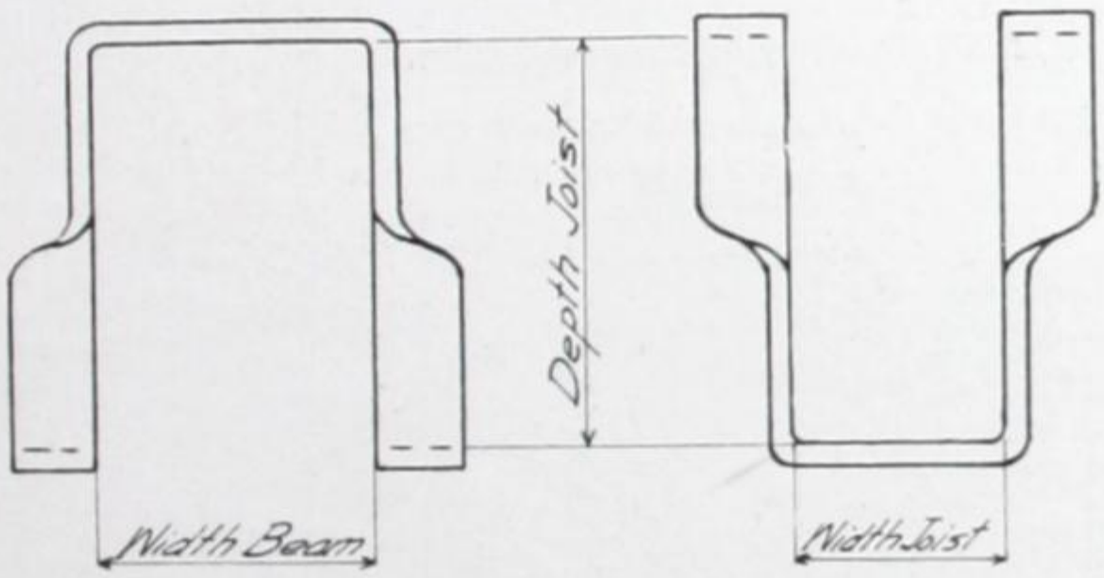


No. 30—Standard Welded Hanger

Welded hangers are made in all sizes, to suit dimensions of timber and thicknesses of material necessary for required loads.

STIRRUPS

Stirrups can be made up very quickly in our forge shop and orders for any number of any size can be executed promptly; we carry a large range of bar iron, flats and rounds from which these stirrups are made. Sometimes holes for lag screws or wire spikes for spiking stirrups to the timbers are wanted. Unless otherwise specified in the order we will always ship stirrups without holes.

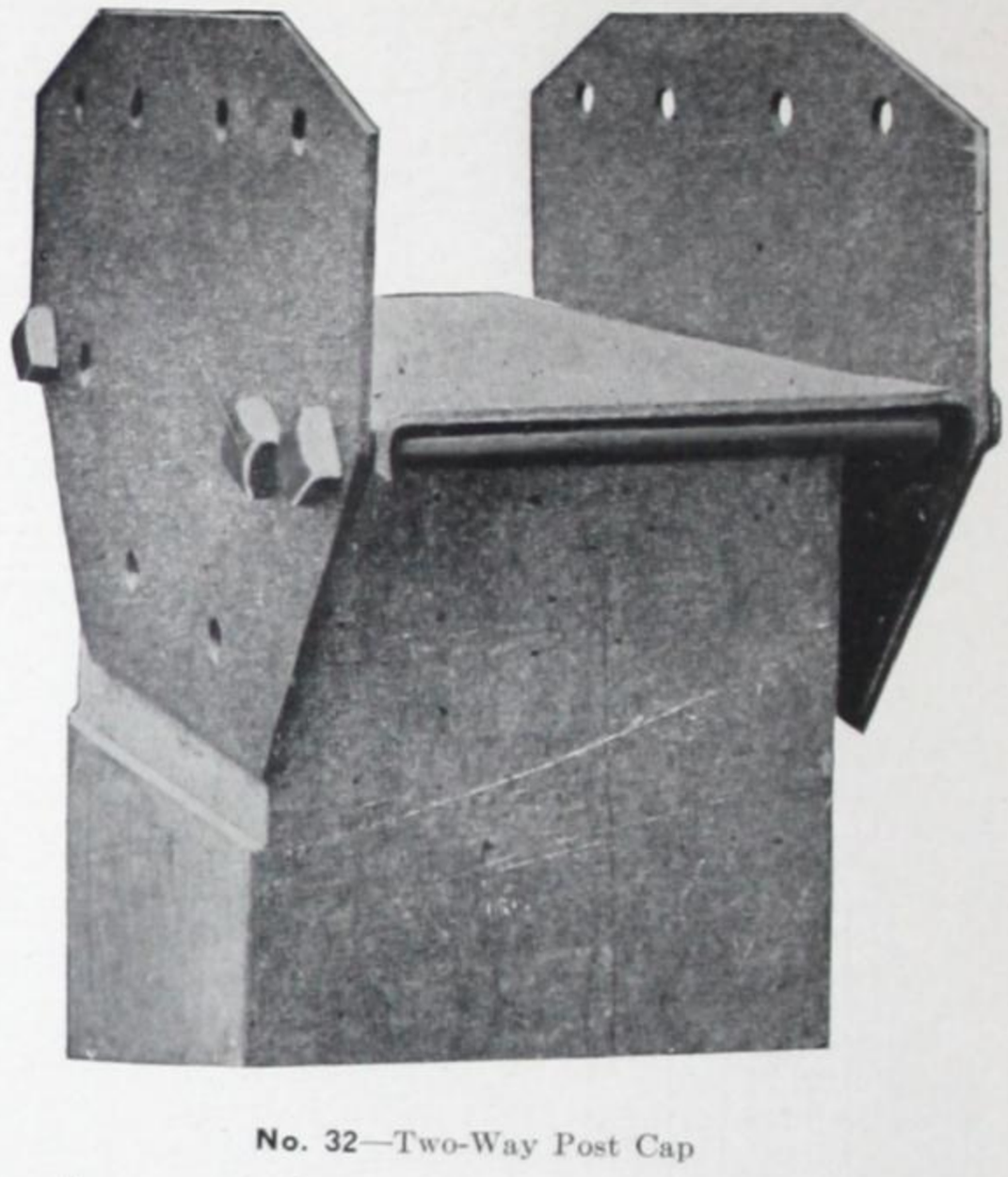


No. 31—Double Stirrup

Double stirrups are used when two beams or joists are to be framed to or carried by one girder or beam; single stirrups are required when one joist or beam is to be framed to or carried by a girder or beam. When ordering stirrups always state the width and depth of the carrying girder as well as the joists or beams to be carried; also state whether single or double stirrups are wanted. If size of iron is not given we will furnish the proper size for the timbers specified. Stirrups are usually made of flat bar iron as shown but may also be made of round iron, which would be somewhat less expensive but not so desirable.

POST CAPS

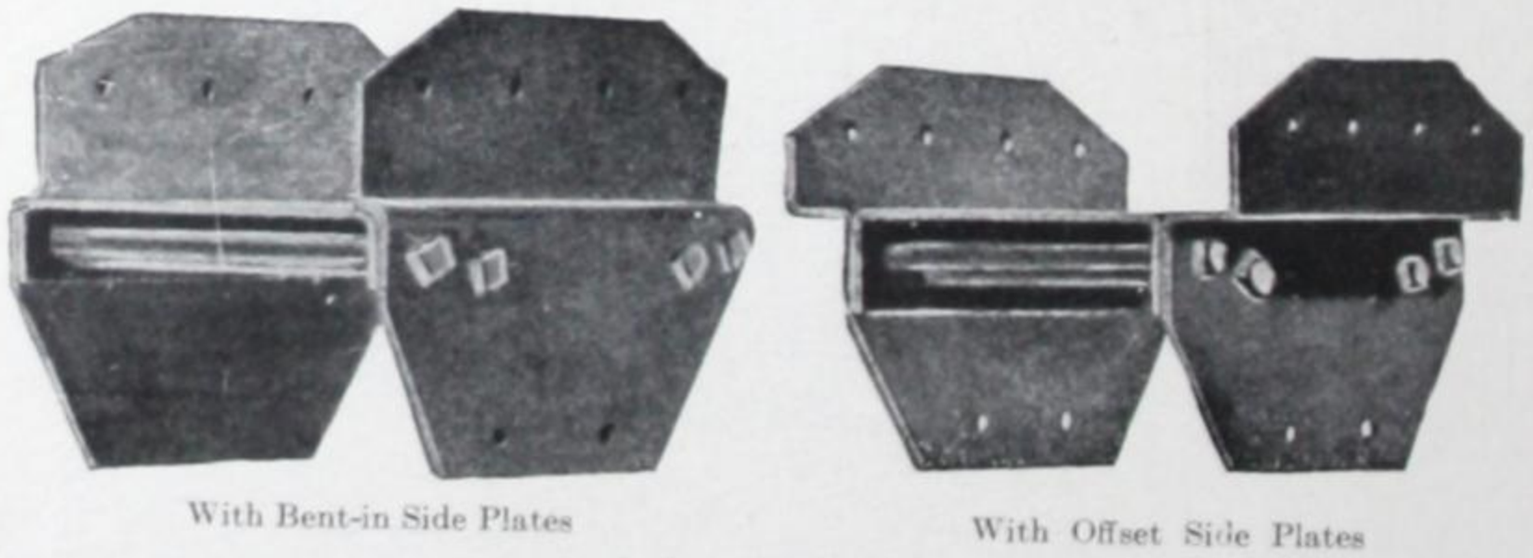
At the present time, there are a number of different types of post caps in general use, the best-known and most popular being the Duplex, illustrated herewith; we sell other styles, however, as requested. Ordinary sizes can be shipped from stock promptly.



No. 32—Two-Way Post Cap

The cap of the Duplex is made in three or more pieces of mild steel. For post caps up to 12-inch, ¼-inch steel is used,and for heavier construction ⅜ or ½-inch plates and bearing brackets are provided. The weight of the girder is carried on the shoulder formed on the post. The heavy bolts underneath the bearing brackets relieve the outer edge of the bracket and transmit the load directly to the post. The outer bolt is directly underneath the bearing bracket, while the inner bolt is close up against the post. The post cap is fastened to the post by lag screws forming a most rigid construction and virtually making a continuous post. The cap may be used for a continuous post by cutting the bearing brackets in the centre and notching the post to form a shoulder for the bearing bracket. These caps on account of their simple construction are readily made up to any desired detail and we illustrate a few of the stock sizes.

No. 32 represents the standard two-way cap while No. 33 shows a two-way post cap with bent-in side plates to accomodate a 10-inch girder with a 10 x 10



With Bent-in Side Plates

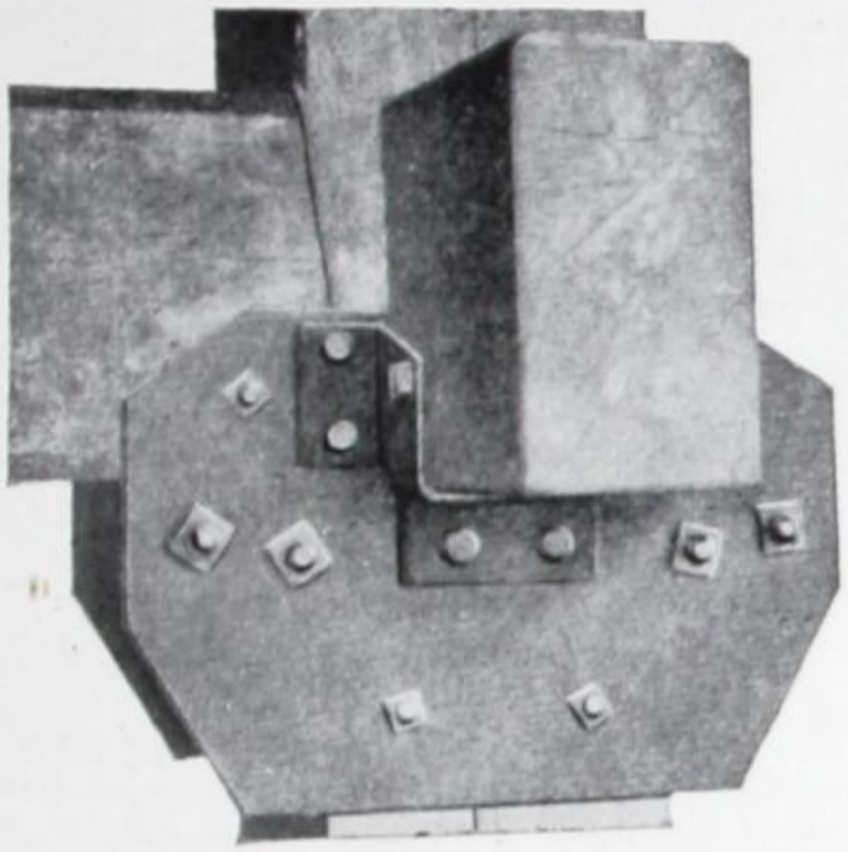
With Offset Side Plates

No. 33—Types of Two-Way Post Caps

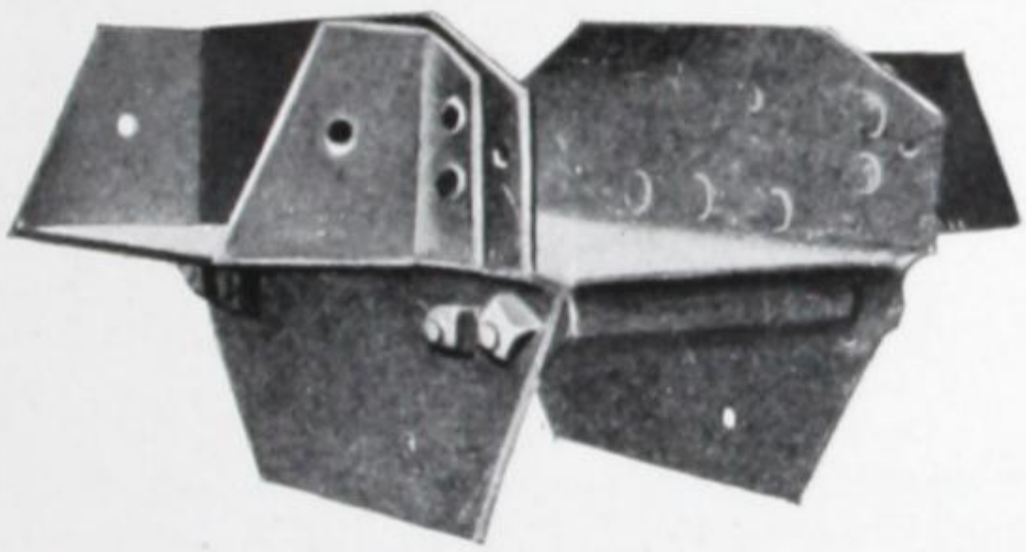
inch post above and a 12 x 12-inch post below, as well as a two-way cap with offset side plates to carry a 14-inch girder, with a 10 x 10-inch post below.

In addition to two-way post caps, three-, four- and one-way caps are used; the latter two styles are illustrated on the following page.

No. 34 represents a four-way post cap to carry four 10-inch girders on a 10 x 10-inch post. A different style of four-way cap is seen in illustration No. 35,

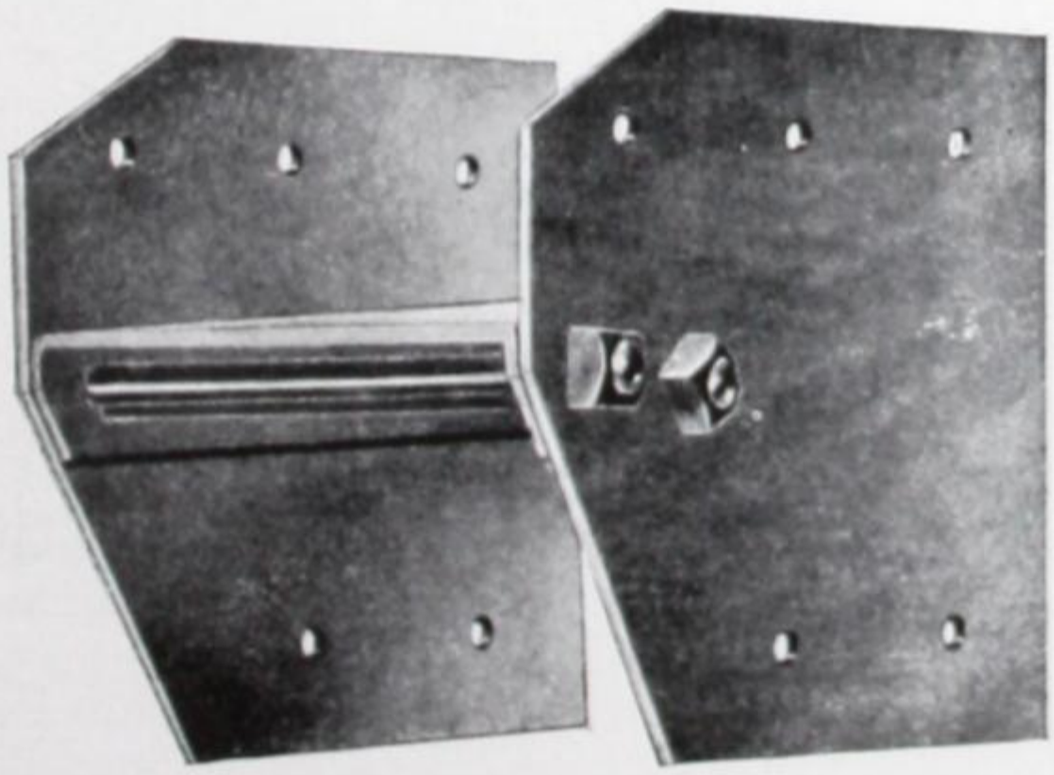


No. 34—Four-Way Post Cap



No. 35—Four-Way Post Cap, Offset

indicating a cap to carry two 14-inch girders and two 10-inch girders on a 10 x 10-inch post.



No. 36—One-Way Post Cap

The one-way cap is shown by No. 36 above, illustrated to carry one 12-inch girder on a 12-inch post.

Shipping Weights of Two-Way Duplex Post Caps

Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.	Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.	Size Post, In.	Size Girder, In.	Off-set, In.	Ship. Wt., Lbs.
6 x 6	6	0	30	10 x 10	12	1	57	14 x 14	18	2	140
6 x 6	8	1	31	10 x 10	14	2	69	16 x 16	16	0	155
6 x 6	10	2	34	12 x 12	12	0	72	16 x 16	18	1	160
8 x 8	8	0	35	12 x 12	14	1	76	16 x 16	20	2	168
8 x 8	10	1	36	12 x 12	16	2	84	18 x 18	18	0	160
8 x 8	12	2	40	14 x 14	14	0	124	20 x 20	20	0	220
10 x 10	10	0	52	14 x 14	16	1	132				

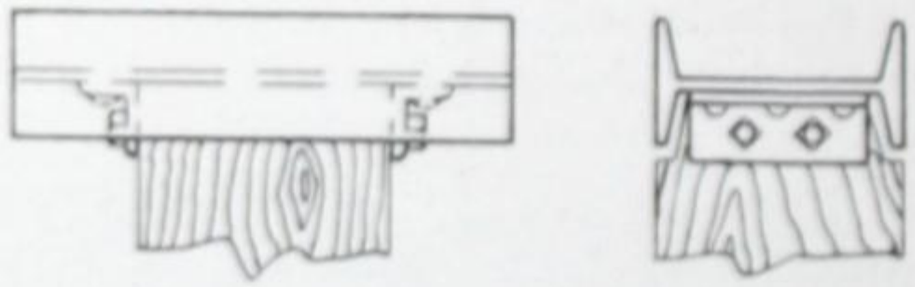
For three-way caps, add 25%. For four-way caps, add 50%. Bent-in caps should be estimated same as offset. Weights include bolts.

MISCELLANEOUS POST CAPS

Very serviceable and low priced post caps can be made up of standard channel, I-beam and angle sections as illustrated. The different parts are rivetted together as shown. Hundreds of them are sold for building construction in all parts of Western Canada. The angles form the post cap and the channel or I-beam carries the girder. Post caps of this description can be made of any size up to the limit of

Side View End View

No. 37—Steel Post Cap—Channel and Angles Rivetted.



Side View End View

No. 38—Steel Post Cap.—I-Beam and Angles Rivetted.

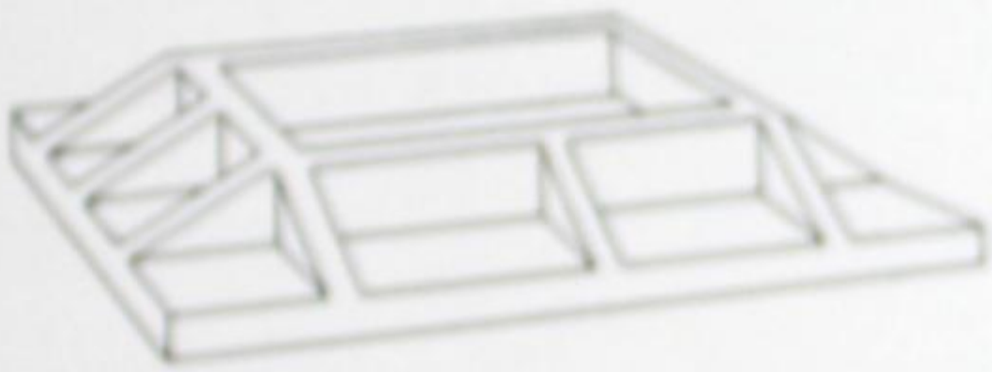
size of standard rolled sections of I-beams and channels. The angles are spiked to the post and the channel or I-beam is spiked to the girders. The girders should be securely fastened together lengthwise with iron straps or dogs. As we always carry a large stock of all sizes of I-beams, channels and angles, steel post caps of this kind can be made up very readily of any required size and shipped promptly. They are sold either at so much per 100 lbs. or at a stated price for any number required. Size of post and of girders should be given when writing for prices.

POST BASES

Both steel and cast iron bases are used for timber posts. The most commonly used styles are illustrated but other types of bases can be made up if desired.

No. 39—Steel Post Base

The illustration above shows a steel post base made up of a plate of angles all riveted together and properly finished off. These bases can be made up for any size of post and will be shipped promptly. Prices on application.

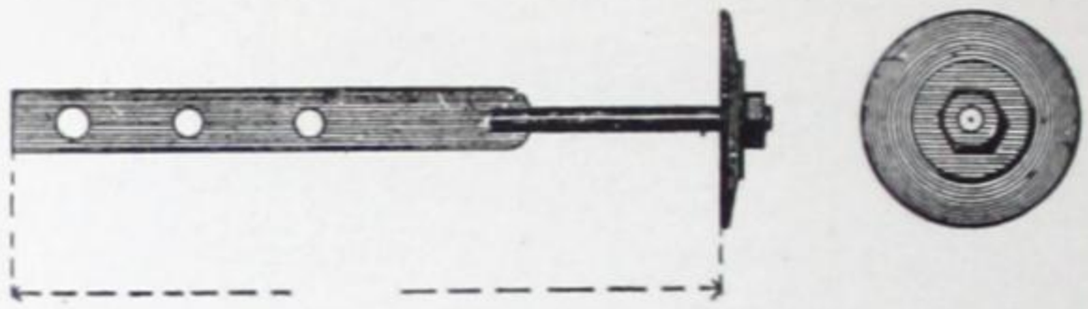


No. 40—Cast Iron Post Base.

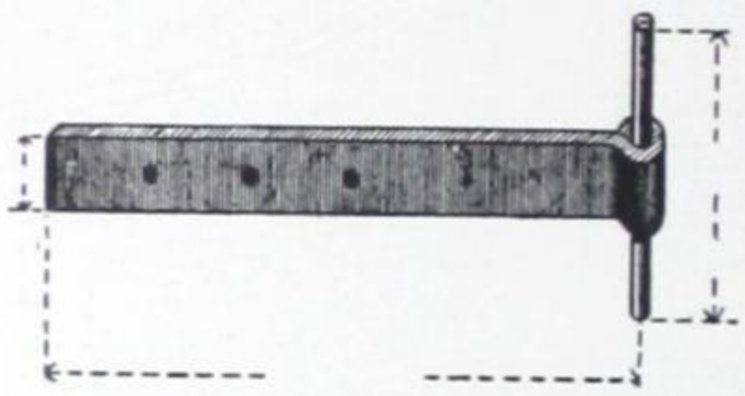
We have on hand a large number of patterns from which castings can be made for cast iron post bases. No. 40 above shows one type for square wooden columns or posts. Any style can be made up on short notice in our foundry, and shipment made promptly. Give sizes of posts when ordering, and specify whether round or square. Prices on application.

JOIST ANCHORS AND BEAM TIES

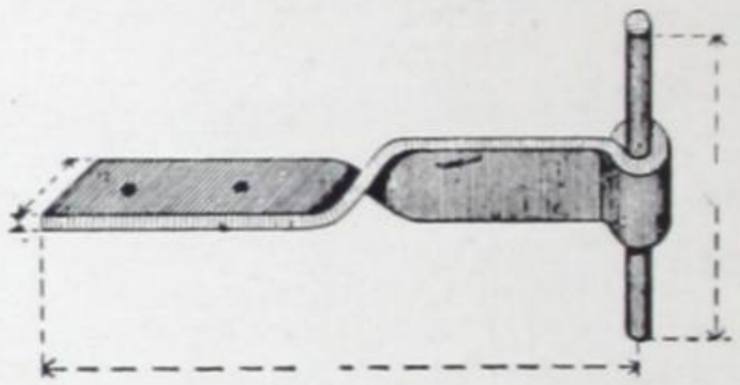
Several styles of joist anchors and dogs, beam anchors and ties are illustrated herewith. We can supply any style desired in these lines.



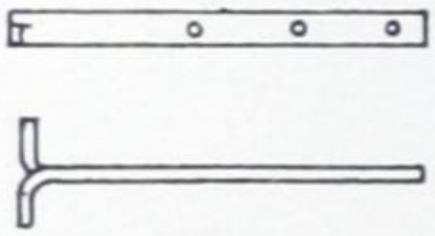
No. 41—Wrought Iron Joist Anchor with Round Face Plate.



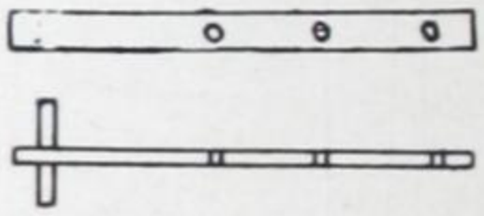
No. 42—Wrought Iron Joist Anchor with Pin.



No. 43—Wrought Iron Joist Anchor with Pin

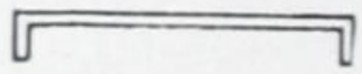


No. 44—Wrought Iron Joist Anchor with Split End.



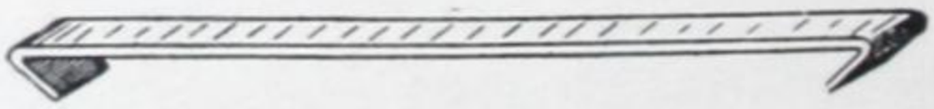
No. 45—Wrought Iron Joist Anchor with Pin.

No. 41 shows a joist anchor for use on either side or top of joist. Nos. 42 and 43 are used fastened to side, and Nos. 44 and 45 fastened to top of joist.



No. 46—Wrought Iron Dog.

The wrought iron dog shown above is used for connecting joists or beams.



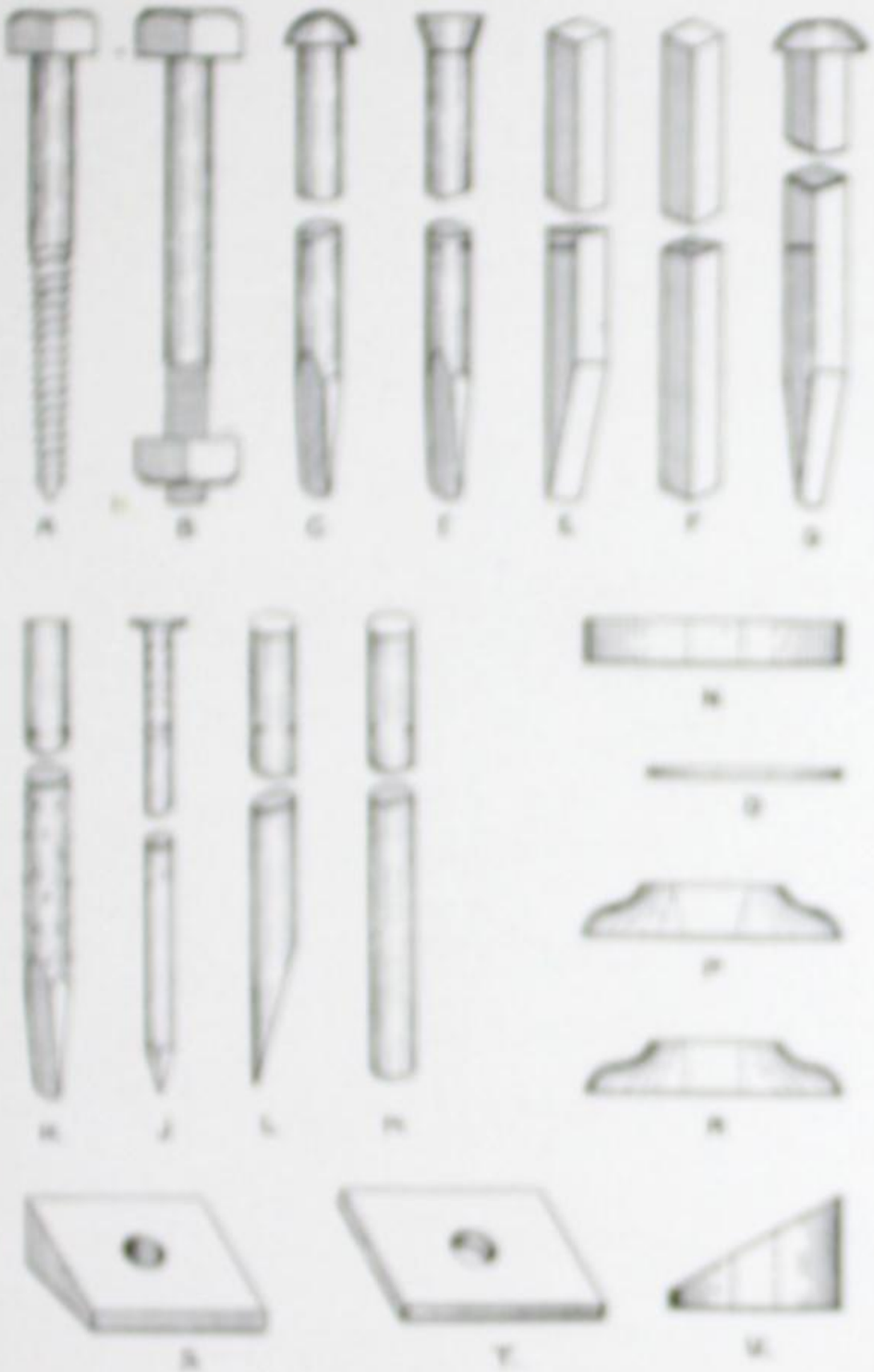
No. 47—Wrought Iron Tie

No. 48—Wrought Iron Pin Anchor

The tie and anchor illustrated above are for use with I-beams.

When ordering give dimensions, and number and size of holes wanted. Estimates for quanity orders will gladly be submitted.

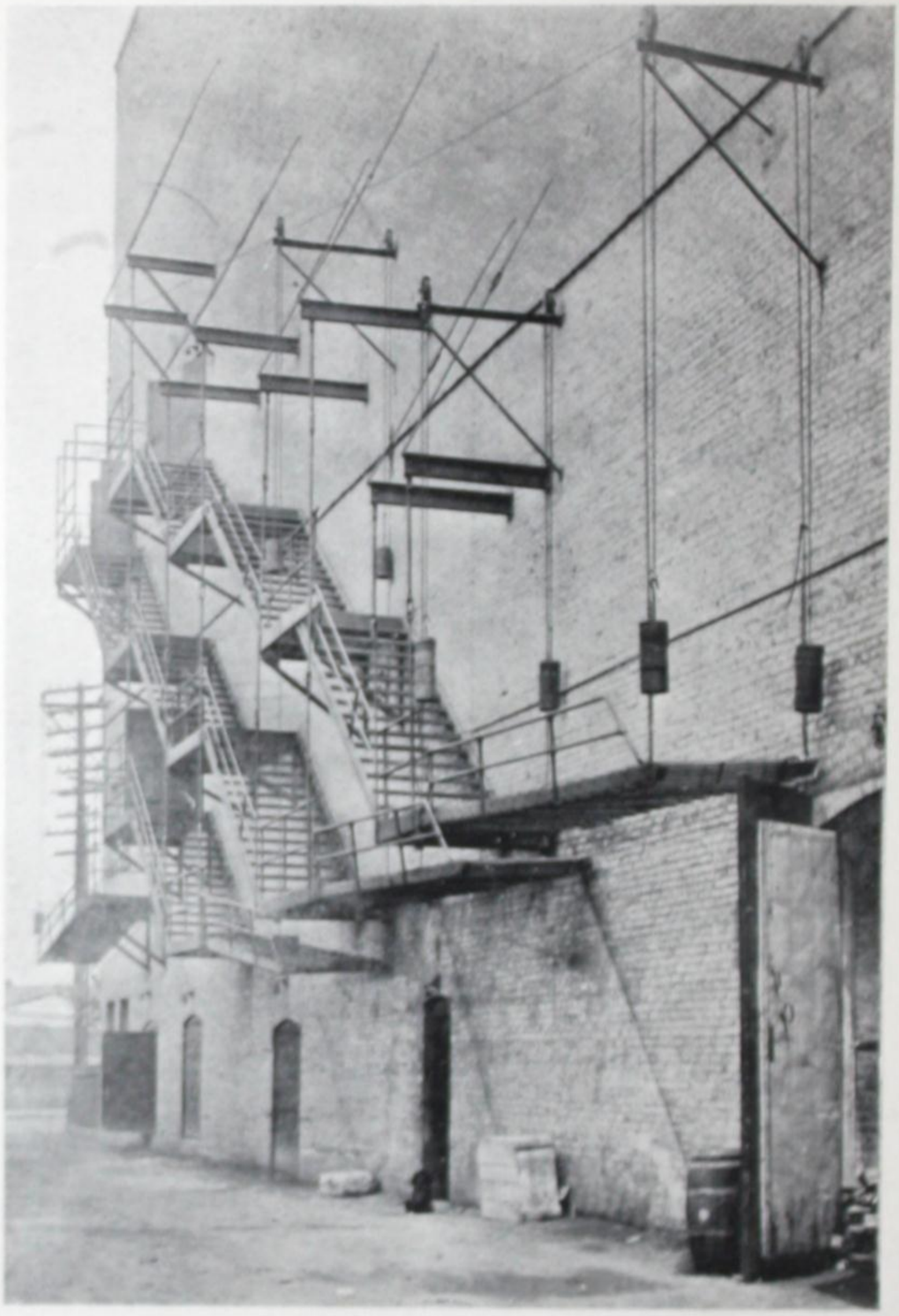
BRIDGE BOLTS



No. 48

A—Lag screw.
B^{s}_{n}—Bridge bolt; square head and nut.
C—Button head, wedge point, drift spike.
D—Countersunk head, wedge point, drift spike.
E—Square, shear point, drift spike; without head.
F—Square dowel pin.
G—Pressed or ship spike.
H—Ragged drift spike, wedge point; without head.
J—Wire spike.
L—Round, shear point drift spike; without head.
M—Round dowel pin.
N—Cast iron, flat separator or washer.
O—Ordinary pressed, steel plate washer.
P—Cast iron bridge washer with taper hole for flat or countersunk head spike.
R—Regular pattern, cast iron bridge washer.
S—Square, cast iron, angle or bevel washer.
T—Square, steel plate washer.
U—Round, cast iron, angle or bevel washer.

NOTE—In ordering from above list care must be taken to specify length, diameter, style of head and point, thickness of washer, size of hole, degree of angle, and whether washer is round or square.



No. 50—Fire Escape at Rear of Theatre, Showing Lower Stairs Strung with Counterweights.

NOTE—When fire escapes other than those illustrated in this section are required, sketches and measurements showing how they are to be made up must be forwarded to us before we can quote prices or manufacture the escapes.

FIRE ESCAPES

A modern fire escape consists of one or more balconies or landings securely fastened to the wall of a building opposite some convenient exit, either door or window, with a stairway so placed that the occupants of the building can reach the ground in safety from any balcony in case of fire. The fire escape, including stairs and ladder, should be constructed of steel, wrought iron or a combination of both. Fire escapes may be plain or as ornamental as required. In every case the balconies or landings, with their supporting brackets, should be strong enough to carry safely as many people as can be crowded on to them. It is customary to provide a ladder extending from the topmost balcony to the roof. At the lowest balcony a drop stairway is usually provided, which may be kept off the ground when not in use. Stairs with counterweights are shown by No. 50. The counterweight is enclosed in a pipe to prevent possibility of accident.

Our Standard Fire Escape, designed to conform to by-laws of the city of Winnipeg, is the most serviceable and least expensive on the market to-day. Several hundred have been sold during the past few years. The balconies consist of steel angle frame work with flat steel strap floor, carried on strongly-made steel brackets. Either ladder or stairs may be provided, as required. The ladders are well made, and if properly attached to wall will safely carry as many people as can get on them at one time. The stairs have steel channel or bar strings, with bar treads, no risers.

Balconies and stairs may have either angle railings or pipe railings. Angle railings are the least expensive and being made of steel will, if properly painted, last as long as any othe. kind. When fire escapes are ordered we will always furnish steel angle railings to both stairs and balconies unless otherwise instructed.

These fire escapes are shown by Nos. 50 and 51. We sell these standard fire escapes f.o.b. Winnipeg, made up with all fittings ready for erection.

When ordering or asking for prices on fire escapes it is necessary for us to have the following information:

A—Length and width of balcony.

B—Whether angle or pipe railing is required.

C—Location of stair or ladder opening in floor or balcony; whether at right, left, or in centre.

D—Number of lineal feet of ladder.

E—Whether opening in floor for stand pipe is to be provided or not.

F—Whether ladder or stairs are required.

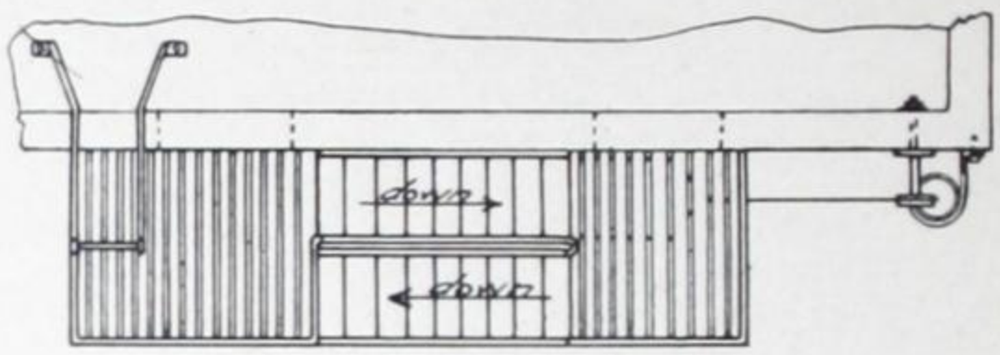
G—Whether ladder is to be attached to wall or to outside of frame work of balcony.

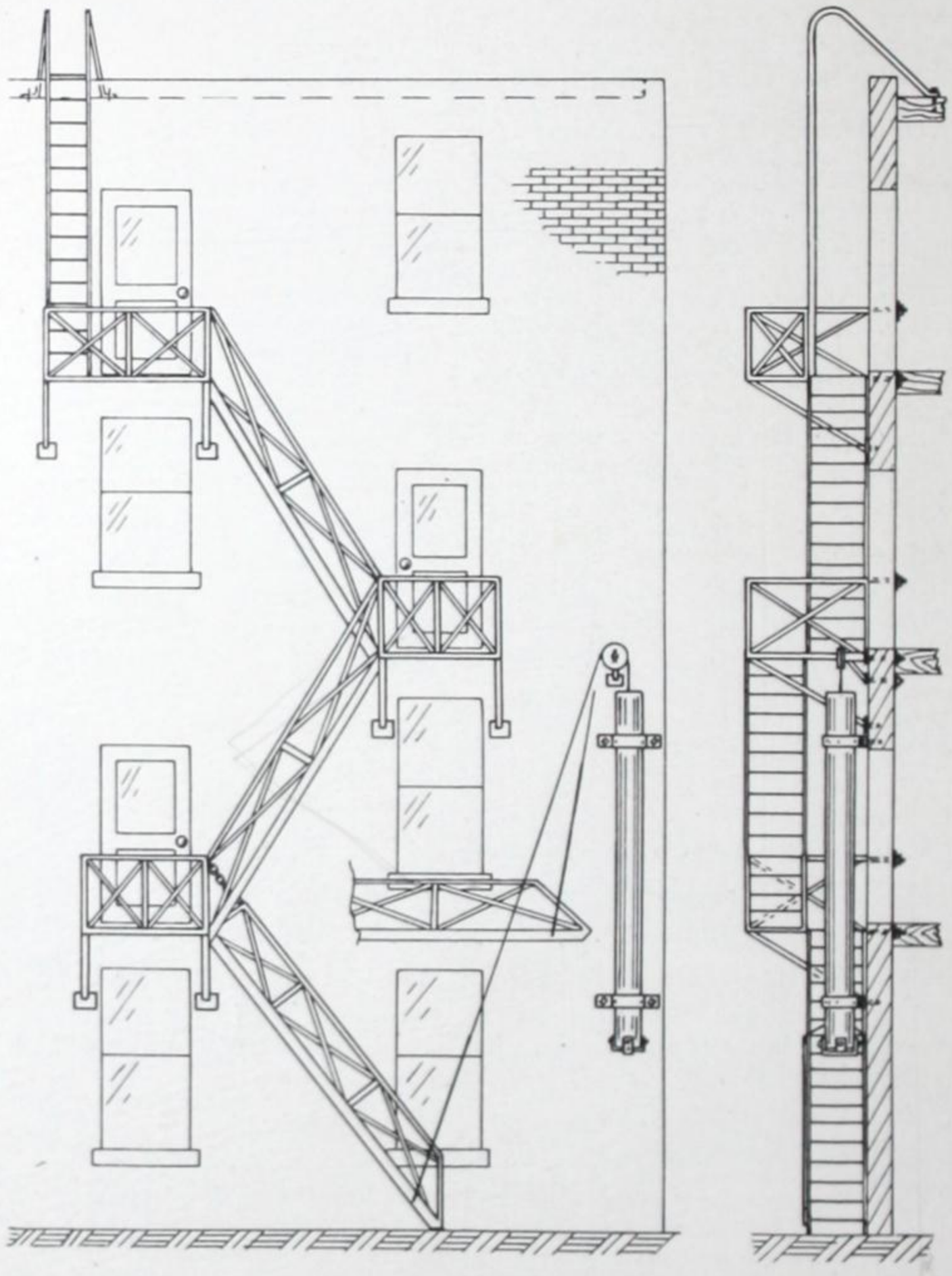
H—Thickness of wall at each landing, so that we may know what length to make the bracket bolts.

I— Width and height of parapet on roof, if any.

J—Projection and depth of cornice, if any.

K—If stairs are wanted, always give the "rise" and the "run". By "rise" we mean the vertical height from ground level to floor of lowest balcony or vertical height from the floor of each balcony to the floor of the one above. The "run" means the length of base of a triangle of which the stairs form the diagonal or longest side. Considering any flight or section of stairs, the stairs themselves would be one side (diagonal) of a triangle, the "rise" would be the vertical side and the "run" the base. These measurements should be given as correctly as possible to avoid mistakes.





No. 51—Standard Fire Escape, with Stairs

Specifications for this fire escape may be found on page 102.

CHUTE FIRE ESCAPES

No. 52—Chute Fire Escape

Chute fire escapes are used very commonly for country schools, their advantage over the ordinary stair type for children being obvious.

The illustration at the left, No. 52, illustrates a chute fire escape actually installed on a Manitoba school.

The top balcony is of the usual fire escape type, while the chute is constructed of twenty-gauge galvanized iron, rolled over a one-inch gas pipe and supported at intervals with flat bar brackets.

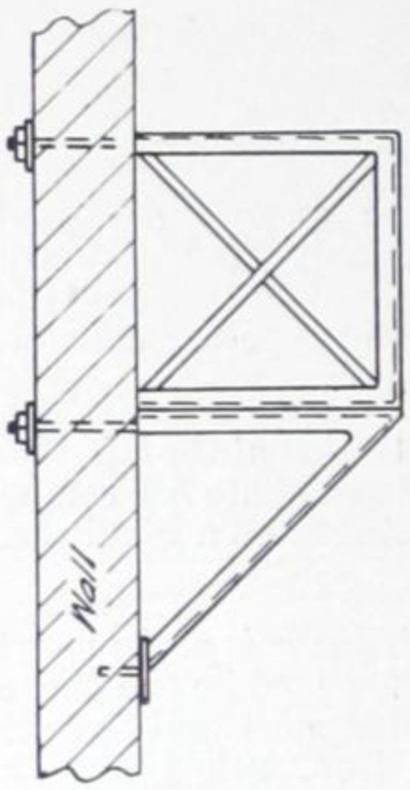
The inside of the chute and the rods are made perfectly smooth, and all corners are rounded.

The slope of the chute is usually 8 inches in 12 inches and at the bottom is a horizontal section about six feet long, two feet above the ground, being supported on four pipe standards. This straight section decreases the speed of the children sliding down and allows of adults standing at side to help the children clear of the escape as they come down.

Sometimes the bottom section of the escape is made with a hinged section and counterweight as shown on the right in illustration No. 53.

No. 53—Chute Escape with Counterweight

FIRE ESCAPE SPECIFICATIONS



No. 54—Showing End View of Balcony

STANDARD STYLE

Balcony

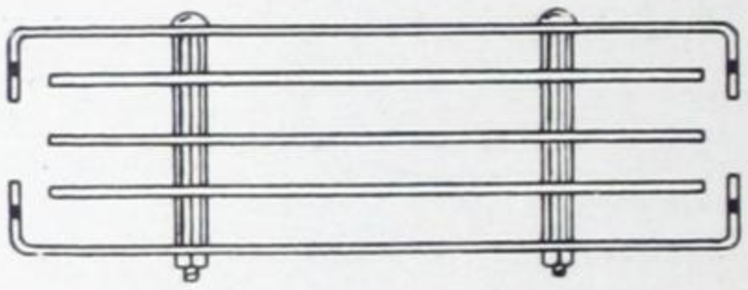
Steel angle frame-work; flat steel strap floor, rivetted.

Brackets

Steel angles and bolts through wall.

Ladders

Side bars, 1½ x ⅝-inch steel; rungs, ⅝-inch square bars.



No. 55—Detail of Standard Tread

Treads

Made of 1¼ x ¼-inch bars. The advantage of these treads is that no snow or ice will lodge in them; thus they are non-slip. This is the only type of tread now approved by by-laws for outside fire escapes.

CHUTE STYLE

Chute

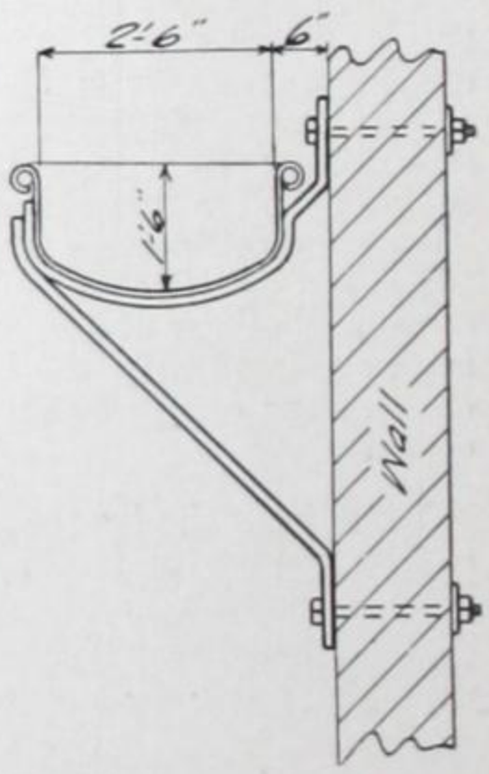
Galvanized iron construction, 20-gauge.

Brackets

Flat bars, 3 x ⅝-inch; ¾-inch bolts through walls.

Chute Beading

1-inch gas pipe with galvanized iron rolled over and soldered.

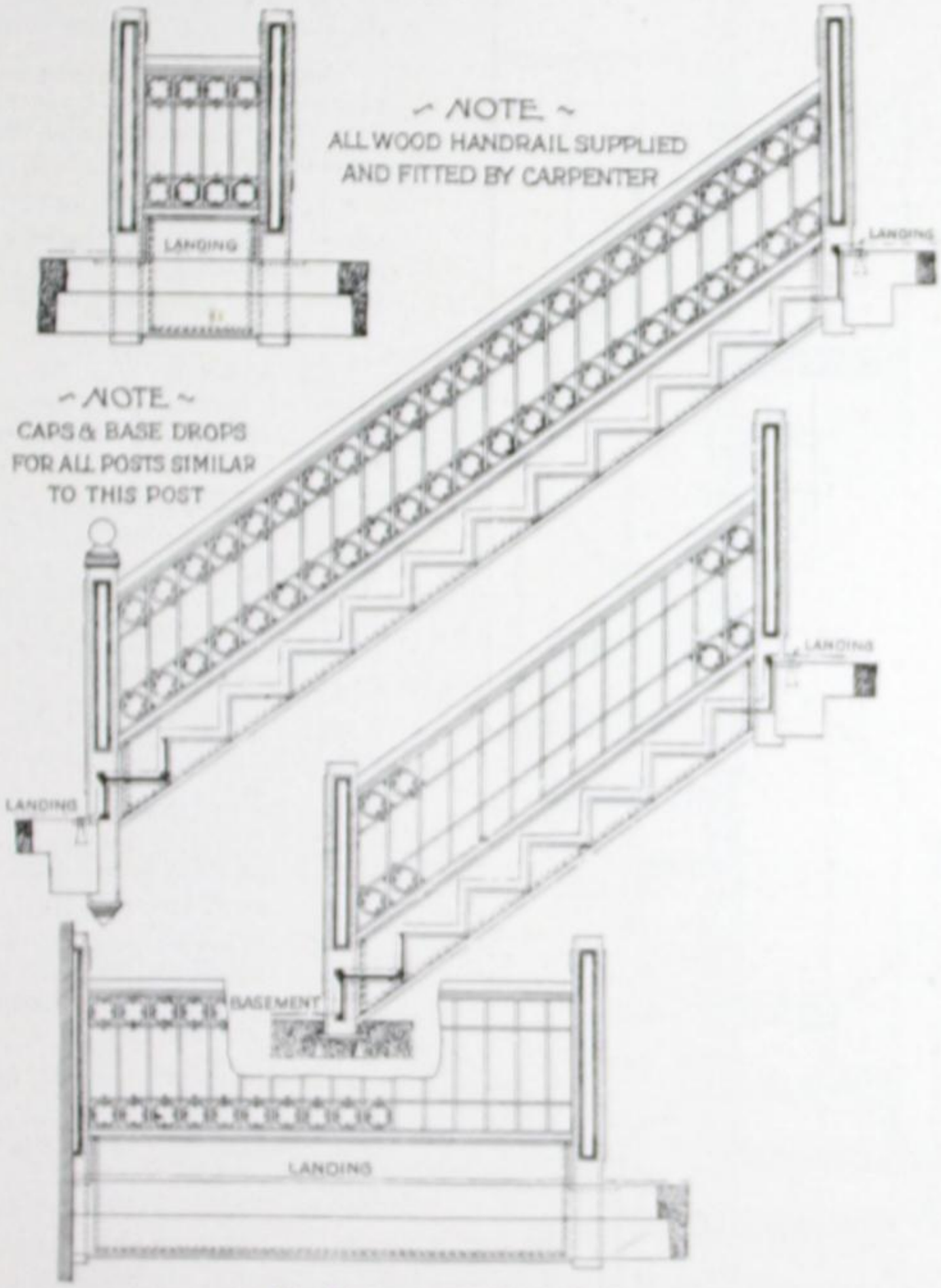


No. 56—Section of Chute Fire Escape

All fire escapes are assembled and properly fitted in our shops before shipment, and mistakes are not often made through any fault of ours. Workmanship is first-class.

STEEL AND IRON STAIRS

In municipal buildings, hotels, apartment houses, theatres, churches, office buildings, etc., interior stairways should be made of steel or iron or a combination of both, because of their fire resisting qualities.



No. 57—Ornamental Iron Stairway

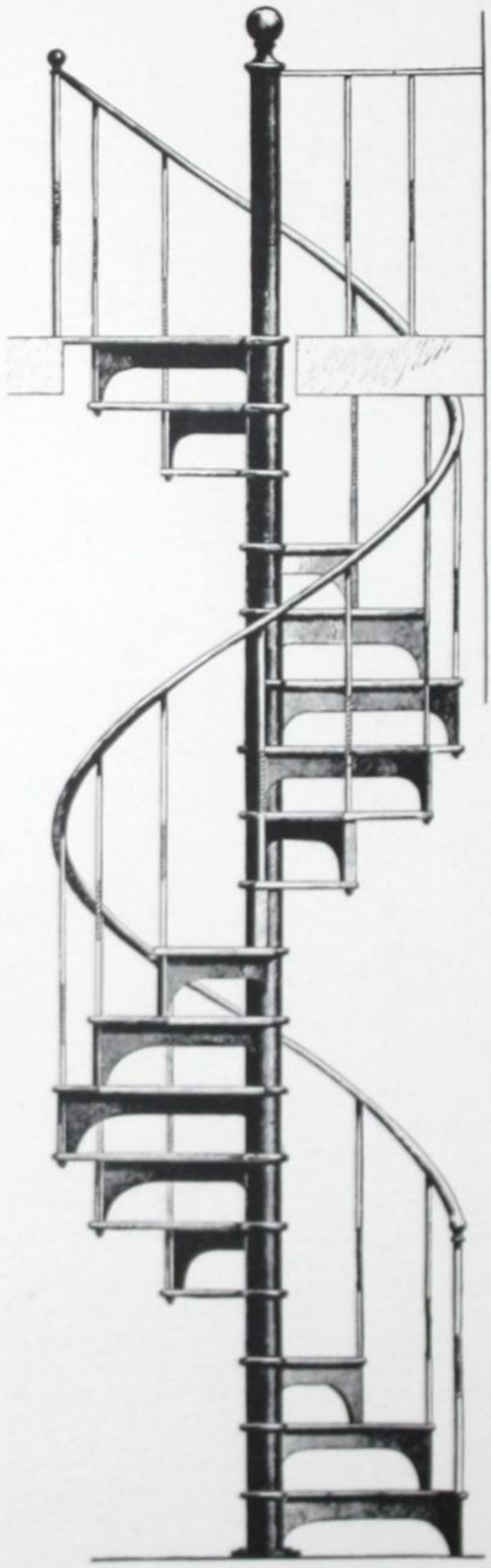
The design above illustrates our standard type of ornamental iron stairway. Posts or newels are cast iron, panelled. Stringers, both wall and well, are cast iron or steel with exposed surfaces panelled; risers, well castings and curbs are of cast iron or steel, with exposed surfaces panelled; balustrade is wrought iron. As the treads are usually made of slate, stone or marble, metal treads are not furnished unless ordered.

Dimensions of standard stairways are as follows:

Width of stairs, 4 feet.
Width of tread, 10 inches.
Height of riser, 7 inches.
Height of balustrade, 27 inches.
Width of stringer, 12 inches.
Width of well casing, 12 inches.
(varies with thickness of floor)

SPIRAL STAIRS

Where space is limited and it is necessary to have means of communication between two or more floors, spiral stairs, made of pipe and cast iron, are often used.



No. 58—Interior Spiral Stairway.

The illustration on the left depicts one type of stairs we make.

The width of the stairs can be made anywhere from 36 inches to 72 inches, while the spiral may be right or left hand.

Landings can be provided anywhere, but, in this type of stairs, are usually limited in size to two treads, or in very exceptional cases, to three.

The center, or carrying post is made of standard wrought iron pipe, fitted with floor plate at bottom and ball cap at top.

Treads, in most cases, are corrugated cast iron, but can be made lead-filled cast iron, the cost in the latter case being much higher. Information concerning and description of lead-filled treads may be found on page 106.

The following information should be given when ordering:

A—Total height of stairs

B—Distance from finished floor to finished floor, each storey.

C—Whether post is to extend to ceiling; or, if not, how far above top landing.

D—Width or diameter of stairs.

E—Size of well or floor openings.

F—Whether spiral is right or left hand.

We have many other designs of spiral stairways besides that shown on the left; these designs will gladly be supplied to our customers without charge. We have patterns in stock which will enable us to make up these stairs within a few days after receiving order.

Shipping weights range from 44 to 120 lbs. per foot for spiral stairs from three to six feet in diameter.

IRON CRESTINGS

Iron crestings are used as decorative material for deck roofs, walls and copings. Besides the designs of crestings shown on this page, many other styles can be made up at reasonable cost. Corner finials for any design are obtainable at small additional expense.

No. 59—Weight per lineal foot, 8.4 lbs.

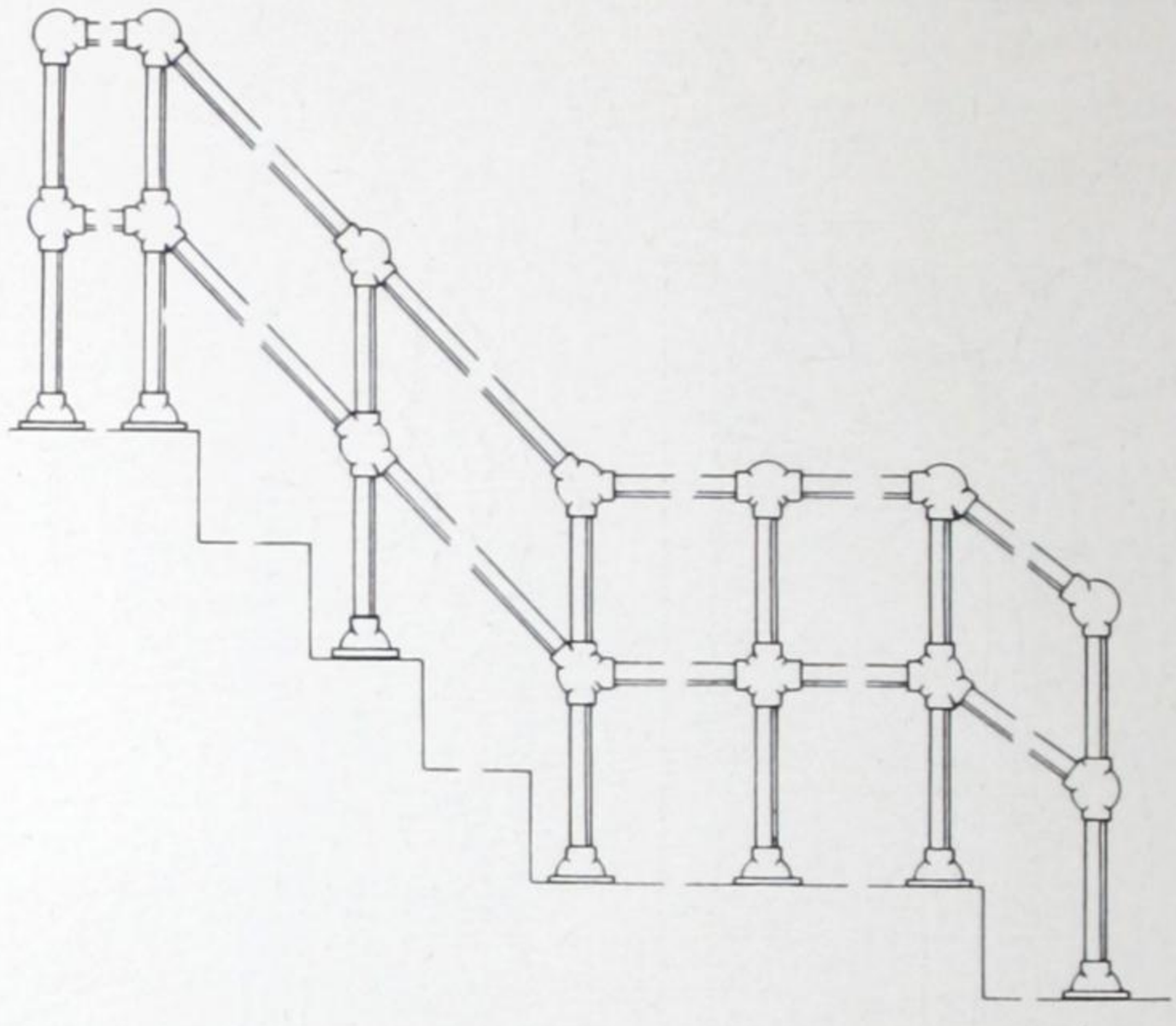
No. 60—Weight per lineal foot, 3 lbs.

No. 61—Weight per lineal foot, 6 lbs.

No. 62—Weight per lineal foot, 9 lbs.

PIPE RAILINGS

We make up pipe railings of all sizes for concrete stairs, area railings, etc. These are fitted up complete before shipping.

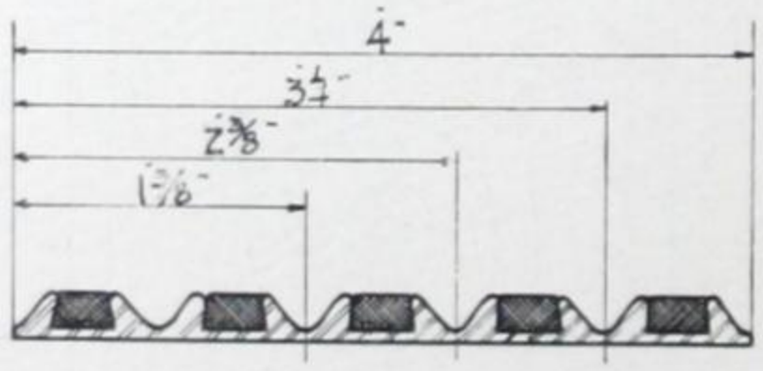


No. 63—Pipe Railing Equipped with Ball Fittings.

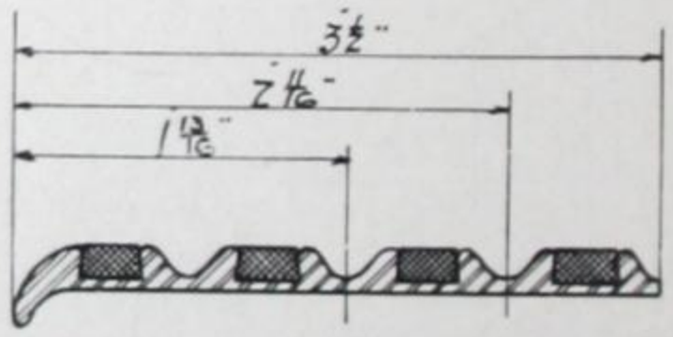
We use ball fittings in making up railings; the different angles of fittings are illustrated above. Our large variety of patterns enables us to furnish railings. fully fitted-up, that will cover all requirements and specifications.

SAFETY TREADS

Lead-filled safety treads for use on concrete steps can be supplied to customer's measurements. These treads are highly durable and afford secure footing in every

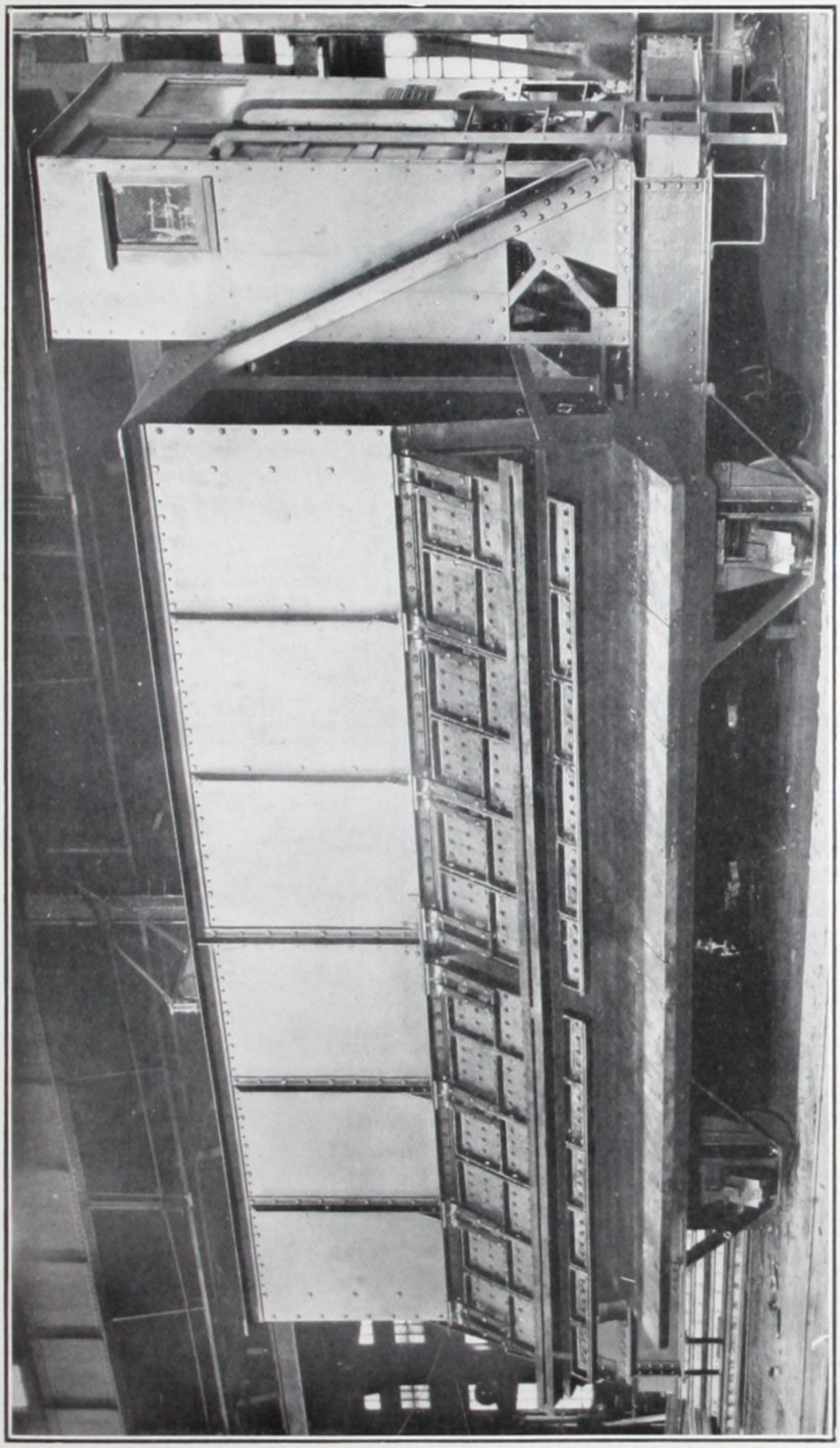


No. 64—Safety Tread



No. 65—Safety Tread with Nosing.

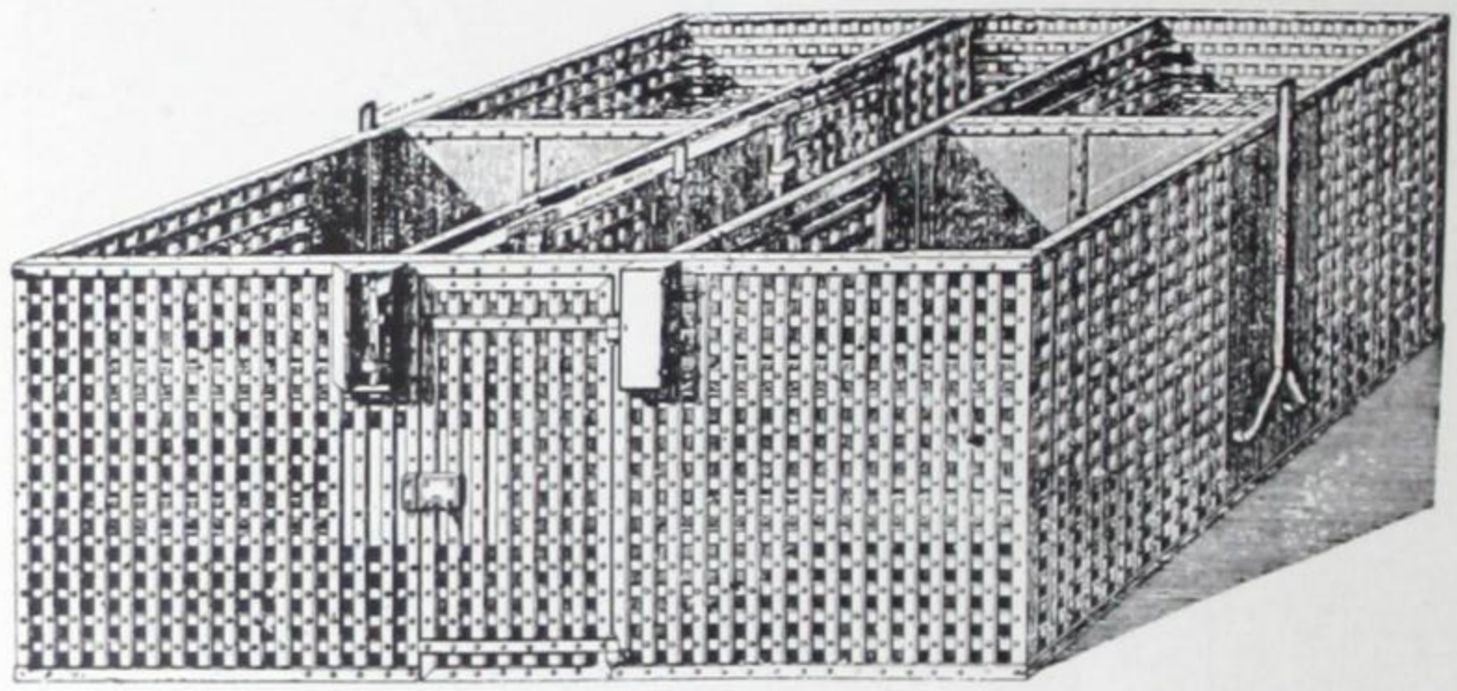
weather. They may be had in depths as indicated in the accompanying diagram, plain or with nosing.



No. 66—Coke Quenching Car built by us for and to the design of the Atlas Car Co., Cleveland, Ohio, for the Winnipeg Electric Company.

JAIL EQUIPMENT

We will be pleased to enter into correspondence with towns, villages or municipal offices interested in jail and cell fittings.

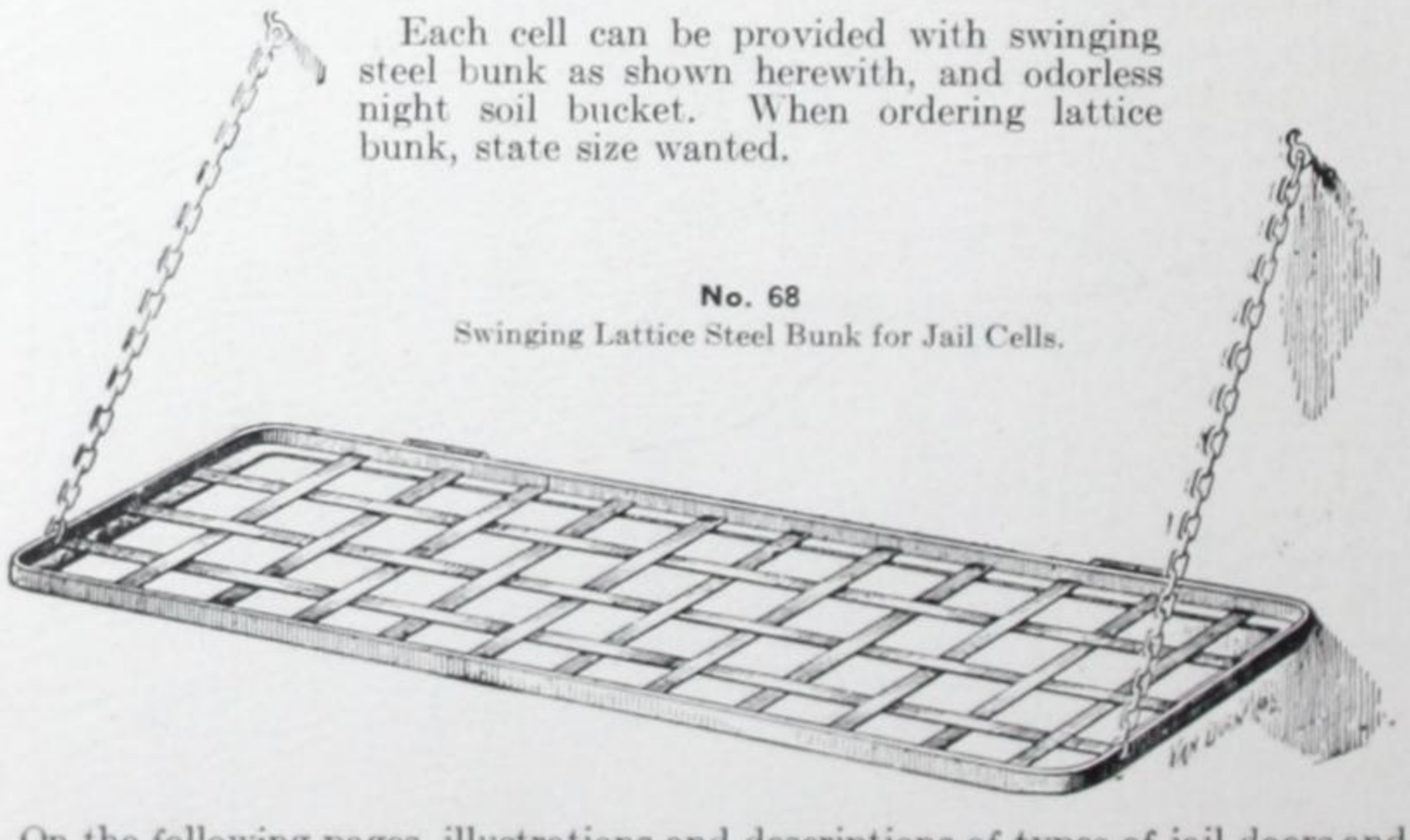


No. 67—Steel Lattice Jail Cells

Above is shown a block of four steel lattice cells with corridor. These cells are usually made of 1½ x ¼inch or 1½ x $\frac{3}{16}$ inch steel bars, with spaces about 4½ inches square, securely riveted wth heavy rivets at all intersections. The frames are formed of 1¾ x 1¾ x $\frac{3}{16}$ inch steel angles. Roof can be lattice work same as front, and sides of solid steel plate. Can be made with steel plate floor if desired or to attach to cement or wood floor. Partitions between cells are usually of steel plate lattice work facing corridor. Doors are fitted with improved locks, which afford ample security. All parts are fitted together complete at works before shipment and marked so that any ordinary mechanic can set up the cells without trouble.

We can furnish single cells or blocks of two, four, six or eight cells, with or without corridor. The lattice jail cell is the best medium priced cell made and has given satisfaction wherever installed.

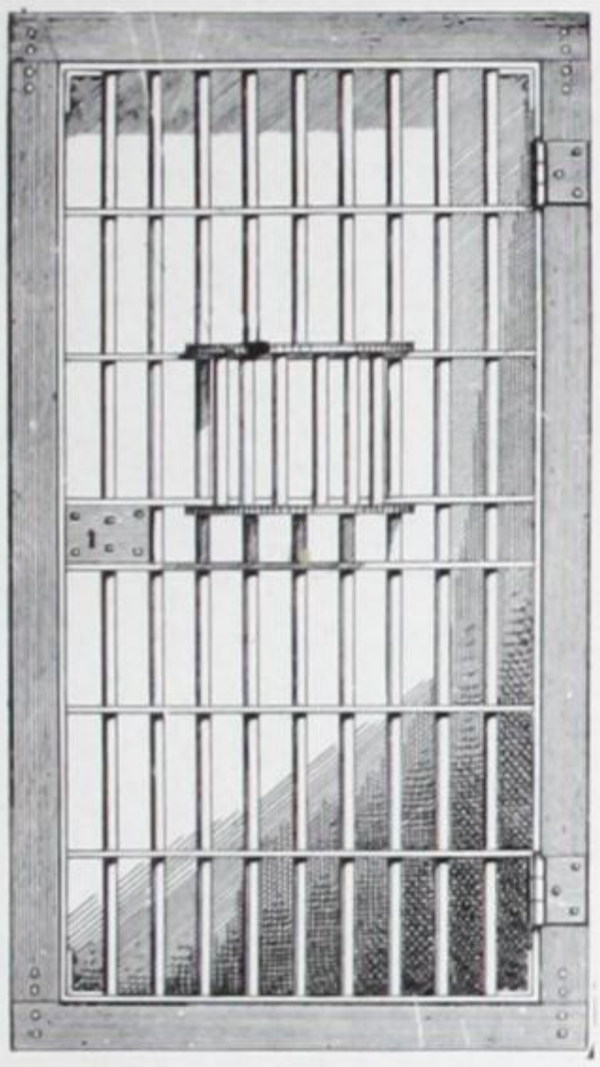
Each cell can be provided with swinging steel bunk as shown herewith, and odorless night soil bucket. When ordering lattice bunk, state size wanted.



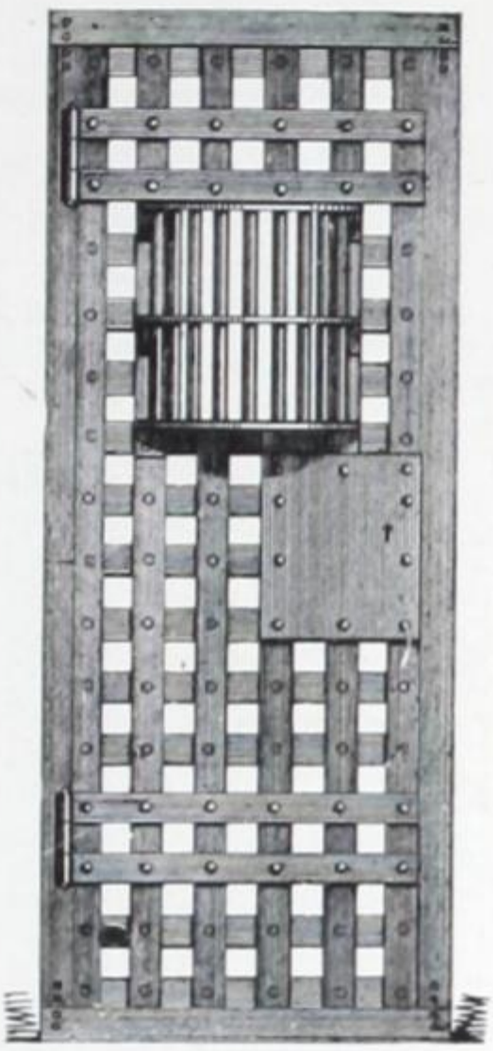
No. 68
Swinging Lattice Steel Bunk for Jail Cells.

On the following pages, illustrations and descriptions of types of jail doors and window-guards will be found. These doors can be constructed as part of the equipment for the jail cells shown above.

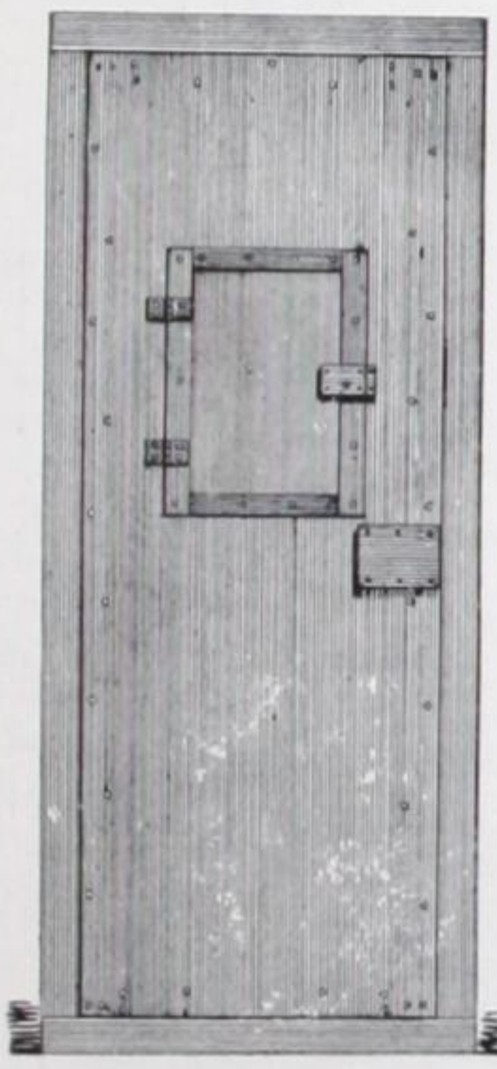
The illustrations on this page show jail doors of steel bar, lattice steel and steel plate construction—the styles of doors generally used for entrance to cell-room or jail building. They can be constructed heavier or lighter as occasion demands.



No. 69

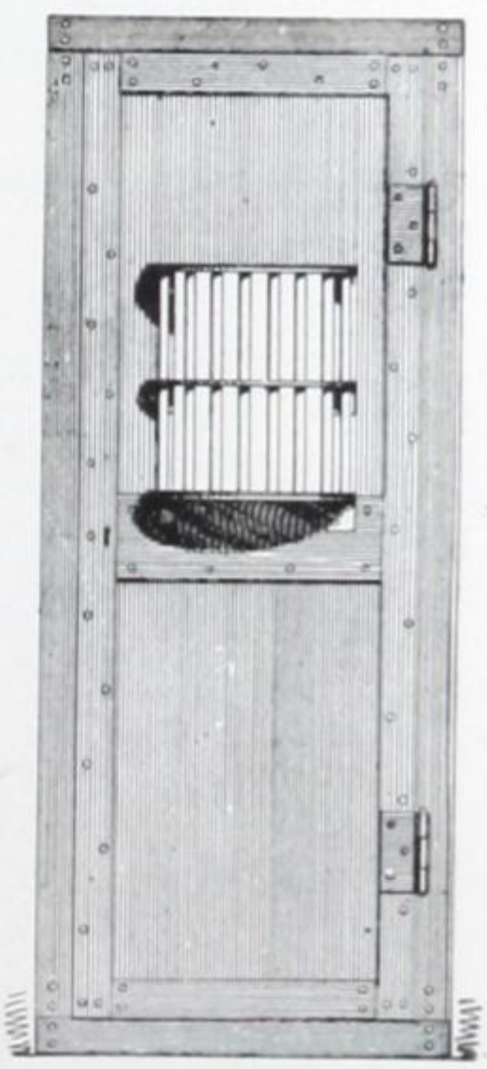


No. 70



No. 71

No. 72



No. 73

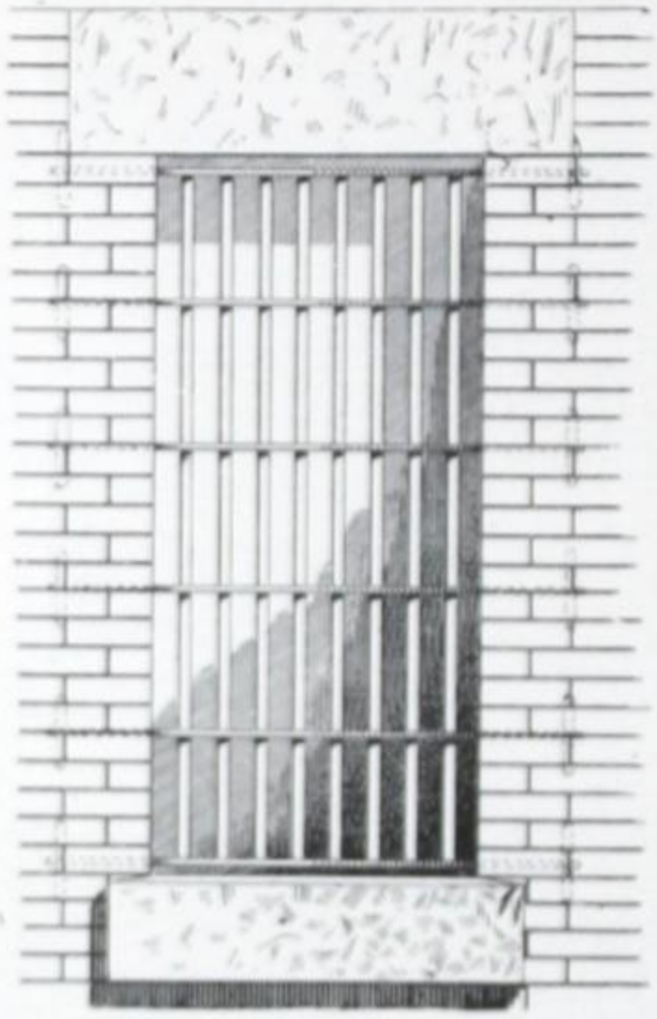
No. 69, above, illustrates a steel bar jail door with round steel vertical bars, 1-inch diameter; horizontal bars 2 x $\frac{3}{16}$-inch; frame, 2 x $\frac{1}{4}$-inch; steel; outside frame heavy steel angle; forged hinges; heavy lock. This style of door can be made to fit any size of opening.

The heavy lattice steel door, No. 70, has steel bars $1\frac{1}{2}$ x $\frac{3}{16}$-inch; open space about $4\frac{1}{2}$ inches square; 2 x 2 x $\frac{1}{4}$-inch angle steel frames into which lattice is

rivetted; forged hinges, steel armor plate around lock as shown; separate angle frame all around, usually wider and heavier than frame to lattice work of door.

Nos. 71, 72 and 73 are types of heavy steel plate jail doors made to fit any size of opening. Usually made of $\frac{3}{16}$-inch or $\frac{1}{4}$-inch steel plate securely riveted to 2 x 2 x $\frac{1}{4}$-inch steel angle frame, extra heavy, forged hinges, separate steel angle frame all around, usually wider and heavier than frame of door.

Steel plate doors can be fitted with observation grating as shown at No. 73, so jailer can see what is going on without opening doors.

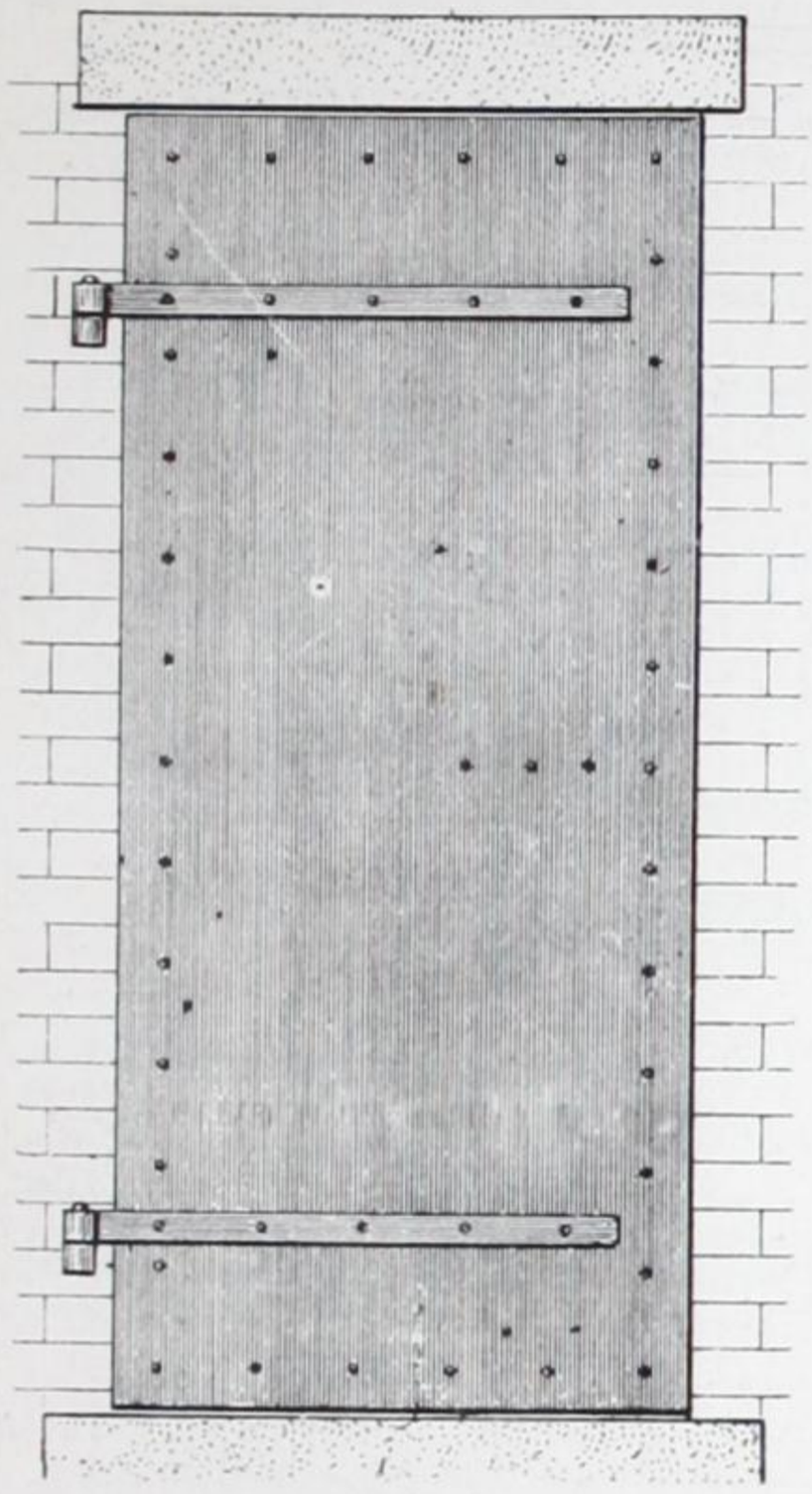


No. 74

No. 75

We can supply window guards, in the styles illustrated above, to fit openings of any size. The guard shown in No. 74 is featured by round steel vertical bars set in heavy horizontal steel bars built securely into the wall, while No. 75 has square steel vertical bars set in heavy horizontal bars securely anchored in the wall. When ordering, give width and height of each clear opening.

Prices on any style of jail or cell fittings will gladly be quoted upon application.



STEEL DOORS AND FIRE SHUTTERS

Steel doors and fire shutters can be made up to any size and in any style. All work is securely rivetted and well finished.

No. 76 represents a sturdy and serviceable type of steel door.

When ordering or asking for prices, give all dimensions and thickness of plates also state if locking bars are wanted.

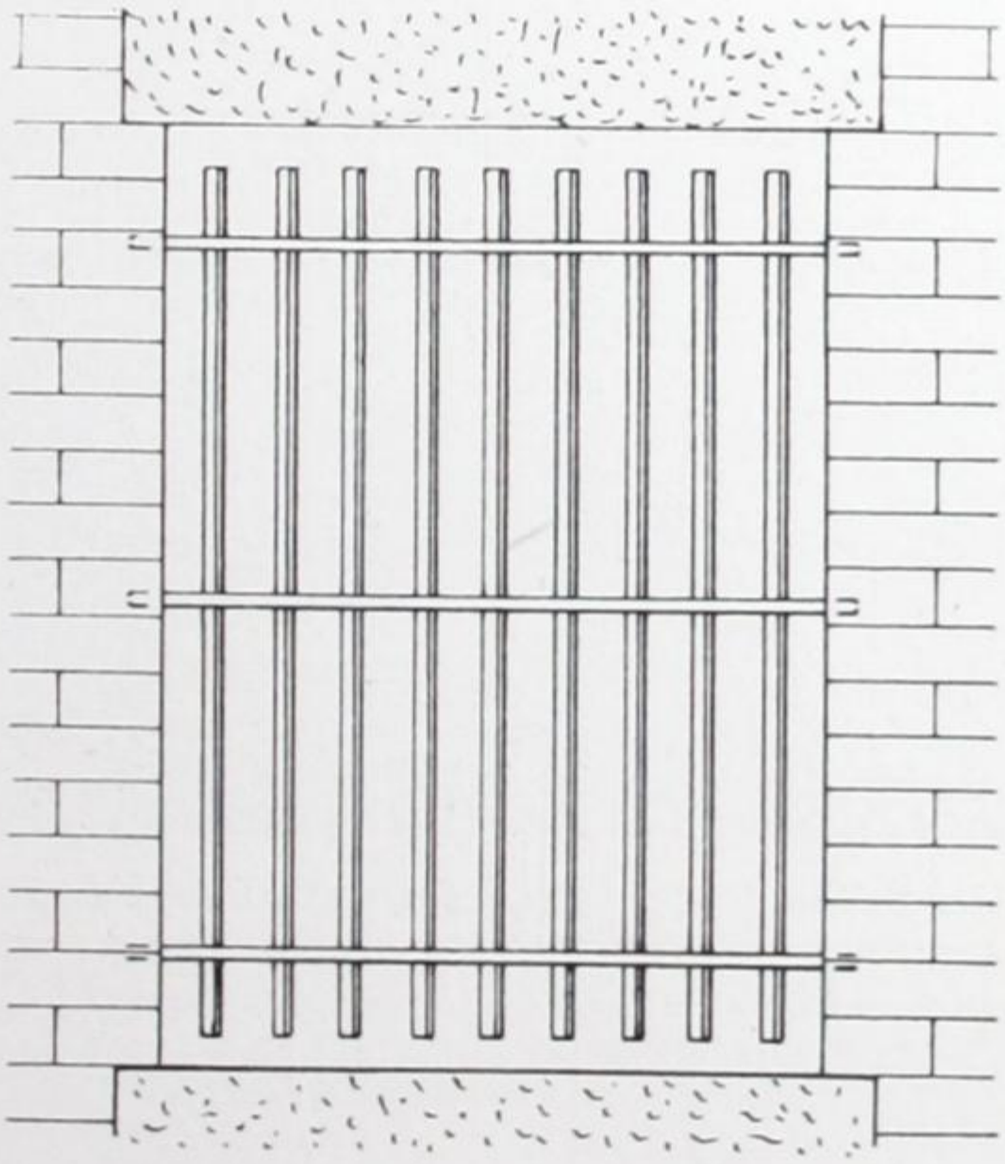
No. 76 (At Left)—Steel Door

WINDOW GUARDS

Steel window guards can be supplied to suit individual requirements.

In the illustration herewith, No. 77, a guard is shown constructed of 1-inch vertical round bars with 2 x ¼-inch horizontal bars.

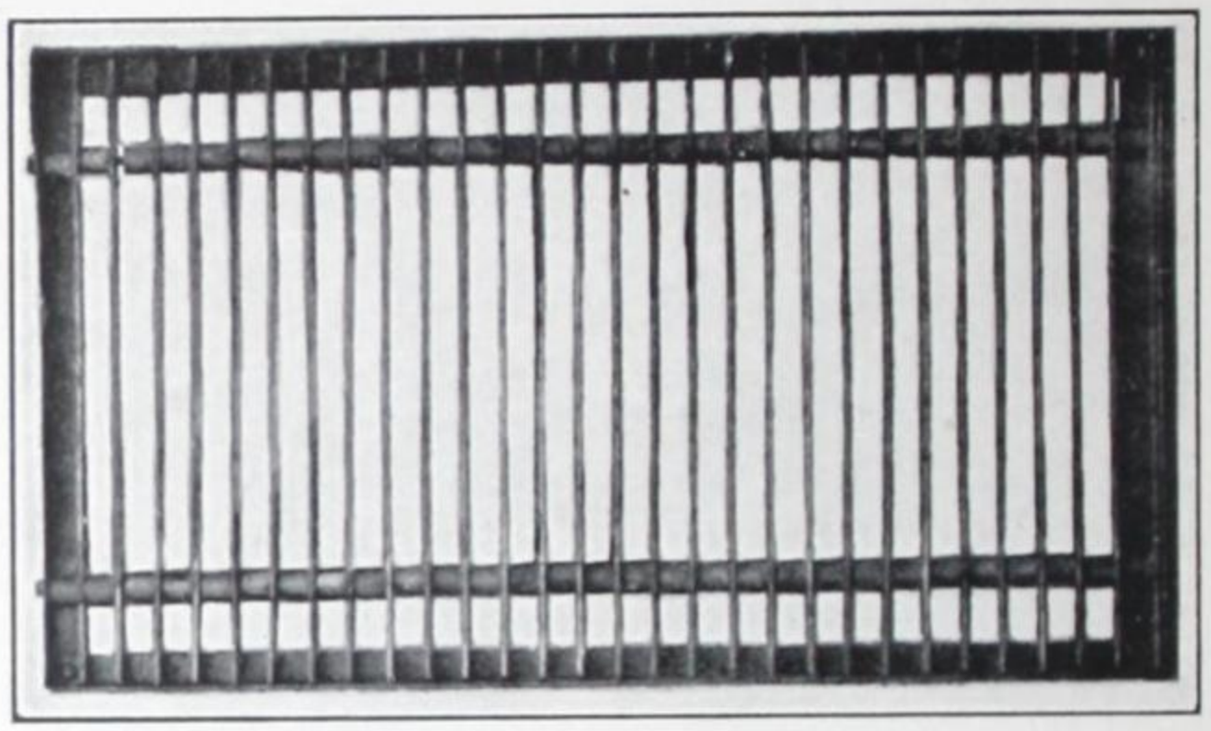
Give width and height of opening when ordering.



No. 77 (At Right)—
Steel Window Guard

AREA GRATINGS

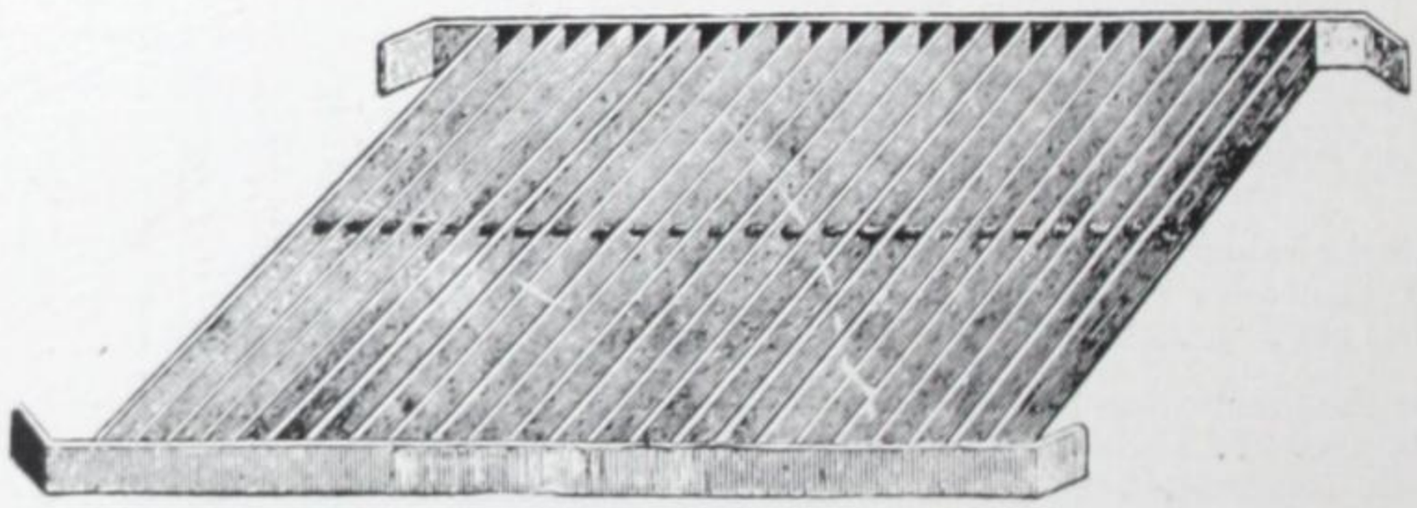
We are able to supply any size of any style of area grating on short notice as a large assortment of flats, rounds and angles are carried in stock for this work.



No. 78—Standard Area Grating.

Our standard side-walk area grating illustrated above, is made up of steel angle frame 1½ x 1½ x $\frac{3}{16}$-inch, riveted at corners; 1¼ x ¼-inch flat bars on edge, spaced at 1½-inch centers with cast iron separators on ⅜-inch round iron rods or bolts. Two of these rods are furnished when grating is three feet or less in width, and when over three feet wide, three or more bolts are used. Weight per square foot, out to out measurements, 14 lbs.

When ordering standard area grating, give length and width overall, allowing 2-inch bearing on all sides; specify whether or not angle frame is desired.



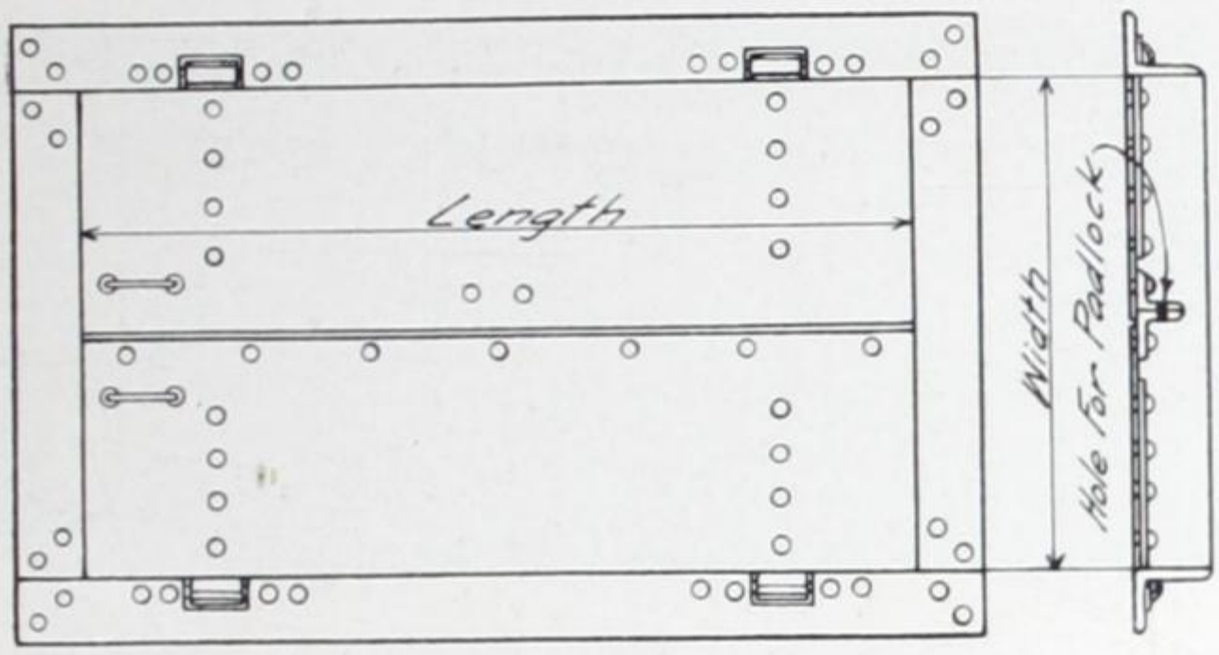
No. 79—Area Grating

Another type of grating is illustrated by No. 79. It is made up of wrought iron slats, fastened to frame at ends; stiffening rod in center.

In writing for prices and discounts, state sizes required and style desired.

SIDEWALK DOORS

Our standard sidewalk door is strongly made and will carry any load likely to be placed on it. It is made of solid steel plates in angle frames, with locking attachment.

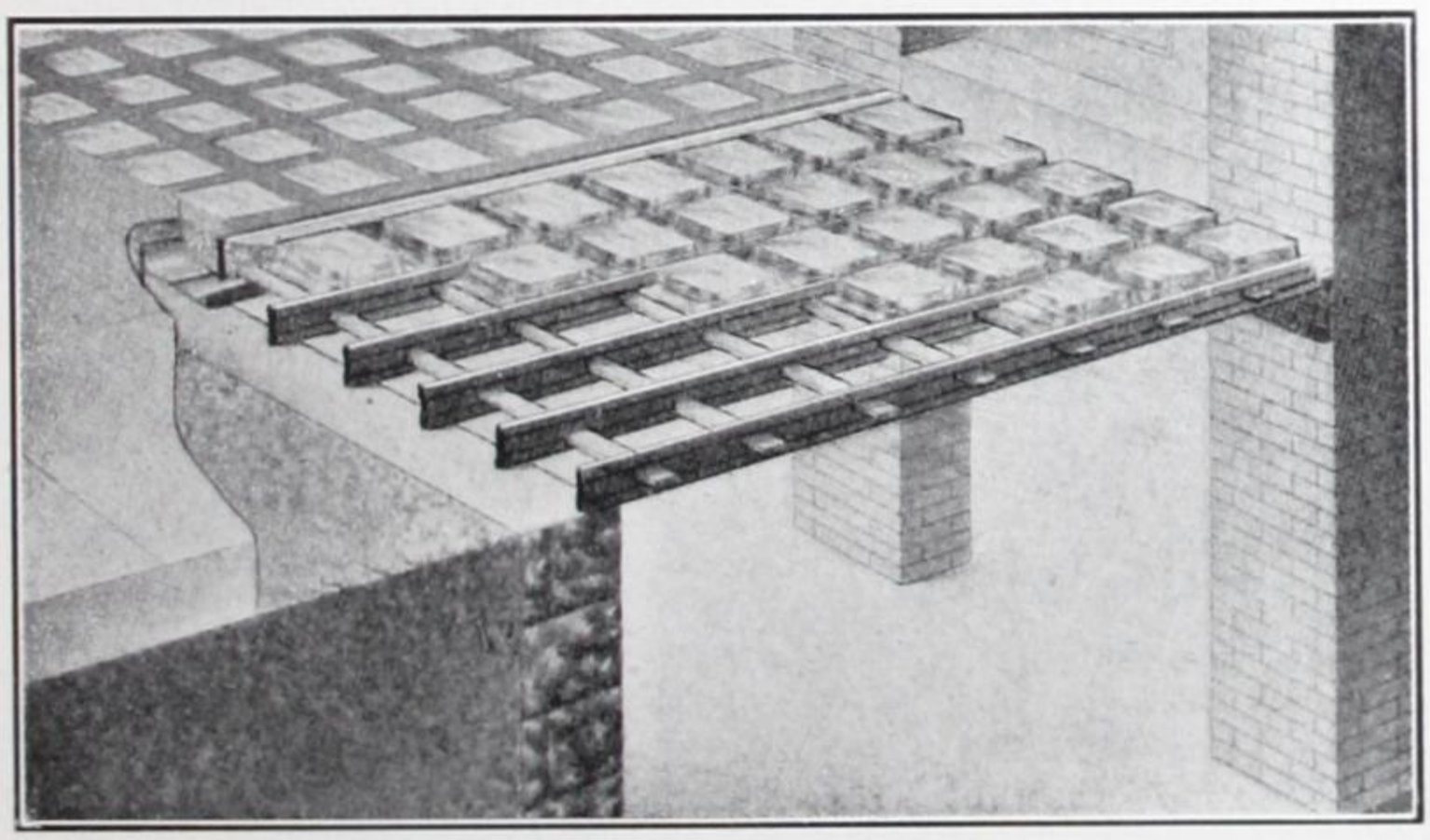


No. 80—Standard Sidewalk Door

Sizes out to out of openings should be specified in orders or requests for estimate; also whether doors are to be in one or two pieces or leaves.

SIDEWALK LIGHTS

Space under a building and adjacent side walk may be made useful by means of sidewalk lights, as shown in the illustration below.



No. 81—Showing the Use of Sidewalk Lights

The lights are carried on wrought steel framework and imbedded in cement, watertight. A bearing of about two inches on the building side and of about the same area on the wall side should be provided; bearing should be 2¼ inches below finish level.

STANDARD WATER STORAGE TANKS

Our standard water storage tanks are tested to 100 pounds hydrostatic pressure and are guaranteed for a working pressure not exceeding 65 pounds per square inch.

No. 82—Standard Water Storage Tank.

Heads are dished to a radius equal to the diameter of the shell; 20-in. to 36-in. diameter tanks are welded throughout; 42-in. diameter tanks have longitudinal and girth seams rivetted, and heads welded.

Tanks can be furnished with manhole or handhole if required. Coils for hot water tanks, see page 116.

Six standard openings as shown above, are included. For larger or smaller openings or for openings located differently than shown, prices will be quoted on request.

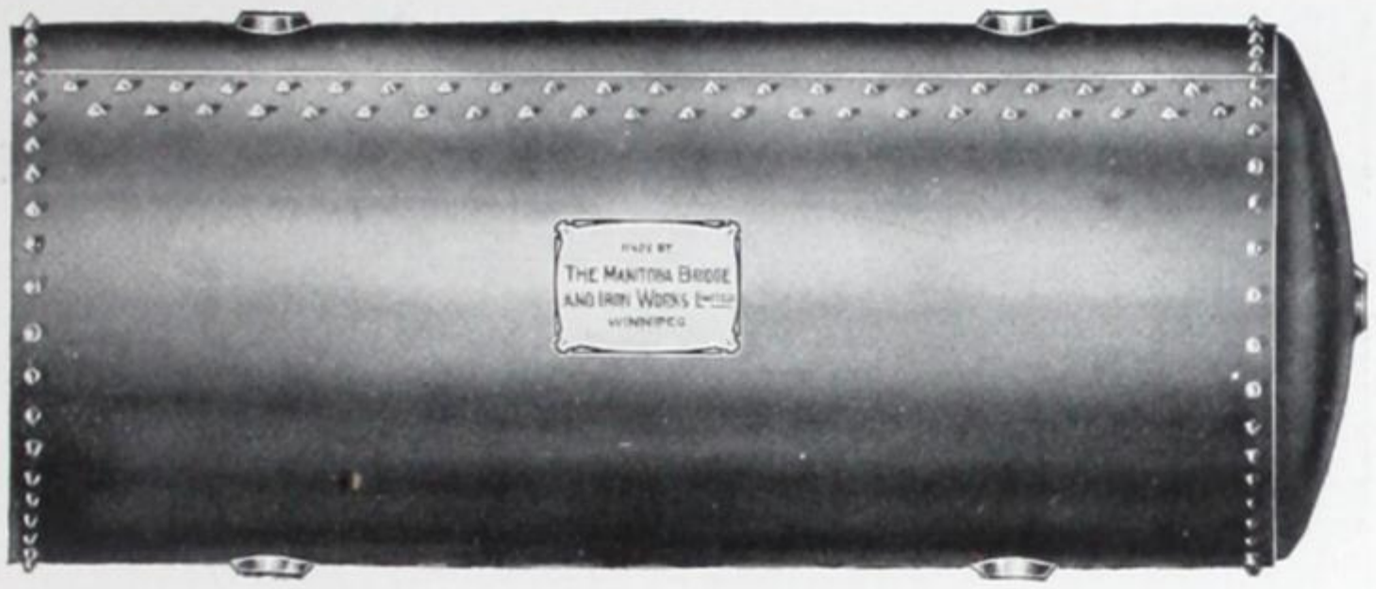
Manufacturers' Standard List

Size		Thickness of Material			Regular Openings, Inches	Approximate Capacity		Approx. Weight Lbs.	List Price Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head		Imp. Gals.	U.S. Gals.		
20	4	3/16	1/4	1/4	1 1/2	55	66	250	$ 94.00
20	5	3/16	1/4	1/4	1 1/2	70	85	295	104.00
24	4	3/16	1/4	1/4	1 1/2	80	100	310	109.00
24	5	3/16	1/4	1/4	1 1/2	100	120	360	123.00
24	6	3/16	1/4	1/4	1 1/2	120	140	410	134.00
30	4	3/16	1/4	1/4	2	125	150	395	143.00
30	5	3/16	1/4	1/4	2	155	180	455	158.00
30	6	3/16	1/4	1/4	2	185	220	515	173.00
30	7	3/16	1/4	1/4	2	215	250	585	196.00
30	8	3/16	1/4	1/4	2	245	295	645	211.00
36	6	3/16	5/16	5/16	2	265	315	685	206.00
36	7	3/16	5/16	5/16	2	310	365	760	241.00
36	8	3/16	5/16	5/16	2	350	420	835	256.00
36	10	3/16	5/16	5/16	2	440	525	980	293.00
42	6	3/16	5/16	5/16	2	360	430	835	276.00
42	7	3/16	5/16	5/16	2	420	500	940	310.00
42	8	3/16	5/16	5/16	2	480	575	1025	333.00
42	10	3/16	5/16	5/16	2	600	720	1250	375.00
42	12	3/16	5/16	5/16	2	720	865	1430	415.00
42	14	3/16	5/16	5/16		840	1000	1620	468.00

Larger sizes than those listed above, quoted upon application. We have a well equipped galvanizing department. Prices for galvanized tanks quoted upon application.

EXTRA HEAVY WATER STORAGE TANKS

Our extra heavy water storage tanks are tested to 150 pounds hydrostatic pressure, and are guaranteed for a working pressure not exceeding 100 pounds per square inch.



No. 82—Extra Havy Water Storage Tank

Heads are dished to a radius equal to the diameter of the shell; 24-in. diameter tanks are welded throughout; 30-in. and 36-in. diameter tanks have longitudinal and girth seams rivetted, and heads welded; 42 in. and 48 in. diameter tanks are rivetted throughout. Tanks can be furnished with manhole or handhole if required. Coils for hot water tanks, see page 116.

Six standard openings as shown above, are included. For larger or smaller openings or for openings located differently than shown, prices will be furnished on request.

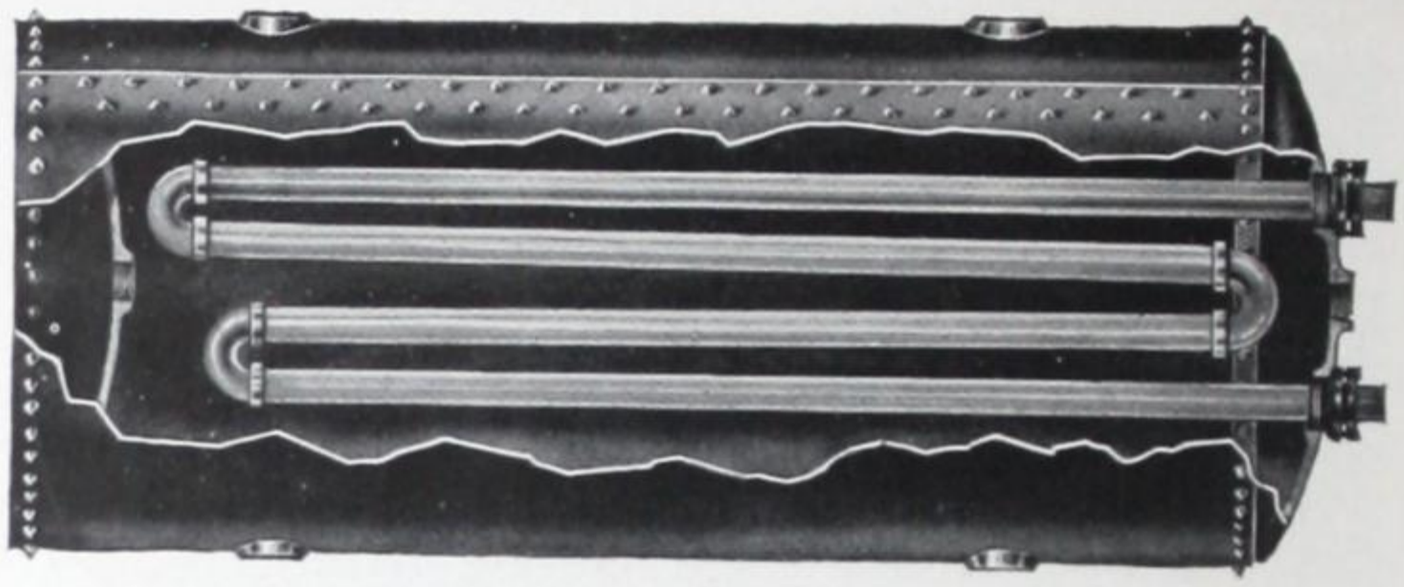
Manufacturers' Standard Specifications

Size		Thickness of Material			Regular Openings, Inches	Approximate Capacity		Approx. Weight Lbs.	List Price, Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head		Imp. Gals.	U.S. Gals.		
24	5	3/16	1/4	1/4	1 1/2	100	120	360	$137.00
24	6	3/16	1/4	1/4	1 1/2	120	140	410	155.00
30	5	3/16	1/4	5/16	2	155	180	480	182.00
30	6	3/16	1/4	5/16	2	185	220	545	198.00
30	7	3/16	1/4	5/16	2	215	250	615	224.00
30	8	3/16	1/4	5/16	2	245	295	680	242.00
36	6	1/4	5/16	3/8	2	265	315	890	264.00
36	7	1/4	5/16	3/8	2	310	365	990	300.00
36	8	1/4	5/16	3/8	2	350	420	1090	328.00
36	10	1/4	5/16	3/8	2	440	525	1200	385.00
42	6	1/4	3/8	7/16	2	360	430	1160	345.00
42	7	1/4	3/8	7/16	2	420	500	1280	390.00
42	8	1/4	3/8	7/16	2	480	575	1430	420.00
42	10	1/4	3/8	7/16	2	600	720	1540	480.00
42	12	1/4	3/8	7/16	2	720	865	1940	540.00
42	14	1/4	3/8	7/16	2	840	1000	2180	514.00
48	8	5/16	7/16	1/2	2	625	750	1760	510.00
48	10	5/16	7/16	1/2	2	785	940	2030	580,00
48	12	5/16	7/16	1/2	2	940	1130	2340	650.00
48	14	5/16	7/16	1/2	2	1125	1300	2610	715.00
48	16	5/16	7/16	1/2	2	1250	1500	2880	800.00
48	18	5/16	7/16	1/2	2	1415	1700	3150	870.00

Larger sizes than those listed above, quoted upon application. We have a well equipped galvanizing department. Prices for galvanized tanks quoted upon application.

STEAM COILS

The illustration below shows the arrangement of horizontal steam coils in standard or extra heavy water storage tanks.



No. 84—Steam Coil Arrangement

List Prices of Horizontal Steam Coils, Built in Tanks.

Size of Tank	Size of Coil	Price of Plain Coil	Price of Galvanized Coil
20″ x 4′	4 Pipes 1 inch	$29.00	$35.00
20″ x 5′	4 " 1 "	30.50	38.50
24″ x 4′	4 " 1¼ "	35.50	42.00
24″ x 5′	4 " 1¼ "	37.00	45.00
24″ x 6′	4 " 1¼ "	38.50	48.00
30″ x 4′	4 " 1¼ "	35.50	42.00
30″ x 5′	4 " 1¼ "	37.00	45.00
30″ x 6′	4 " 1¼ "	38.50	48.00
30″ x 7′	4 " 1¼ "	40.00	51.00
30″ x 8′	4 " 1¼ "	41.50	54.00
36″ x 6′	4 " 1½ "	51.00	62.00
36″ x 7′	4 " 1½ "	54.00	66.00
36″ x 8′	4 " 1½ "	57.50	70.00
36″ x 10′	4 " 1½ "	64.00	78.00
42″ x 6′	4 " 1½ "	51.00	62.00
42″ x 7′	4 " 1½ "	54.50	66.00
42″ x 8′	4 " 1½ "	57.50	70.00
42″ x 10′	4 " 1½ "	64.00	78.00
42″ x 12′	4 " 1½ "	70.50	85.00
42″ x 14′	4 " 1½ "	77.00	93.00

Prices on brass, copper and spiral coils for tanks quoted on application.

Our Tank Catalogue

which treats in a more detailed manner, of this branch of our activities, will be gladly supplied on request. A post-card directed to our Winnipeg office will bring one of these books to you immediately.

HYDRO PNEUMATIC PRESSURE TANKS

Our hydro pneumatic pressure tanks are tested to 125 pounds hydrostatic pressure, and are guaranteed for a working pressure not exceeding 75 pounds per square inch.

No. 85—Hydro Pneumatic Pressure Tank

Heads are dished to a radius equal to the diameter of the shell; 24-in., 30-in. and 36-in. diameter tanks are welded throughout; 42 in. and 48 in. diameter tanks are rivetted throughout. All tanks are furnished with 3 standard openings in shell for 1¼- in. pipe, 2½-in. openings in shell and 2½-in. openings in concave head for water glass fittings, so that tank can be used either vertically or horizontally. Tanks can be furnished with manhole or handhole if required.

For larger or smaller openings, or for openings located differently than shown, prices will be furnished on request.

MANUFACTURERS' STANDARD LIST
HORIZONTAL OR VERTICAL

Size		Thickness of Material			Approximate Capacity		Approx. Weight Lbs.	List Price, Black
Dia. in Inches	Length in Feet	Shell	Convex Head	Concave Head	Imp. Gals.	U.S. Gals.		
24	5	3/16	1/4	1/4	100	120	335	$120.00
24	6	3/16	1/4	1/4	120	140	390	135.00
24	10	3/16	1/4	1/4	200	235	500	204.00
30	6	3/16	5/16	5/16	185	220	545	172.00
30	8	3/16	5/16	5/16	245	295	675	212.00
30	10	3/16	5/16	5/16	305	365	800	244.00
36	6	3/16	5/16	5/16	265	315	675	205.00
36	8	3/16	5/16	5/16	350	420	840	255.00
36	10	3/16	5/16	5/16	440	525	985	295.00
36	12	3/16	5/16	5/16	530	630	1130	330.00
36	14	7/32	5/16	5/16	615	735	1310	380.00
42	8	1/4	5/16	3/8	480	575	1340	365.00
42	10	1/4	5/16	3/8	600	720	1580	425.00
42	12	1/4	5/16	3/8	720	865	1820	480.00
42	14	1/4	5/16	3/8	840	1000	2110	545.00
48	10	1/4	5/16	7/16	785	940	1875	490.00
48	14	1/4	5/16	7/16	1095	1300	2470	620.00
48	16	1/4	5/16	7/16	1250	1500	2735	690.00
48	20	1/4	5/16	7/16	1565	1880	3280	835.00
48	24	1/4	5/16	7/16	1880	2260	3830	965.00

Sizes other than those listed above quoted upon application.

COMPRESSED AIR TANKS

These compressed air tanks are adapted to public or private garage use.

All compressed air tanks manufactured by us, comply with the Canadian Interprovincial Regulations for the construction and installation of tanks and receptacles for compressed air and other gases.

Designs have been approved and registered by the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba and Ontario.

Tanks 18-in. to 24-in. in diameter are fitted with two 2½ x 3½-inch handholes in the shell. Tanks 24-in. to 36-in. in diameter have two 4 x 6-inch handholes. Tanks over 36-in. diameter are provided with a manhole 11 x 15 inches.

NOTE—In order to facilitate the delivery of tanks over 24-in. diameter, buyer should furnish a sketch showing position and sizes of inlet and outlet. If these sizes are not known, buyer should state for what purpose the tank is to be used, and the size of compressor.

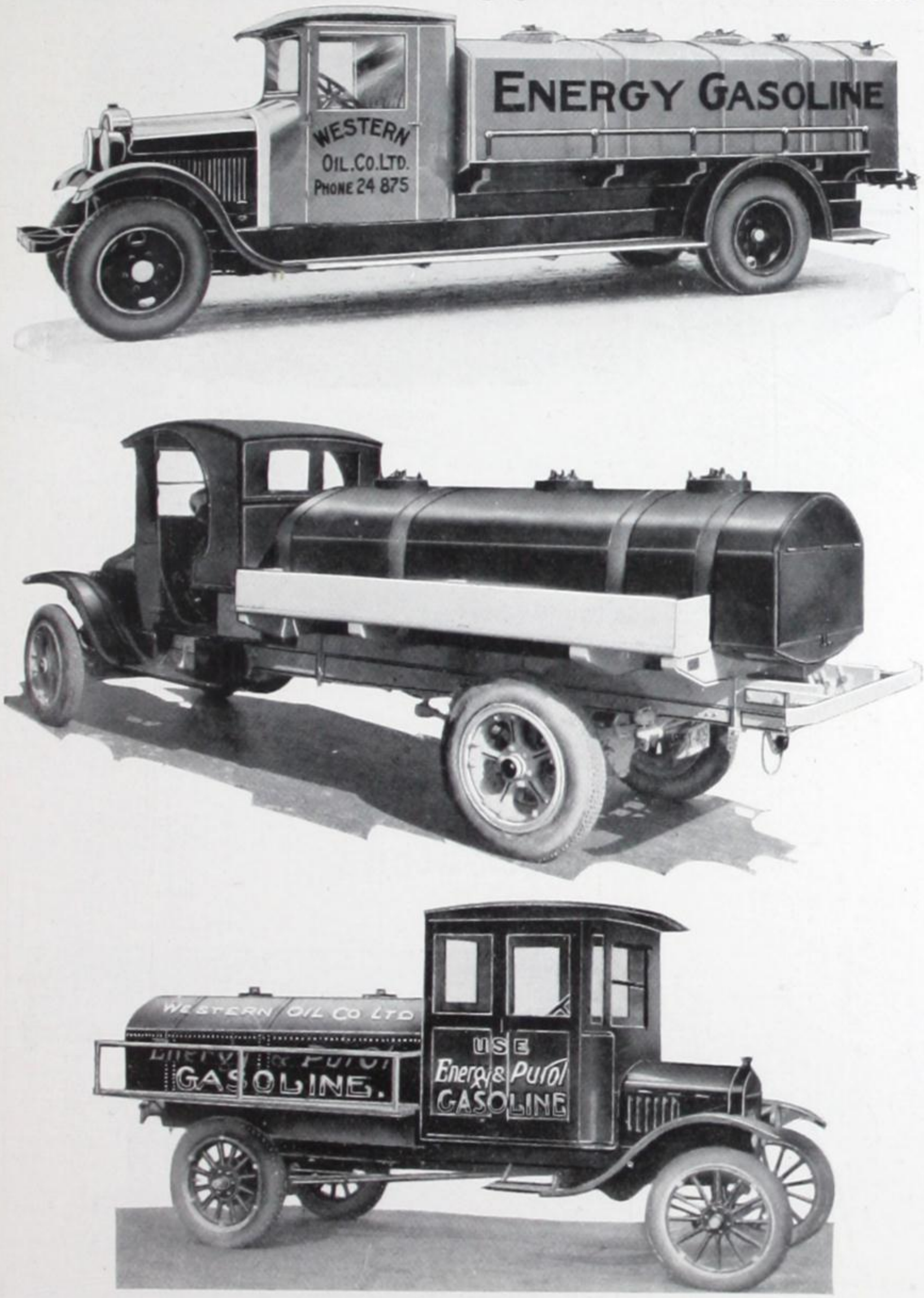
No. 86 (At Left)—Compressed Air Tank

Size		Thickness of Material		Cubic Feet Capacity	Approximate Capacity		Approx. Weight Lbs.	List Price
Dia. in Inches	Length in Feet	Shell	Heads		Imp. Gals.	U.S. Gals.		
12	3	3/16	3/16	2½	15	18	105	$ 37.00
14	4	3/16	3/16	4½	30	36	154	41.00
14	5	3/16	3/16	5	35	42	185	46.00
16	5	1/4	1/4	7	45	54	286	58.00
18	5	1/4	1/4	9¼	55	66	334	69.00
20	5	1/4	5/16	11	70	84	395	75.09
20	6	1/4	5/16	13½	85	102	450	85.00
24	5	1/4	5/16	16	100	120	490	87.00
24	6	1/4	5/16	19	120	144	560	100.00
30	5	5/16	3/8	24	150	180	800	137.00
30	6	5/16	3/8	29	180	216	905	156.00
30	8	5/16	3/8	39	245	294	1115	194.00
36	6	3/8	7/16	42	265	318	1320	181.00
36	8	3/8	7/16	56	350	420	1620	231.00
42	8			77	480	576	....	
42	10			96	600	720	....	
42	12			115	720	864	....	
48	10			125	785	942	....	Prices
48	12	Special		150	935	1122	....	on
48	14			176	1095	1314	....	Appli-
60	12			235	1470	1764	....	cation
60	14			275	1700	2040	....	
60	16			315	1950	2340	....	

TRUCK TANKS

Steel tanks for gasoline and oil delivery trucks, supplied in capacities up to one thousand Imperial gallons, in as many compartments as desired.

Tanks have baffle plates to prevent surging. Can room at back and also racks

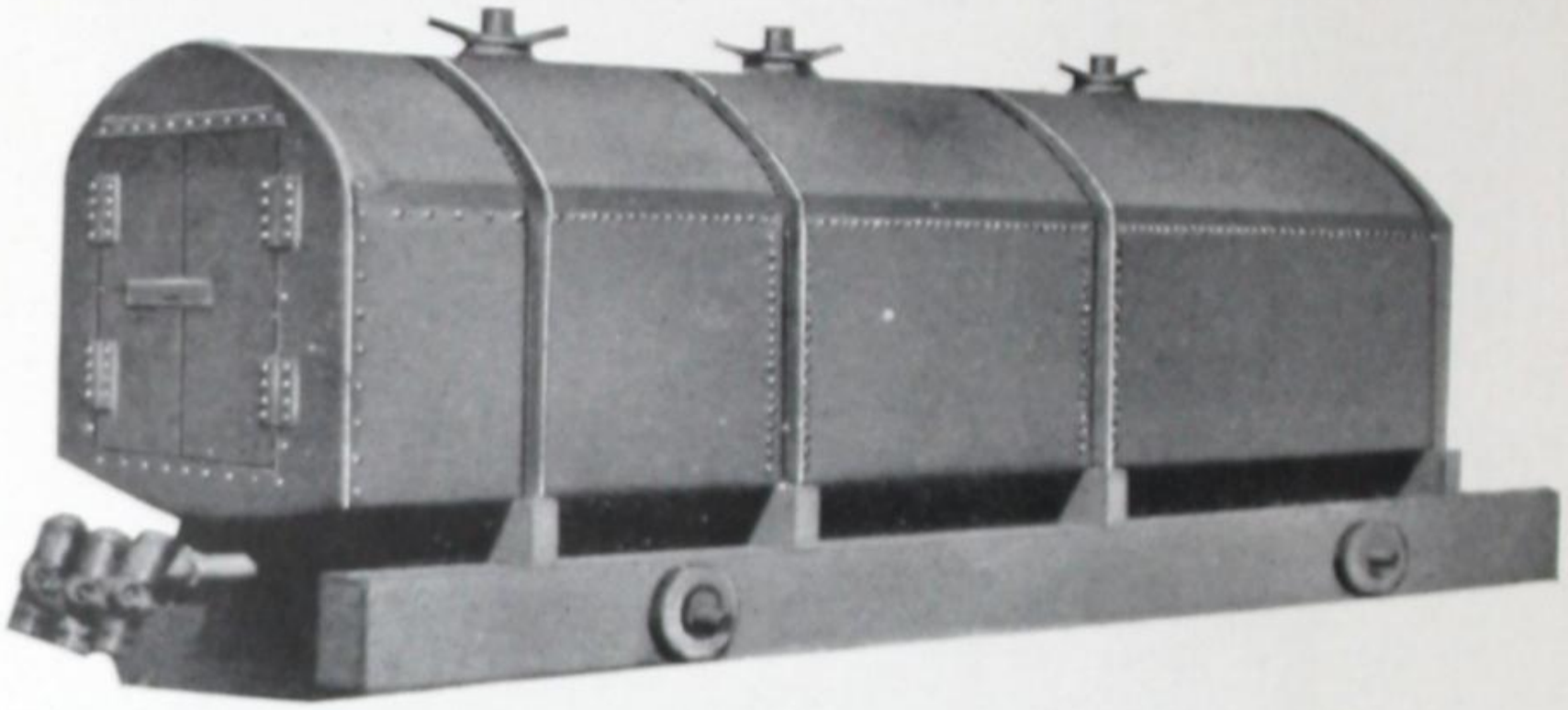


No. 87—Types of Truck Tanks

at side if specified. Tanks for Ford trucks can be supplied with two compartments and can room, with capacity 250 Imperial gallons. These tanks can be made either rivetted or welded, and are tested and guaranteed gasoline tight.

WAGON OR TRUCK TANKS

The tank shown in illustration No. 88 is designed for use on an ordinary truck or wagon, where deliveries by means of tank are made only intermittently. When it is desired to use the truck or wagon for other purposes the tank can be easily removed.

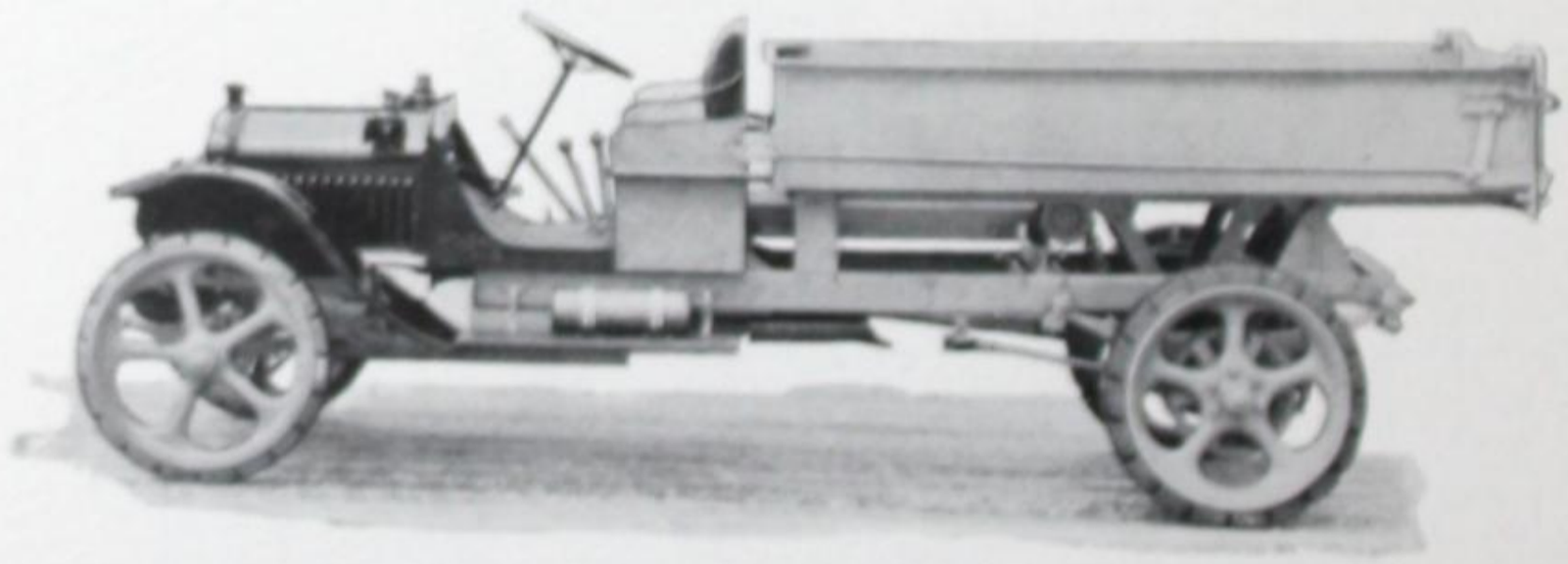


No. 88—Portable Wagon or Truck Tank

This tank is mounted on two wood bolsters with two pairs of small wheels and axles. The wheels have eccentric centres, and to remove tanks from truck or wagon, the eccentrics are turned by means of hand levers into a position which raises the tank on to the wheels so that it can easily be rolled into warehouse.

By reversing the operation, the tank sits rigidly on the floor of the warehouse.

TRUCK BODIES

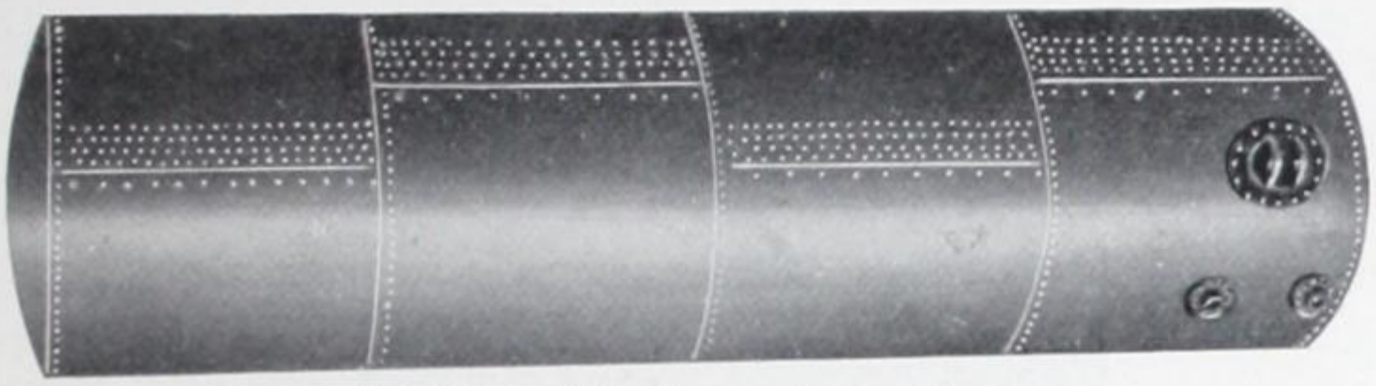


No. 89—Typical Steel Truck Body

We furnish steel bodies for trucks in sizes and capacities as desired. The illustration above shows a typical truck body constructed to customer's design. Prices furnished upon request.

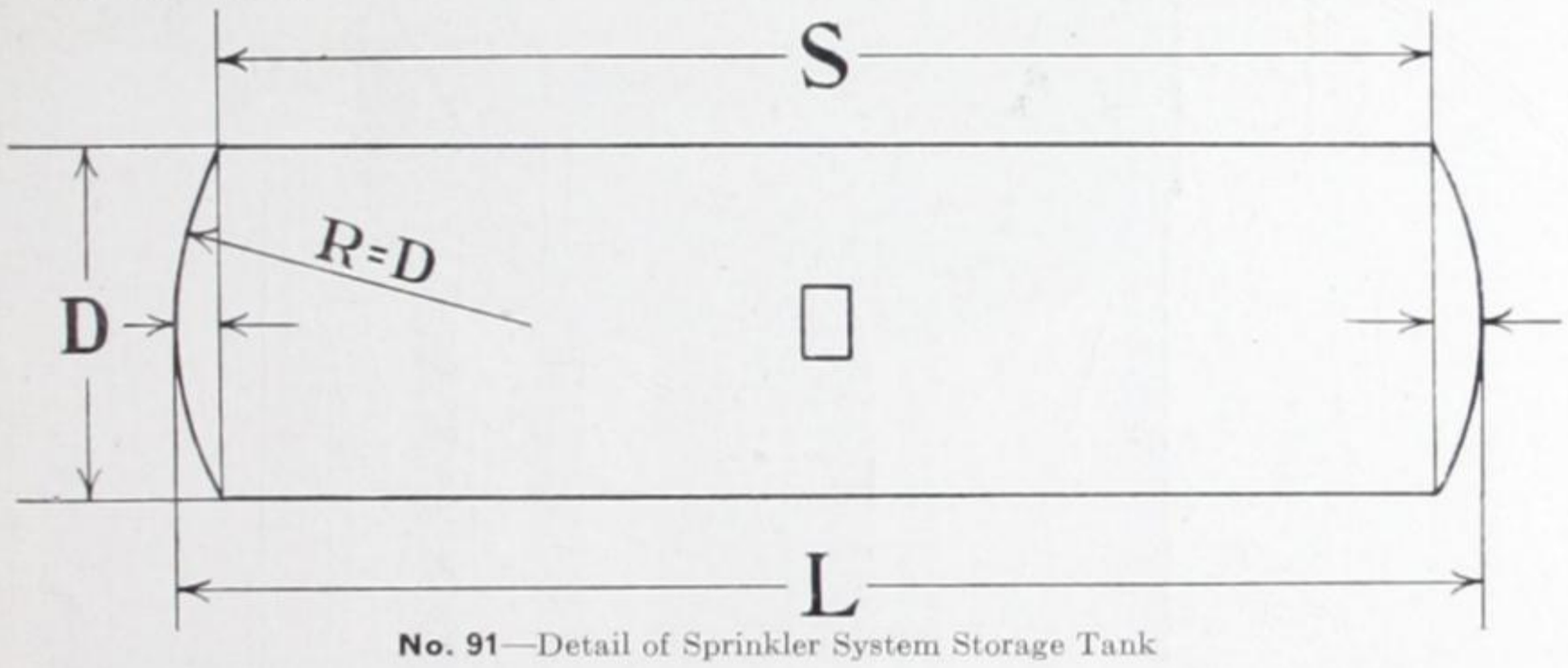
SPRINKLER SYSTEM STORAGE TANKS

Our tanks for sprinkler system storage are built to Western Canada Fire Underwriters specifications, and are inspected during construction by the Western Canada Fire Underwriters.



No. 90—Sprinkler System Storage Tank

The table below gives specifications for standard pressure tanks for sprinkler systems. All capacities for Underwriters' specifications are U.S. gallons. All diameters are inside shell. Flange quality stamped steel is the material used. Girth seams single riveted; longitudinal seams triple-riveted with butt-straps inside and out.



No. 91—Detail of Sprinkler System Storage Tank

SPECIFICATIONS FOR STANDARD SPRINKLER SYSTEM PRESSURE TANKS

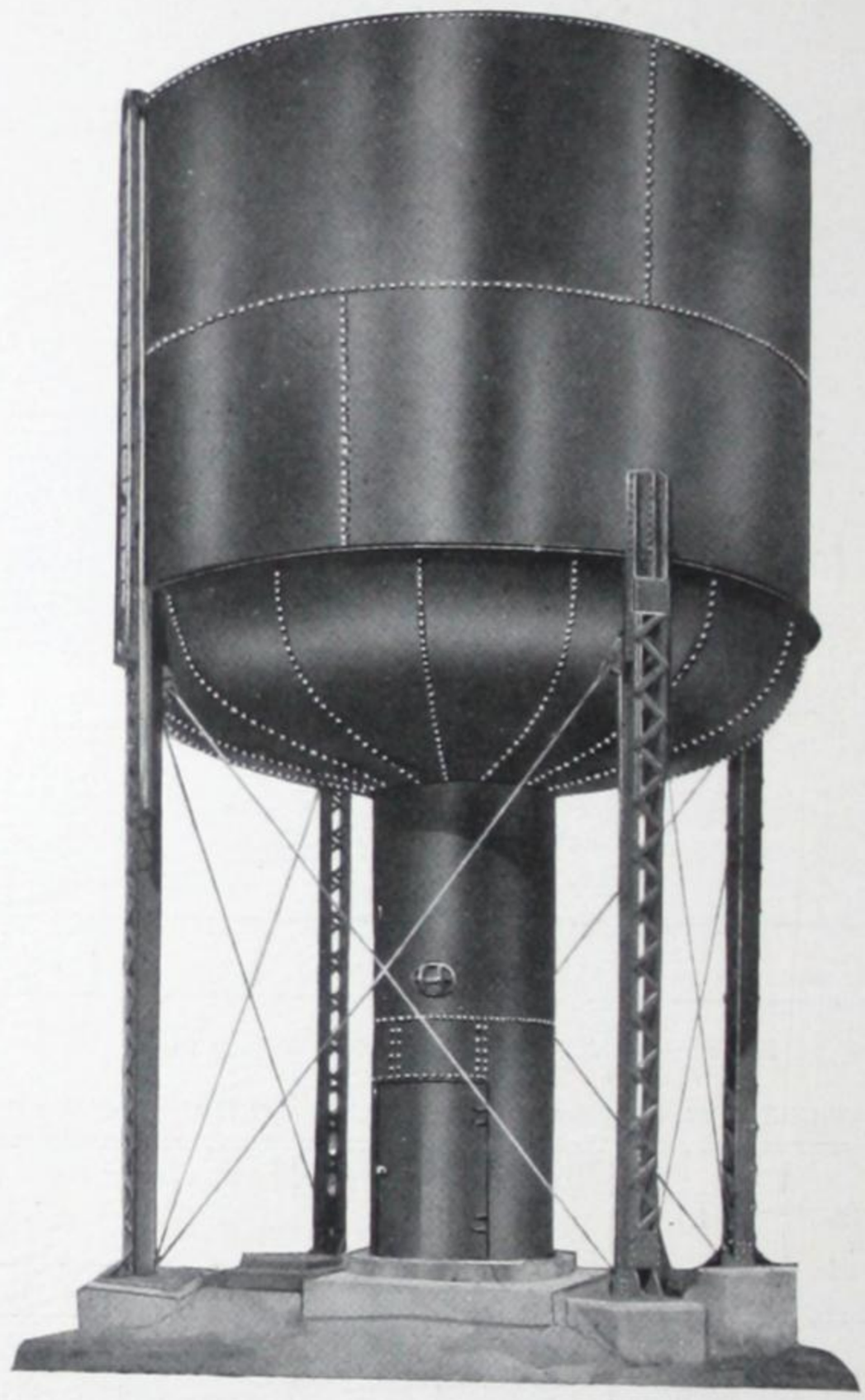
Diameter D	Dish of Heads	S	L	No. of Sheets	S	L	No. of Sheets
		4500 Gallons			6000 Gallons		
60″	8 ″	30′	31′ 4″	4	.....	.....	.
66″	8¾″	24′ 7″	26′ ½″	3	.....	.....	.
72″	9½″	20′ 7″	22′ 2″	3	27′ 8″	29′ 3″	4
78″	10½″	17′ 4″	19′ ½″	3	23′ 4″	25′ ½″	3
84″	11 ″	14′ 9″	16′ 7″	2	19′ 11″	21′ 9″	3
90″	12 ″	12′ 8″	14′ 8″	2	17′ 2″	19′ 2″	3
96″	13 ″	10′ 11 ′	13′ 1″	2	14′ 10″	17′ 0″	2
		7500 Gallons			9000 Gallons		
78″	10½″	29′ 4½″	31′ 1″	4	35′ 5″	37′ 1″	5
84″	11 ″	25′ 1½″	26′ 11½″	4	30′ 4″	32′ 2″	4
90″	12 ″	21′ 8½″	23′ 8½″	3	26′ 3″	28′ 3″	4
96″	13 ″	18′ 10″	21′ 10″	3	22′ 10″	25′ 0″	3

L = Length Overall S = Length of Shell Radius of Dish of Head = Diameter of Tank

One saddle is required under each sheet of shell, consisting of cast iron formed saddles resting on compound steel beam, varying in size according to spans. Separate price will be given on these on information as to spans required.

STEEL TANKS AND TOWERS

We can furnish water supply tanks and towers of any height or capacity for municipalities, railways or corporations; also steel towers for supporting wooden tanks, though we do not manufacture wooden tanks.



No. 92—A steel tank and tower designed and erected by the Manitoba Bridge and Iron Works, Limited.

We will design tanks and towers and give estimates of cost without charge to prospective buyers. When writing send all particulars covering height of tower and capacity of tank.

MUNICIPAL WATER TOWERS AND STAND-PIPES

We undertake to design, construct and erect complete elevated tanks or stand-pipes for municipal, domestic or railway water supply service.

No. 93—Elevated Water Tank at Transcona, Man., Capacity 125,000 Gallons, with Suspended Drinking-Water Tank.

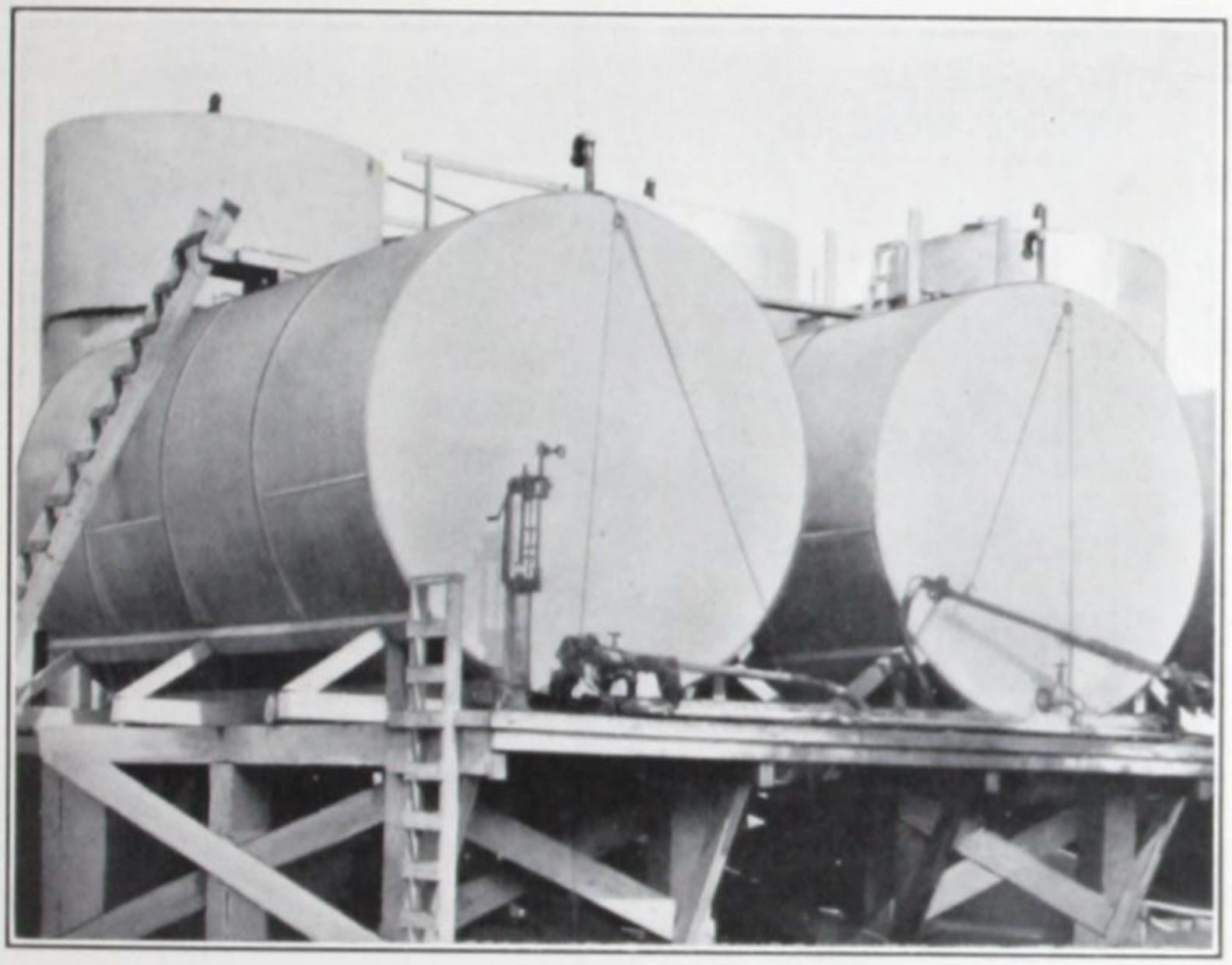
Specifications submitted on receipt of statement of storage capacity and head required. Drawings and estimates of cost will be furnished to prospective buyers.

No. 94—Vertical Storage Tank with Rivetted Seams

STEEL STORAGE TANKS

Our steel storage tanks embody the latest developments in this class of work, being the result of twenty-five years experience in the steel and iron industry. As the largest producers of tanks in Western Canada, we are prepared to fill our customers' requirements, whether for standard or special designs. Our service is prompt and efficient.

We produce steel storage tanks, either horizontal or vertical, and with seams either welded or rivetted. All welding is done electrically, and all rivets in tanks are power-driven.



No. 95—Horizontal Storage Tanks with Electrically Welded Seams

The illustration on the opposite page shows a vertical storage tank with rivetted seams.

Above are shown horizontal storage tanks with electrically welded seams. This type of tank can be furnished with division plates to make two or more compartments.

All our storage tanks are made with one-piece bottoms or ends, and with large body plates, thus reducing the number of joints to a minimum.

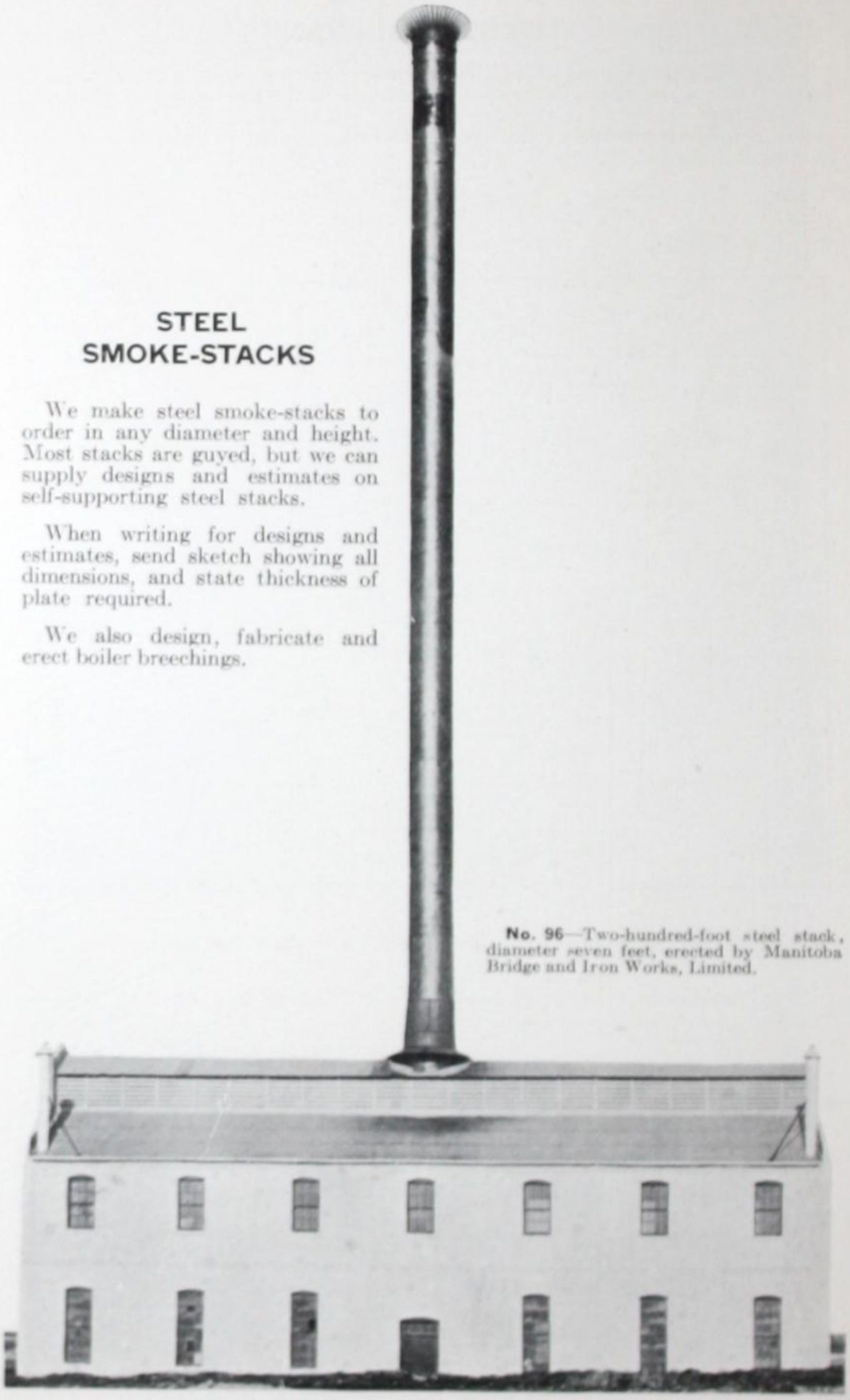
We can supply steel storage tanks in all sizes and to suit the customer's individual requirements.

STEEL SMOKE-STACKS

We make steel smoke-stacks to order in any diameter and height. Most stacks are guyed, but we can supply designs and estimates on self-supporting steel stacks.

When writing for designs and estimates, send sketch showing all dimensions, and state thickness of plate required.

We also design, fabricate and erect boiler breechings.

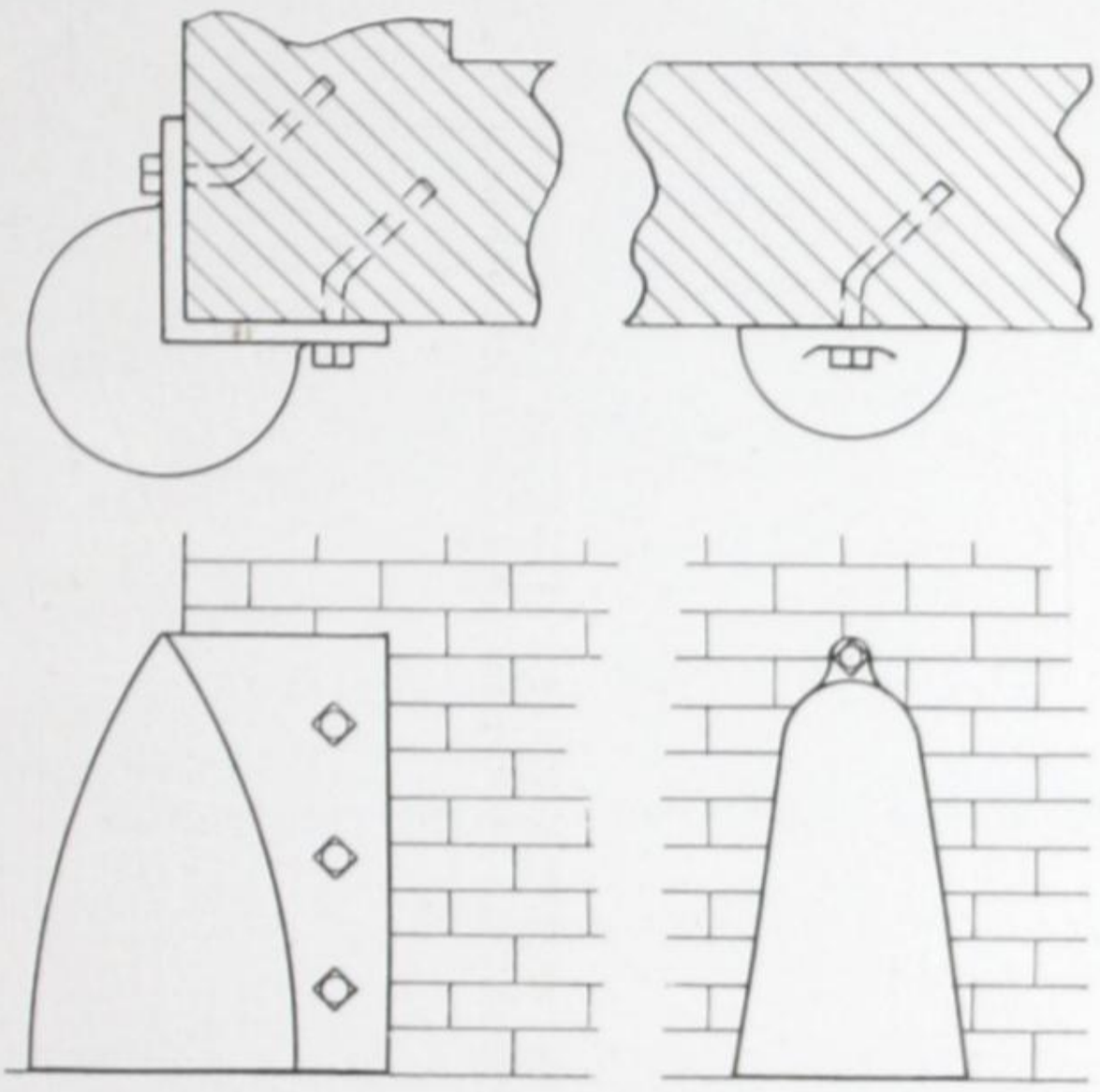


No. 96—Two-hundred-foot steel stack, diameter seven feet, erected by Manitoba Bridge and Iron Works, Limited.

WHEEL GUARDS

Wheel guards are used to protect corners and flat surfaces of walls at entrances to driveways and to warehouses and other buildings where trucks are driven in.

These guards are heavily constructed and securely anchored in the wall which they are designed to protect. Their cost is soon saved in damage prevented.



No. 97—Wheel Guards, for Corner and for Side of Wall

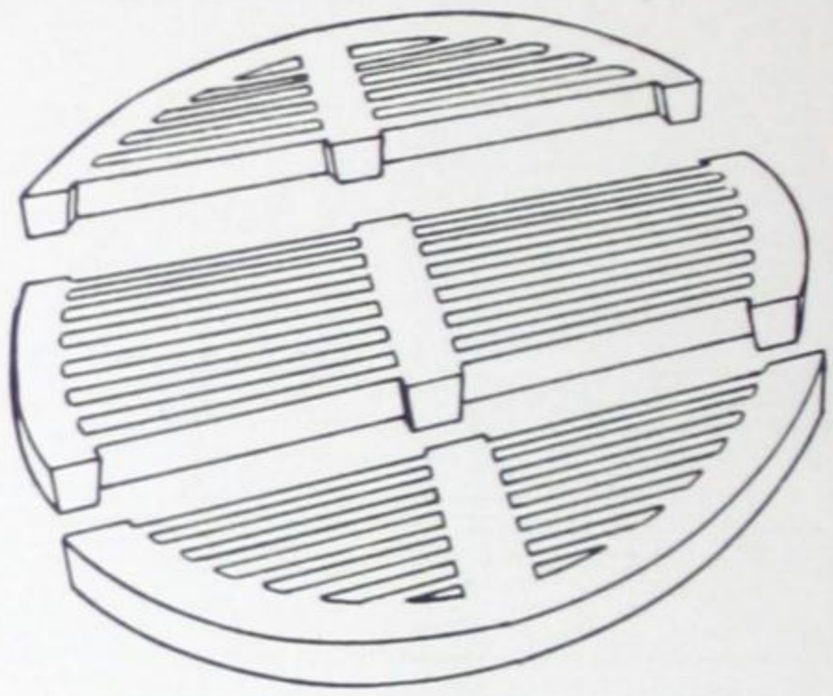
We have in stock patterns for all sizes and weights of wheel guards, and consequently are able to supply guards to suit any requirement on short notice.

We can also supply steel angle jamb guards with anchor, and either cast iron or plate steps, curbs and thresholds for door openings in warehouses, etc.

Any size or style, whether of steel or cast iron, can be furnished. In writing for prices, give all necessary information.

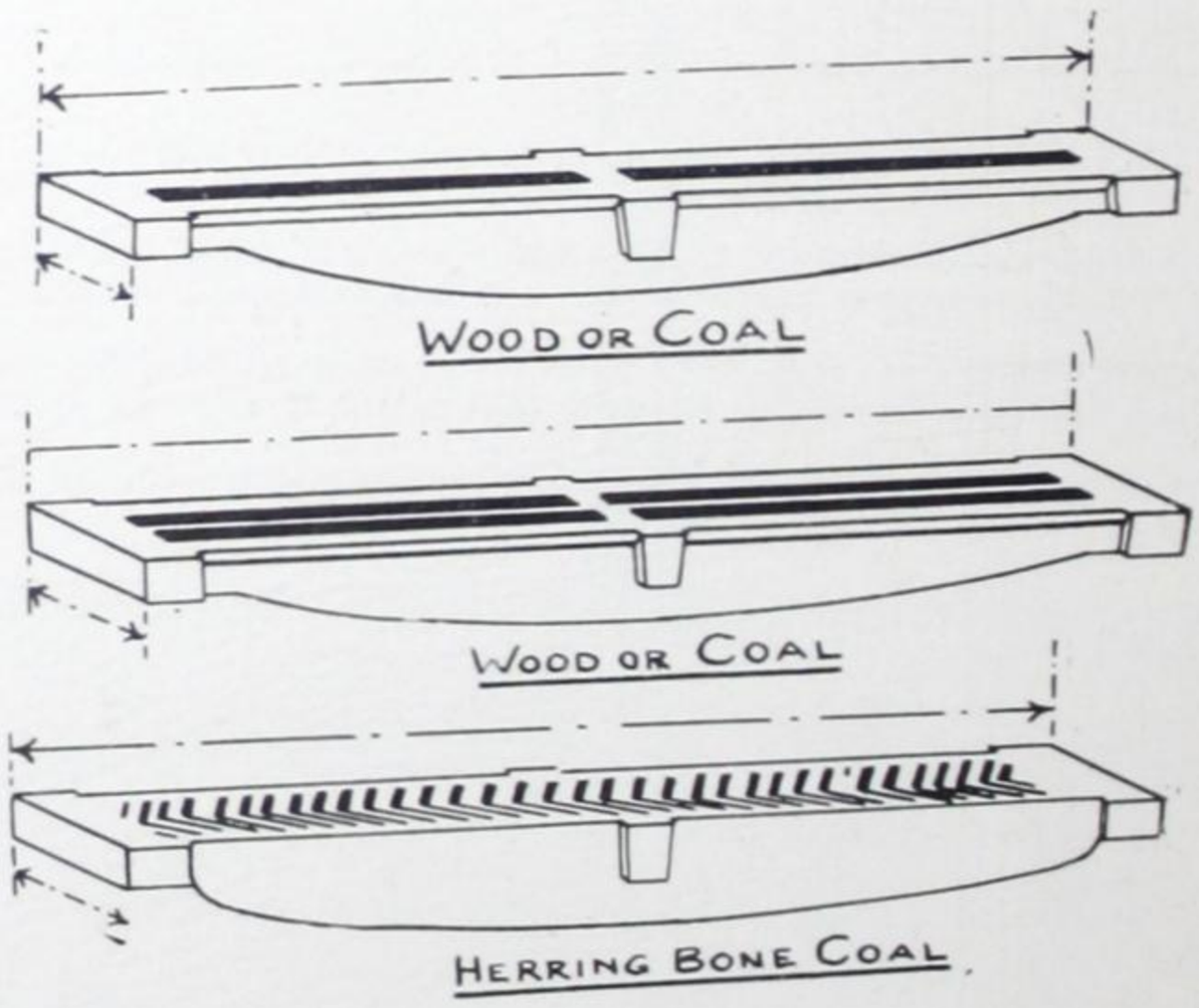
FURNACE GRATES

Many styles of furnace grates are now in use. Several varieties are illustrated on this and the following page. The number of patterns for furnace grates which we have on hand enables us to offer a considerable selection of castings.



No. 98—Circular Grate

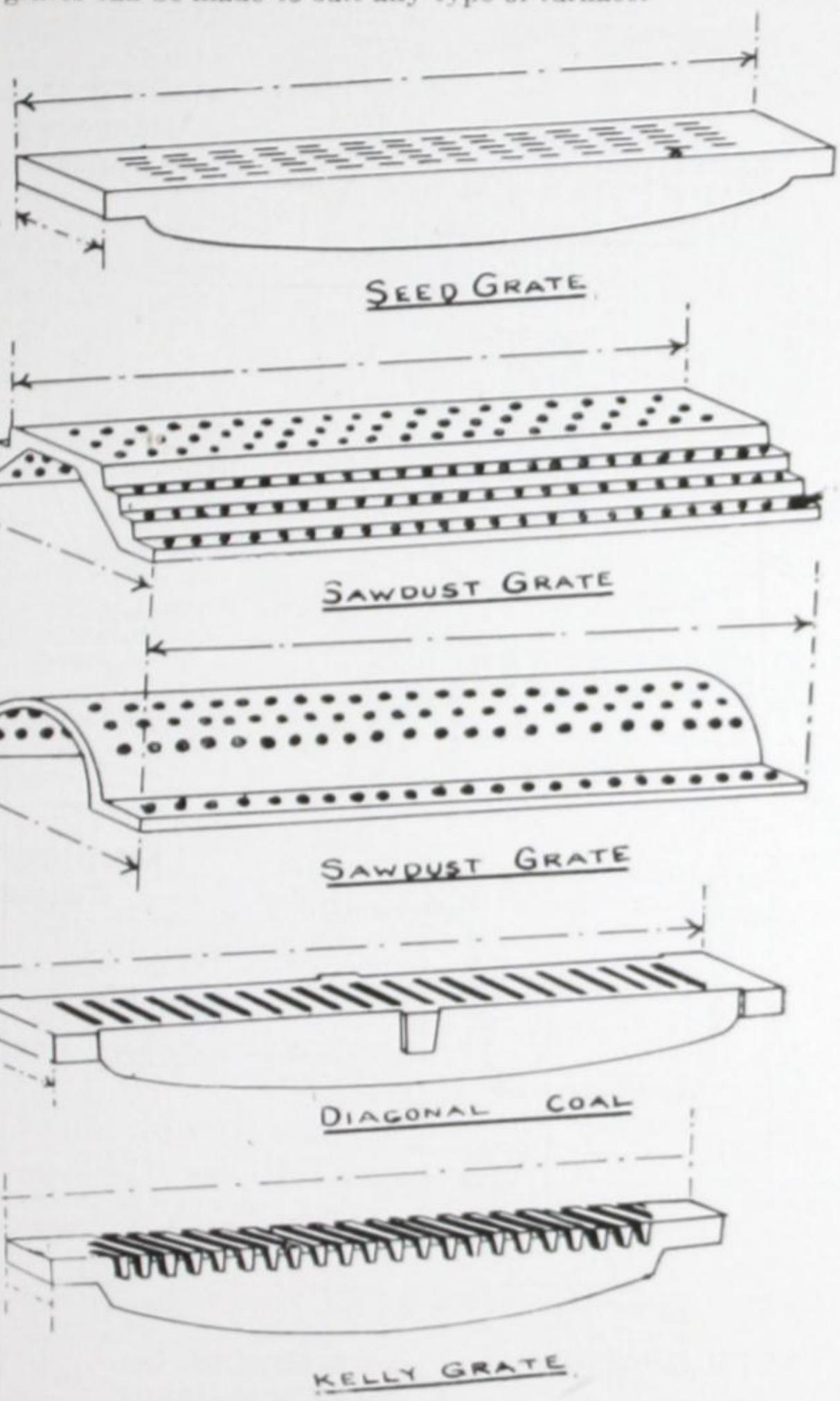
The illustration above depicts a circular style grate in three sections. This grate can be furnished in sizes to suit the customer's requirements.



No. 99—Types of Furnace Grates

In addition to the circular grate, many styles of rectangular sectional grates are used.

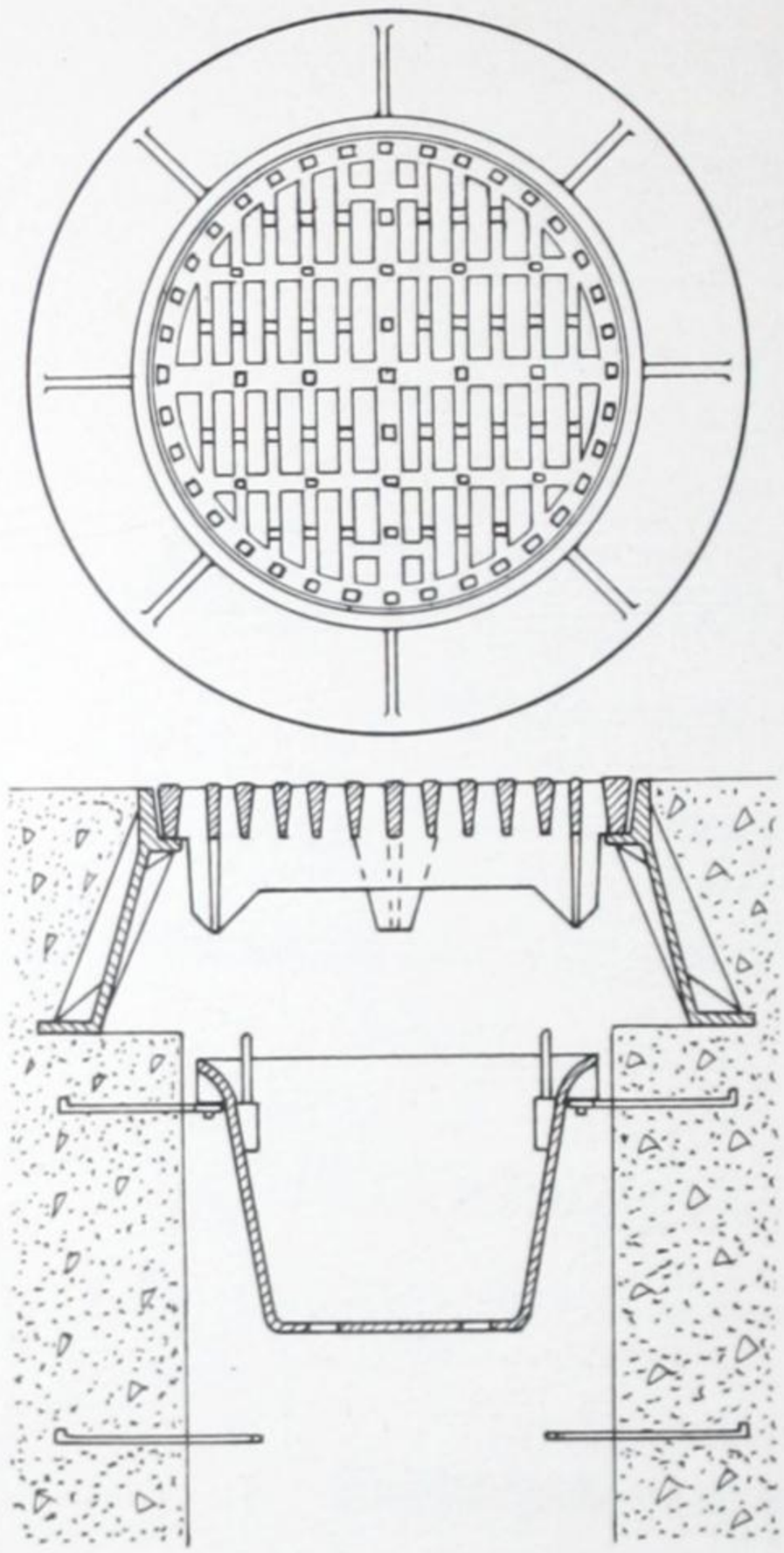
A number of additional varieties of furnace grates are shown in the designs below, and grates can be made to suit any type of furnace.



No. 100—Types of Furnace Grates

Write for prices, stating dimensions and style wanted. Estimates will be made on request.

SEWER CASTINGS



MUNICIPAL STANDARD MANHOLE FRAME AND COVER

The municipal standard manhole frame as illustrated at the left is especially adapted for city and town use.

This type of manhole frame can be supplied with solid cover as well as with grate cover shown in No. 101.

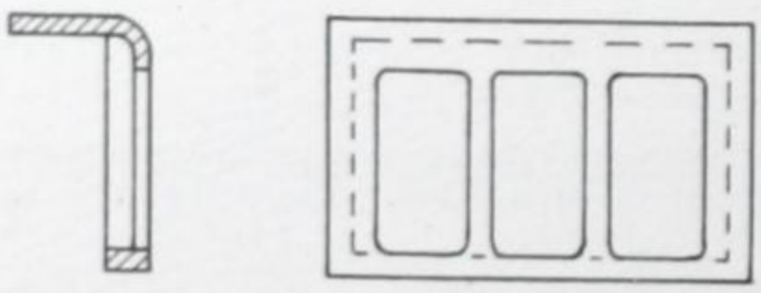
Our range of patterns enables us to offer numerous other types of manhole frames, while we can supply standards to suit the customer's individual requirements. Further information will be furnished on request.

MANHOLE MUD BASKETS

The mud basket shown fitted into the manhole in No. 101 can be supplied complete with brackets.

No. 101 (At Left)—Municipal Standard Sewer Manhole Frame Fitted with Grate Cover and Mud Basket.

CURB GRATINGS



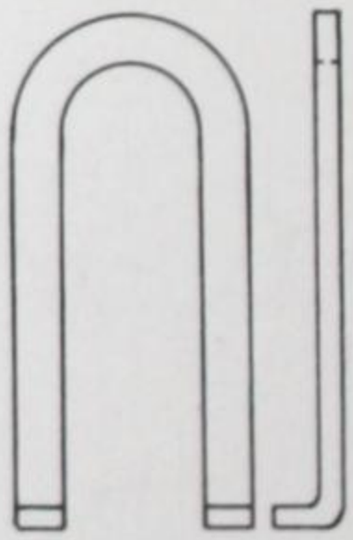
No. 102—Standard Cast Iron Curb Grating

The standard cast iron curb grating, illustrated above in No. 102, can be furnished to suit any depth of curb.

Estimates and further information furnished on request.

MANHOLE OR CATCH-BASIN STEPS

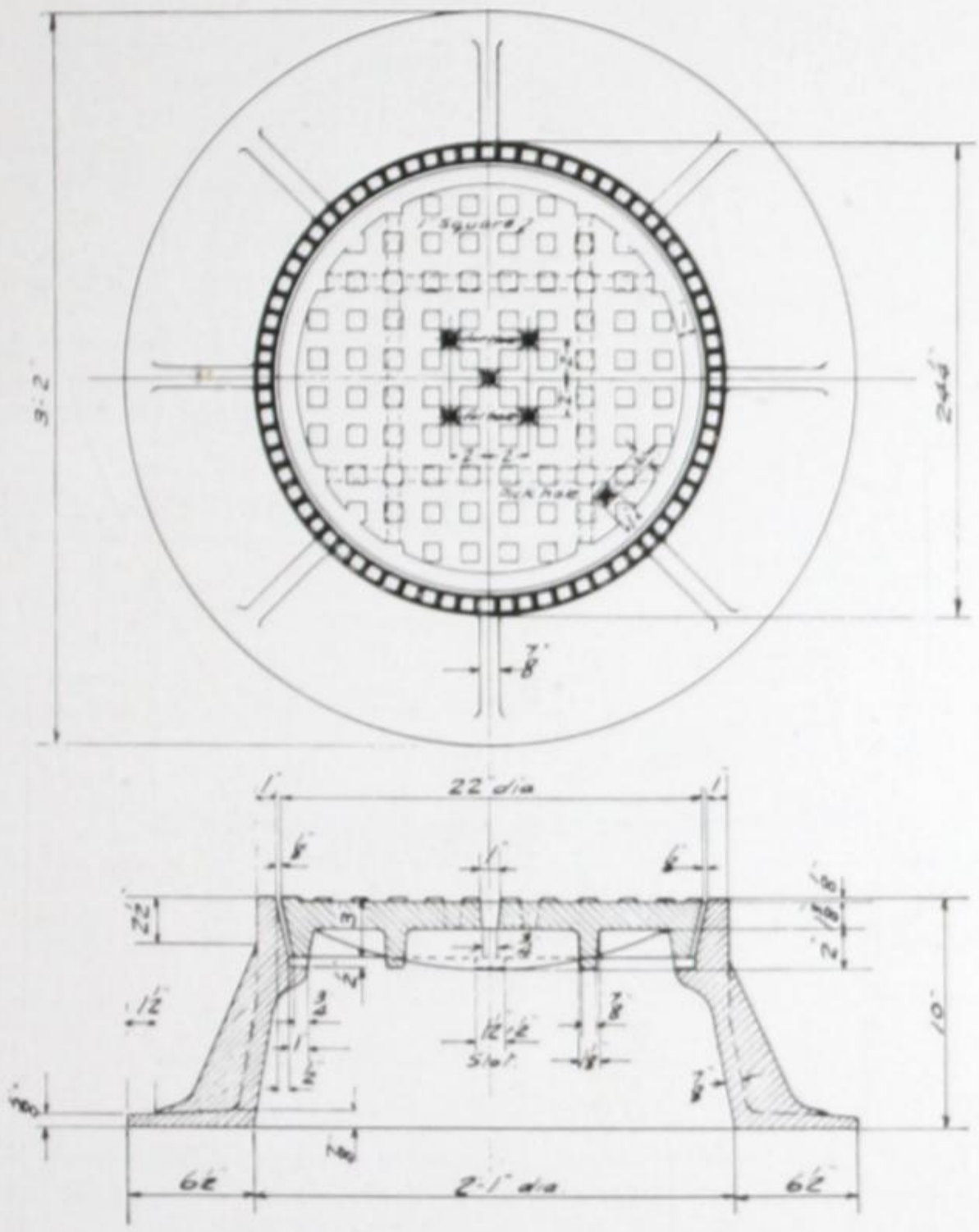
The wrought iron steps illustrated at the right are for use in manholes or catch-basins. They are shown in No. 101 above, as used in a manhole. Prices furnished on request.



No. 103—Wrought Iron Manhole or Catch-Basin Steps.

MANHOLE COVERS AND FRAMES

Our patterns for manhole covers and frames include those used by most of the cities of Western Canada, by the Manitoba Telephone System, Winnipeg Hydro Electric System, etc.

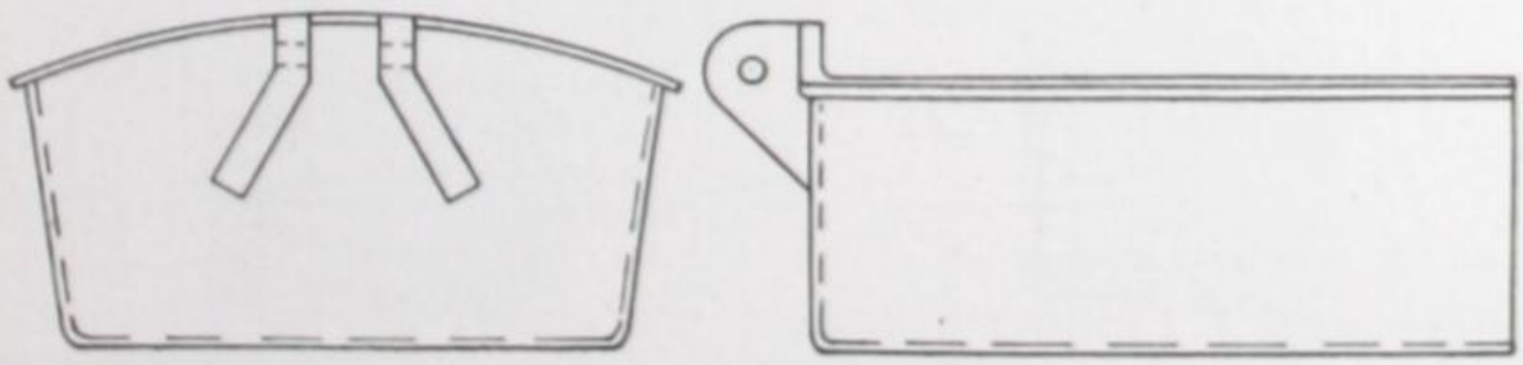


No. 104—Cast Iron Man-Hole Cover and Frame

Special air-tight covers with machined groove and oil seal can be supplied on order.

We make all kinds and sizes of manhole covers and frames. Estimates gladly given upon receipt of specifications.

CATCH-BASIN HOODS

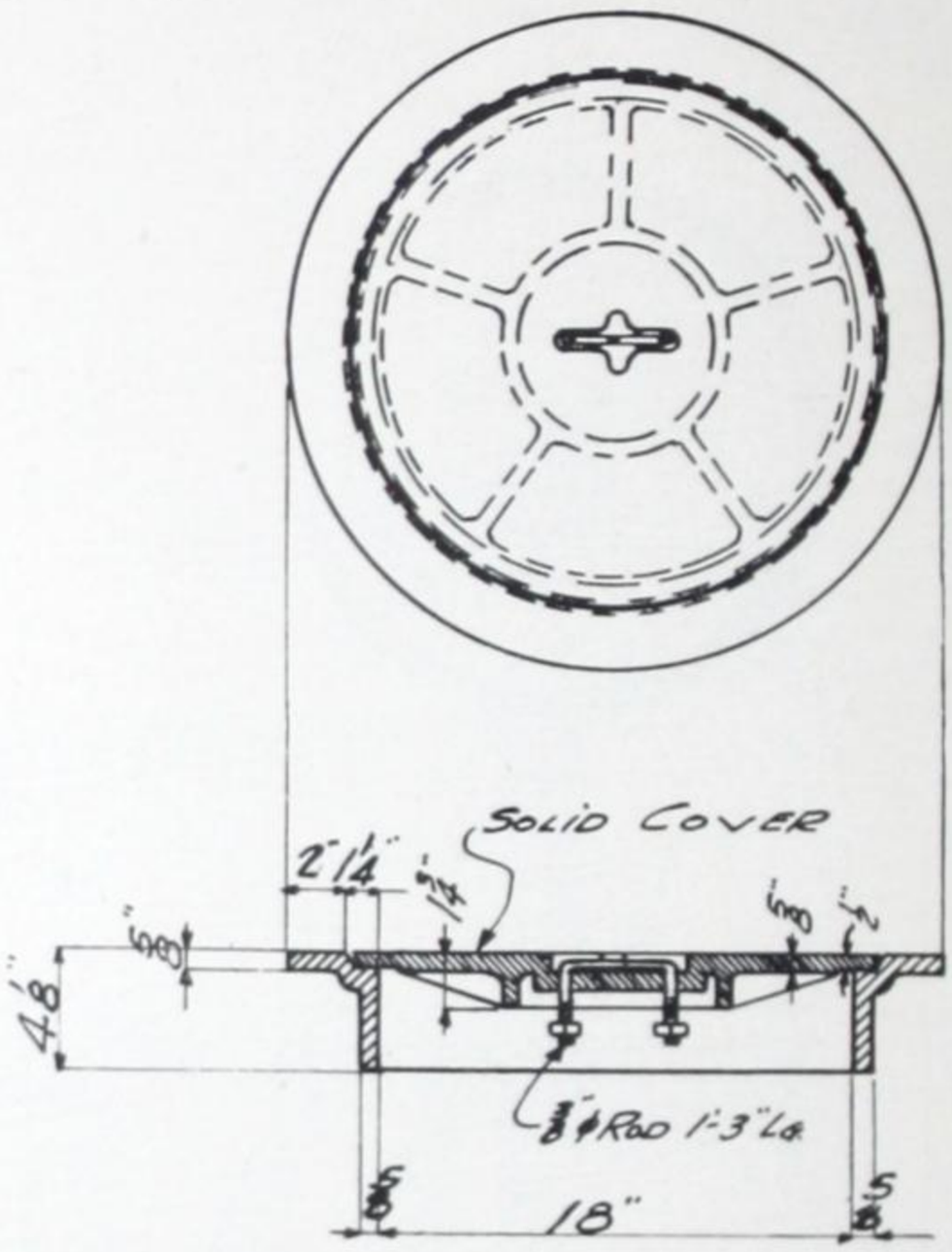


No. 105—End and Side Views of Standard Catch-Basin Hood

The standard catch-basin hood, shown in No. 105 above, is supplied complete with hinge and pin. Estimate will be furnished if requested.

CATCH-BASIN COVERS AND FRAMES

Covers and frames for catch-basins from 10-inch to 36-inch diameter and in heavy or light pattern, either solid or perforated, according to purpose intended, can readily be supplied.



No. 106—Cast Iron Catch-Basin Cover and Frame

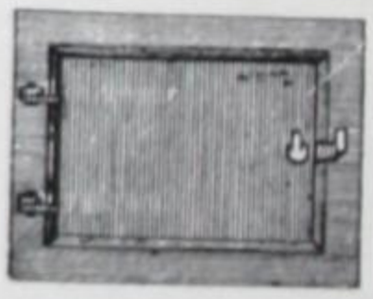
Where heavy trucking may take place over a catch-basin, steel plate covers may be supplied to fit cast iron frames; these covers are lighter and stronger than the cast iron variety, and will not crack under load.

Coal-Hole Rings and Covers—The larger sizes of catch-basin covers, with the addition of an inside locking device, are used as coal-hole covers.

CLEAN-OUT DOORS

Cast-iron clean-out doors for general use can be supplied by us in the styles

No. 107—Circular Head Clean-out Door



No. 108—Rectangular Head Clean-out Door, Hinged

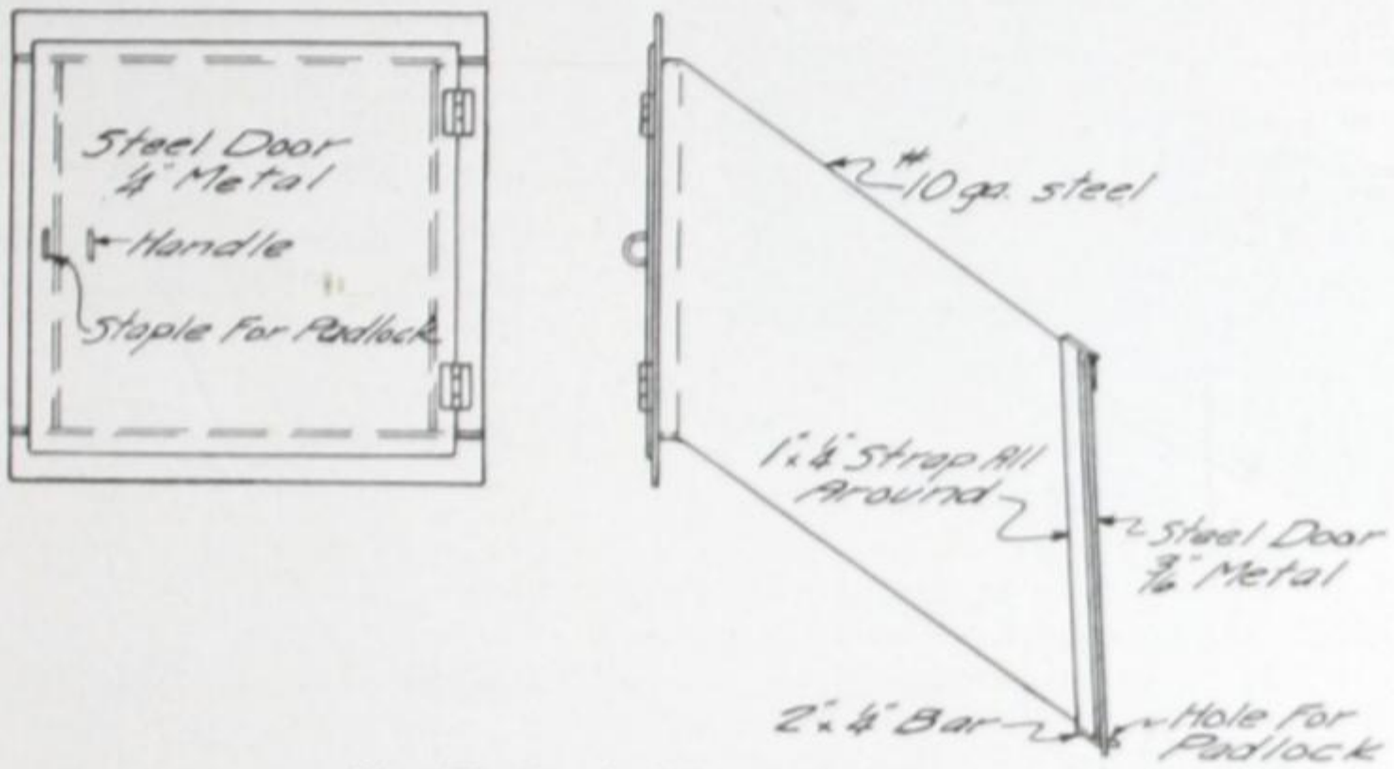
illustrated herewith, hinged or unhinged, with circular or rectangular head. Any size is obtainable. When writing for prices, state size of opening.

FUEL CHUTES

The selection of fuel chutes offered to our customers includes square and round, flush and projecting types; the chutes may also be for wall or sidewalk use.

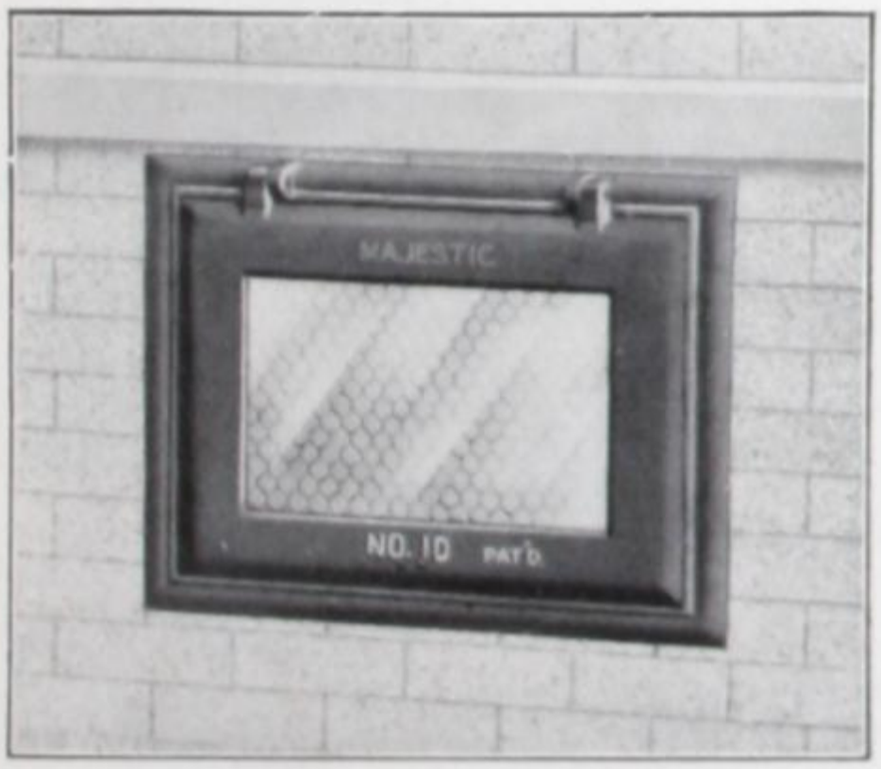
SQUARE FLUSH TYPE

Our Standard All Steel Design—This pattern of fuel chute is featured by steel doors with locking devices at both inside and outside terminations of the of the chute. Highly durable and economical. Standard sizes shown below.



No. 109—Standard Square Fuel Chute

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
1	24 x 24	13	
2	24 x 24	17	
3	24 x 24	21	
4	24 x 24	27	
5	24 x 24	18	



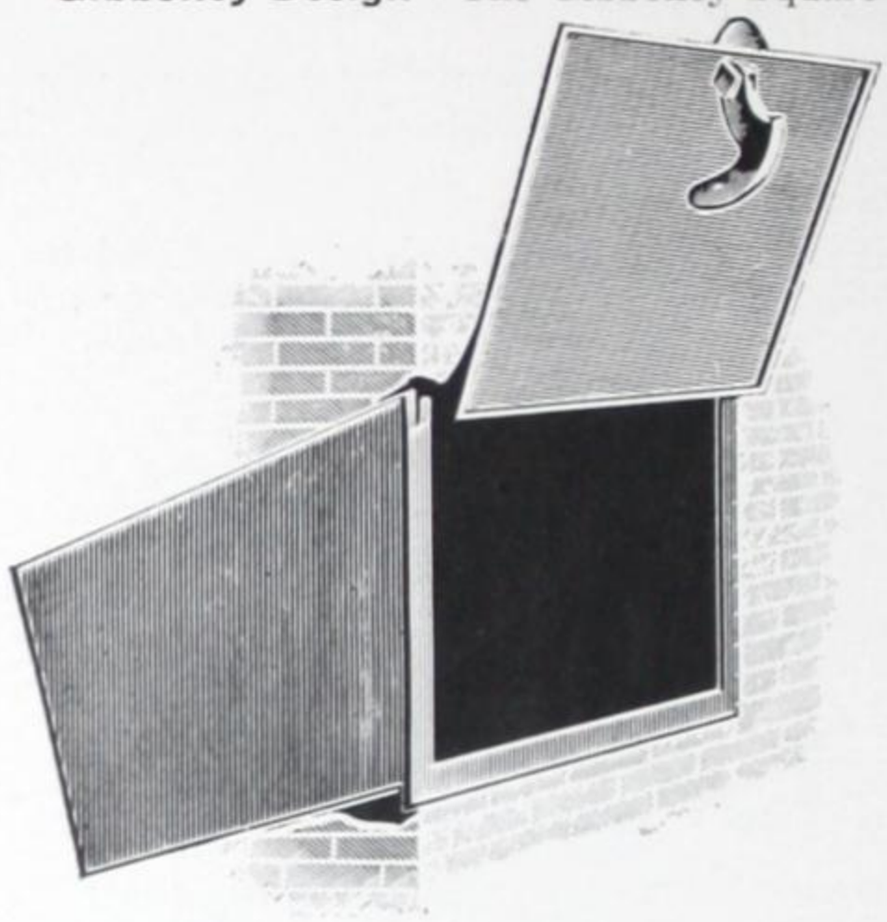
Majestic Design—The "Majestic" is a well-known pattern of the square flush type of chute. It is well-made, giving great convenience with a maximum of service, even under heavy use. It can be supplied with cast iron or glass door. The latter style is shown by No. 110. The standard sizes for this chute are tabulated below.

No. 110 (At Left)—Majestic Chute

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
10A—Glass Door	19 x 22	12	
10B—Iron Door	19 x 22	12	

Both our Standard and Majestic Designs are also made in Special Sizes.

Gibboney Design—The Gibboney Square Self-Locking Chute as seen in No. 111 is deservedly popular. It has a flanged door which fits over the rim of frame making it both wind and water proof.



The cast frame and door, combined with a sturdy steel body make the Gibboney a strong, reliable chute which will stand while the building lasts.

Ideal for receiving coal, wood or vegetables, and suitable for any style of building.

The door closes flush with the building and can be opened only from the inside.

No. 111 (At Left)—Gibboney Square Fuel Chute

MADE IN THE FOLLOWING SIZES:

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
4	18 x 18	24	70
5	18 x 24	30	105

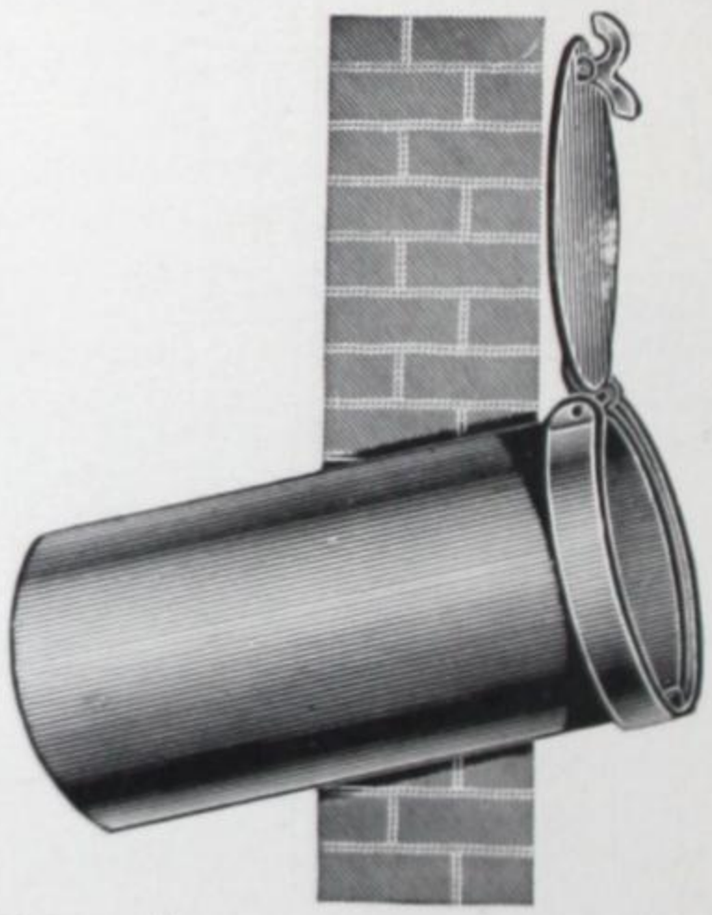
Also made in sizes to suit individual requirements.

ROUND PROJECTING TYPE

Gibboney Design—The Round Gibboney Chute has practically the same features as the square type. It is self-locking and can be opened only from the inside. The frame and door are cast, while the body is of heavy steel.

The door is made with a flange which fits over rim of frame, making it wind and water proof.

The chute is neat in appearance and can be used in residences, business blocks, churches and other public buildings.



No. 112 (At Right)—Gibboney Round Fuel Chute.

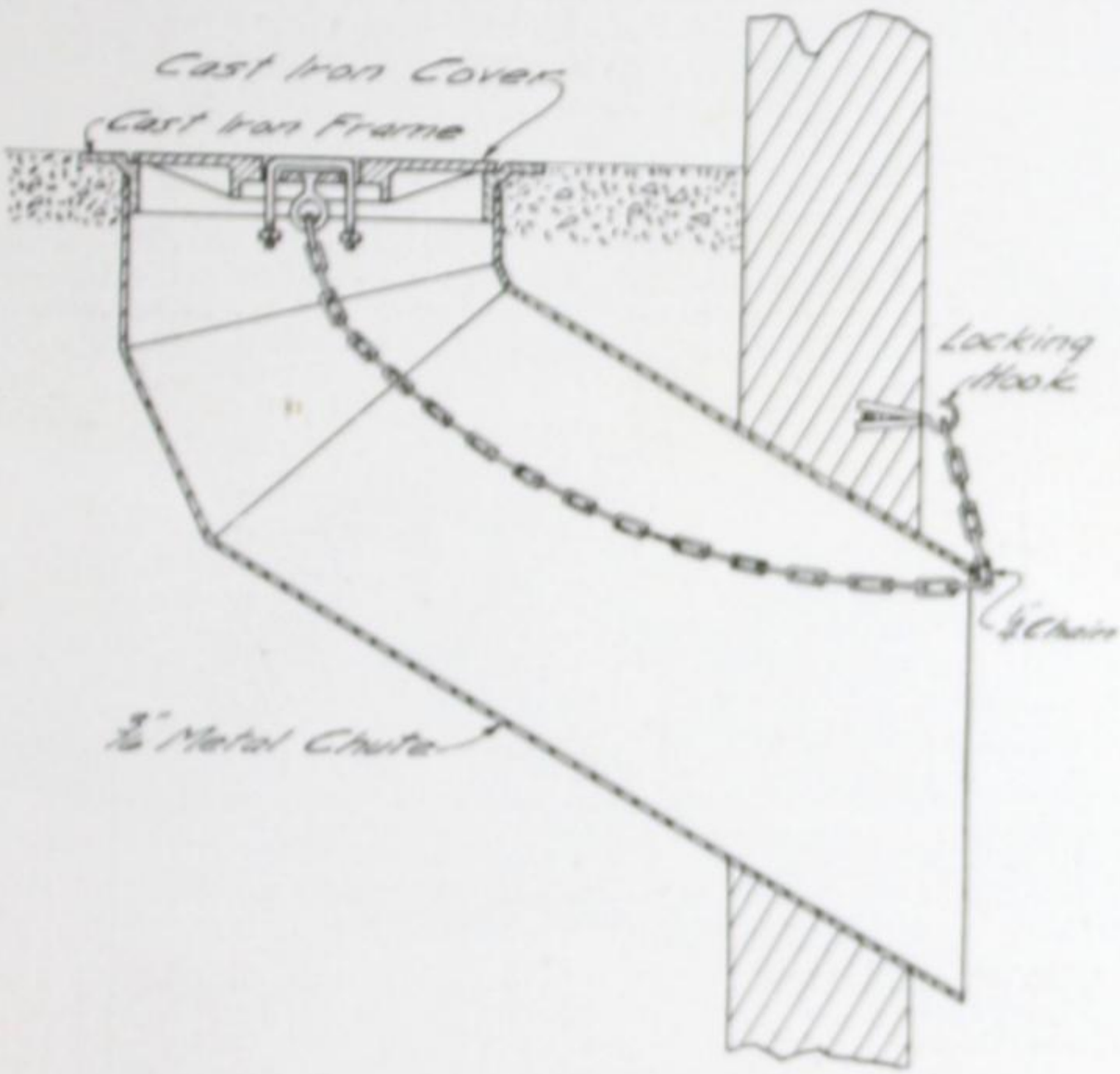
MADE IN THE FOLLOWING SIZES:

No.	Opening, In.	Depth Chute, In.	Weight, Lbs.
1	18 (diam.)	24	85
2	18 (diam.)	30	90
3	24 (diam.)	30	155

Also made in sizes to suit individual requirements.

ROUND SIDEWALK TYPE

Our Standard Design—This pattern of chute which passes through both sidewalk and wall is a popular style in cases where its use is suitable.



No. 113—Standard Sidewalk Chute

The heavy round cast cover fits into a frame built into the sidewalk. The chute passes down and through the adjoining wall into the interior of the building. The cover is fastened on the inside by a simple but effective locking device as shown in No. 113 above.

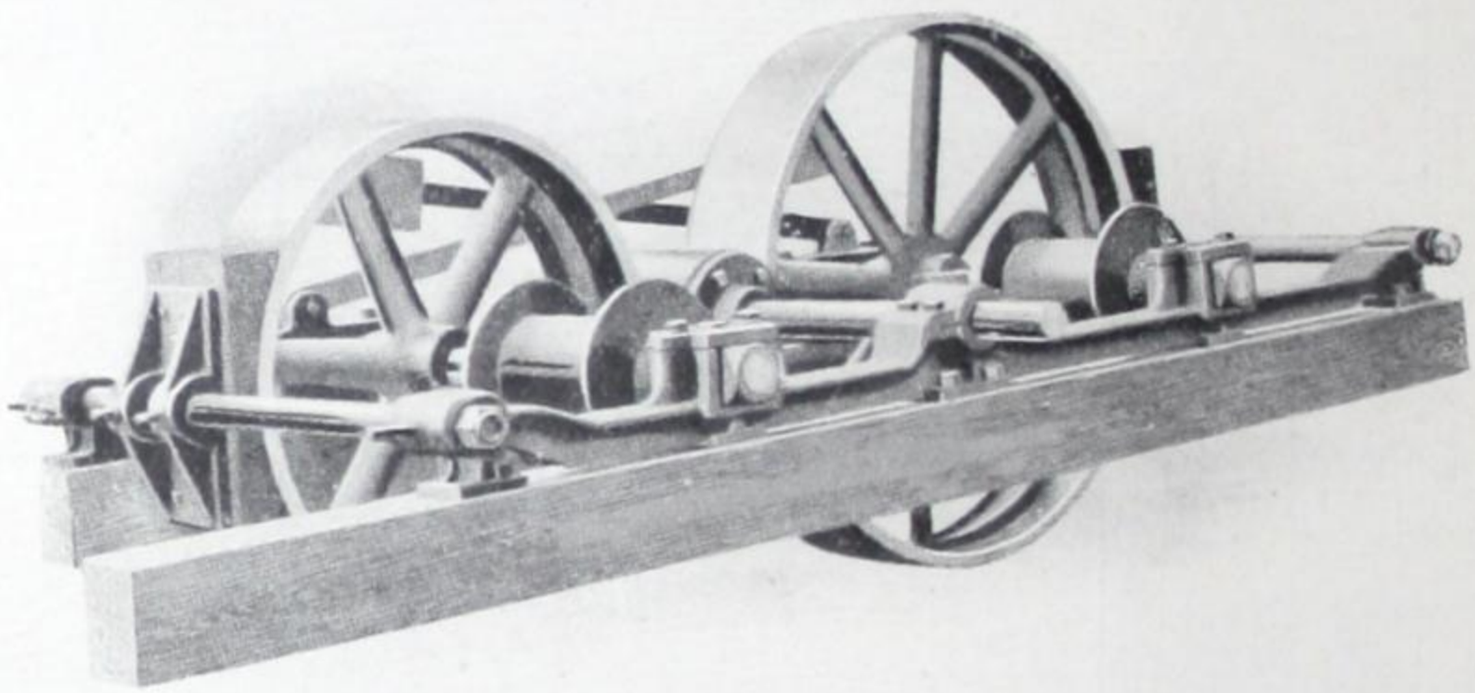
This chute is made in sizes to suit the specifications of the individual customer. Estimates gladly furnished.

PACKING HOUSE EQUIPMENT

We manufacture a varied range of equipment for use in abattoirs, cold storage plants, etc. In the design and construction of our products of this nature, every attention is given to assuring economical production in the packing industry. The following pages show some of the lines in which we specialize, but by no means indicate the limit of our ability; we can supply any requirement of this nature.

BEEF HOISTS

We can supply both single and double beef hoists to suit the requirements of any meat packer. The hoist shown on this page is a double hoist, equipped with heavy-rimmed friction wheels, accurately machined and balanced. The paper friction is constructed with a cast iron sleeve and held firmly by bolts through the paper and flanges.



No. 114—Beef Hoist

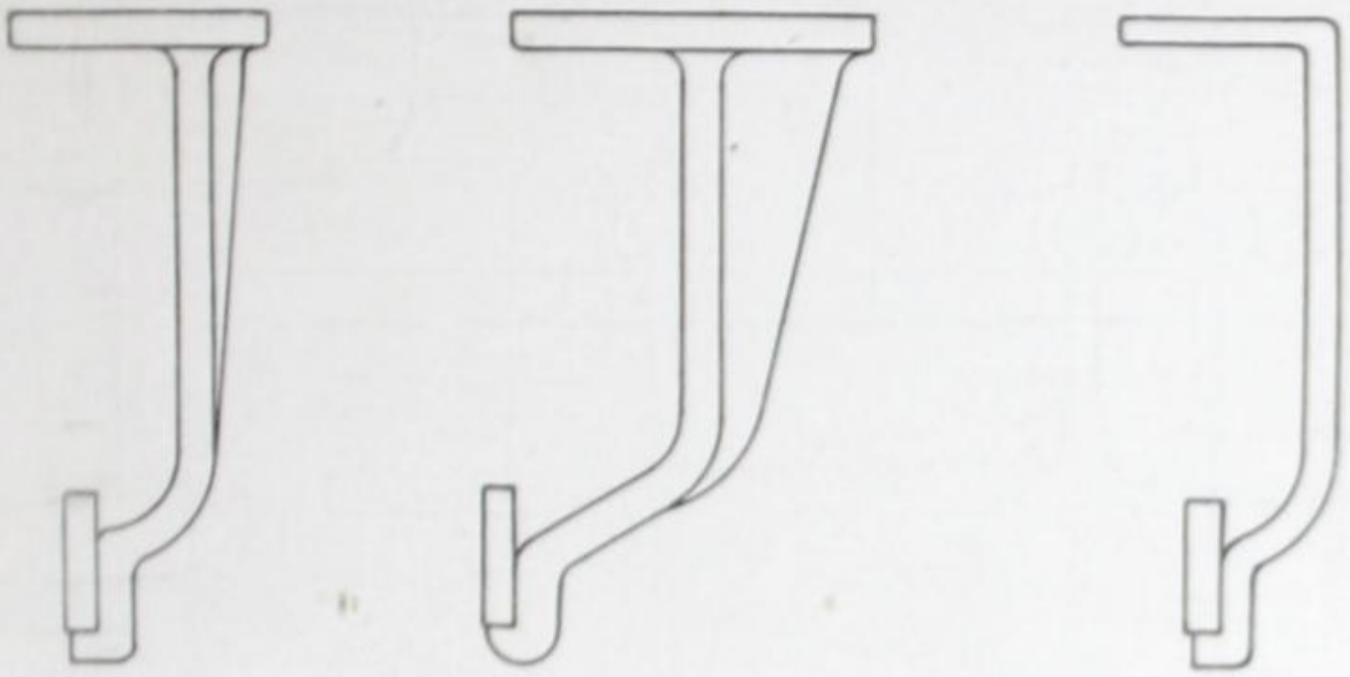
The frames are of a heavy flanged ribbed construction and are made from high-grade cast iron, same as is used for machine castings. They are machined on the bottom of the frame and the bearings are babbitted with high grade babbit in perfect alignment with the lower surface so that in erecting these frames on overhead timber or steel beams it is not necessary to use liners under frames to line them with other shafts.

The weight levers are forged from high-grade steel. The sliding boxes on the friction wheel shaft are designed so that there will always be a square contact on the paper friction by the friction wheels.

The brakes are adjustable so that the brake block can be set squarely and in perfect alignment on the face of the friction wheel. The tie rods are made of heavy steel. The line shaft carrying paper friction is not furnished unless specified in order.

In ordering, state whether single or double hoist is desired.

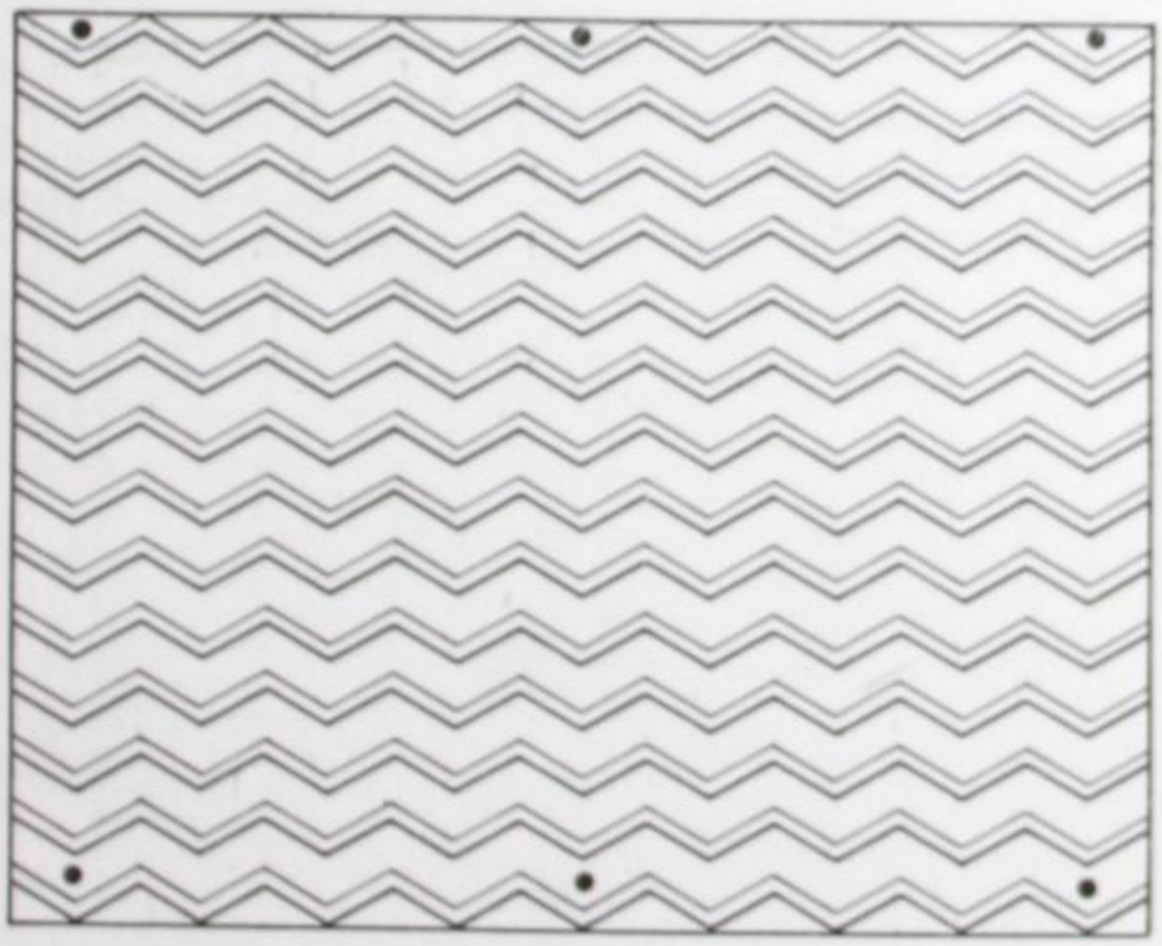
TRACK HANGERS



No. 115 No. 116 No. 117

The illustration above shows three standard types of hangers to support overhead tracking. They are the strongest hangers for their weight obtainable, and in them are incorporated all the latest improvements. No. 115 is a cast iron track hanger; No. 116 is a soft steel track hanger; No. 117 is a cast iron sticking rail hanger. In ordering, specify length of drop, width of track, and style desired. We also roll all different types of steel track.

PRITCH PLATES



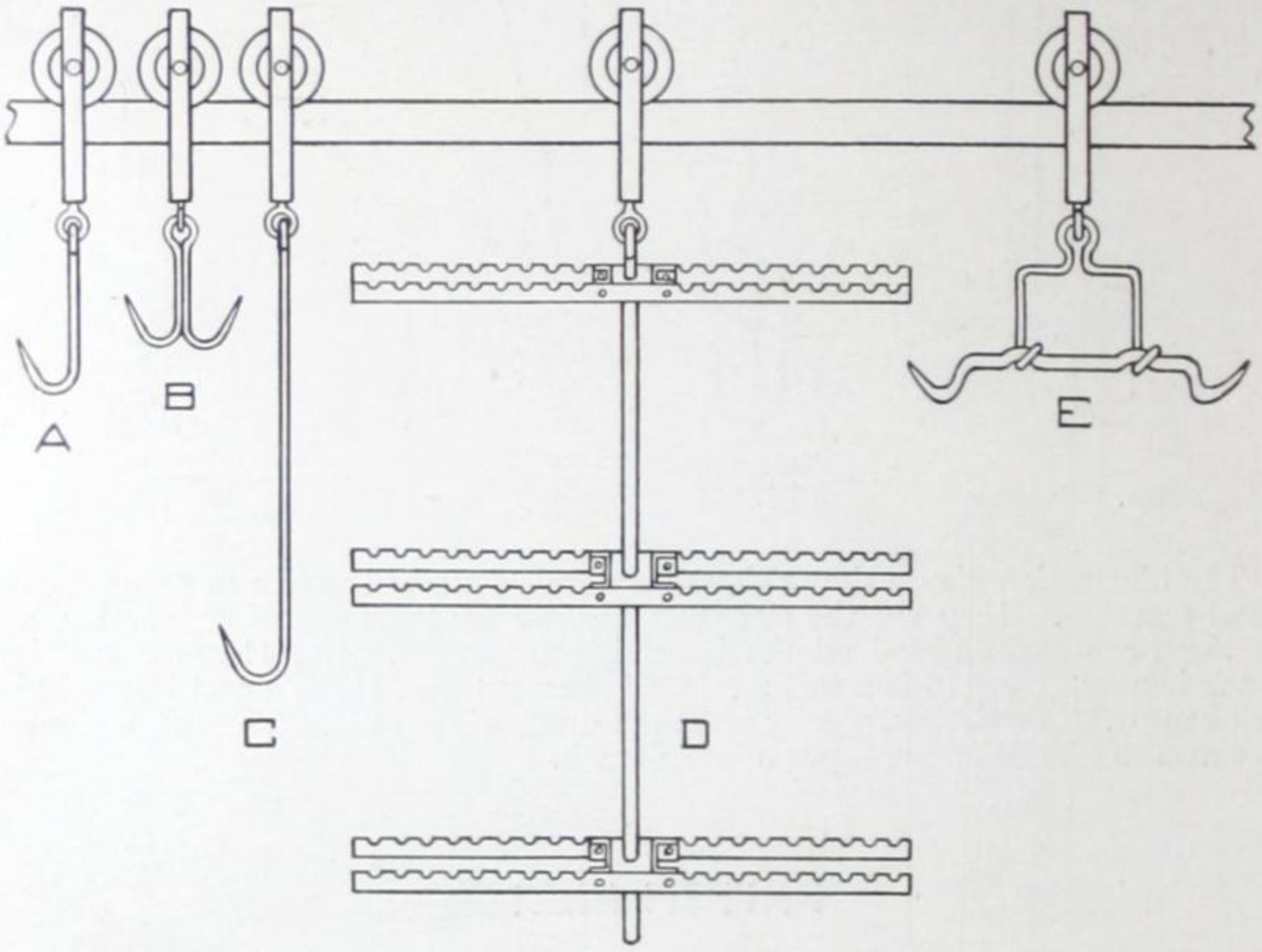
No. 118

Pritch plates for the beef dressing floor of heavy cast iron with special ribbed surface as illustrated above can be furnished in various sizes to suit conditions.

Made in different designs, varying in weight from 13 to 27 lbs. per square foot.

MEAT TROLLEYS

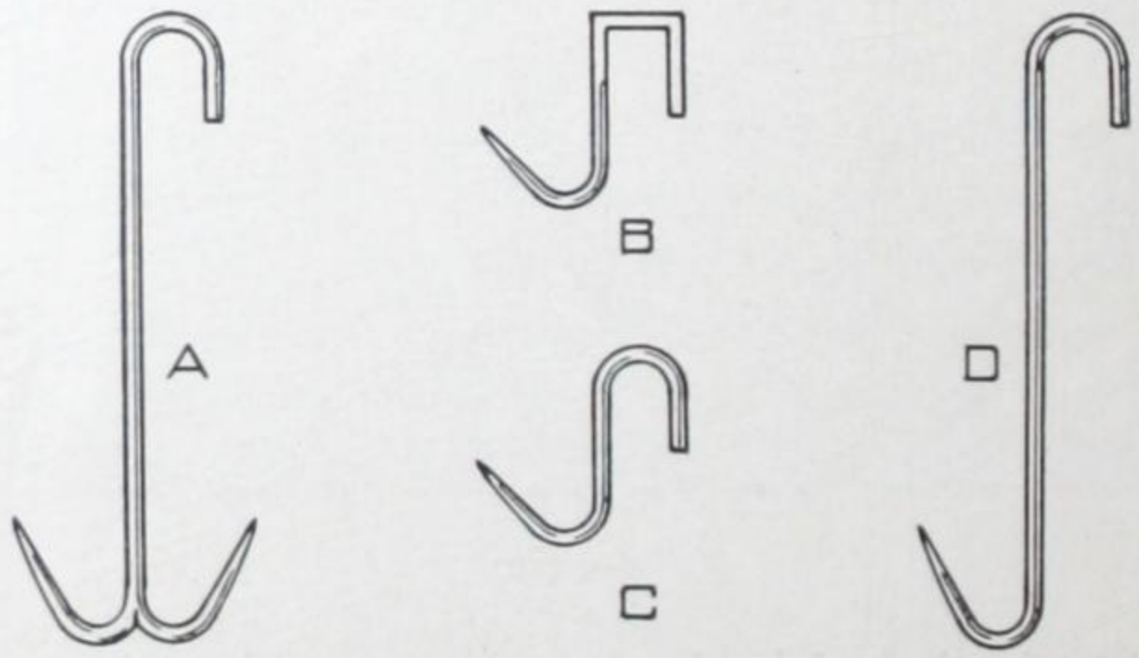
We can supply the most modern and improved designs of trolleys for packing-houses and markets. The wheels are machined in the groove and run on cold rolled steel pins, which makes them very easy to operate.



No. 119—Standard Meat Trolleys

In the illustration above, A represents a hind-quarter beef trolley; B, a double-hook sheep trolley; and C, a fore-quarter beef trolley. A three-station smoke-house trolley is shown by D, while E shows a hog trolley with steel gambrel. Other styles may be had to suit individual requirements.

CAR AND MEAT HOOKS



No. 120—Types of Meat Hooks

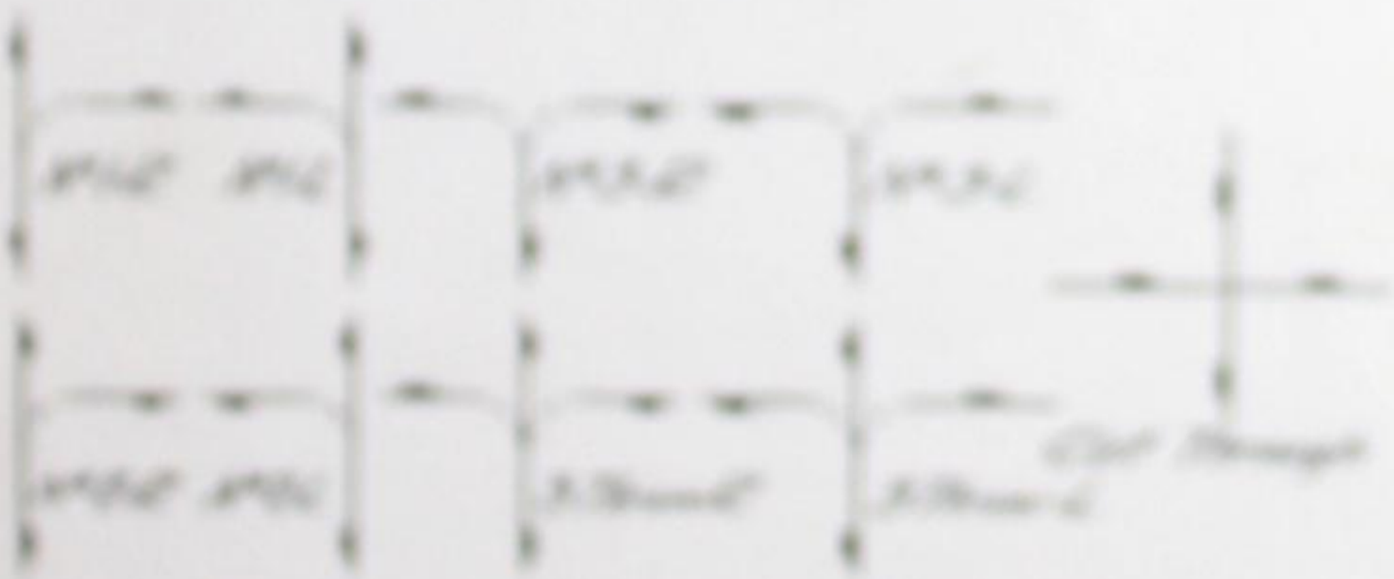
Above are shown some of the types of hooks made for packing-house use. Single and double car hooks are shown by A and D; C represents a shorter car hook, while B shows a meat hook. These hooks can be furnished black or tinned.

DUNCAN SWITCHES

No. 140 — Duncan Switch, Open.

No. 140 — Duncan Switch Closed.

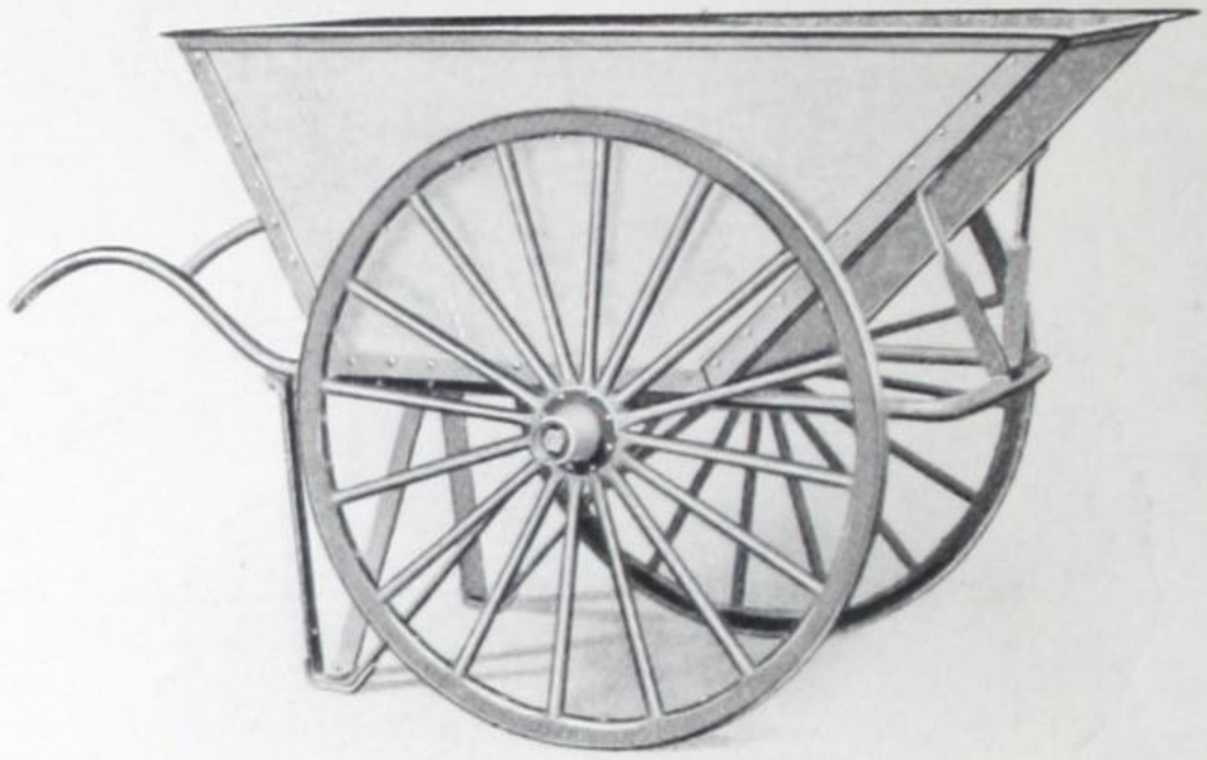
The Duncan is considered the easiest working switch on the market — a most important article. It is very convenient for operating on a high track, or where it is desirable to locate the operating handle at a distance from the track.



The above chart will aid in ordering switches. The solid black marks indicate the side of track the hangers should be placed upon to suit the particular switch to which the partners number on the chart refers.

PACKING-HOUSE TRUCKS

We can supply a variety of styles of meat trucks for packing-house use, which will prove well adapted to the style of work done by packers.



No. 123—Sanitary Meat Truck

A popular model is shown by No. 123 above. The body is made of No. 14 steel with all seams welded, which makes it easy to clean. It is made up complete and then galvanized so that all crevices are filled and the body is protected by the heaviest possible coat. Well-rounded corners insure the greatest possible sanitation. The reinforced edge is constructed by bending the sheet over and under, forming a beading which is perfectly smooth and free from crevices. All wheels are accurately fitted to the proper size and with a smooth-running fit on the axle, thereby reducing friction to the minimum.

No. 124—Tank-Charging Truck

The galvanized steel truck shown by No. 124 is well adapted for all work requiring the use of a round-nose truck. The body is made of No. 12 steel with welded seams, rounded corners and galvanizing features as in the model shown by No. 123.

Trucks can be constructed in sizes and styles to meet the ideas of the customer. Please furnish us with particulars and your requests will be accorded the closest attention.

RENDERING TANKS

Rendering tanks for any purpose, and in any size to suit the customer's demands, can readily be supplied by us.

The illustration at the left shows a typical closed rendering tank for separating grease from tankage and drain waters, as well as from condemned parts of animals.

It is constructed of heavy boiler steel, with large inlet and discharge openings, and is equipped with draw-off cocks to remove the grease. It can be supplied in any size and for any purpose. Estimates gladly furnished.

No. 135 (At Left)—Rendering Tank

LARD KETTLES

The type of round steel-jacketed lard kettle shown herewith is made in six standard sizes, varying from 25 to 200 gallons in capacity.

Fittings comprise air valve, drip valve, water gauge and stop cock for tapping the lard.

The table herewith gives the dimensions of the standard sizes of lard kettles.

Cap., Gal.	Diam. In.	Depth, In.	Height In.
25	22	18	42
50	28	20	43
75	28	29	52
100	34	26	48
150	38	31	51
200	44	32	53

No. 136—Lard Kettle

POLE LINE HARDWARE

We carry a full line of pole line hardware, available in stock sizes, as noted in the following paragraphs, or in additional sizes on special order; the material can be supplied either plain or galvanized by the "hot-dip" process.

Eye Bolts—These bolts can be made in any size desired and with eye welded

No. 127—Eye Bolt

or not welded and with square nut. Stocked in the following sizes and weights:

Size, In.	Weight per 100 Lbs.
5/8 x 20	227
5/8 x 22	240
5/8 x 24	260

Machine or Pole Bolts—This style of bolt has a square head and nut; sizes

No. 128—Machine Bolt

13 inches long and shorter have four inches of thread, while sizes longer than 13 inches have six inches of thread. The following sizes are stocked:

Size, In.	Weight per 100, Lbs.
5/8 x 10	101
5/8 x 12	117
5/8 x 14	133
5/8 x 15	140
5/8 x 16	150
5/8 x 18	171
5/8 x 20	192

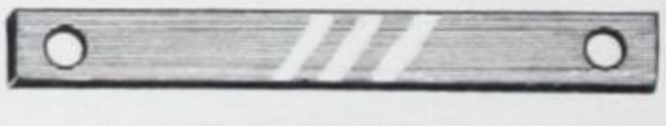
Double Arming Bolts—Made with two square nuts and four inches of thread

No. 129—Double Arming Bolt

on each end. Can be supplied to suit any specifications. Stock sizes are:

Size, In.	Weight per 100, Lbs.
5/8 x 12	131
5/8 x 14	150
5/8 x 16	170
5/8 x 18	190
5/8 x 20	212

Cross-Arm Braces—Standard cross-arm braces are one inch or 1¼-inch wide,



No. 130—Cross-Arm Brace

with 9/16-inch holes at ends, center of hole one inch from end of brace. Lengths are as specified. Stock sizes are:

Size, In.	Weight per 100, Lbs.
¼ x 1 x 24	167
¼ x 1 x 26	181
¼ x 1 x 28	195
¼ x 1 x 30	215
¼ x 1¼ x 24	212
¼ x 1¼ x 26	230
¼ x 1¼ x 28	247
¼ x 1¼ x 30	265

Transposition Brackets—These brackets are for use with glass or porcelain

No. 131—Transposition Bracket

insulators. Provided with square nut and round plate washer. Made to suit specifications; standard size is:

Size, In.	Weight per 100, Lbs.
4½ x 13½	207

Guy Clamps—Made of rolled steel with longitudinal groove to grasp wire; this groove may be made plain or with raised grip. Two-bolt for small sizes; others three-bolt. The following are the stock sizes:

No. 132—Two-bolt Guy Clamp

No. 133—Three-bolt Guy Clamp

Size, In.	Weight per 100, Lbs.
2-bolt x 3	93
3-bolt x 3	144
3-bolt x 6	163

Anchor Rods—Made with drop forged or long welded eye at one end and fitted

No. 134—Anchor Rod

with thread and square nut at other end. The following sizes are carried in stock:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
½ x 3	333	¾ x 6	975
½ x 6	398	¾ x 7	1125
¾ x 3	537	¾ x 8	1353
¾ x 6	620	¾ x 9	1435
¾ x 7	780	1 x 6	1806
¾ x 8	878	1 x 8	2269
¾ x 9	927		

Ground Rods—These rods are made of rolled steel and may be supplied drilled and pointed or drilled, pointed and wired. The following sizes are carried in stock:

Drilled and Pointed		Drilled, Pointed and Wired	
Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
½ x 72	443	½ x 72	630
¾ x 72	308	¾ x 72	373
¾ x 84	780	¾ x 84	800

Lag Screws—These screws are made with square head, cone-point drive and cut thread. We carry them in the following stock sizes:

Size In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
$\frac{3}{8}$ x 2	7	$\frac{3}{8}$ x 3½	11
$\frac{3}{8}$ x 2½	8½	$\frac{5}{8}$ x 4	41
$\frac{3}{8}$ x 3	10		

Pole Shims—The standard sizes of pole shims are as follows:

Size, In.	Weight per 100, Lbs.	Size, In.	Weight per 100, Lbs.
$\frac{3}{16}$ x 1 x 6	32	$\frac{3}{16}$ x 1 x 8	43

Wire Rope Thimbles—Made of iron or mild steel and stocked in the following sizes:

Size, In.	Weight per 100, Lbs.
$\frac{3}{8}$	7
½	12

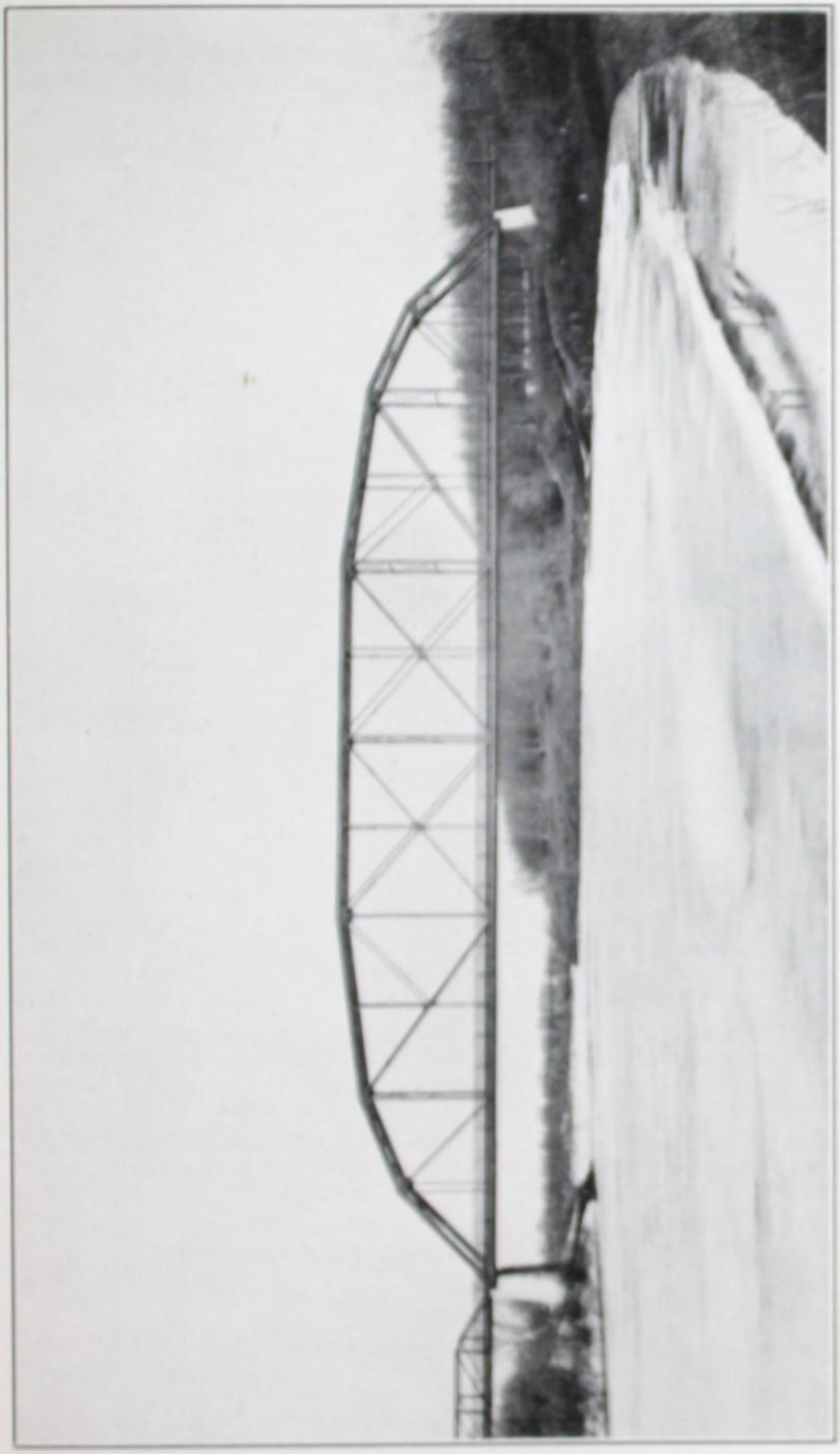
Square Washers—Made of pressed steel plate with punched hole. Following are stock sizes:

Size, In.	Weight per 100, Lbs.	Size, In	Weight per 100, Lbs.
2¼ x 2¼ x $\frac{3}{16}$	25	4 x 4 x ¼	115
2¼ x 2¼ x ¼	32	4 x 4 x $\frac{5}{16}$	140
2¼ x 2¼ x $\frac{5}{16}$	41	4 x 4 x $\frac{3}{8}$	170
4 x 4 x $\frac{3}{16}$	85	4 x 4 x ½	227

All the previously mentioned lines of pole line hardware can be supplied either plain or "hot-dip" galvanized, and to any specifications, whether provincial government telephones or railway telegraphs.

COMMERCIAL GALVANIZING

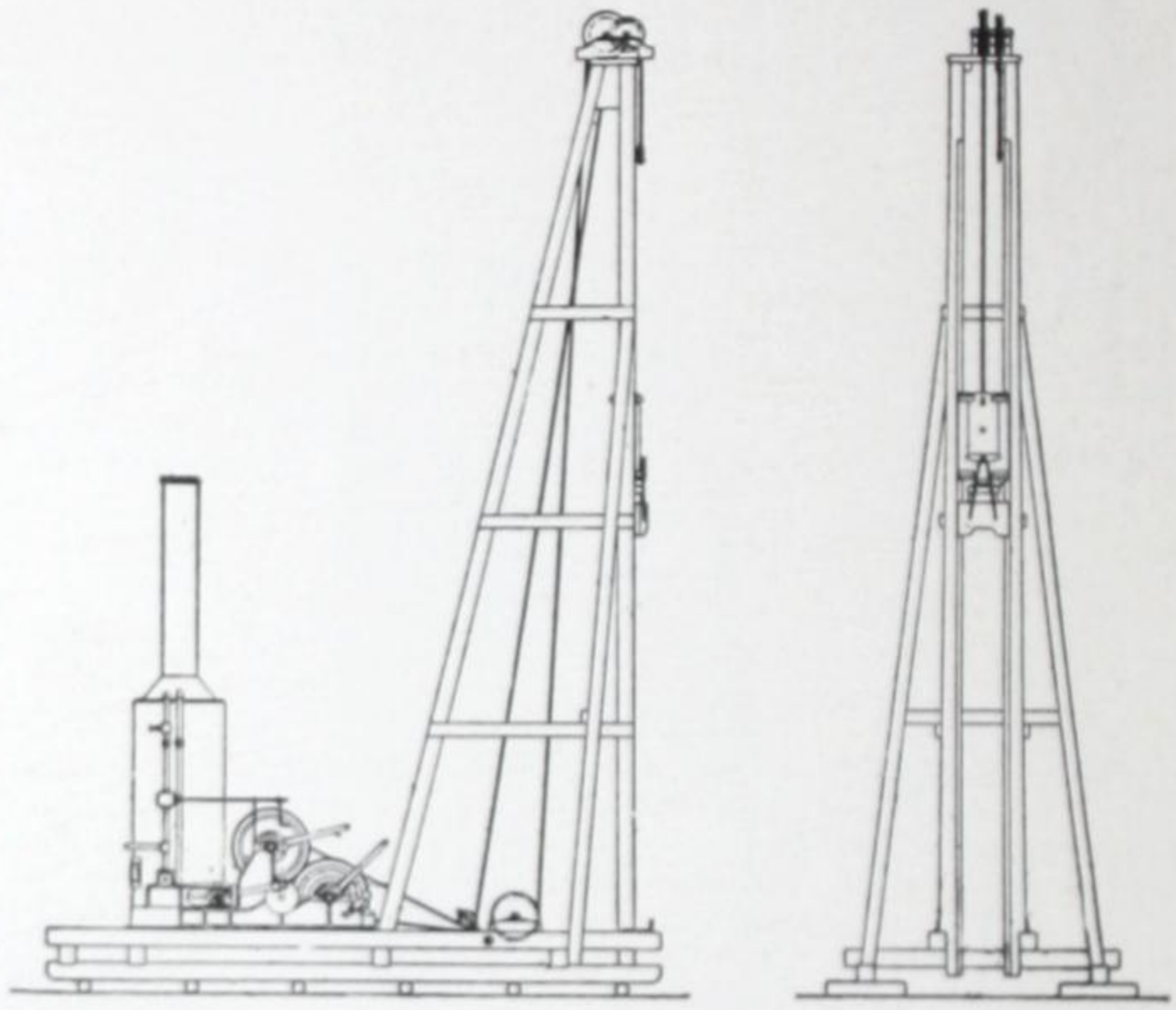
We are fully equipped to handle orders of galvanizing for special commercial purposes, such as tanks, bolts, angles, pump rods, castings, etc. This galvanizing can be done either by the "hot-dip" or by the cold electrolytic process.



No. 38.—336-Foot Highway Span over Red River, at Morris, Manitoba. Fabricated and Erected by The Manitoba Bridge and Iron Works, Limited

PILE-DRIVERS

We furnish all iron-work required for any style of pile-driver, but we do not handle the wooden portion of the frame-work. A full set of iron-work usually



No. 136—Contractor's Standard Pile-Driver with Extension Sills

consists of the following: Hammer, with steel pin fitted in; top sheaves; shafts; boxes and bolts; toggles with bolts; and channel iron liners with bolts and washers. When a pile cap is used, toggles are not required.

The illustration No. 136 shows a contractor's standard driver with extension sills, adapted to carry the engine. They are also constructed with shorter sills for use when the engine is located elsewhere or when it is necessary to move the leaders in a circle for the purpose of driving a number of piles in a limited area.

A special form of this driver can be arranged by leaving out the rollers under the sills and substituting rigid roller bearings. Four of these would be used, bolted directly to the lower sill, using either the 10-inch iron pipe or 10-inch oak rollers, the roller lying across the driver instead of lengthwise.

Other types of pile-drivers may be constructed to suit customers' specifications; our engineering department will make up designs of any kind of pile-driver for our customers without charge.

Prices on all iron-work will be supplied on request. When ordering or asking for prices, state fully dimensions of driver and give list of iron-work required.

PILE HAMMERS

No. 137—Pile Hammer

We have numerous patterns in stock from which we can supply pile-hammers of all sizes and weights; we are also able to make pile-followers to any specifications.

Illustration No. 137 shows a 2000-pound pile-hammer with diamond and nippers; iron castings of this variety can be turned out very promptly.

In designing, we aim to supply the best form of hammers suitable for the purpose, and we give careful attention to three points, viz.:

1. To get as much of the weight as possible in the bottom of the hammer.

2. To have the hammer as long as the size of leaders will permit; this gives longer bearing in the guides.

3. To have as little play as possible between the hammer and the leaders; this is required to obviate as much as possible the jar on the leaders at the moment of impact.

PILE-CAPS AND COVERS

In foundation work, piles are required to be driven below the surface sometimes 20 feet. When driven to the end of the leaders, a follower has to be used for the remaining distance. The follower cap shown by No. 138, is recessed on the bottom, the same as the pile cap, to fit over the pile. In its upper end the operator inserts and bolts a pile of the requisite length, with its upper end trimmed to fit into the pile cap or steam hammer. We supply these caps in two sizes: "A" size is for piles up to 12-inch diameter follower, and is six inches deep; the casting is 12 inches long over-all; "B" size is for pile up to 16 inches diameter; the upper recess is for a 14-inch diameter follower and is 8 inches deep; the casting is 13 inches long overall. Bolts are included. Write for prices stating what size is required.

No. 138—Follower Cap

To protect pile heads from the weather, and at the same time to serve as an efficient advertising medium, pile-head covers, as shown by No. 139, are used. On orders of two dozen or more, the name of the buyer will be cast in. Holes are drilled in sides of pile-head cover and counter-sunk. The regular sizes for this work are 11½ and 13½ inches diameter. We have a variety of patterns in stock. Write for prices, stating sizes.

No. 139—Pile-Head Cover

PILE POINTS OR "SHOES"

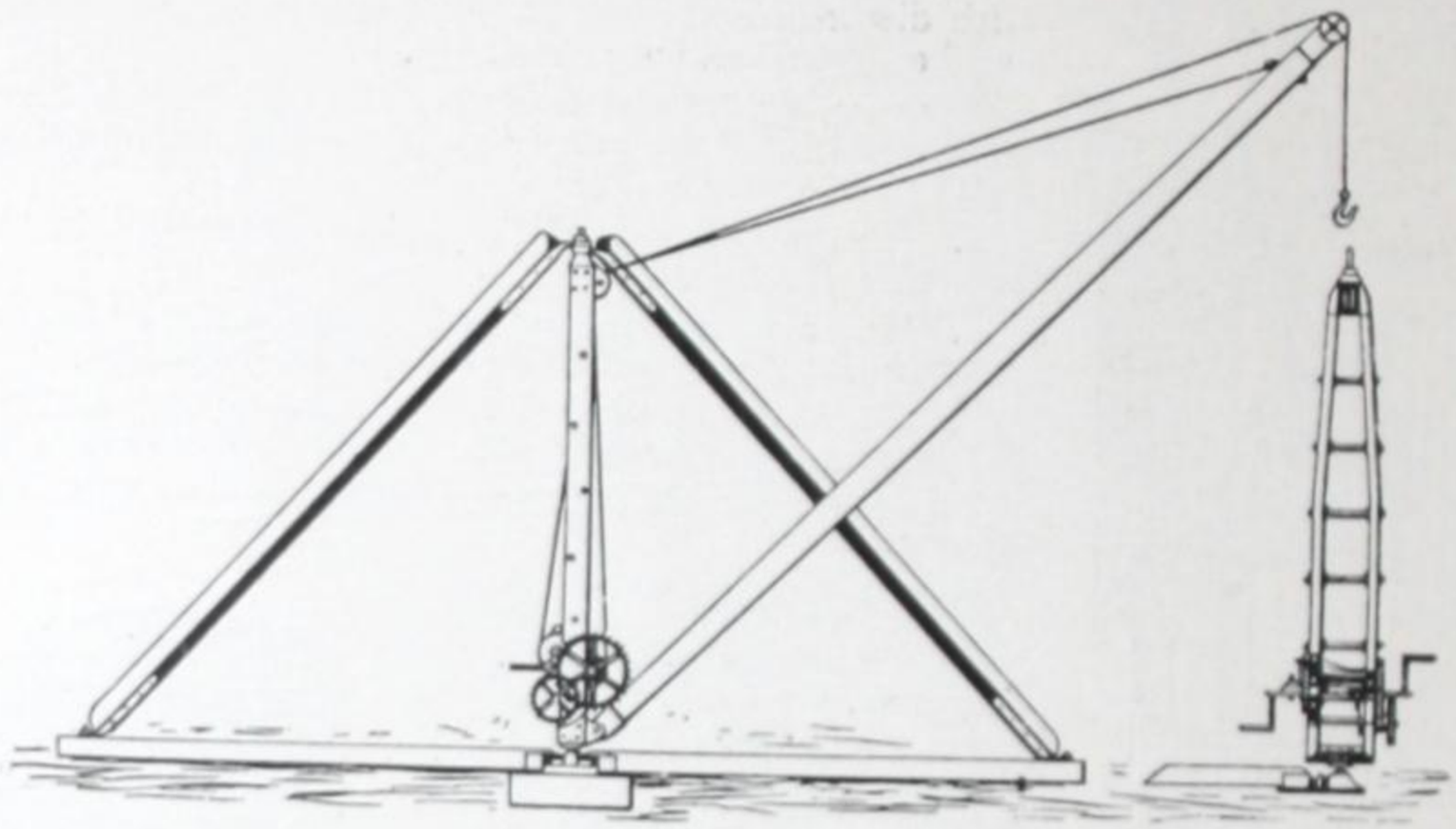
No. 140—Pile Shoe

Pile points are of great assistance in driving piles in hard soil and they prevent the piles from becoming broomed-up as a result of too great resistance. The shoe shown in No. 140 is usually made in 6-, 8- or 10- in. diameter, with respective weights of 35, 78 and 130 lbs., but other sizes can be supplied on orders. All sizes are measured on the upper or bearing end. Of course, these sizes will do for piles of much larger size, as the piles should be tapered to fit in the straps.

Estimates for any style of pile-point will gladly be submitted on request.

DERRICKS

We can supply iron-work for any type of contractors' or builders' derricks, especially of the Scotch and Stiff-Leg design. We make up special steel-angle derricks for use in steel erection and other heavy work.



No. 141—Scotch Derrick—(Hand Power).

SPECIFICATIONS FOR SCOTCH DERRICK

Capacity, Tons	Length Boom, Ft.	Weight, Lbs.	Rope Equipment			
			Diam. In.	Hoist, Ft.	Boom, Ft.	Total Feet
¾	25	2300	½	80	45	125
1	25	2400	½	130	55	185
1½	30–35	2700	⅝	140	65	205
2	35–40	3000	⅝	150	75	225
3	40–45	4200	¾	150	75	225
4	40–45	4800	¾	150	75	225
5	45–50	5700	¾	150	110	260

HORSE POWER OF AN ENGINE

a = area of piston in square inches.

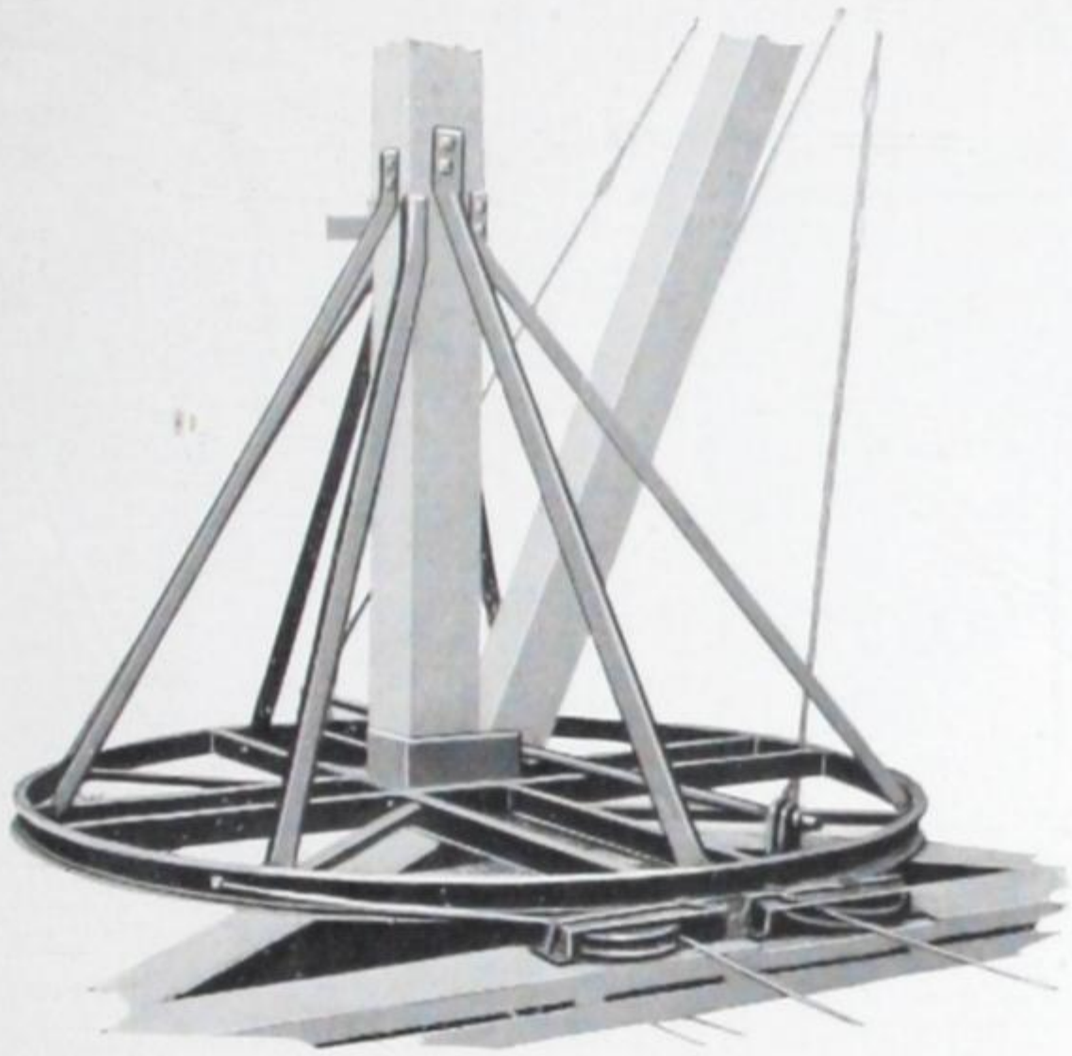
p = mean pressure of the steam on the piston per square inch.

v = velocity of piston per minute in feet.

Then H. P. $= \frac{a \times p \times v}{33000}$

DERRICK BULL-WHEELS

The bull-wheel, for swinging booms on power derricks is a most valuable feature in any derrick, and will save enough time and labor to pay for itself several times in a season. It may be attached, without changes, to any power derrick mast bottom.



No. 142—Derrick Bull-Wheel

It takes time and money to swing a derrick by hand with men pulling on the tag line when teams, cars or men are waiting for the derrick.

With a bull-wheel and derrick swinging engine, the engineer can lift the load and swing it into place in the time it takes to do the lifting only.

The accompanying illustration shows a 12-foot bull-wheel and gives a good view of the bracing to mast and boom.

STONE GRABS AND TONGS

We can supply promptly stone-setters' grabs or stone tongs of any capacity merely upon your specification of opening and maximum capacity. No. 143 shows a stone-setters' grab, which can be furnished suitable for any kind of stone. A common style of stone tong is shown by No. 144. Prices quoted upon request.

No. 143—Stone-Setters' Grab

No. 144—Stone Tongs

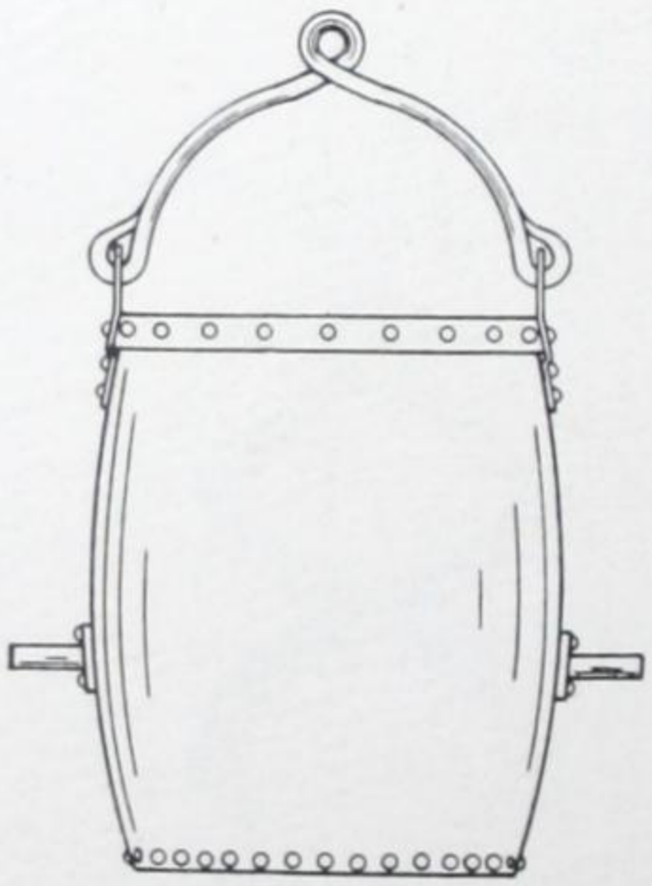
ORE BUCKETS

Ore buckets can be supplied in either the self-dumping style or in the regular side-lug type; in the former the bale is attached below the center of gravity and in the latter it is fixed to the bucket above the center of gravity.

Self-Dumping Type—The center-swing type of bucket for easy dumping is shown by No. 145. It is constructed throughout of $\frac{3}{16}$-inch steel, except in the 1½-cubic-yard size, in which the bottom is ¼-inch steel. The bail and trunnions are heavy, while the catch is strong, reliable and simple in operation. Specifications for this type of bucket follow:

No. 145 (At Right)—Self-Dumping Ore Bucket

Capacity	Diam. Top, In.	Diam. Bottom, In.	Depth, In.	Weight, Lbs.
8 Cubic Feet	26	23	27	240
10 Cubic Feet	29	25	30	300
½ Cubic Yard	32	27	35	360
¾ Cubic Yard	36	31	40	430
1 Cubic Yard	39	34	45	500
1½ Cubic Yards	45	40	50	650



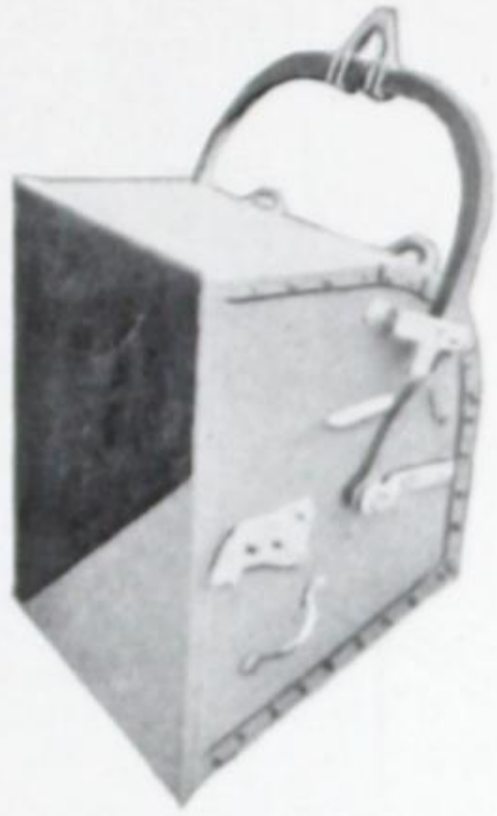
Regular Type—The sides and bottom of this style of bucket, illustrated by No. 146, are made of $\frac{3}{16}$-inch steel, pressed into shape by hydraulic pressure. The sides have welded or countersunk-rivetted seams to prevent catching upon sides of shaft. Banded around top. This bucket can be constructed in any size to suit any specification. Estimates furnished on request.

No. 146 (At Left)—Regular Style Ore Bucket

CONTRACTORS' BUCKETS

We can construct self-dumping and self-righting contractors' buckets to suit individual requirements. Steel plate, $\frac{3}{16}$-inch, is used, securely rivetted. The

No. 147—Self Dumping Bucket

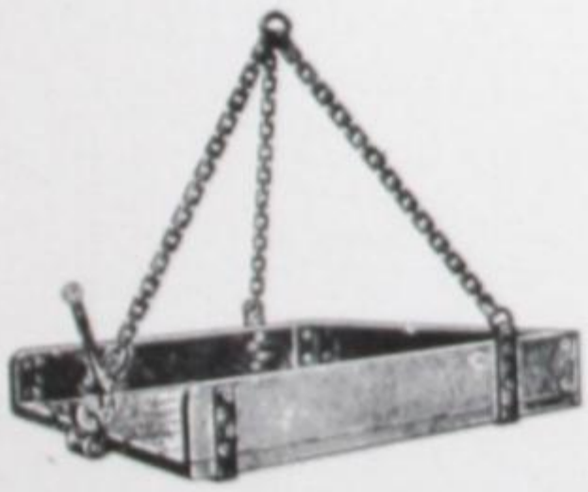


No. 148—Self-Righting Bucket

illustrations show both types of contractors' buckets, self-dumping and self-righting, in typical patterns. Write for prices giving full particulars as to height-diameter, capacity, etc.

DERRICK SKIPS

Derrick skips for handling stone, clay, earth, etc., can be supplied in either steel or wood construction and in any design required. The skip shown in No. 149 is constructed of well-ironed two-inch oak in any capacity specified, usually one



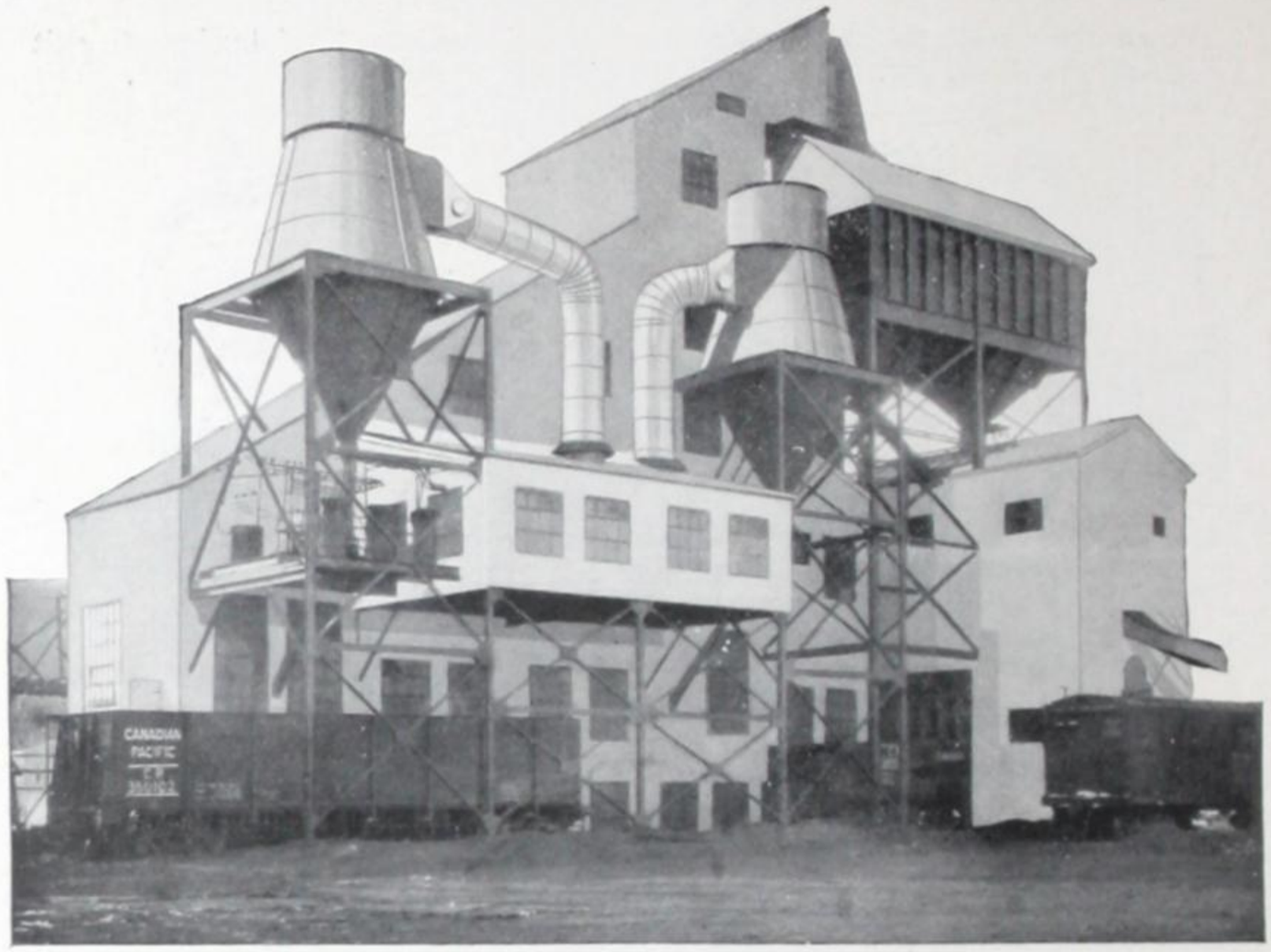
No. 149—Wooden Derrick Skip

No. 150—Steel Derrick Skip

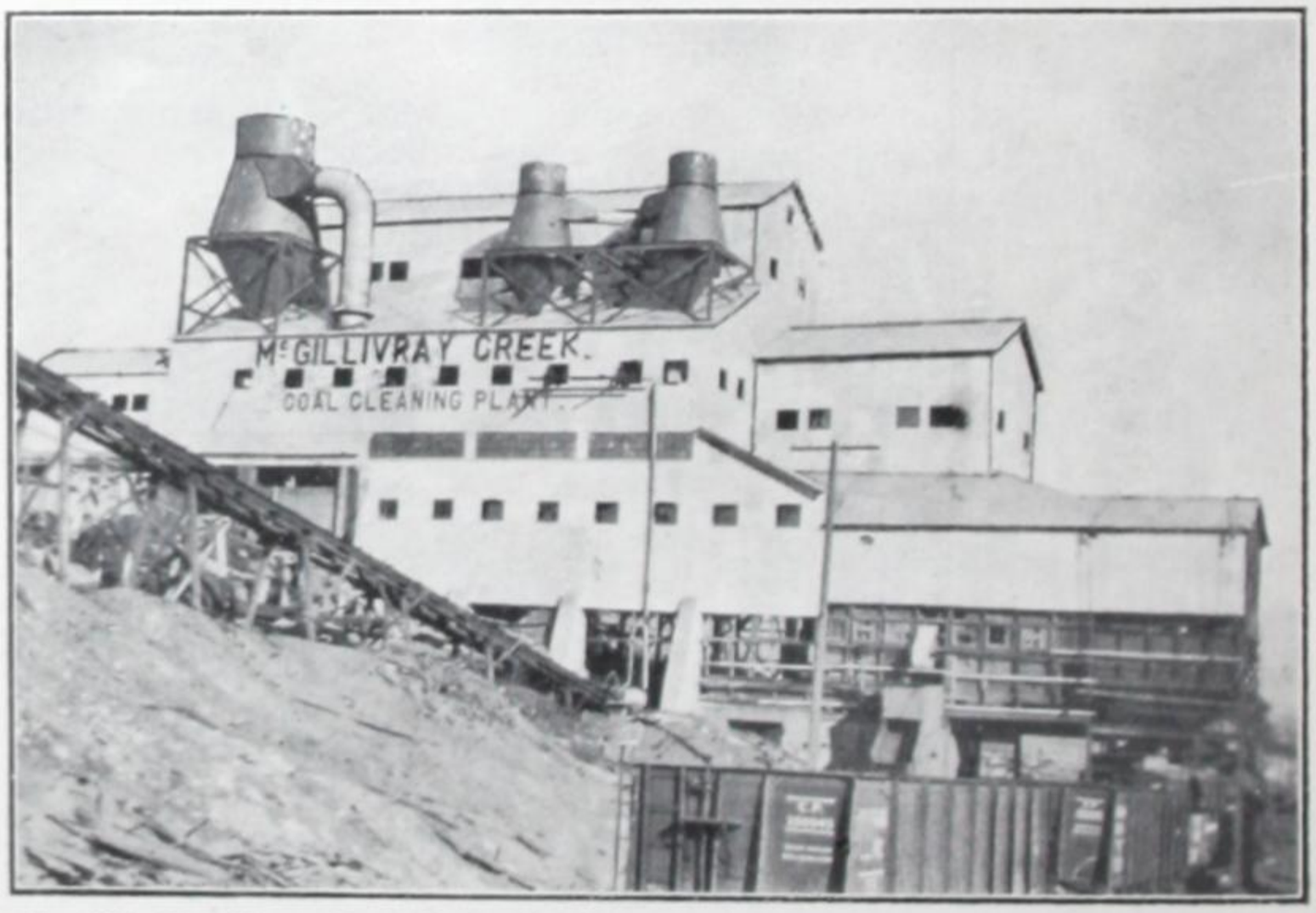
or two cubic yards. No. 150 illustrates the steel derrick skip of which the standard capacity is 35 cubic feet. The box is constructed of No. 8 steel, well rivetted and braced, with angle corners and flat top band, and supported by three $\frac{1}{2}$-inch diameter chains. Heavier skips of any size can be supplied on order.

When ordering or asking for prices specify full dimensions, thickness of plate or wood desired, where chains are to be attached, etc.

COAL-MINING EQUIPMENT



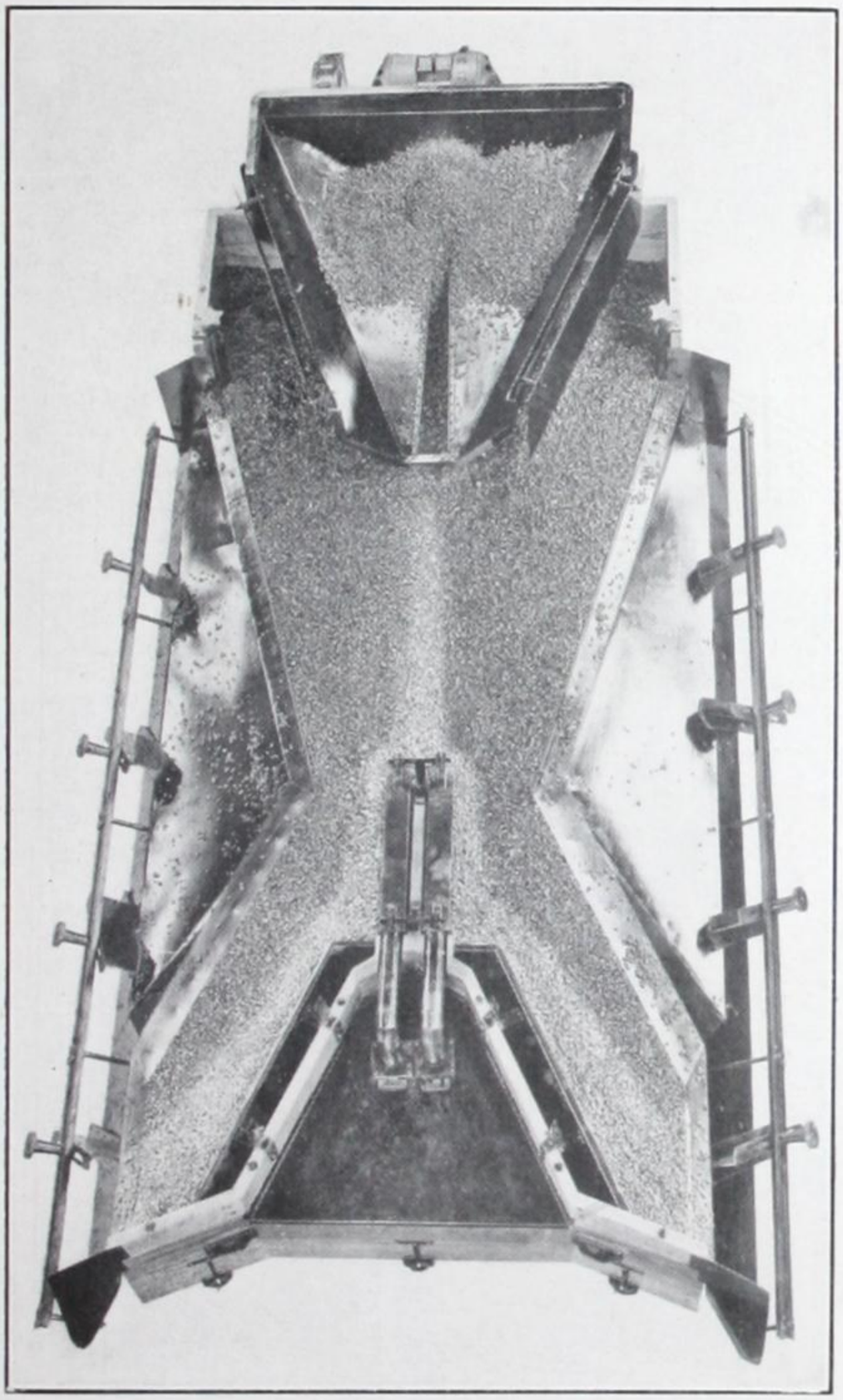
No. 151—Steel Tipple and Pneumatic Cleaning Plant of the International Coal and Coke Company, Coleman, Alta.



No. 152—McGillivray Creek Coal and Coke Co.'s Steel Tipple and Pneumatic Cleaning Plant at Coleman, Alta.

We design, fabricate and erect coal-mining buildings and equipment of all kinds, including pneumatic tables for coal-cleaning, Marcus screens, rotary dumps,

shaking, rotary and bar screens, weigh pans, pan, belt, scraper and Eickhoff conveyors, elevators, belt and chain car irons, steel car ends, steel rock cars, spiral separators, etc. We specialize particularly in all-steel coal tipples and have done work for many of the prominent Western Canadian mines including Regal, Luscar, Mercoal, Cadomin, International, McGillivray and West Canadian Collieries.

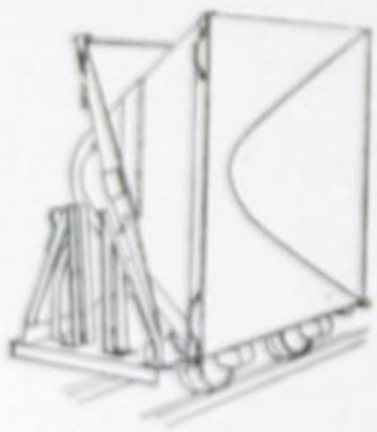


No. 153—Air-Cleaning Y- Table.

The illustration above conveys a good idea of the definite stream-line between rock and coal on the pneumatic table. These tables are manufactured by us at Winnipeg under license from the American Coal Cleaning Corporation, Welch, W.Va. Three Y- and three SJ-tables are installed in the International plant, five Y- and one SJ-table at the McGillivray plant, and two SJ-tables at the West Canadian Collieries' Bellevue plant.

MINE CARS

All-steel dump cars for carrying stone, clay, earth, cinders, ashes, coal, concrete, etc., can be supplied according to specifications. These cars may have rocker or rotary dump arrangement.



No. 154—Rocker Dump Car

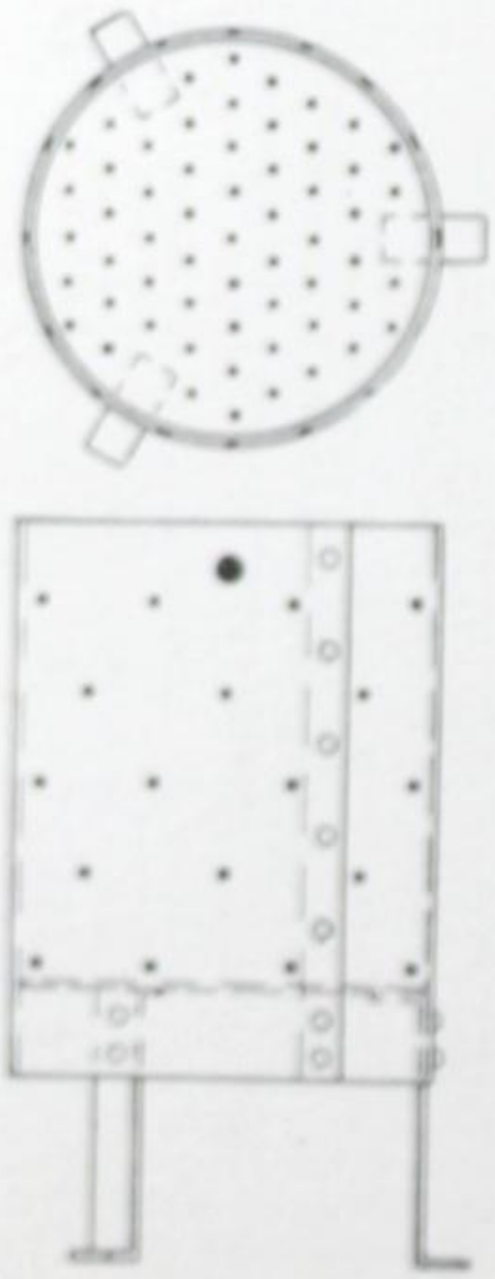
No. 155—Rotary Dump Car

The rocker type of side-dump car is seen in No. 154 above, in dumping position. The dumping arrangement is positive and easily worked, none of the contents falling between the rails; box can be held in a slanting position for convenience in loading.

A scoop-box dump car of rotary type is illustrated in dumping position by No. 155. The body is supported on a wrought steel turn-table and is securely locked to the truck by a treadle catch; when unlocked, body is swung on its turn-table, permitting the load to be dumped at the end or either side.

All cars are made of ⅛-inch steel plate riveted. We are prepared to design and manufacture all steel cars for any purpose whatever. Wheels, axles, trucks, etc., will also be furnished without the cars if wanted. We have a number of patterns of car wheels in stock and can promise quick delivery of material.

For coal mines we can supply complete sets of irons for use with wooden cars; we also manufacture steel plate ends for wooden cars.



FIELD STOVES

Field stoves or salamanders are used by contractors, water supply companies, and others, for heating lead on construction work, for heating buildings under construction, and for similar purposes.

The sides of the stoves are of No. 14-gauge plate, rivetted; the grate is of ½-inch cast iron plate, perforated.

Field stoves may be supplied with or without handle, as desired.

All sizes of field stoves can be made to order. Other patterns are available if desired.

In writing for prices, state sizes required and specify preference as to patterns.

No. 156 (At Left)—Field Stove or Salamander.

COAL AND ASH HANDLING EQUIPMENT

We design, fabricate and erect coal and ash handling equipment for power houses. At the Canada Gas and Electric Company, Brandon, we supplied and erected the 600-ton suspension steel bunker with elevators, conveyors, spouts, etc.

No. 167—Colonial Brandon Power-house (Before) (exterior View Showing Coal-Handling Equipment

We also make machinery, bunkers, elevators, etc., for 40-, 100- and 200-ton coal docks on the C. P. and C. N. Rys. We have all patterns, and carry spares in stock.

SEAMLESS BOILER TUBES

WEIGHTS AND DIMENSIONS

External Diam.	MINIMUM STANDARD THICKNESS		Nominal Weight per Foot in Pounds					
			STANDARD THICKNESS		ONE EXTRA WIRE GAUGE		TWO EXTRA WIRE GAUGES	
In.	Birmingham Wire Gauge	Inches	Exact Theoretical Weight	Approx. Manufact'g Weight	Exact Theoretical Weight	Approx. Manufact'g Weight	Exact Theoretical Weight	Approx. Manufact'g Weight
1	13	.095	.92	1.06	1.04	1.20	1.13	1.30
1¼	13	.095	1.17	1.34	1.33	1.53	1.45	1.67
1½	13	.095	1.42	1.63	1.62	1.86	1.77	2.03
1¾	13	.095	1.68	1.93	1.91	2.20	2.09	2.40
2	13	.095	1.93	2.22	2.20	2.53	2.41	2.77
2¼	13	.095	2.19	2.52	2.49	2.86	2.73	3.14
2½	12	.109	2.78	3.20	3.05	3.51	3.39	3.90
2¾	12	.109	3.07	3.53	3.37	3.87	3.74	4.30
3	12	.109	3.37	3.87	3.69	4.24	4.10	4.71
3¼	11	.120	4.01	4.61	4.46	5.00	4.90	5.63
3½	11	.120	4.33	4.98	4.82	5.54	5.30	6.09
4	10	.134	5.53	6.36	6.09	7.00	6.76	7.77
4½	10	.134	6.25	7.18	6.88	7.91	7.64	8.78
5	9	.148	7.67	8.82	8.52	9.79	9.27	10.66
6	8	.165	10.28	11.82	11.19	12.86	12.57	14.45

External Diam.	MINIMUM STANDARD THICKNESS		THREE EXTRA WIRE GAUGES		FOUR EXTRA WIRE GAUGES	
			Exact Theoretical Weight	Approx. Manuf'g Weight	Exact Theoretical Weight	Approx. Manuf'g. Weight
In.	Birmingham Wire Gauge	Inches				
1	13	.095	1.24	1.43	1.35	1.55
1¼	13	.095	1.60	1.84	1.74	2.00
1½	13	.095	1.95	2.24	2.14	2.46
1¾	13	.095	2.31	2.66	2.53	2.91
2	13	.095	2.67	3.07	2.93	3.37
2¼	13	.095	3.02	3.47	3.32	3.82
2½	12	.109	3.72	4.28	4.12	4.74
2¾	12	.109	4.11	4.72	4.56	5.24
3	12	.109	4.51	5.18	5.00	5.75
3¼	11	.120	5.44	6.25	5.90	6.78
3½	11	.120	5.88	6.76	6.38	7.33
4	10	.134	7.34	8.44	8.23	9.46
4½	10	.134	8.30	9.54	9.32	10.71
5	9	.148	10.40	11.95	11.23	12.91
6	8	.165	13.58	15.61	14.65	16.84

Boiler tubes to special specifications, if desired.

BOILER TUBES

STANDARD DIMENSIONS

Diameter, In.		Nominal Thickness, In.	Nearest B.W.G. Gauge Number	Circumference, In.		Transverse Areas, Sq. In.			Length Tube per Sq. Ft., Feet		Nominal Wt. per Ft., Lbs.
External	Internal			External	Internal	External	Internal	Metal	External	Internal	
1	.810	.095	13	3.142	2.545	.785	.515	.270	3.819	4.715	.90
1¼	1.060	.095	13	3.927	3.330	1.227	.882	.344	3.056	3.603	1.15
1½	1.310	.095	13	4.712	4.115	1.767	1.347	.419	2.547	2.916	1.40
1¾	1.560	.095	13	5.498	4.901	2.405	1.911	.494	2.183	2.448	1.66
2	1.810	.095	13	6.283	5.686	3.142	2.573	.569	1.909	2.110	1.91
2¼	2.060	.095	13	7.069	6.472	3.976	3.333	.643	1.698	1.854	2.16
2½	2.282	.109	12	7.854	7.169	4.909	4.090	.819	1.528	1.674	2.75
2¾	2.532	.109	12	8.639	7.954	5.940	5.035	.905	1.390	1.508	3.04
3	2.782	.109	12	9.425	8.740	7.069	6.079	.990	1.273	1.373	3.33
3¼	3.010	.120	11	10.210	9.456	8.296	7.116	1.180	1.175	1.269	3.96
3½	3.260	.120	11	10.996	10.242	9.621	8.347	1.274	1.091	1.172	4.28
3¾	3.510	.120	11	11.781	11.027	11.045	9.676	1.369	1.018	1.088	4.60
4	3.732	.134	10	12.566	11.724	12.566	10.939	1.627	.955	1.024	5.47
4½	4.232	.134	10	14.137	13.295	15.904	14.066	1.838	.849	.902	6.17
5	4.704	.148	9	15.708	14.778	19.635	17.379	2.256	.764	.812	7.58
6	5.670	.165	8	18.850	17.813	28.274	25.249	3.025	.637	.673	10.16
7	6.670	.165	8	21.991	20.954	38.485	34.942	3.543	.546	.573	11.90
8	7.670	.165	8	25.133	24.096	50.266	46.204	4.062	.477	.498	13.65
9	8.640	.180	7	28.274	27.143	63.617	58.629	4.988	.424	.442	16.76
10	9.594	.203	6	31.416	30.140	78.540	72.292	6.248	.382	.398	21.00
11	10.560	.220	5	34.558	33.175	95.033	87.583	7.451	.347	.362	25.00
12	11.542	.229	4½	37.699	36.260	113.098	104.629	8.469	.319	.331	28.50
13	12.524	.238	4	40.841	39.345	132.733	123.190	9.543	.294	.305	32.06
14	13.504	.248	3½	43.982	42.424	153.938	143.224	10.714	.273	.283	36.00
16	15.460	.270	2½	50.265	48.569	201.060	187.710	13.350	.239	.247	45.20

We carry in stock and can supply copper ferrules for seamless or lap-welded boiler tubes.

NOTE.—In estimating effective steam-heating or evaporating surface of tubes, the surface in contact with air or gases of combustion, according to manner of application, as whether internal or external, is to be thus taken. For heating liquids by steam, superheating steam, or transferring heat from one liquid or one gas to another, mean surface of tubes to be computed. Stock lengths, 12, 14, 16, 18 and 20 feet.

HORSE-POWER OF ANY BOILER

It is general practice to base the computation of the horsepower of ordinary boilers on the following rule:

Estimate the total heating surface in square feet. This is equal to the surface area of all the tubes, plus two-thirds the surface of the shell and both tube sheets minus the area of the tube holes. Then allow one horsepower for every fifteen square feet of heating surface in horizontal tubular boilers and one horse-power for every 11½ square feet of heating surface in water tube boilers.

STANDARD WROUGHT MERCHANT PIPE
FOR STEAM, WATER, GAS AND OIL

Nominal Inside Diam., In.	Thick-ness, In.	Nominal Wt. per Ft., Lbs.	No. of Threads per In. of Screw	Nominal Inside Diam., In.	Thick-ness, In.	Nominal Wt. per Ft., Lbs.	No. of Threads per In. of Screw
1/8	.068	.24	27	3 1/2	.226	9.00	8
1/4	.088	.42	18	4	.237	10.66	8
3/8	.091	.56	18	4 1/2	.246	12.34	8
1/2	.109	.84	14	5	.259	14.50	8
3/4	.113	1.12	14	6	.280	18.76	8
1	.134	1.67	11 1/2	7	.301	23.27	8
1 1/4	.140	2.24	11 1/2	8	.322	28.18	8
1 1/2	.145	2.68	11 1/2	9	.344	33.70	8
2	.154	3.61	11 1/2	0	.366	40.06	8
2 1/2	.204	5.74	8	1	.375	45.02	8
3	.217	7.54	8	2	.375	49.00	8

Stock lengths of merchant pipe are 19, 21 and 22 feet.

"XX" STRONG PIPE

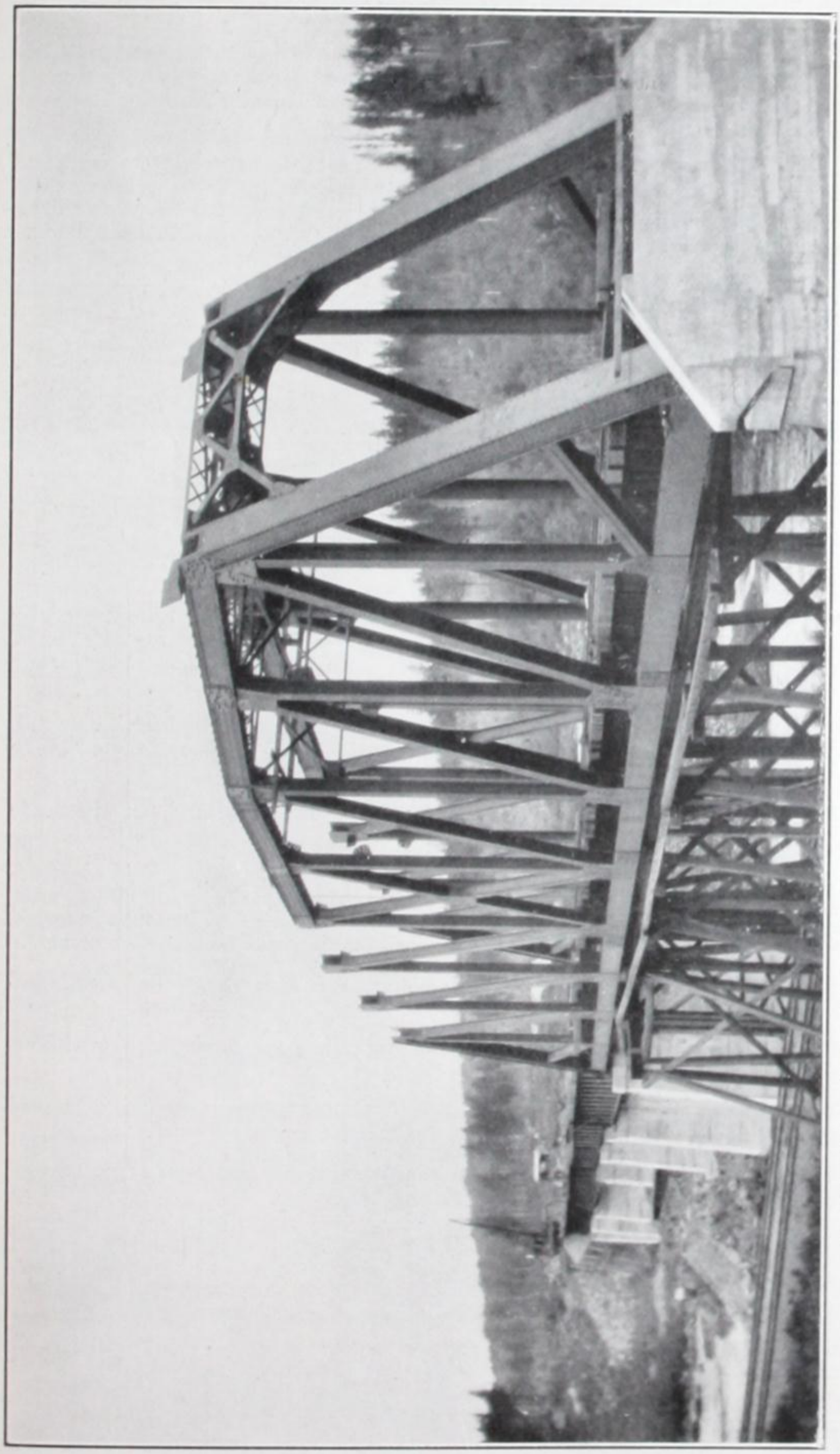
Size, In.	Actual Out-side Diam., In.	Nom-inal Inside Diam., In.	Thick-ness, In.	Nom-inal Wt. per Ft., Lbs.	Size, In.	Actual Out-side Diam., In.	Nom-inal Inside Diam., In.	Thick-ness, In.	Nom-inal Wt. per Ft., Lbs.
1/2	.84	.244	.298	1.70	3 1/2	4.00	2.716	.642	22.75
3/4	1.05	.422	.314	2.44	4	4.50	3.136	.682	27.48
1	1.315	.587	.364	3.65	4 1/2	5.00	3.56	.72	32.53
1 1/4	1.66	.885	.388	5.20	5	5.563	4.063	.75	38.12
1 1/2	1.90	1.088	.406	6.40	6	6.625	4.875	.875	53.11
2	2.375	1.491	.442	9.02	7	7.625	5.875	.875	62.38
2 1/2	2.875	1.755	.560	13.68	8	8.625	6.875	.875	71.62
3	3.50	2.284	.608	18.56					

Stock lengths of "XX" Pipe are 19, 21 and 22 feet. This class of pipe is always shipped, plain ends, unless otherwise specified.

The outside diameters of "XX" pipe are the same as standard, the extra thickness decreasing the inside diameter.

CAST IRON PIPE

We manufacture cast iron specials of all classes, in elbows, tees, bends, etc., and will send estimates on receipt of specifications.

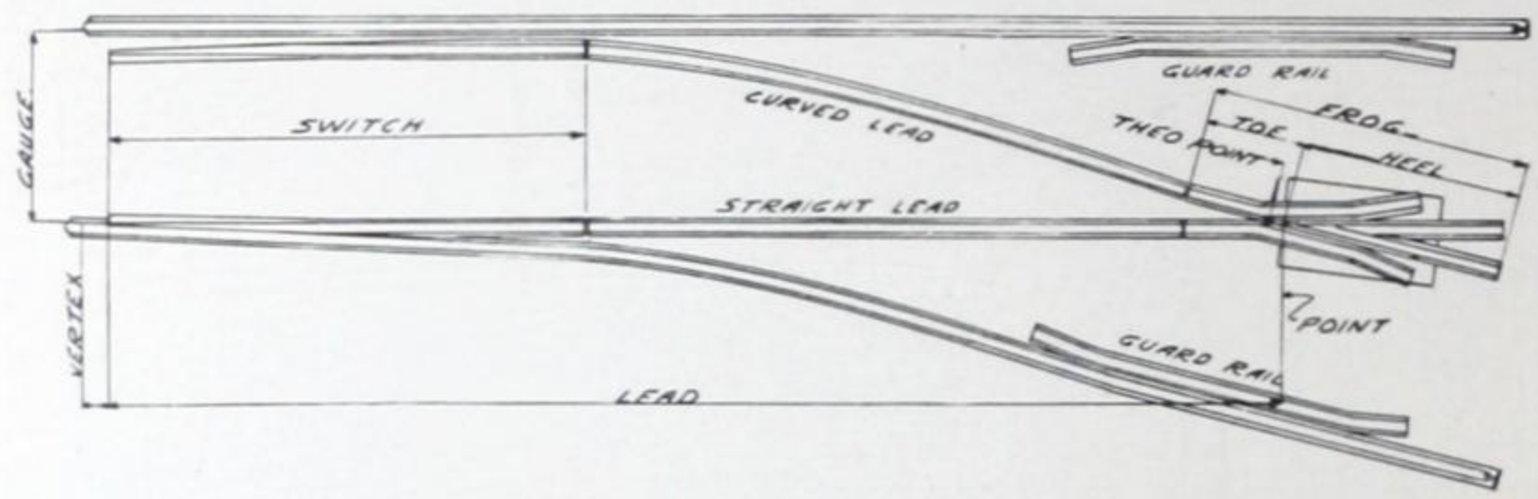


No. 158—Railway Bridge, Fabricated and in Process of Erection by the Manitoba Bridge and Iron Works, Limited

RAILWAY TURNOUTS

We are manufacturers of complete lines of frog and switch material and diamonds for railway, industrial and mine work. The superior merit of our work is attested to by the fact that we build for both the Canadian National Railways and the Canadian Pacific Railway.

The illustration herewith shows the different parts that enter into a complete turnout. The gauge may vary from standard railway gauge down to the smallest industrial track, and the weight of the rails may range from 100 lbs. per yard, as used on the heaviest railway sections, down to 12-lb. rail used in industrial plants.



No. 159—Railway Turnout

Switches may be stub, split, spring or automatic; they may be operated by ground throws or switch stands. They can be supplied complete with riser plates, braces, bridle bars, switch rods, etc., in the most complicated types for heavy railroad traffic, or in the simplest style for periodic light traffic.

Guard rails may be plain bent for light rail, or bent and planed for heavy rail, and spiked to ties, or bent, planed and chamfered for heavy rail, and bolted to the main rail with cast iron adjustable separators.

Frogs may be bolted rigid, spring or forged for light rail, and may be made with cast manganese centers for heavy rail.

Railroad crossings or diamonds are made to any angle, of strong rigid construction. Flangeways of crossing track are planed through the heads of the rails, leaving webs and bases uncut. The filling material used for diamonds is forged wrought iron, and heavy rolled straps are used for the inside and outside corners.

Bolts are from $\frac{7}{8}$-inch to $1\frac{1}{8}$-inch diameter, depending on the size of rail, and are furnished with head and nut locks.

Crossings can be made in any number, of any rail, of any angle, with or without curves.

We make up tongue switches and mates for street railways, for use on paved streets. To ensure length of wear, these are made of special material.

We also manufacture Jackson switch stands, both low and high type, as well as ground throws, both hand and automatic.

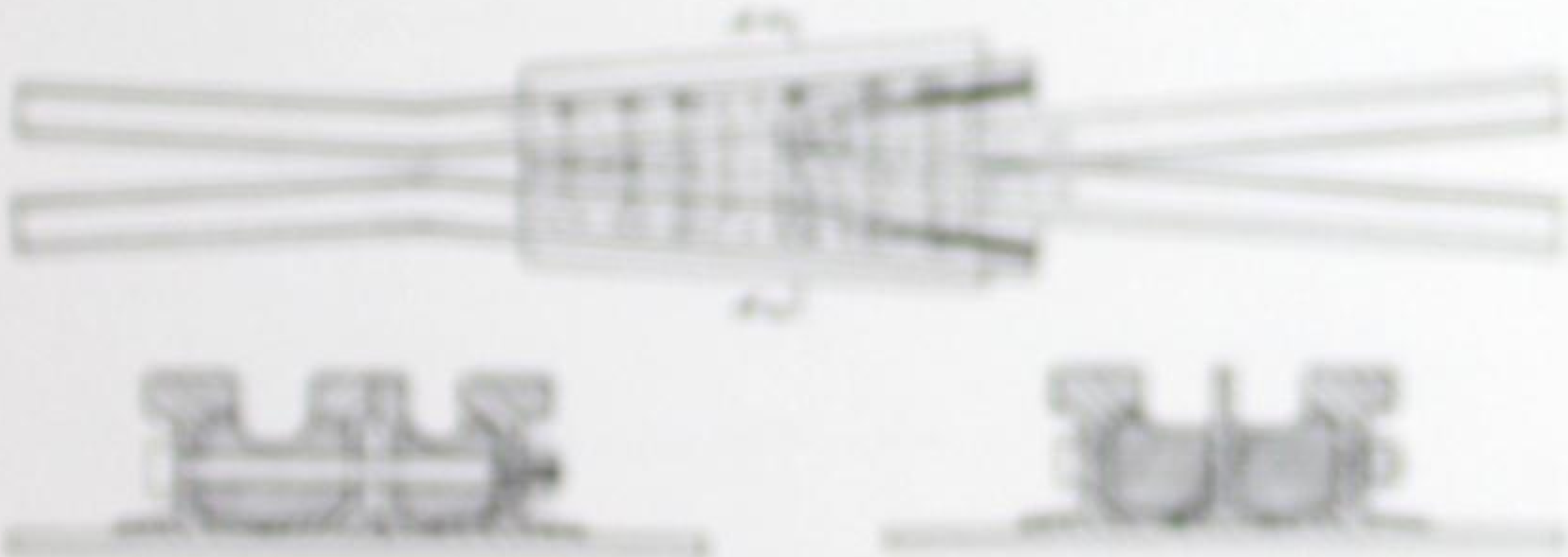
RAILWAY FROGS

We can supply frogs of any type, ranging from bolted rigid, spring or forged frogs for light rail to frogs with cast manganese centers for heavy rail.

A rigid forged point frog, especially adapted for use in mines, is illustrated by No. 160 below. The rails are rigidly riveted to base plates which are furnished with square holes for spiking to ties.

No. 160 - Rigid Frog for Light Rail

Our standard frog for medium or heavy weight rail is illustrated by No. 161. The fillers are cast iron or steel and fit the profile of the rail in the same way as an angle bar. They are bolted through with 7/8-inch to 1 1/8-inch bolts, according to the size of the rail, with head lock washer, bevelled washer and spring washer under nut of each bolt; the number of bolts depends on the number and size of the frogs.



No. 161 - Rigid Frog for Medium Weight Rail, Showing Sectional Views

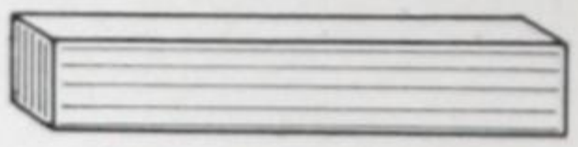
The actual point on the frog is 1/2-inch rounded off on top to prevent excessive shock, while the web is carried through filler blocks to the theoretical point. A 1/2-inch base plate is rigidly riveted to the flanges of the rails, and square spike holes are punched close to the outer edge to permit spiking to ties. The short and long point are riveted together.

This frog can be provided with throat filler and also with inverted rail heel riser if desired. It has each of the flare ends of the wings depressed to prevent dragging brake beams or chains from catching the end of the rail. It is of extremely heavy, durable construction and is one of the best designs of rigid bolted frogs in use.

CONCRETE REINFORCING BARS

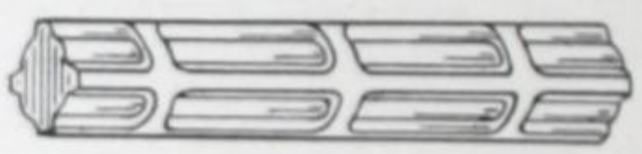
Concrete reinforcing bars can be rolled in the shapes shown below, to any specification, structural, intermediate or hard grade, and in lengths up to eighty feet. For weights of reinforcing, see table of Rounds and Squares, pages 25 and 26.

No. 162—Plain Round



No. 163—Plain Square

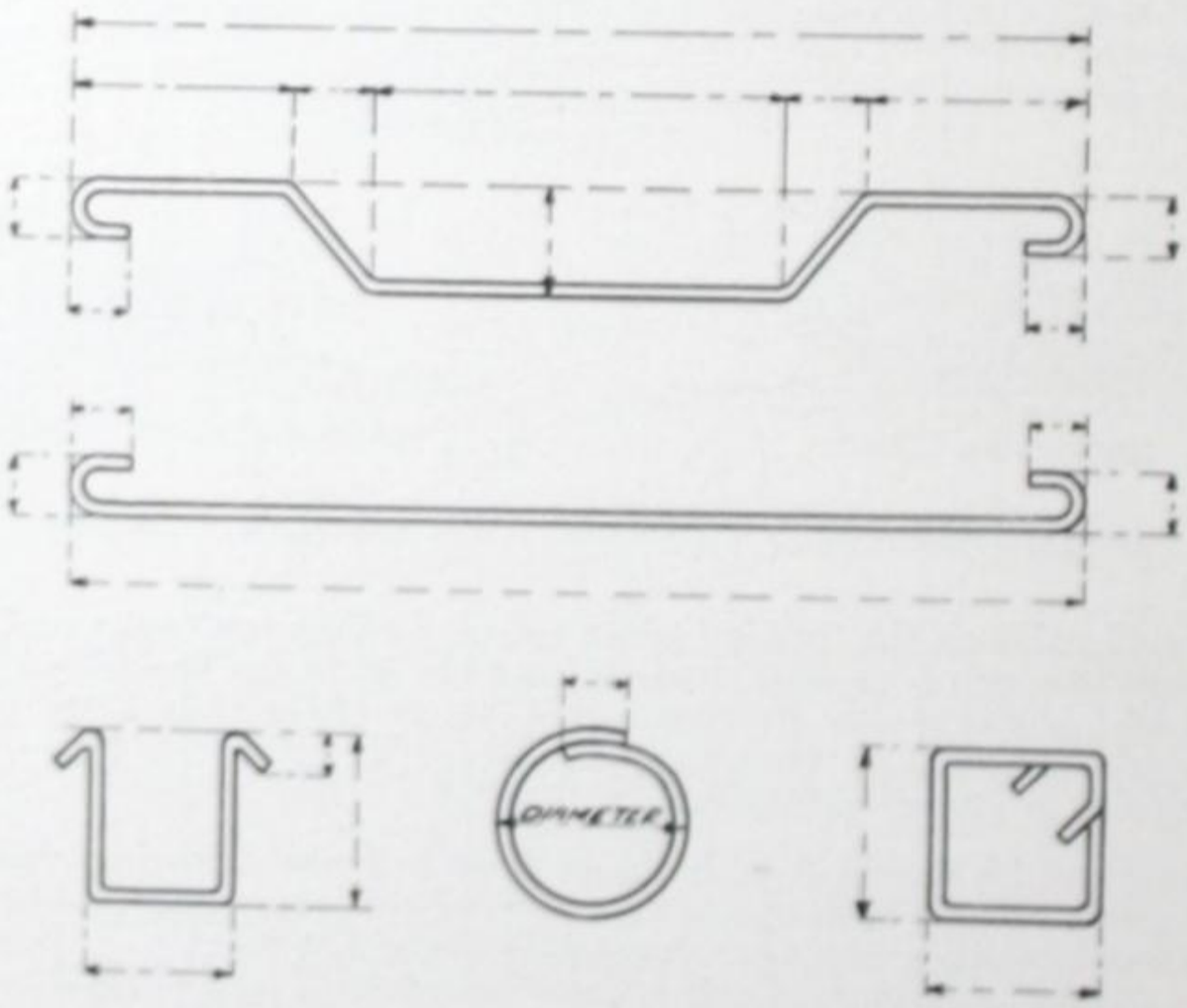
No. 164—Cold Twisted



No. 165—Deformed Round or Square

Our reinforcing bar stock of plain and deformed bars is very complete and our equipment enables us to bend reinforcing to any shape. We can make very prompt shipments from stock. Concrete specialties such as bar chairs, spacers, tees, inserts, etc., can be supplied to meet any requirements. We can also furnish wire mesh, expanded metal wire, small channels, etc.

It is to the contractor's advantage to have all reinforcing bent to shape in the shops. For the commoner different types of bars, the dimensions as shown in the diagram below, should be given. In ordering bent reinforcement, always give dimensions from outside to outside of bars.



No. 166—Dimensions Required when Ordering Reinforcing

We can also supply spirals, in ordering which, give size of wire, outside diameter of core, pitch or distance centre to centre of wire, overall length and number of spacers.

REINFORCED CONCRETE DESIGN

The design of reinforced concrete structures assumes that the concrete and the reinforcement deform equally under load or that absolute bond exists between the two materials. Having made this assumption, the proportioning of slabs, beams, girders, etc., follows the common theory of flexure, neglecting any tensile value for the concrete.

STANDARD NOTATION

The following symbols are recommended for use as standard notation:

(a) Rectangular Beams —

f_s = Tensile unit stress in steel.

f_c = Compressive unit stress in concrete.

E_s = Modulus of elasticity of steel.

E_c = Modulus of elasticity of concrete.

$n = \frac{E_s}{E_c}$

M = Moment of resistance, or bending moment in general.

A_s = Steel area.

b = Breadth of beam.

d = Depth of beam to center of steel.

k = Ratio of depth of neutral axis to depth d.

kd = Depth below top to resultant of compressive stresses.

j = Ratio of lever arm of resisting couple to depth d.

jd = d - z = lever arm of resisting couple.

p = Steel ratio $= \frac{A_s}{bd}$

(b) T-Beams —

b = Width of flange.

b' = Width of stem.

t = Thickness of flange.

(c) Beams Reinforced for Compression —

A'_s = Area of compressive steel.

p' = Steel ratio for compressive steel.

f'_c = Compressive unit stress in steel.

C = Total compressive stress in concrete.

C' = Total compressive stress in steel.

d' = Depth to center of compressive steel.

z = Depth to resultant of C and C'.

(d) Shear, Bond and Web Reinforcement —

V = Total shear.

V' = Total shear producing stress in reinforcement.

v = Shearing unit stress.

u = Bond stress per unit surface of bar.

s = Circumference or perimeter of bar.

Σs = Sum of all perimeters of bars.

T_s = Total stress in single reinforcing member.

x = Horizontal spacing of reinforcing members.

(e) Columns —

A = Total unit area.

A_c = Area of concrete.

A_s = Area of longitudinal steel.

P = Total safe load.

FORMULAS

The formulas which follow are for working loads and assume a straight line variation of stress to deformation of concrete in compression; tension in the concrete is neglected.

(a) Rectangular Beams—

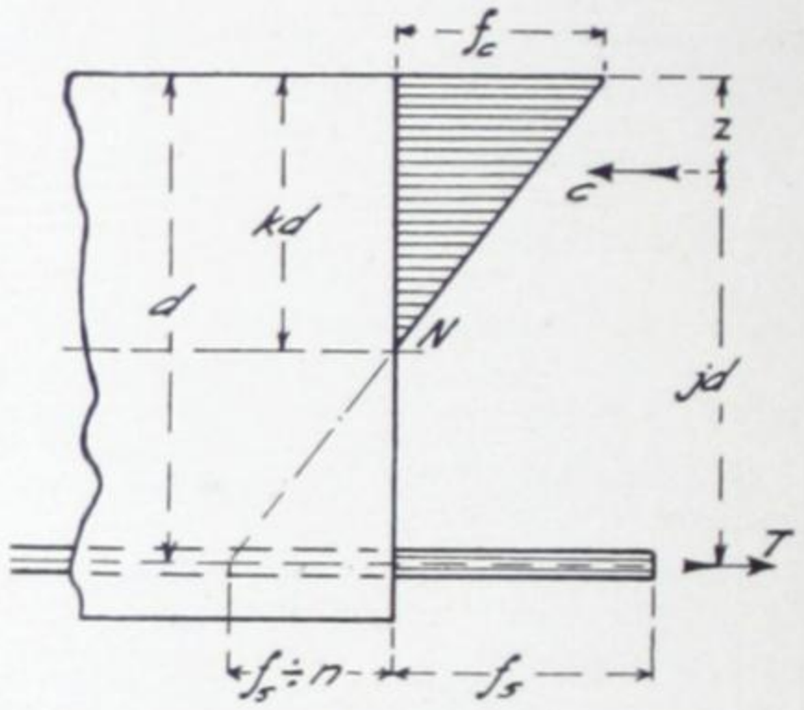
Position of neutral axis,

$$k = \sqrt{2pn + (pn)^2} - pn, \quad k = \frac{nf_c}{nf_c + f_s} \tag{1}$$

Arm of resisting couple,

$$j = 1 - \tfrac{1}{3}k \tag{2}$$

[For $f_s = 15{,}000$ to $16{,}000$ and $f_c = 600$ to 650, j may be taken at $\frac{7}{8}$.]



No. 167

Fiber stresses,

$$f_s = \frac{M}{A_s jd} = \frac{M}{pjbd^2} \tag{3}$$

$$f_c = \frac{2M}{jkbd^2} \tag{4}$$

If constant $K = \frac{1}{2}f_c\,kj$ or pf_sj,

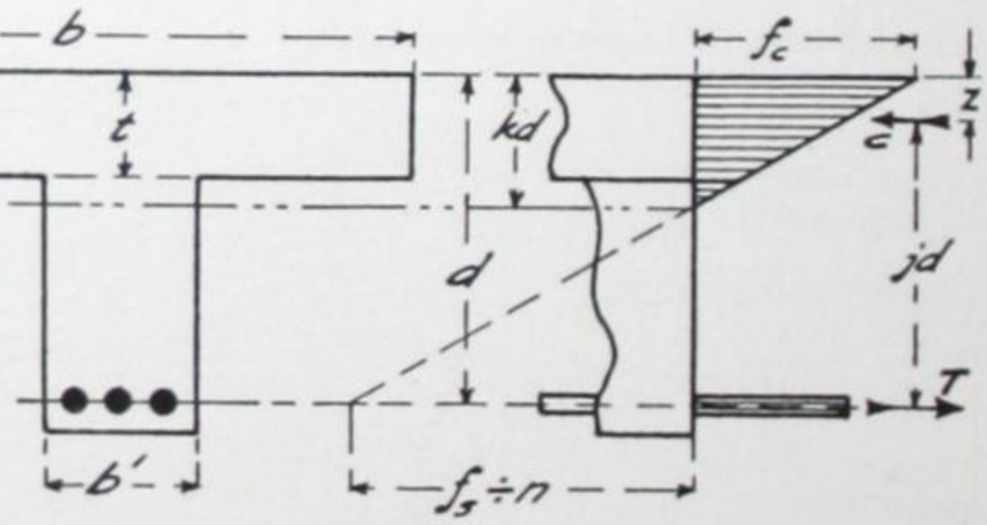
$$M = Kbd^2 \tag{5}$$

Steel ratio, for balanced reinforcement,

$$p = \frac{\frac{1}{2}}{\frac{f_s}{f_c}\left(\frac{f_s}{nf_c} + 1\right)} \tag{6}$$

(7)

(b) T-Beams—



No. 168

CASE I. *When the neutral axis lies in the flange,* use the formulas for rectangular beams.

CASE II. *When the neutral axis lies in the stem.*
The following formulas neglect the compression in the stem.

Position of neutral axis,

$$kd = \frac{2ndA_s + bt^2}{2nA_s + 2bt} \tag{8}$$

Position of resultant compression,

$$z = \frac{3kd - 2t}{2kd - t} \cdot \frac{t}{3} \tag{9}$$

Arm of resisting couple,

$$jd = d - z. \tag{10}$$

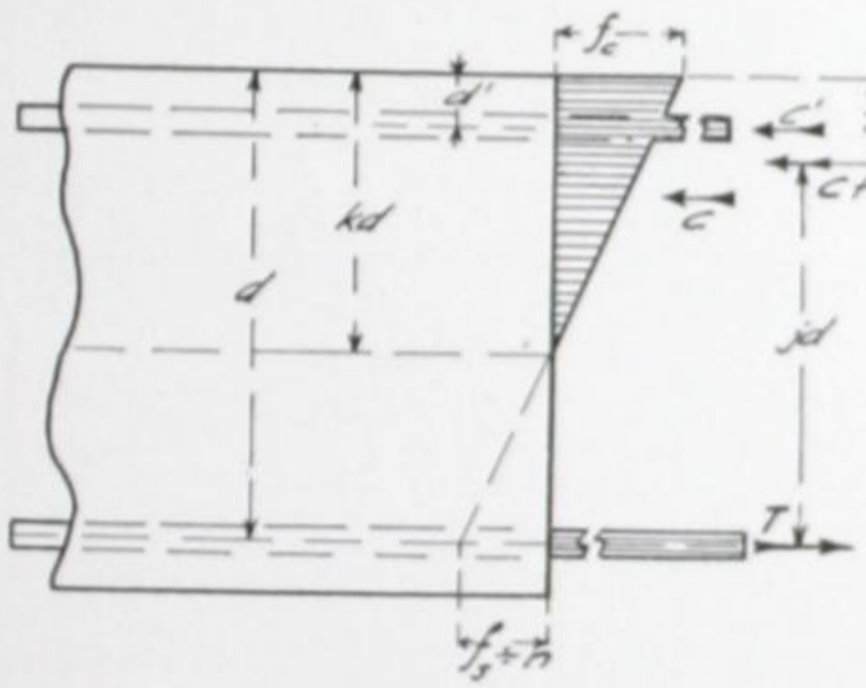
Fiber stresses,

$$f_s = \frac{M}{A_s jd} \tag{11}$$

$$f_c = \frac{Mkd}{bt(kd - \frac{1}{2}t)jd} = \frac{f_s}{n} \cdot \frac{k}{1-k} \tag{12}$$

[For approximate results, the formulas for rectangular beams may be used.]

(c) Beams Reinforced for Compression—



No. 169

Position of neutral axis,

$$k = \sqrt{2n\left(p + p'\frac{d'}{d}\right) + n^2(p+p')^2} - n(p+p') \tag{13}$$

Position of resultant compression,

$$z = \frac{\frac{1}{3}k^3 d + 2p'nd'\left(k - \frac{d'}{d}\right)}{k^2 + 2p'n\left(k - \frac{d'}{d}\right)} \tag{14}$$

Arm of resisting couple,

$$jd = d - z \tag{15}$$

Fiber stresses,

$$f_c = \frac{6M}{bd^2\left[3k - k^2 + \frac{6p'n}{k}\left(k - \frac{d'}{d}\right)\left(1 - \frac{d'}{d}\right)\right]} \tag{16}$$

$$f_s = \frac{M}{pjbd^2} = nf_c \frac{1-k}{k} \tag{17}$$

$$f_s' = nf_c \frac{k-\frac{d'}{d}}{k} \tag{18}$$

(d) **Shear, Bond, and Web Reinforcement**—

For rectangular beams,

$$v = \frac{V}{bjd} \tag{19}$$

$$u = \frac{V}{jd.\Sigma o} \tag{20}$$

[For approximate results, j may be taken at $\frac{7}{8}$.]

The stresses in web reinforcement may be estimated by means of the following formulas:

Vertical web reinforcement,

$$T_s = \frac{V's}{jd} \tag{21}$$

Bars bent up at angles between 20° and 45° with the horizontal and web members inclined at 45°,

$$T_s = \frac{3}{4}\frac{V's}{jd} \tag{22}$$

The same formulas apply to beams reinforced for compression as regards shear and bond stress for tensile steel.

For T-Beams,

$$v = \frac{V}{b'jd} \tag{23}$$

$$u = \frac{V}{jd.\Sigma o} \tag{24}$$

[For approximate results, j may be taken at $\frac{7}{8}$.]

(e) **Columns**—

Total safe load,

$$P = f_c(A_c + nA_s) = f_cA[1 + (n-1)p] \tag{25}$$

Unit stresses,

$$f_c = \frac{P}{A[1 + (n-1)p]} \tag{26}$$

$$f_s = nf_c. \tag{27}$$

Bending Moments.—When the beam or slab is reinforced over its supports to take care of negative bending moments, the bending moment at the center of the span will be reduced. It is considered good practice to use the following values.

Floor slabs, M at center and at supports $= \frac{1}{12} wl^2$, where w represents the load per linear unit, and l the span length.

Beams, M at center and at supports $= \frac{1}{12} wl^2$ for interior spans, and, for end spans, $\frac{1}{10} wl^2$ for center and interior support for both dead and live loads.

Working Stresses—*The following working stresses are in current use for reinforcing bars of medium structural steel and good Portland cement and gravel concrete of a 1:2:4 mixture.*

f_c = unit compressive strength of concrete ..... 650 lbs. per sq. in.
f_v = unit shearing stress of concrete,
  straight horizontal reinforcement ..... 40 lbs. per sq. in.
  special shear reinforcement ..... 90 to 120 lbs. per sq. in.
f_t = unit bond stress of concrete,
  plain bars ..... 80 lbs. per sq. in.
  deformed bars ..... 100 lbs. per sq. in.
f_s = unit tensile strength of steel,
  rod reinforcement ..... 16,000 lbs. per sq. in.
  wire reinforcement ..... 20,000 lbs. per sq. in.
f_b = unit compressive stress of steel ..... 10,000 lbs. per sq. in.
$n = E_s \div E_c = 15$.

Substituting in the formulae given for slabs and rectangular beams, reinforced for tension only, and with various values for f_c, f_s and n, the constants given in the table below are obtained:

$$K = f_c p j \qquad k = \frac{np_1}{np_1 + f_c}$$

$$p = \frac{1}{2} \frac{f_c}{f_s} \left(\frac{1}{\frac{f_c}{np_1} + 1} \right) \qquad j = 1 - \frac{k}{3}$$

		$n = 15$				$n = 12$			
f_s	f_c	K	p	k	j	K	p	k	j
16000	550	93.0	0.00556	0.340	0.887	72.3	0.00587	0.292	0.903
	600	95.0	0.00604	0.333	0.889	82.3	0.00526	0.311	0.897
	650	102.5	0.00727	0.373	0.876	94.9	0.00667	0.328	0.891
	700	120.6	0.00917	0.386	0.869	106.7	0.00775	0.344	0.885
	750	133.5	0.00997	0.413	0.862	118.9	0.00894	0.360	0.880
	800	146.9	0.01137	0.429	0.857	131.3	0.00944	0.375	0.875
18000	650	100.9	0.00624	0.351	0.883	88.4	0.00525	0.302	0.899
	700	113.1	0.00724	0.369	0.877	99.0	0.00642	0.318	0.894
	750	125.7	0.00843	0.385	0.872	111.1	0.00804	0.333	0.889
	800	139.7	0.00955	0.401	0.867	123.0	0.00877	0.349	0.884
20000	650	94.9	0.00553	0.326	0.891	82.7	0.00446	0.281	0.906
	700	106.7	0.00661	0.344	0.885	93.1	0.00522	0.296	0.901
	750	118.9	0.00826	0.360	0.880	104.3	0.00626	0.311	0.897
	800	131.3	0.00774	0.375	0.875	113.7	0.00655	0.324	0.892

Fireproofing of Steel—*The following depths of concrete below steel may ordinarily be employed.*

For slabs,

Depth to steel (d)	Depth below centre of steel
3¼ in. and under	¾ in.
Between 3¼ in. and 4¾ in.	1 in.
4¾ in. and over	1¼ in.

For beams,

Depth to steel (d)	Depth in clear below steel
10 in. and under	1 in.
Between 10 in. and 20 in.	1½ in.
20 in. and over	2 in.

The lateral spacing of parallel bars should not be less than three diameters center to center, nor should the distance from the side of the beam be less than two diameters. The clear spacing between two layers of bars should not be less than 1½ inches. Where more than one layer is used, at least all the bars above the lower layer should be bent up and anchored beyond the edge of the support.

Tables of Safe Loads—These will be found to cover fairly well the ordinary requirements. The following examples are given only to illustrate the use of the constants K and p, on page 167.

EXAMPLE—Given a slab of 12-ft. span, simply supported, to carry a load of 180 lbs. per sq. ft., including its own weight.

$f_c = 700 \quad f_s = 18000 \quad n = 15$

$$M = \frac{wl^2}{8} = \frac{(180)(12)^2(12)}{8} = 38{,}880 \text{ in. lb.}$$

K and p may be found from the table for this combination on page 167.

$$K = \frac{M}{bd^2} = 113.1 \qquad d = \sqrt{M \div bk} \qquad p = 0.0072 \text{ and } A_s = pbd$$

Assuming b = 12 in.,

$$d = \sqrt{38880 \div (12 \times 113.1)} = 5.34 \text{ in.}$$

and $A_s = 0.0072 \times 12 \times 5.34 = 0.46$ sq. in.

Allowing for cover, the slab should be 6½ in. deep and the reinforcing may be ⅝-in. round rods at 7½-in. centers, which would be equivalent to 0.49 sq. in. per foot width. The weight of the slab in this case is 81 lbs., and the safe superimposed load = 180-82 = 98 lbs. per sq. ft.

EXAMPLE—Design a beam of rectangular section to span 30 feet. Total uniform distributed load is 100 lbs. per lineal foot. Beam simply supported.

$f_c = 750 \quad f_s = 18000 \quad n = 15 \quad v_1 = 40$

$$M = \frac{wl^2}{8} = \frac{(1000)(30)^2(12)}{8} = 1{,}350{,}000 \text{ in.-lb.}$$

From the table for this combination on page 167,
$K = 125.7 \quad p = 0.008$ and $A_s = pbd$

Assuming b = 15 in.,

$$d = \sqrt{1350000 \div (15 \times 125.7)} = 26.75 \text{ or, say, 27 in.}$$

and $A_s = 0.008 \times 15 \times 27 = 3.24$ sq. in.

Using three ⅞-inch and two 1-inch round rods, the total section will be 3.38 sq. in.

$$v = \frac{15000}{(15)(\frac{7}{8})(27)} = 42 \text{ lbs.}$$

When v = 42, provision for shear is unnecessary, but for practical reasons it is advisable to use stirrups at ends.

If the two 1-inch rods are bent up at 45°, beginning at a point 2 ft. 6 in. from the support, a better design will result.

The three ⅞-inch rounds remain in the bottom to develop the safe load stress.

$$\text{Bond stress } u = \frac{15000}{(8.25)(\frac{7}{8})(27)} = 77 \text{ lbs. per sq. in.}$$

This bond stress is within the safe limits and will not require special anchorage.

Slab Design—*Solid reinforced concrete slabs are designed for given loads by using the same formulas given for rectangular beams. A width of 12 inches is usually employed in proportioning the depth d, percentage p, etc. As a general rule, it is more economical to use the balancing values for f_c and f_s. After the point is reached beyond which the extreme fibre stress in the concrete controls in the design, it will be determined that the small increase in moment derived will not justify the cost of additional steel, which is added only for the purpose of lowering the neutral plane to prevent exceeding the maximum working value assigned to f_c.*

For all slabs, it is advisable to use temperature rods ¼-inch or ⅜-inch in size, extending perpendicular to the carrying reinforcement, to lessen the chance of cracks from shrinkage and temperature stresses, as well as to form ties to which carrying bars can be wired to preserve a given spacing.

The investigation of shear in solid slabs is seldom necessary except in the case of heavy concentrated loads. Continuous slabs should always be provided with sufficient steel extending over the supports to take negative moment. It is customary practice to bend up one-half of the bars from each opposite panel, at approximately the one-fourth point, which gives a steel section for negative moment equal to that of the positive moment requirements at the center of the panel.

Two-way Reinforced Slabs.—*A series of panels reinforced in two directions at right angles, and supported along four sides, should be made continuous over supports. In oblong panels, the greatest length should not exceed 1½ times the least width. As a panel becomes oblong, the proportion of load carried by the longer span becomes rapidly less.*

Let r = proportion of total load carried by shorter span

l = length of longer span in feet

b = breadth of panel or shorter span in feet

$$\text{Then } r = \frac{1}{\frac{l}{b}} - 0.50$$

T- Beams.—*In calculating the strength of T-beams, advantage is taken of the floor slab, which must act as the compression flange of the member. To properly perform its function, a T-beam must be poured simultaneously with the floor slab, and the stem and flange securely tied together by means of bent rods, stirrups and cross reinforcement from the slab. The slab should be an integral part of the beam.*

The thickness of the flange is fixed by the depth of the slab, but the distance to either side of the stem over which compression may be assumed to act is arbitrarily selected from the result of tests.

If T-beams are simply supported at the ends, full advantage may be taken of the flange in resisting the compressive stress, the width of flange on either side of the web being taken at not more than six times its thickness in the calculations for compressive strength. If the beam is continuous at supports, a negative moment is developed which places the flange in tension and the web in compression and the beam becomes one of rectangular section. However, as only a short section of the beam is in compression at this point, it is regarded as permissible to use a higher unit concrete stress here than at the center of the span, an increase of 15% being allowed. It is also permissible to consider the straight bars in the bottom of the beam as compressive reinforcement, provided they are extended sufficient distance beyond the face of the support to develop their stress in bond. It is evident that in the continuous T-beam the capacity should be rated on the rectangular section at this point rather than upon the T-section at the center of the span. The web stresses and the limitation in placing and spacing the longitudinal reinforcement will probably be controlling factors in design.

Web Reinforcement.—Providing effective web reinforcement to resist diagonal tension in rectangular and T-beam sections is most essential. The intensity of the shearing stress for any point between the steel and the neutral axis is given by the formula—

$$v = \frac{V}{bjd} \text{ for rectangular beams, and } v = \frac{V}{b'jd} \text{ for T-beams.}$$

Since the value of j varies but slightly for the various percentages of steel, the ratio of $\frac{7}{8}$ may be substituted in above, in which case—

$$v = \frac{8V}{7\ bd}$$

If the unit shear v exceeds 40 lbs., then stirrups must be used, even with web reinforcement; v should never exceed 120 lbs. The combination of bent rods and stirrups gives the best result. It is good design to permit the stirrups to develop the required resistance to diagonal tension and allow the bent-up rods to act only as an additional safety factor. Stirrups placed at a distance apart greater than one-half the depth of the beam are of little value.

$v = \frac{V}{bjd}$ = total unit shearing stress

v_1 = unit shearing stress to be taken by concrete = 40 lbs.

V_1 = total shear to be taken by all stirrups in one of a beam.

X_1 = distance in feet from support to point beyond which stirrups are not required.

l = span of beam in feet.

A_s = sectional area of steel in one stirrup (2 legs for U-stirrup)

Then $V_1 = \frac{(v\text{-}v_1) bx_1}{2}$ (12)

$$X_1 = \frac{l}{2}\left(1 - \frac{v_1}{v}\right)$$

$\frac{V_1}{A_s f_s}$ = total number of stirrups for V_1

Stirrup spacing at the critical point near the bearing, assuming a given size of stirrup, will be—

$$\frac{A_s f_s}{(v\text{-}v_1)b}$$

With the distance x_1, total number of stirrups required and minimum spacing known, it will be safe to increase gradually the spacing over the distance x_1 from the smallest spacing to the maximum of d/2. The number of stirrups necessary in most cases can readily be determined from the table given on page 179. For intermediate values of v, the number required can be found by interpolation. For values of v between 40 and 80, it would be well to use not less than the minimum given.

Bond.—Adequate bond strength should be provided. The formula given for bond stresses in beams is for straight longitudinal bars. In restrained and cantilever beams, full tensile strength exists in the reinforcing bars at the point of support and the bars should be anchored in the support sufficiently to develop this stress. Adequate bond strength throughout the length of a bar is preferable to end anchorage, but, as an additional safeguard in special cases, the ends may be hooked.

Columns.—*It is recommended that the ratio of unsupported length to least width be limited to 15. The reinforcement usually consists of longitudinal bars tied together by hoops at intervals of about 12 inches, or of longitudinal bars surrounded by spiral hooping. The amount of vertical reinforcing varies from about 1% to 6% of the core area, and of spiral hooping from ½% to 2% of the volume of the core. The core is that portion of the cross-section of the column assumed to carry the load. The outside 1½ or 2 inches of the column is considered as fireproofing and is not included in calculating for strength. If columns are eccentrically loaded, bending stresses are induced, and the cross-section should be increased until the maximum stress does not exceed the working stress allowed. Formula (25) gives the total safe load for columns. Vertical bars in columns are usually spliced at floor levels by lapping a sufficient distance to develop their stress in bond. Similarly they are spliced at the tops of footings by means of dowels.*

Footings.—*Reinforced concrete column footings are of several types: (a) square or rectangular footings; (b) combined or cantilever footings, supporting two or more columns; (c) spread footings supported on piles; (d) raft type footings, covering the entire foundation area. Reinforced concrete footings require much less depth than footings of masonry or plain concrete, with a consequent saving on both concrete and excavation. The purpose of a footing is to receive and distribute the load uniformly over the soil. This is accomplished in the case of the single column by placing it in the center of the footing area. Where more than one column rests on the footing, the center of gravity of the foundation area must coincide with the center of gravity of the column loads in order to secure uniformity of soil pressure. Having determined this feature, the proportioning of the column section proceeds in accordance with the principle of design for slabs and beams.*

SOLID CONCRETE SLABS

1-2-4 Mix

SAFE LOADS IN POUNDS PER SQUARE FOOT

Including Weight of Slab

Continuous Spans. Unit Stress Steel = 16,000 lbs. per sq. in., Medium Steel.

Extreme Fiber Stress Concrete = 650 lbs. per sq. in.

n = 15

Thickness of slab, in.	Round Bars		$M\ (\text{in.-lb.}) = \frac{wl^2}{12} \times 12$														Weight of Slab per square ft., lbs.	Effective Depth, In.
	Size, in.	Spacing, in.	Span in Feet															
			4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
3	¼	3¼	323	206	143	106	80											38	2
	⅜	7																	
3½	⅜	5¾	504	323	224	165	126	100	80									44	2½
4	⅜	4¾	726	464	323	237	181	143	116	96	80							50	3
	½	8½																	
4½	⅜	4	988	632	439	323	247	195	158	130	110	93						57	3½
	½	7¼																	
5	½	6½		826	573	421	323	255	206	170	143	122	106					63	4
	⅝	10																	
5½	½	5¾		1045	726	533	408	323	261	216	181	155	133	116	102			69	4½
	⅝	8¾																	
6	½	5			896	658	504	397	323	266	224	191	165	143	126	111		75	5
	⅝	8																	
6½	⅝	7¼			1084	796	610	482	390	323	271	231	199	174	152	135	120	82	5½
	¾	10½																	
7	⅝	6½				948	726	573	464	384	323	275	237	206	181	161	143	88	6
	¾	9½																	
7½	⅝	6				1112	852	673	545	450	378	323	278	242	213	188	168	94	6½
	¾	8¾																	
8	⅝	5¾					988	781	632	523	439	374	323	281	247	219	195	100	7
	¾	8¼																	
8½	⅝	5¼					1133	896	726	600	504	429	370	323	283	251	224	107	7½
	¾	7½																	
9	⅝	5						1019	826	682	573	488	421	367	323	286	255	113	8
	¾	7¼																	
9½	¾	6¾						1151	932	770	647	551	476	414	364	323	287	119	8½
	⅞	9¼																	
10	¾	6¼							1045	863	726	618	533	364	408	361	323	125	9
	⅞	8¾																	

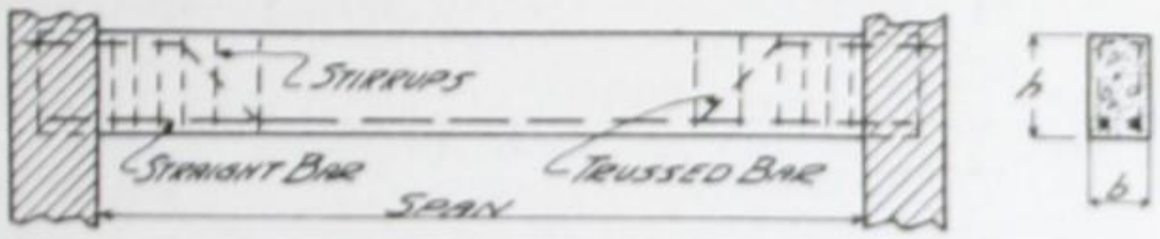
NOTE—This table is based on $M = \frac{wl^2}{12}$. Top reinforcement for negative M same area A_s as for positive M at center of span, top steel over supports extending to ¼ of span. For end spans, when $M = \frac{wl^2}{10}$, use 5/6 of the values given above; for simple spans, when $M = \frac{wl^2}{8}$, use 2/3 of the above values.

To compute safe superimposed loads for spans, subtract corresponding weight of slab from the above values.

RECTANGULAR BEAMS

SIMPLE SPANS

Bending Moment: $M = \frac{1}{8}wl^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



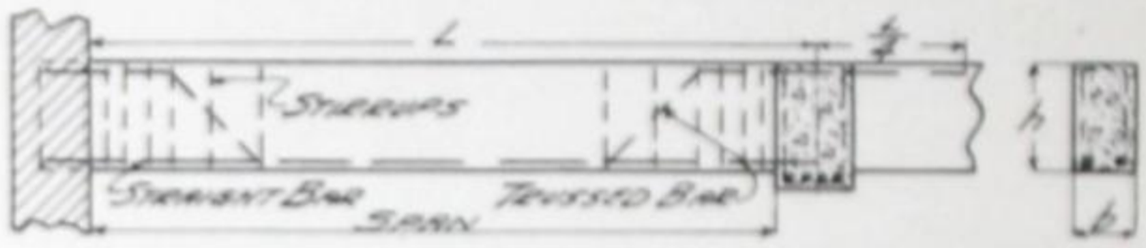
SIZE		Wt., Section *bh*, Lbs. per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
h,	*b*,		Straight		Trussed		10	12	14	16	18	20	21	22	23	24
In.	In.		No.	Size	No.	Size	Safe loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	75	1	5/8	1	1/2	459	318	234	179						
12	8	100	1	5/8	1	5/8	583	406	298	228						
	10	125	2	1/2	2	1/2	750	521	383	293	232					
	8	117	1	3/4	1	5/8	849	590	433	331	262	212				
14	10	146	2	5/8	1	5/8	1048	729	535	410	324	262	238			
	12	175	2	5/8	2	5/8	1315	913	671	513	406	329	298			
	8	133	1	3/4	1	3/4	1149	799	587	450	355	288	261	238		
16	10	167	1	7/8	1	3/4	1375	955	701	538	424	344	311	283		
	12	200	2	3/4	1	3/4	1724	1197	880	672	531	430	390	355		
	8	150	1	7/8	1	3/4	1513	1050	771	591	467	378	343	312	285	
18	10	188	2	5/8	2	5/8	1855	1288	946	725	573	464	421	383	350	
	12	225	2	3/4	1	7/8	2232	1550	1139	872	688	558	505	460	420	386
	14	262	2	3/4	2	3/4	2623	1825	1341	1027	812	657	596	542	496	456
	8	167	1	7/8	1	3/4	1765	1225	901	690	545	442	400	364	333	306
20	10	208	2	3/4	1	3/4	2243	1560	1145	878	694	562	510	463	424	391
	12	250	2	3/4	2	3/4	2878	1998	1468	1123	888	719	652	594	543	499
	14	292	2	7/8	2	3/4	3364	2337	1718	1315	1040	841	763	695	635	584
	8	183	1	7/8	1	7/8	2252	1563	1150	880	695	563	511	465	426	391
22	10	229	1	1	1	1	2885	2003	1472	1128	890	721	655	596	545	501
	12	275	2	3/4	2	3/4	3324	2310	1698	1300	1027	831	754	687	629	577
	14	321	2	7/8	2	3/4	3912	2715	1995	1528	1207	977	886	808	739	679
	8	200	1	1	1	7/8	2800	1945	1430	1095	864	700	635	578	530	486
24	10	250	2	3/4	2	3/4	3551	2464	1812	1388	1097	887	805	734	671	616
	12	300	2	7/8	1	1	4080	2833	2082	1595	1260	1020	925	844	772	709
	14	350	2	7/8	2	7/8	4902	3405	2502	1915	1513	1227	1112	1013	926	851
	8	217	1	1	1	1	3373	2342	1720	1318	1040	843	765	697	638	585
26	10	271	2	7/8	1	1	4049	2810	2064	1580	1250	1011	918	836	765	702
	12	325	2	7/8	2	7/8	5114	3550	2610	1996	1580	1280	1160	1057	966	888
	14	379	2	1	2	7/8	5934	4118	3025	2317	1830	1482	1345	1225	1121	1030
	8	233	1	1	1	1	3807	2643	1944	1488	1176	952	864	787	720	661
28	10	292	2	7/8	1	1	4820	3350	2460	1884	1489	1205	1093	996	911	837
	12	350	2	7/8	2	7/8	5847	4060	2980	2283	1805	1461	1325	1208	1105	1015
	14	408	2	1	2	7/8	6722	4668	3430	2627	2077	1681	1525	1390	1271	1168
	10	312	2	1	1	7/8	5646	3918	2880	2203	1740	1410	1280	1167	1068	980
30	12	375	2	1	1	1 1/8	6705	4658	3425	2620	2070	1678	1521	1387	1268	1165
	14	437	2	1	2	1	7976	5540	4065	3115	2460	1995	1810	1648	1508	1385
	16	500	3	7/8	2	1	8825	6130	4500	3450	2725	2205	2000	1825	1670	1532

RECTANGULAR BEAMS

END SPANS

Bending Moment: $M = \frac{1}{10} w l^2$

Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



SIZE		Wt. Section lbs. Lbs per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
h,	b,		Straight		Trussed		10	12	14	16	18	20	21	22	23	24
In.	In.		No.	Size	No.	Size	Safe loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	75	1	½	1	½	473	328	241	185						
12	8	100	1	⅝	1	⅝	729	506	372	284	225					
	10	125	2	½	2	½	937	651	478	366	289	234	212			
	8	117	1	⅝	1	⅝	880	611	449	344	272	220	200			
14	10	146	1	¾	1	¾	1250	868	638	488	386	312	283	257		
	12	175	2	⅝	2	⅝	1644	1141	838	642	507	411	373	339		
	8	133	1	¾	1	¾	1436	997	733	560	443	359	325	296	271	
16	10	167	1	⅞	1	⅞	1836	1275	936	716	566	458	416	378	346	
	12	200	2	⅝	2	⅝	2035	1412	1039	795	628	508	461	419	384	352
	8	150	1	¾	1	¾	1671	1161	853	653	516	418	379	345	315	290
18	10	188	2	⅝	2	⅝	2319	1610	1182	905	715	580	525	478	437	401
	12	225	2	⅝	2	⅝	2340	1625	1193	914	722	585	530	482	441	405
	14	262	2	¾	2	¾	3279	2275	1672	1280	1011	820	744	677	620	569
	8	167	1	⅞	1	⅞	2401	1667	1225	937	741	600	544	495	454	416
20	10	208	2	⅝	2	⅝	2621	1821	1338	1024	810	655	594	541	495	454
	12	250	2	¾	2	¾	3597	2500	1835	1405	1111	899	816	742	679	624
	14	292	2	¾	2	¾	3752	2605	1914	1465	1158	938	850	774	708	651
	8	183	2	⅝	2	⅝	2888	2007	1475	1129	892	722	655	597	546	502
22	10	229	1	1	1	1	3606	2504	1841	1410	1112	901	818	745	682	626
	12	275	2	¾	2	¾	4155	2887	2121	1625	1283	1040	943	859	786	722
	14	321	2	⅞	2	⅞	5231	3630	2668	2042	1614	1308	1186	1080	989	908
	8	200	1	⅞	1	⅞	3109	2159	1586	1214	959	777	705	642	588	539
24	10	250	2	¾	2	¾	4438	3080	2263	1732	1370	1110	1006	917	839	770
	12	300	2	¾	2	¾	4592	3187	2342	1793	1417	1148	1040	949	868	797
	14	350	2	⅞	2	⅞	6127	4257	3125	2395	1891	1531	1390	1267	1159	1063
	8	217	1	1	1	1	**4216**	2925	2150	1646	1300	1052	956	871	797	732
26	10	271	2	¾	2	¾	**4976**	3455	2540	1944	1536	1244	1129	1028	940	864
	12	325	2	⅞	2	⅞	**6392**	4440	3260	2495	1972	1598	1450	1320	1208	1110
	14	379	2	⅞	2	⅞	6761	4700	3450	2642	2085	1691	1534	1398	1280	1174
	8	233	1	1	1	1	**4759**	3305	2430	1860	1470	1190	1080	984	900	826
28	10	292	2	¾	2	¾	5420	3767	2768	2120	1674	1357	1230	1120	1025	942
	12	350	2	⅞	2	⅞	**7308**	5080	3730	2855	2257	1829	1659	1510	1382	1270
	16	467	2	1	2	1	**9518**	6610	4858	3720	2940	2380	2160	1969	1800	1652

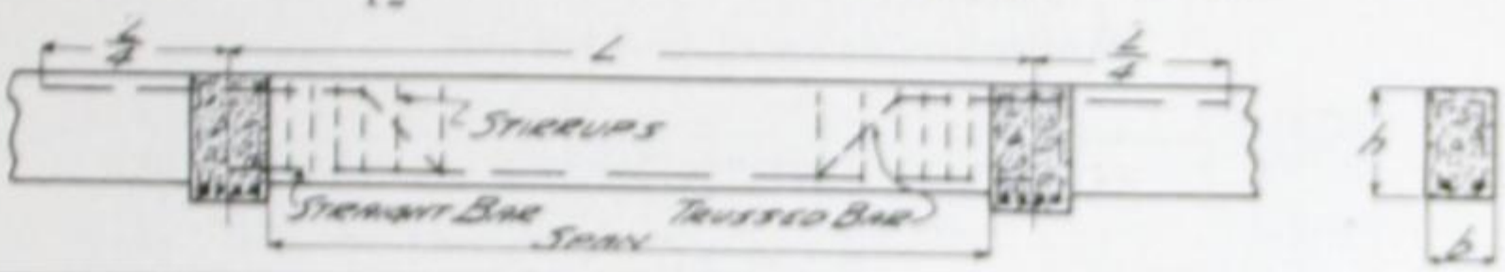
Loads in "**heavy**" type should not be used unless stirrups are provided.

RECTANGULAR BEAMS

CONTINUOUS OVER SUPPORTS

Bending Moment: $M = \frac{1}{12} wl^2$

Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



SIZE		Section lbs. per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
			Straight		Trussed											
h,	*b*,	W., Lbs.	No.	Size	No.	Size	10	12	14	16	18	20	21	22	23	24
In.	In.						Safe loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	75	1	½	1	½	568	394	290	222						
12	8	100	1	⅝	1	⅝	875	608	447	342	270	219				
	10	125	2	½	2	½	1125	781	574	440	347	281	255			
	8	117	1	⅝	1	⅝	1056	734	539	413	326	264	240			
14	10	146	1	¾	1	¾	1500	1040	765	585	463	375	340	309		
	12	175	2	⅝	2	⅝	1973	1371	1008	771	610	493	448	407		
	8	133	1	¾	1	¾	1724	1195	880	674	532	431	391	356	325	
16	10	167	1	⅞	1	⅞	2203	1530	1125	861	680	551	500	455	416	
	12	200	2	⅝	2	⅝	2442	1697	1247	955	754	610	554	504	461	423
	8	150	1	¾	1	¾	2005	1391	1022	783	619	501	455	414	378	347
18	10	188	2	⅝	2	⅝	2783	1932	1420	1088	859	696	631	575	526	483
	12	225	2	⅝	2	⅝	2808	1950	1433	1098	866	702	637	580	530	487
	14	262	2	¾	2	¾	3935	2732	2007	1537	1215	984	892	812	743	682
	8	167	1	⅞	1	⅞	2881	2003	1472	1127	890	721	654	595	545	500
20	10	208	2	⅝	2	⅝	3146	2184	1605	1229	972	786	714	649	594	545
	12	250	2	¾	2	¾	4317	3000	2205	1689	1335	1080	980	892	816	750
	14	292	2	¾	2	¾	4503	3130	2300	1761	1391	1127	1022	931	851	782
	8	183	2	⅝	2	⅝	**3466**	2407	1770	1355	1070	866	786	716	655	602
22	10	229	1	1	1	1	**4328**	3005	2208	1690	1336	1082	981	894	818	751
	12	275	2	¾	2	¾	4986	3460	2542	1946	1538	1246	1130	1030	942	865
	14	321	2	⅞	2	⅞	**6277**	4357	3203	2453	1939	1570	1423	1297	1188	1090
	8	200	1	⅞	1	⅞	**3730**	2591	1903	1457	1551	933	845	770	705	648
24	10	250	2	¾	2	¾	**5326**	3700	2720	2080	1644	1331	1208	1100	1008	925
	12	300	2	¾	2	¾	5510	3827	2812	2153	1700	1378	1250	1139	1042	958
	14	350	2	⅞	2	⅞	**7353**	5105	3750	2873	2269	1840	1669	1520	1390	1278
	8	217	1	1	1	1	**5060**	**3517**	2582	1978	1562	1265	1149	1047	956	879
26	10	271	2	¾	2	¾	**5972**	4150	3047	2333	1842	1493	1355	1233	1129	1038
	12	325	2	⅞	2	⅞	**7671**	**5327**	3914	3000	2367	1918	1740	1586	1450	1332
	14	379	2	⅞	2	⅞	**8114**	5640	4145	3170	2505	2030	1841	1679	1535	1410
	8	233	1	1	1	1	**5711**	**3965**	2915	2232	1764	1429	1296	1180	1080	991
28	10	292	2	¾	2	¾	**6504**	4518	3320	2540	2010	1627	1476	1344	1230	1130
	12	350	2	⅞	2	⅞	**8770**	**6095**	4475	3425	2710	2192	1990	1813	1659	1524
	16	467	2	1	2	1	**11422**	**7940**	5827	4460	3525	2858	2590	2362	2160	1983

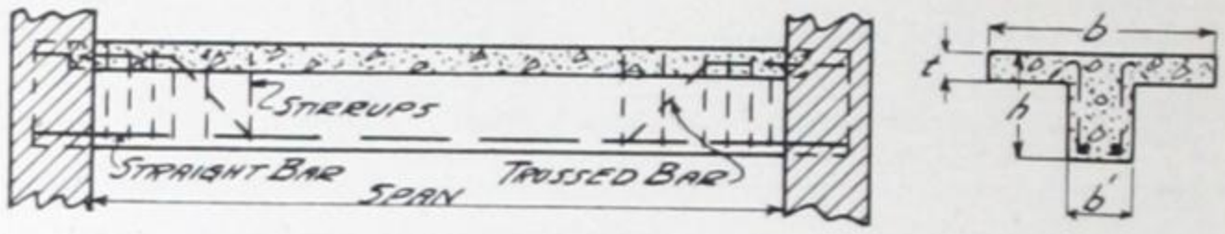
Loads in "**heavy**" type should not be used unless stirrups are provided.

TEE BEAMS

SIMPLE SPANS

Bending Moment: $M = \frac{1}{8} wl^2$ Unit Stresses: $f_s = 16{,}000$ $f_c = 650$

Minimum Value of t = 4 Inches



SIZE			Wt., Section $b'h$, Lbs. per Foot	ROUND BARS				SPAN OF BEAM IN FEET									
				Straight		Trussed		10	12	14	16	18	20	22	24	25	26
h	b'	b															
In.	In.	In.		No.	Size	No.	Size	Safe Loads in Pounds per Foot Uniformly Distributed, Including Weight of Beam									
	6	18	75	1	1	1	7/8	1295	900	660	506	....	....	....	....	....	....
12	8	23	100	1	1 1/8	1	1	1664	1156	849	650	....	....	....	....	....	....
	10	31	125	2	1	1	1	**2195**	1525	1120	856	....	....	....	....	....	....
	8	24	117	1	1 1/4	1	1 1/8	**2463**	1711	1257	963	761	616	....	....	....	....
14	10	28	146	2	1	1	1 1/8	**2875**	1995	1467	1122	886	718	....	....	....	....
	12	36	175	2	1 1/8	1	1 1/4	**3580**	2485	1828	1398	1105	895	....	....	....	....
	8	25	133	2	7/8	2	7/8	**2954**	**2052**	1508	1153	912	738	....	....	....	....
16	10	32	167	2	1	2	1	**3794**	**2635**	1936	1482	1171	948	....	....	....	....
	12	36	200	3	1	2	7/8	**4430**	**3077**	2260	1731	1368	1108	....	....	....	....
	8	26	150	2	1	2	7/8	....	**2717**	**1997**	1530	1208	978	808	679	....	....
18	10	33	188	2	1 1/8	2	1	....	**3453**	**2538**	1943	1535	1244	1028	864	....	....
	12	40	225	3	1	2	1 1/8	....	**4219**	**3097**	2372	1874	1519	1254	1054	....	....
	8	27	167	2	1	2	1	....	**3458**	**2541**	**1945**	1537	1245	1028	864	797	737
20	10	34	208	3	1	2	1	....	**4380**	**3220**	**2463**	1947	1577	1302	1094	1008	932
	12	41	250	3	1	3	1	....	**5187**	**3811**	**2918**	2305	1867	1543	1297	1195	1105

SPAN OF BEAM IN FEET									
20	22	24	26	28	30	32	34	36	38
	8	29	183	2	2 1/8	2	1	1580	1305	1097	934	806	702	....	....	....	....
22	10	36	229	3	1	2	1 1/8	1929	1594	1340	1140	984	857	....	....	....	....
	12	44	275	3	1 1/8	3	1	2367	1957	1645	1400	1208	1052	....	....	....	....
24	10	37	250	3	1	3	1	2308	1908	1602	1367	1178	1026	901	....	....	....
	12	47	300	3	1 1/8	3	1 1/8	**2895**	2391	2009	1712	1475	1286	1130	....	....	....
26	10	40	271	3	1 1/8	3	1	**2867**	**2369**	1991	1696	1463	1274	1119	992	....	....
	12	47	325	3	1 1/4	2	1 1/4	**3293**	2721	2287	1948	1680	1462	1285	1140	....	....
	10	44	292	3	1 1/8	3	1 1/8	....	....	....	2041	1758	1532	1347	1192	1064	954
28	12	49	350	3	1 1/4	3	1 1/8	....	....	....	2290	1975	1720	1512	1339	1195	1072
	14	59	408	4	1 1/8	4	1 1/8	....	....	....	2728	2352	2050	1800	1596	1424	1277
	10	44	312	3	1 1/4	2	1 1/4	....	....	....	**2287**	1970	1718	1509	1338	1193	1070
30	12	55	375	4	1 1/8	3	1 1/4	....	....	....	**2832**	2442	2127	1870	1657	1477	1326
	14	64	437	4	1 1/4	4	1 1/8	....	....	....	**3290**	2836	2470	2172	1923	1717	1540

Loads in "**heavy**" type should not be used unless stirrups are provided.

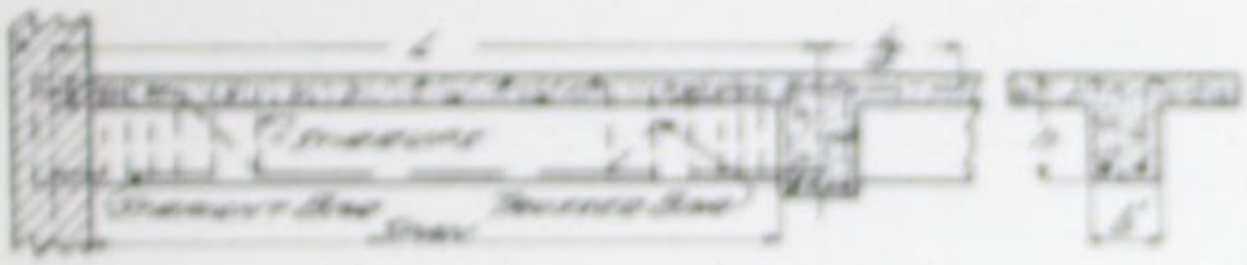
TEE BEAMS
END SPANS

Bending Moment:

$$M = \frac{1}{10} wl^2$$

Unit Stresses:

$f_s = 16{,}000 \quad f_c = 650$



SIZE		$\frac{p}{b} = \frac{A_s}{bd} = \frac{f_c}{2f_s}$	ROUND BARS		SPAN OF BEAM IN FEET							
A.	b'.		Straight	Trussed	10	12	14	16	18	20	22	24
In.	In.		No. and Size	No. and Size	Safe Loads in Pounds, per Foot, Uniformly Distributed, Including Weight of Beam.							
	6	75	1-$\frac{5}{8}$	1-$\frac{5}{8}$	700	487	357	273				
12	8	100	1-$\frac{3}{4}$	1-$\frac{3}{4}$	1002	697	512	392				
	10	125	1-$\frac{7}{8}$	1-$\frac{7}{8}$	1343	933	687	525				
	12	150	2-$\frac{5}{8}$	2-$\frac{5}{8}$	1400	972	714	547				
	6	88	1-$\frac{3}{4}$	1-$\frac{3}{4}$	1202	834	612	470	371			
14	8	117	1-$\frac{7}{8}$	1-$\frac{7}{8}$	1628	1125	827	632	500			
	10	146	1-1	1-1	2061	1432	1052	805	637			
	12	175	2-$\frac{3}{4}$	2-$\frac{3}{4}$	2403	1670	1226	938	742			
	6	100	1-$\frac{7}{8}$	1-$\frac{7}{8}$	**1800**	1251	918	703	556	450		
16	8	133	1-1	1-1	**2372**	1647	1210	926	732	593		
	10	167	2-$\frac{3}{4}$	2-$\frac{3}{4}$	**2817**	1957	1437	1101	870	704		
	12	200	1-$\frac{7}{8}$ + 1-$\frac{3}{4}$	1-$\frac{7}{8}$ + 1-$\frac{3}{4}$	3356	2330	1712	1311	1036	838		
	8	150	1-1	1-1	**2894**	2010	1477	1131	893	723	588	502
18	10	188	1-$\frac{7}{8}$ + 1-$\frac{3}{4}$	1-$\frac{7}{8}$ + 1-$\frac{3}{4}$	**3808**	2644	1942	1489	1176	952	787	661
	12	225	2-$\frac{7}{8}$	2-$\frac{7}{8}$	**4423**	3072	2257	1728	1365	1106	914	768
	14	262	1-1 + 1-$\frac{7}{8}$	1-1 + 1-$\frac{7}{8}$	**5136**	3571	2622	2008	1587	1285	1062	892
	8	167	1-1$\frac{1}{8}$	1-1$\frac{1}{8}$		**2792**	2050	1569	1242	1005	830	697
20	10	208	2-$\frac{7}{8}$	2-$\frac{7}{8}$		**3417**	2510	1923	1518	1230	1017	854
	12	250	1-1 + 1-$\frac{7}{8}$	1-1 + 1-$\frac{7}{8}$		**4033**	2962	2271	1793	1452	1200	1008
	14	292	2-1	2-1		**4566**	3354	2567	2029	1643	1358	1142

SIZE		$\frac{p}{b} = \frac{A_s}{bd} = \frac{f_c}{2f_s}$	ROUND BARS		SPAN OF BEAM IN FEET							
A.	b'.		Straight	Trussed	16	18	20	22	24	26	28	30
In.	In.		No. and Size	No. and Size	Safe Loads in Pounds, per Foot, Uniformly Distributed, Including Weight of Beam.							
	8	183	1-1$\frac{1}{8}$	1-1$\frac{1}{8}$	1810	1430	1158	957	804	686	591	
22	10	229	1-1 + 1-$\frac{7}{8}$	1-1 + 1-$\frac{7}{8}$	2448	1933	1566	1293	1087	926	803	
	12	275	2-1	2-1	2875	2271	1838	1520	1277	1088	939	
	14	321	3-$\frac{7}{8}$	3-$\frac{7}{8}$	3296	2604	2109	1743	1465	1248	1076	
	10	250	1-1 + 1-$\frac{7}{8}$	1-1 + 1-$\frac{7}{8}$	2798	2210	1789	1479	1243	1059	913	796
24	12	300	3-$\frac{7}{8}$	3-$\frac{7}{8}$	**3559**	2812	2277	1882	1582	1347	1162	1012
	14	350	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$	**4007**	3167	2565	2120	1781	1517	1308	1140
	16	400	3-1	3-1	**4700**	3712	3008	2483	2087	1778	1533	1336
	10	271	2-1	2-1	**3464**	2737	2217	1832	1541	1312	1132	985
26	12	325	2-1$\frac{1}{8}$	2-1$\frac{1}{8}$	**4283**	3383	2742	2265	1902	1621	1398	1217
	14	379	1-1$\frac{1}{4}$ + 1-1$\frac{1}{8}$	1-1$\frac{1}{4}$ + 1-1$\frac{1}{8}$	**4871**	3846	3117	2575	2162	1842	1589	1384
	16	433	2-1 + 2-$\frac{7}{8}$	2-1 + 2-$\frac{7}{8}$		**4622**	3744	3094	2600	2215	1910	1664

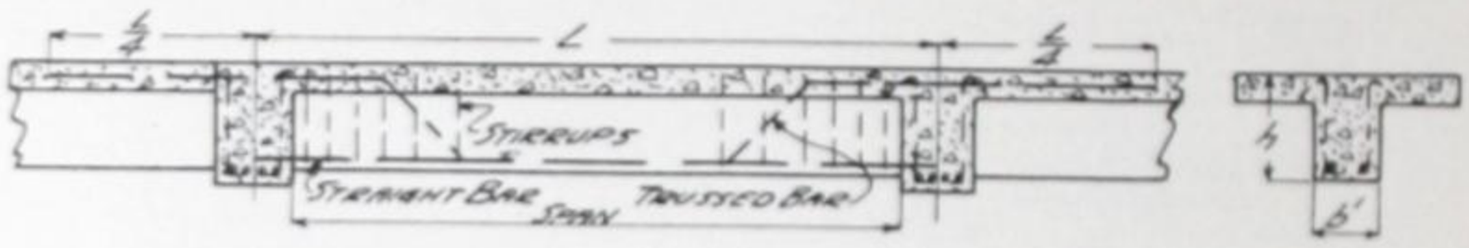
Loads in "**heavy**" type should not be used unless stirrups are provided.

TEE BEAMS

CONTINUOUS OVER SUPPORTS

Bending Moment: $M = \frac{1}{12} wl^2$

Unit Stresses: $f_s = 16{,}000$ $f_c = 650$



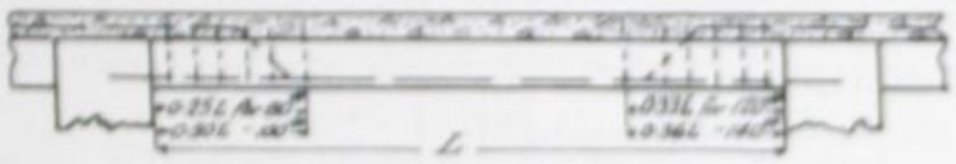
SIZE		Wt., Section $b'h$, Lbs. per Foot	ROUND BARS		SPAN OF BEAM IN FEET							
h,	b',		Straight	Trussed	10	12	14	16	18	20	22	24
In.	In.		No. and Size	No. and Size	Safe loads in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
	6	75	1-5/8	1-5/8	840	584	429	328	....	....	....	....
12	8	100	1-3/4	1-3/4	1203	836	614	470	....	....	....	....
	10	125	1-7/8	1-7/8	1612	1120	824	630	....	....	....	....
	12	150	2-5/8	2-5/8	1680	1167	857	656				
	6	88	1-3/4	1-3/4	1442	1001	735	564	445	....	....	....
14	8	117	1-7/8	1-7/8	1944	1350	992	759	600	....	....	....
	10	146	1-1	1-1	2473	1719	1262	966	764	....	....	....
	12	175	2-3/4	2-3/4	2884	2004	1472	1127	890	....	....	....
	6	100	1-7/8	1-7/8	**2161**	**1501**	1102	844	667	540	....	....
16	8	133	1-1	1-1	**2846**	**1976**	1452	1111	878	712	....	....
	10	167	2-3/4	2-3/4	**3381**	2348	1725	1321	1044	845	....	....
	12	200	1-7/8+1-3/4	1-7/8+1-3/4	**4027**	2796	2054	1573	1243	1006	....	....
	8	150	1-1	1-1	....	2412	1772	1357	1072	868	718	603
18	10	188	1-7/8+1-3/4	1-7/8+1-3/4	....	3173	2331	1787	1411	1142	944	793
	12	225	2-7/8	2-7/8	....	3686	2708	2074	1638	1327	1097	922
	14	262	1-1+1-7/8	1-1+1-7/8	....	4285	3147	2410	1904	1542	1275	1071
	8	167	1-1 1/8	1-1 1/8	....	....	**2460**	1883	1490	1206	996	837
20	10	208	2-7/8	2-7/8	....	....	3012	2308	1822	1476	1220	1025
	12	250	1-1+1-7/8	1-1+1-7/8	....	....	**3555**	2725	2152	1742	1440	1210
	14	292	2-1	2-1	....	....	**4025**	3080	2435	1972	1630	1370

SIZE		Wt., Section $b'h$, Lbs. per Foot	ROUND BARS		SPAN OF BEAM IN FEET							
h,	b',		Straight	Trussed	16	18	20	22	24	26	28	30
In.	In.		No. and Size	No. and Size	Safe loads in Pounds per Foot, Uniformly Distributed, Including Weight of Beam							
	8	183	1-1 1/8	1-1 1/8	**2172**	1716	1390	1149	965	823	709	....
22	10	229	1-1+1-7/8	1-1+1-7/8	**2937**	2320	1879	1552	1305	1111	960	....
	12	275	2-1	2-1	**3450**	2725	2206	1824	1533	1306	1127	....
	14	321	3-7/8	3-7/8	**3955**	3125	2531	2092	1758	1498	1291	....
	10	250	1-1+1-7/8	1-1+1-7/8	....	**2652**	2147	1775	1492	1271	1096	955
24	12	300	3-7/8	3-7/8	....	**3375**	2733	2259	1898	1617	1395	1215
	14	350	2-1 1/8	2-1 1/8	....	**3800**	3078	2544	2137	1821	1570	1368
	16	400	3-1	3-1	....	**4455**	3610	2980	2505	2134	1840	1603
	10	271	2-1	2-1	....	....	**2660**	2198	1849	1574	1358	1182
26	12	325	2-1 1/8	2-1 1/8	....	....	**3290**	2718	2283	1945	1678	1461
	14	375	1-1 1/4+1-1 1/8	1-1 1/4+1-1 1/8	....	....	**3740**	3090	2595	2211	1907	1661
	16	433	2-1+2-7/8	2-1+2-7/8	....	....	**4493**	**3713**	3120	2658	2292	1997

Loads in "**heavy**" type should not be used unless stirrups are provided.

STIRRUP REINFORCEMENT
FOR UNIFORMLY LOADED BEAMS

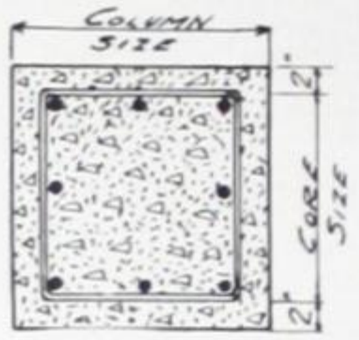
Unit Stresses,
$f_s = 16{,}000$
$v = 40$



NOTE.—The table gives total number of stirrups per beam. Place one-half the number at each end of beam, as shown.

Clear Span of Beam,	Number and Size of Round Bar U-Stirrups							
	End Shear = **80 Lbs.** per Sq. In.				End Shear = **100 Lbs.** per Sq. In.			
	Width of Beam, In.				Width of Beam, In.			
Feet	8	10	12	14	8	10	12	14
10	6¼	8¼	10¼	10¼	12¼	6⅜	8⅜	10⅜
12	8¼	10¼	12¼	12¼	6⅜	8⅜	10⅜	10⅜
14	10¼	12¼	14¼	16¼	8⅜	10⅜	10⅜	12⅜
16	10¼	12¼	8⅜	8⅜	8⅜	10⅜	12⅜	14⅜
18	12¼	14¼	8⅜	8⅜	10⅜	12⅜	14⅜	16⅜
20	12¼	16¼	8⅜	10⅜	10⅜	12⅜	16⅜	18⅜
22	14¼	18¼	10⅜	10⅜	12⅜	14⅜	16⅜	20⅜
24	16¼	18¼	10⅜	12⅜	12⅜	16⅜	18⅜	22⅜
26	16¼	20¼	12⅜	12⅜	14⅜	16⅜	20⅜	22⅜
28	18¼	22¼	12⅜	14⅜	14⅜	18⅜	20⅜	24⅜
30	18¼	24¼	12⅜	14⅜	16⅜	18⅜	22⅜	26⅜

Clear Span of Beam,	Number and Size of Round Bar U-Stirrups							
	End Shear = **120 Lbs.** per Sq. In.				End Shear = **140 Lbs.** per Sq. In.			
	Width of Beam, In.				Width of Beam, In.			
Feet	8	10	12	14	8	10	12	14
10	8⅜	10⅜	12⅜	14⅜	10⅜	12⅜	14⅜	10½
12	10⅜	12⅜	14⅜	16⅜	12⅜	14⅜	10½	12½
14	10⅜	14⅜	16⅜	18⅜	14⅜	18⅜	12½	14½
16	12⅜	14⅜	18⅜	12½	16⅜	20⅜	14½	16½
18	14⅜	16⅜	20⅜	14½	18⅜	22⅜	16½	18½
20	16⅜	18⅜	22⅜	16½	20⅜	24⅜	16½	20½
22	16⅜	20⅜	24⅜	16½	22⅜	26⅜	18½	22½
24	18⅜	22⅜	26⅜	18½	24⅜	30⅜	20½	24½
26	20⅜	24⅜	28⅜	20½	26⅜	18½	22½	26½
28	20⅜	26⅜	30⅜	20½	28⅜	20½	24½	28½
30	22⅜	28⅜	32⅜	22½	30⅜	20½	26½	30½

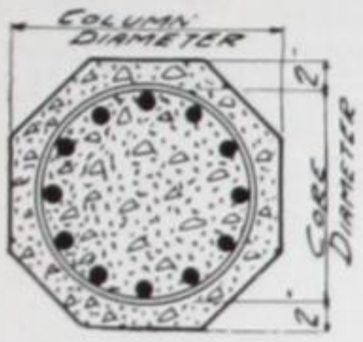


SQUARE TIED COLUMNS

SAFE AXIAL LOADS IN THOUSANDS OF POUNDS

Ratio of Length of Column to its Side, Limited to 15

Column Size, In.	Core Size, In.	Round Bar Ties		Round Bar Verticals		1: 2: 4 Concrete fc = 500 lbs. per sq. in. n = 15	1: 1½: 3 Concrete fc = 600 lbs. per sq. in. n = 12
		Size, In.	Spacing In.	No.	Size		
12	8	¼	7	4	½	38	44
		¼	9	4	⅝	41	46
		¼	11	4	¾	44	50
		¼	12	4	⅞	49	54
14	10	¼	9	4	⅝	59	68
		¼	11	4	¾	62	72
		¼	12	4	⅞	67	76
		¼	12	4	1	72	81
		¼	12	4	1⅛	78	86
16	12	¼	11	4	¾	84	98
		¼	12	4	⅞	89	102
		¼	12	4	1	94	107
		¼	12	4	1⅛	100	113
		¼	12	6	1⅛	114	126
18	14	¼	12	4	1	120	139
		¼	12	6	⅞	123	142
		¼	12	6	1⅛	140	158
		¼	12	8	1⅛	154	171
20	16	¼	12	6	⅞	153	177
		¼	12	8	⅞	162	185
		¼	12	8	1⅛	184	206
		¼	12	10	1⅛	197	219
22	18	¼	12	6	1	195	226
		¼	12	8	1	206	236
		¼	12	8	1¼	231	259
		¼	12	12	1⅛	245	273
24	20	¼	12	6	1⅛	242	279
		¼	12	10	1	255	292
		¼	12	12	1⅛	284	319
		¼	12	16	1⅛	311	345
26	22	¼	12	10	1	297	342
		¼	12	12	1	308	353
		¼	12	14	1⅛	340	382
		¼	12	18	1⅛	367	409
28	24	¼	12	12	1	354	408
		¼	12	14	1	365	418
		¼	12	18	1⅛	413	463
		¼	12	22	1⅛	441	490
30	26	¼	12	12	1	404	468
		¼	12	14	1⅛	435	497
		¼	12	20	1⅛	477	537
		¼	12	22	1¼	527	584



SPIRAL COLUMNS

SAFE AXIAL LOADS IN THOUSANDS OF POUNDS

Ratio of Length of Column to its Side or Diameter, Limited to 15.

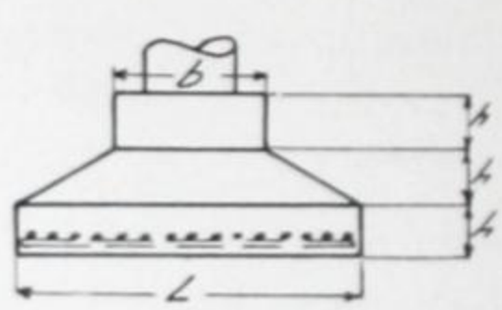
Column Diam., In.	Core Diam., In.	Round Bar Verticals No.	Round Bar Verticals Size	1: 2: 4 Concrete $f_c = 500$ lbs. per sq. in. $n = 15$		1: 1½: 3 Concrete $f_c = 600$ lbs. per sq. in. $n = 12$	
16	12	4	¾	¼″dia.–2″pitch 104	5/16″dia.–1⅞″pitch 128	¼″dia.–2″pitch 115	5/16″dia.–1⅞″pitch 139
		4	⅞	109	133	119	143
		4	1	114	138	124	148
		7	⅞	122	146	131	155
18	14	5	¾	¼″dia.–1¾″pitch 139	⅜″dia.–2¼″pitch 173	¼″dia.–1¾″pitch 154	⅜″dia.–2¼″pitch 188
		5	⅞	145	179	159	193
		6	1	157	191	170	204
		8	1	168	202	181	214
20	16	7	¾	5/16″dia.–2½″pitch 182	⅜″dia.–1⅞″pitch 233	5/16″dia.–2½″pitch 200	⅜″ dia.–1⅞″pitch 252
		7	⅞	189	241	208	259
		8	1	204	255	222	273
		10	1	215	266	232	283
22	18	9	¾	5/16″dia.–2¼″pitch 229	7/16″dia.–2⅜″pitch 294	5/16″dia.–2¼″pitch 253	7/16″dia.–2⅜″pitch 317
		9	⅞	239	304	263	327
		10	1	256	321	279	343
		12	1	267	332	289	353
24	20	10	¾	5/16″dia.–2″pitch 281	7/16″dia.–2¼″pitch 350	5/16″dia.–2″pitch 311	7/16″dia.–2¼″pitch 380
		10	⅞	292	361	321	390
		12	1	316	385	344	413
		12	1⅛	333	403	360	429
26	22	9	¾	⅜″dia.–2½″pitch 332	7/16″dia.–2″pitch 419	⅜″dia.–2½″pitch 368	7/16″dia.–2″pitch 455
		10	⅞	346	433	382	468
		10	1	359	446	394	481
		13	1⅛	395	481	427	514
		15	1⅛	408	495	441	527
28	24	10	¾	⅜″dia.–2¼″pitch 395	½″dia.–2⅜″pitch 496	⅜″dia.–2¼″pitch 438	½″dia.–2⅜″pitch 540
		10	1	419	520	461	562
		12	1	430	531	471	572
		14	1⅛	461	563	501	602
		15	1¼	493	594	531	632
30	26	10	⅞	⅜″dia.–2⅛″pitch 467	½″dia.–2¼″pitch 581	⅜″dia.–2⅛″pitch 518	½″dia.–2¼″pitch 632
		10	1	480	594	530	644
		12	1⅛	508	623	556	671
		16	1⅛	536	651	583	697
		17	1¼	571	685	615	730

NOTE.—Size and pitch of spiral wire given at head of group of loads for each size column.

SQUARE COLUMN FOOTINGS

Unit Stresses:

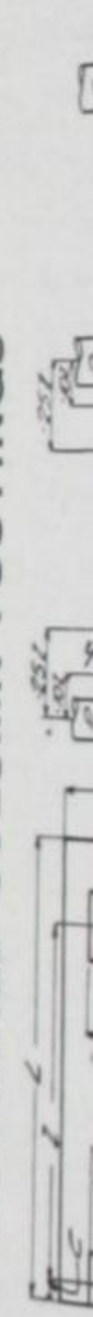
$f_s = 16{,}000$ $f_c = 650$



L		Soil Value, Lbs. per Sq. Ft.	Column Load in 1000 Lbs.	Minimum Column Diam., In.	h		b		Reinforcement Round Bars Each Way		Weight of Steel, Lbs.	Volume of Concrete Cu. Ft.
Ft.	In.				Ft.	In.	Ft.	In.	No.	Size		
5	0	4000	96	13	0	7	1	10	14	½	88.8	23.7
5	0	6000	145	16	0	8	2	3	16	½	100.3	29.3
5	6	4000	116	14	0	8	2	1	14	½	97.0	33.3
5	6	6000	175	17	0	10	2	6	15	½	104.0	44.3
6	0	4000	137	15	0	9	2	3	14	½	106.3	44.5
6	0	6000	207	18	0	11	2	9	16	½	121.4	58.2
6	6	4000	161	16	0	9	2	4	17	½	140.3	51.6
6	6	6000	242	19	1	0	2	10	17	½	140.3	73.2
7	0	4000	186	17	0	10	2	6	17	½	151.5	66.2
7	0	6000	280	20	1	1	3	1	18	½	160.4	92.3
7	6	4000	212	18	0	11	2	9	18	½	172.3	84.3
7	6	6000	322	22	1	1	3	3	20	½	191.4	105.2
8	0	4000	240	19	1	0	2	10	18	½	184.1	103.6
8	0	6000	363	22	1	3	3	6	20	½	204.6	138.7
8	6	4000	272	20	1	0	2	11	21	½	228.7	116.0
8	6	6000	410	24	1	3	3	8	23	½	250.5	155.8
9	0	4000	303	21	1	1	3	2	21	½	242.6	141.8
9	0	6000	456	24	1	5	3	11	22	½	254.1	198.5
9	6	4000	333	21	1	3	3	5	16	⅝	310.8	183.4
9	6	6000	506	25	1	6	4	1	18	⅝	349.7	233.2
10	0	4000	370	22	1	3	3	6	17	⅝	384.1	201.7
10	0	6000	559	26	1	7	4	3	19	⅝	389.0	271.6
10	6	4000	405	23	1	4	3	8	18	⅝	387.5	237.0
10	6	6000	614	28	1	8	4	7	19	⅝	409.0	318.5
11	0	4000	442	24	1	5	3	11	18	⅝	406.4	277.8
11	0	6000	671	28	1	9	4	8	20	⅝	451.5	363.0
11	6	4000	484	25	1	5	4	0	20	⅝	472.5	301.8
11	6	6000	731	30	1	10	4	1	21	⅝	496.1	416.8
12	0	4000	524	26	1	6	4	2	22	⅝	542.9	347.8
12	0	6000	792	31	1	11	5	2	22	⅝	542.9	475.9
12	6	4000	566	26	1	7	4	3	23	⅝	591.7	396.0
12	6	6000	857	32	2	0	5	4	22	⅝	566.0	537.0

COMBINED COLUMN FOOTINGS

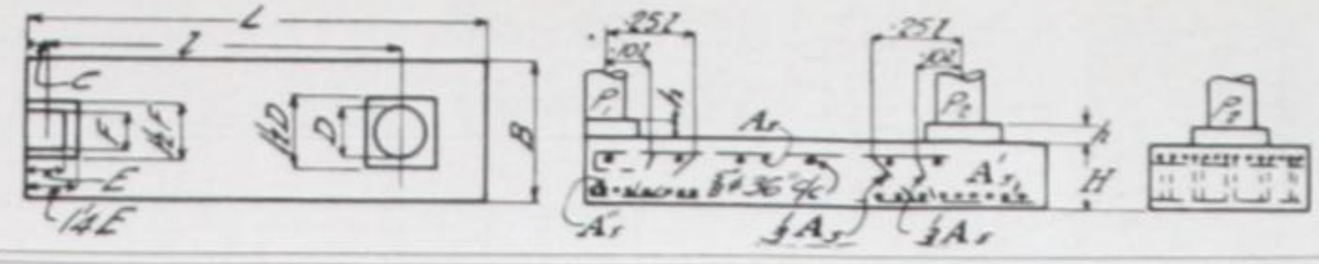
Unit Stresses:



A_s = Tension steel in top
A'_s = Transverse steel under column P_2

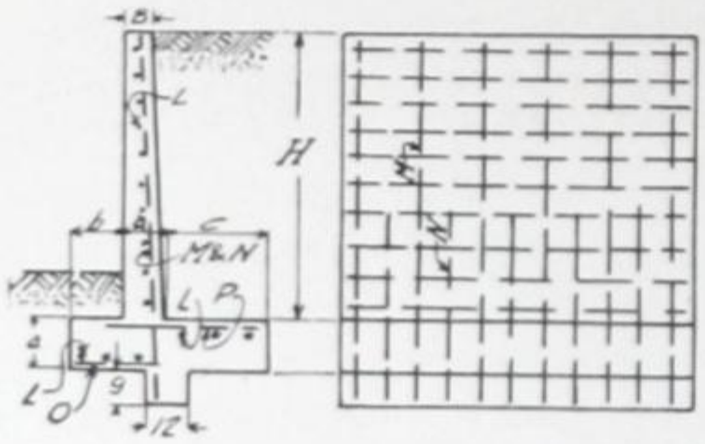
COMBINED COLUMN FOOTINGS

A_s = Tension steel in top
A'_s = Transverse steel under column P_2
A''_s = Transverse steel under column P_1
l = Distance c. to c. of columns in feet



Unit Stresses:
f_s = 16,000
f_c = 650

P_1+P_2, Lbs.	$\frac{P_1}{P_2}$	L, Ft.	Soil Value = 4,000 lbs. per square foot						Soil Value = 5,000 pounds per square foct					
			B, Ft.	H, Ft.	h, Ft.	As Sq. In.	A's Sq. In.	A"s Sq. In.	B, Ft.	H, Ft.	h, Ft.	As, Sq. In.	A's Sq. In.	A"s, Sq. In.
300,000	1.2	$1.09l+2c$	$71/l$	$0.17l+0.25$	l	12.9	$638/l^2$	$532/l^2$	$58/l$	$0.19l+0.25$	l	11.6	$456/l^2$	$380/l^2$
	1.3	$1.13l+2c$	$71/l$	$0.17l+0.25$	2.3-—	12.4	$630/l^2$	$485/l^2$	$56/l$	$0.19l+0.25$	2.1-—	11.1	$455/l^2$	$350/l^2$
	1.4	$1.17l+2c$	$69/l$	$0.16l+0.25$	6	12.4	$680/l^2$	$480/l^2$	$54/l$	$0.18l+0.25$	6	11.0	$476/l^2$	$340/l^2$
	1.5	$1.20l+2c$	$67/l$	$0.16l+0.25$		11.7	$670/l^2$	$450/l^2$	$53/l$	$0.18l+0.25$		10.4	$482/l^2$	$322/l^2$
400,000	1.2	$1.09l+2c$	$98/l$	$0.17l+0.25$		17.4	$1121/l^2$	$935/l^2$	$77/l$	$0.19l+0.25$		15.6	$805/l^2$	$671/l^2$
	1.3	$1.13l+2c$	$96/l$	$0.17l+0.25$	l	16.2	$1142/l^2$	$895/l^2$	$75/l$	$0.19l+0.25$	l	14.5	$817/l^2$	$628/l^2$
	1.4	$1.17l+2c$	$93/l$	$0.16l+0.25$	2.8-—	16.2	$1225/l^2$	$875/l^2$	$73/l$	$0.18l+0.25$	2.6-—	14.5	$871/l^2$	$622/l^2$
	1.5	$1.20l+2c$	$90/l$	$0.16l+0.25$	6	15.5	$1200/l^2$	$810/l^2$	$71/l$	$0.18l+0.25$	6	13.8	$867/l^2$	$578/l^2$
500,000	1.2	$1.09l+2c$	$122/l$	$0.17l+0.25$		21.4	$1734/l^2$	$1446/l^2$	$96/l$	$0.19l+0.25$		19.2	$1249/l^2$	$1041/l^2$
	1.3	$1.13l+2c$	$119/l$	$0.17l+0.25$	l	20.0	$1710/l^2$	$1420/l^2$	$94/l$	$0.19l+0.25$	l	17.9	$1283/l^2$	$987/l^2$
	1.4	$1.17l+2c$	$115/l$	$0.16l+0.25$	3.2-—	20.0	$1870/l^2$	$1340/l^2$	$91/l$	$0.18l+0.25$	3.0-—	17.9	$1357/l^2$	$966/l^2$
	1.5	$1.20l+2c$	$111/l$	$0.16l+0.25$	6	19.3	$1840/l^2$	$1220/l^2$	$88/l$	$0.18l+0.25$	6	17.2	$1330/l^2$	$887/l^2$
600,000	1.2	$1.09l+2c$	$146/l$	$0.17l+0.25$		25.8	$2480/l^2$	$2070/l^2$	$115/l$	$0.19+0.25$		23.1	$1794/l^2$	$1494/l^2$
	1.3	$1.13l+2c$	$141/l$	$0.17l+0.25$	l	24.4	$2397/l^2$	$2000/l^2$	$111/l$	$0.19+0.25$	l	21.9	$1788/l^2$	$1375/l^2$
	1.4	$1.17l+2c$	$136/l$	$0.16l+0.25$	3.6-—	24.4	$2620/l^2$	$1870/l^2$	$107/l$	$0.18+0.25$	3.3-—	21.9	$1867/l^2$	$1333/l^2$
	1.5	$1.20l+2c$	$133/l$	$0.16l+0.25$	6	23.1	$2630/l^2$	$1760/l^2$	$105/l$	$0.18+0.25$	6	20.6	$1894/l^2$	$1263/l^2$
700,000	1.2	$1.09l+2c$	$169/l$	$0.17l+0.25$		29.9	$3330/l^2$	$2770/l^2$	$133/l$	$0.19l+0.25$		26.8	$2390/l^2$	$1996/l^2$
	1.3	$1.13l+2c$	$164/l$	$0.17l+0.25$	l	27.9	$3240/l^2$	$2705/l^2$	$129/l$	$0.19l+0.25$	l	25.0	$2420/l^2$	$1860/l^2$
	1.4	$1.17l+2c$	$159/l$	$0.16l+0.25$	3.9-—	28.0	$3580/l^2$	$2550/l^2$	$125/l$	$0.18l+0.25$	3.6-—	24.9	$2555/l^2$	$1820/l^2$
	1.5	$1.20l+2c$	$155/l$	$0.16l+0.25$	6	26.4	$3590/l^2$	$2380/l^2$	$122/l$	$0.18l+0.25$	6	23.5	$2555/l^2$	$1703/l^2$



CANTILEVER RETAINING WALLS

Surface of Earth Horizontal

Angle of Repose, 33°
Weight of earth, 100 lbs. per cu. ft.
$f_s = 16{,}000$ lbs. per sq. in.
$f_c = 650$ lbs. per sq. in.
$n = 15$

CONCRETE

Heightof Wall H, Feet	a	b	c	Soil Pressure at Toe, Lbs. per sq. ft.	Soil Pressure at Heel, Lbs. per sq. ft.	Concrete per ft. Length of Wall, Cubic Feet
7	1′ 0″	1′ 0″	1′ 10″	1460	90	10.41
8	1′ 1″	1′ 1″	2′ 1″	1470	270	12.35
9	1′ 1″	1′ 2″	2′ 9″	1770	130	14.04
10	1′ 2″	1′ 4″	2′ 10″	2000	60	16.14
11	1′ 2″	1′ 6″	3′ 2″	2100	90	17.65
12	1′ 3″	1′ 8″	3′ 7″	2210	160	20.37
13	1′ 4″	1′ 8″	4′ 0″	2480	120	23.10
14	1′ 4″	2′ 1″	4′ 3″	2400	240	24.95
15	1′ 5″	2′ 1″	4′ 7″	2680	200	27.79
16	1′ 5″	2′ 2″	4′ 11″	2870	170	29.45
17	1′ 6″	2′ 3″	5′ 3″	3060	160	32.65
18	1′ 7″	2′ 4″	5′ 7″	3280	140	36.00
19	1′ 7″	2′ 6″	6′ 1″	3350	230	38.25
20	1′ 8″	2′ 8″	6′ 6″	3430	310	42.13

REINFORCEMENT

Bars in ali Cases of Round Section.

Height, Wall 4 in Feet	M Bars			N Bars			O Bars			P Bars			L Bars			Wt. per Ft. Lgth. of Wall
	Size	Spacing in In.	Length	Size	Spacin in In.	Length	Size	Spacing in In.	Length	Size	Spacing In In.	Length	No.	Size	Spacing in In.	
7	½	24	8′ 6″	½	24	3′ 9″	⅝	12	2′ 3″	⅝	12	3′ 0″	12	½	12	14.4
8	½	24	9′ 6″	½	24	4′ 3″	⅝	12	2′ 3″	⅝	12	3′ 3″	13	½	12	15.7
9	½	17	10′ 6″	½	17	4′ 9″	⅝	12	2′ 3″	½	11½	4′ 3″	15	½	12	21.3
10	⅝	21	11′ 9″	⅝	21	5′ 0″	⅝	10	2′ 6″	½	9½	4′ 6″	16	½	12	26.2
11	⅝	16	12′ 9″	⅝	16	5′ 3″	⅝	7½	2′ 9″	½	8	4′ 9″	17	½	12	32.3
12	¾	20	14′ 3″	¾	20	6′ 3″	½	11	3′ 3″	⅝	10	5′ 6″	20	½	12	41.8
13	¾	16	15′ 3″	¾	16	6′ 6″	½	10½	3′ 3″	¾	12	6′ 6″	22	⅝	12	63.4
14	¾	13	16′ 3″	¾	13	6′ 6″	⅝	11	4′ 0″	¾	10	6′ 9″	24	⅝	12	75.4
15	⅞	16	17′ 6″	⅞	16	7′ 3″	⅝	10	4′ 0″	⅞	11	7′ 6″	26	⅝	12	88.9
16	⅞	13	18′ 6″	⅞	13	7′ 3″	⅝	9	4′ 3″	⅞	9½	7′ 9″	27	⅝	12	105.2
17	1	15	19′ 6″	1	15	8′ 0″	⅝	8½	4′ 3″	⅞	8	8′ 0″	29	⅝	12	122.2
18	1	13	20′ 6″	1	13	8′ 3″	⅝	7½	4′ 3″	⅞	7½	8′ 6″	30	⅝	12	139.8
19	1⅛	14	21′ 6″	1⅛	14	8′ 9″	¾	9	5′ 0″	1	7½	9′ 3″	33	⅝	12	174.7
20	1⅛	13	22′ 6″	1⅛	13	9′ 0″	¾	8½	5′ 0″	1	7	9′ 9″	34	⅝	12	192.9

Hooks are required at lower end of M and N Bars for walls over 11′ 0″ in height.

BIRMINGHAM WIRE GAUGE

EQUIVALENTS IN INCHES

CORRESPONDING WEIGHTS OF FLAT ROLLED STEEL

Gauge Number	Thickness, Inches	Pounds per Square Foot	Thickness, Inches		Pounds per Square Foot
			Fractional	Decimal	
....	....	.....	1/2	.5	20.4
0000	.454	18.5232	15/32	.46875	19.125
000	.425	17.34	7/16	.4375	17.85
....	....	.....	13/32	.40625	16.575
00	.380	15.504	3/8	.375	15.3
0	.340	13.872	11/32	.34375	14.025
1	.300	12.24	5/16	.3125	12.75
2	.284	11.5872	19/64	.296875	12.1125
3	.259	10.5672	9/32	.28125	11.475
....	....	.....	17/64	.265625	10.8375
4	.238	9.7104	1/4	.25	10.2
5	.220	8.976	15/64	.234375	9.5625
6	.203	8.2824	7/32	.21875	8.925
7	.180	7.344	13/64	.203125	8.2875
8	.165	6.732	3/16	.1875	7.65
9	.148	6.0384	11/64	.171875	7.0125
10	.134	5.4672	5/32	.15625	6.375
11	.120	4.896	9/64	.140625	5.7375
12	.109	4.4472	1/8	.125	5.1
13	.095	3.876	7/64	.109375	4.4625
14	.083	3.3864	3/32	.09375	3.825
15	.072	2.9376	5/64	.078125	3.1875
16	.065	2.652	....	.....	.....
17	.058	2.3664	1/16	.0625	2.55
18	.049	1.9992	....	.....	.....
19	.042	1.7136	3/64	.046875	1.9125
20	.035	1.428	....	.....	.....
21	.032	1.3056	....	.....	.....
22	.028	1.1424	1/32	.03125	1.275
23	.025	1.02	....	.....	.....
24	.022	0.8976	....	.....	.....
25	.020	0.816	....	.....	.....
26	.018	0.7344	....	.....	.....
27	.016	0.6528	....	.....	.....
28	.014	0.5712	1/64	0.15625	0.6375
29	.013	0.5304	....	.....	.....
30	.012	0.4896	....	.....	.....
31	.010	0.408	....	.....	.....
32	.009	0.3672	....	.....	.....
33	.008	0.3264	1/128	.0078125	0.31875
34	.007	0.2856	....	.....	.....
35	.005	0.2040	....	.....	.....
36	.004	0.1632	1/256	.00390625	0.159375

UNITED STATES STANDARD GAUGE
FOR SHEET AND PLATE IRON AND STEEL

The United States Standard Gauge is a weight gauge based upon the weights per square foot in ounces avoirdupois and approximate thickness based upon 480 pounds per cubic foot. In the practical use and application of the United States Standard Gauge, a weight variation of 2½ per cent either way may be allowed.

Gauge Number	Approximate Thickness		Weight per Square Foot, Ounces, Avoirdupois	Weight per Square Foot, Pounds, Avoirdupois
	Fractional Inches	Decimal Inches		
0000000	1/2	.5	320	20.00
000000	15/32	.46875	300	18.75
00000	7/16	.4375	280	17.50
0000	13/32	.40625	260	16.25
000	3/8	.375	240	15.00
00	11/32	.34375	220	13.75
0	5/16	.3125	200	12.50
1	9/32	.28125	180	11.25
2	17/64	.265625	170	10.625
3	1/4	.25	160	10.00
4	15/64	.234375	150	9.375
5	7/32	.21875	140	8.75
6	13/64	.203125	130	8.125
7	3/16	.1875	120	7.50
8	11/64	.171875	110	6.875
9	5/32	.15625	100	6.25
10	9/64	.140625	90	5.625
11	1/8	.125	80	5.00
12	7/64	.109375	70	4.375
13	3/32	.09375	60	3.75
14	5/64	.078125	50	3.125
15	9/128	.0703125	45	2.8125
16	1/16	.0625	40	2.50
17	9/160	.05625	36	2.25
18	1/20	.05	32	2.00
19	7/160	.04375	28	1.75
20	3/80	.0375	24	1.50
21	11/320	.034375	22	1.375
22	1/32	.03125	20	1.25
23	9/320	.028125	18	1.125
24	1/40	.025	16	1.00
25	7/320	.021875	14	.875
26	3/160	.01875	12	.75
27	11/640	.0171875	11	.6875
28	1/64	.015625	10	.625
29	9/640	.0140625	9	.5625
30	1/80	.0125	8	.50
31	7/640	.0109375	7	.4375
32	13/1280	.01015625	6½	.40625
33	3/320	.009375	6	.375
34	11/1280	.00859375	5½	.34375
35	5/640	.0078125	5	.3125
36	9/1280	.00703125	4½	.28125
37	17/2560	.006640625	4¼	.265625
38	1/160	.00625	4	.25

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile, Feet	Weights per Square Foot of Floor, Pounds	Recommended Live Loads, Pounds per Square Foot
Groceries				
Canned Goods, in cases	58	6	348	
Coffee, Roasted, in bags	33	8	264	
Flour, in barrels	40	5	200	
Molasses, in barrels	48	5	240	
Rice, in bags	58	6	348	
Salt, in bags	70	5	350	250 to 300
Soap Powder, in cases	38	8	304	
Starch, in barrels	25	6	150	
Sugar, in barrels	43	5	215	
" in cases	51	6	306	
Tea, in chests	25	8	200	
Dry Goods, Cotton, Wool, Etc.				
Cotton, in bales, compressed	18	8	144	
Cotton Bleached Goods, in cases	28	8	224	
Cotton Flannel, in cases	12	8	96	
Cotton Sheeting, in cases	23	8	184	
Cotton Yarn, in cases	25	8	200	
Linen Goods, in cases	30	8	240	200 to 250
Sisal, compressed	21	8	168	
Tow, compressed	29	8	232	
Wool, in bales, compressed	48	5	240	
" " " not compressed	13	8	104	
" worsted, in cases	27	8	216	
Building Materials				
Cement, Natural	59	6	354	
" Portland	73	6	438	300 to 400
Lime and Plaster	53	5	265	
Hardware, Etc.				
Door Checks	45	...	...	
Hinges	64	...	...	
Locks, in cases, packed	31	...	...	
Sash Fasteners	48	...	...	300 to 400
Screws	101	...	...	
Sheet Tin, in boxes	278	2	556	
Wire Cables, on reels	...	...	425	
Wire, Galvanized Iron, in coils	74	4½	333	
Drugs, Paints, Oil, Etc.				
Bleaching Powder, in hogsheads	31	3½	102	
Linseed Oil, in barrels	36	6	216	
Rosin, in barrels	48	6	288	
Shellac, Gum	38	6	228	
Soda, Caustic, in iron drums	88	3-1/3	294	200 to 300
Sulphuric Acid	60	1-2/3	100	
White Lead Paste, in cans	174	3½	610	
White Lead, dry	86	4¾	408	
Red Lead and Litharge, dry	132	3¾	495	
Miscellaneous				
Glass and Chinaware, in crates	40	8	320	....
Hides and Leather, in bales	20	8	160	....
Paper, Newspaper, and Strawboards	35	6	210	300
Paper, Writing and Calendared	60	6	360	
Rope, in coils	32	6	192	....

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Metals, Alloys, Ores		
Aluminum, cast-hammered	2.55–2.75	165
Aluminum, bronze	7.7	481
Brass, cast-rolled	8.4–8.7	534
Bronze, 7.9 to 14% Sn	7.4–8.9	509
Copper, cast-rolled	8.8–9.0	556
" ore, pyrites	4.1–4.3	262
Gold, cast-hammered	19.25–19.35	1205
Iron, cast, pig	7.2	450
" wrought	7.6–7.9	485
" steel	7.8–7.9	490
" ferro-silicon	6.7–7.3	437
" ore, hematite	5.2	325
" " magnetite	4.9–5.2	315
" slag	2.5–3.0	172
Lead	11.37	710
Manganese	7.2–8.0	475
Mercury	13.6	849
Nickel	8.9–9.2	565
" monel metal	8.8–9.0	556
Platinum, cast-hammered	21.1–21.5	1330
Silver, cast-hammered	10.4–10.6	656
Tin, cast-hammered	7.2–7.5	459
Zinc, cast-rolled	6.9–7.2	440
Various Solids		
Cereals, oats, bulk		32
" barley, "		39
" corn, rye, "		48
" wheat, "		48
Hay and Straw, bales		20
Cotton, Flax, Hemp	1.47–1.50	93
Flate	0.90–0.97	58
Flour, loose	0.40–0.50	28
Glass, common	2.40–2.60	156
Leather	0.86–1.02	59
Paper	0.70–1.15	58
Potatoes, piled		42
Rubber	0.92–0.96	59
Salt, granulated, piled		48
Starch	1.53	96
Sulphur	1.93–2.07	125
Wool	1.32	82
Timber, Seasoned		
Ash, white-red	0.62–0.65	40
Cedar, white-red	0.32–0.38	22
Chestnut	0.66	41
Fir, Douglas spruce	0.51	32
" eastern	0.40	25
Elm, white	0.72	45
Hemlock	0.42–0.52	29
Hickory	0.74–0.84	49
Maple, hard	0.68	43
Oak, live	0.95	59
" red, black	0.65	41
Pine, Oregon	0.51	32
Poplar	0.48	30
Spruce, white, black	0.40–0.46	27
Walnut, black	0.61	38
Moisture Contents:		
Seasoned timber 15 to 20%		
Green timber up to 50%		
Various Liquids		
Alcohol, 100%	0.79	49
Acids, muriatic 40%	1.20	75
Acids, nitric 91%	1.50	94
" sulphuric 87%	1.80	112
Oils, vegetable	0.91–0.94	58
" mineral, lubricants	0.90–0.93	57
Water, 4°C, max. density	1.0	62.428
" 100°C	0.9584	59.830
" ice	0.88–0.92	56
" snow, fresh fallen	.125	8
" sea water	1.02–1.03	64
Ashlar Masonry		
Granite, syenite, gneiss	2.3–3.0	165
Limestone, marble	2.3–2.8	160
Sandstone, bluestone	2.1–2.4	140
Mortar Rubble Masonry		
Granite, syenite, gneiss	2.2–2.8	155
Limestone, marble	2.2–2.6	150
Sandstone, bluestone	2.0–2.2	130
Dry Rubble Masonry		
Granite, syenite, gneiss	1.9–2.3	130
Limestone, marble	1.9–2.1	125
Sandstone, bluestone	1.8–1.9	110
Brick Masonry		
Pressed brick	2.2–2.3	140
Common brick	1.8–2.0	120
Soft brick	1.5–1.7	100
Concrete Masonry		
Cement, stone, sand	2.2–2.4	144
" slag, etc.	1.9–2.3	130
" cinder, etc.	1.5–1.7	100
Various Building Mat'l		
Ashes, cinders		40–45
Cement, portland, loose		90
" " set	2.7–3.2	183
Lime, gypsum, loose		53–64
Mortar, set	1.4–1.9	103
Slags, bank slag		67–72
" " screenings		98–117
" machine slag		96
" slag sand		49–55
Earth, etc., Excavated		
Clay, dry		63
" damp, plastic		110
Clay and gravel, dry		100
Earth, dry, loose		76
" " packed		95
" moist, loose		78
" " packed		96
" mud, flowing		108
" " packed		115
Riprap, limestone		80–85
" sandstone		90
" shale		105
Sand, gravel, dry, loose		90–105
" " " packed		100–120
" " " wet		110–120

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Excavations in Water		
Sand or gravel	.....	60
" " " and clay	.....	65
Clay	.....	80
River mud	.....	90
Soil	.....	70
Stone riprap	.....	65
Minerals		
Asbestos	2.1–2.8	153
Basalt	2.7–3.2	184
Borax	1.7–1.8	109
Clay, marl	1.8–2.6	137
Dolomite	2.9	181
Granite, syenite	2.5–3.1	175
Gypsum, alabaster	2.3–2.8	159
Limestone, marble	2.5–2.8	165
Magnesite	3.0	187
Pumice, natural	0.37–0.90	40
Quartz, flint	2.5–2.8	165
Sandstone, bluestone	2.2–2.5	147
Shale, slate	2.7–2.9	175
Soapstone, talc	2.6–2.8	169
Stone, Quarried, Piled		
Basalt, granite, gneiss	.....	96
Limestone, marble, quartz	.....	95
Sandstone	.....	82
Stone, Quarried, Piled (Cont.)		
Shale	.....	92
Greenstone, hornblende	.....	107
Bituminous Substances		
Asphaltum	1.1–1.5	81
Coal, anthracite	1.4–1.7	97
" bituminous	1.2–1.5	84
" lignite	1.1–1.4	78
" peat, turf, dry	0.65–0.85	47
" charcoal, pine	0.28–0.44	23
" " oak	0.47–0.57	33
" coke	1.0–1.4	75
Graphite	1.9–2.3	131
Paraffine	0.87–0.91	56
Petroleum	0.87	54
" refined	0.79–0.82	50
" benzine	0.73–0.75	46
" gasoline	0.66–0.69	42
Pitch	1.07–1.15	69
Tar, bituminous	1.20	75
Coal and Coke, Piled		
Coal, anthracite	.....	47–58
" bituminous, lignite	.....	40–54
" peat, turf	.....	20–26
" charcoal	.....	10–14
" coke	.....	23–32

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C and 760 mm pressure. The weights per cubic foot are derived from average specific gravities except where stated that weights are for bulk, heaped or loose material, etc.

STRENGTH OF MATERIALS

STRESSES IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Stresses					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression Ultimate	Bending, Ultimate	Shearing Ultimate		
Aluminum, cast	15	6.5	12	..	12	11,000,000	.....
" bars, sheets	24–28	12–14	...	..	..	.....	.....
Aluminum Bronze,							
5% to 7½% Al	75	40	120	..	..	.....	.....
10% Al	85–100	60	..	..	..	.....	.....
Brass, cast, common	18–24	6	30	20	36	9,000,000	.....
" wire, hard	80	..	..	..	..	.....	.....
" " annealed	50	16	..	..	..	14,000,000	.....
Bronze—							
Gun Metal, 9 Cu, 1Sn	25–55	10	..	52	..	10,000,000	.....
Manganese, cast 10%Sn	60	30	125	..	..	.....	.....
" rolled 2%Mn	100	80	..	..	..	.....	.....
Phosphorus, cast 9%Sn	50	24	..	..	..	.....	.....
" wire 1%P	100	..	..	..	..	.....	.....
Bronze Tobin, cast—							
38% Zn	66	..	..	..	..	.....	.....
1½% Sn	80	40	..	..	..	4,5000,00	.....
1/3% Pb	100	..	..	..	..	.....	.....
Copper, cast	25	6	40	22	30	10,000,000	.....
" plates, rods, bolts	32–35	10	32	..	..	.....	.....
" wire, annealed	36	10	..	..	..	15,000,000	.....
Delta Metal, cast—							
55—60% Cu	45	..	..	..	..	.....	.....
38—40% Zn	68	..	..	..	..	.....	.....
2— 4% Fe	85	..	..	..	..	.....	.....
1— 2% Sn	100	..	..	..	..	.....	.....
German Silver, 25% Zn, 20% Ni	..	..	..	..	..	.....	.....
Iron, see next page	..	..	..	..	..	.....	.....
Lead, cast	1.8	..	..	..	..	1,000,000	.....
" pipe, wire	2.2–2.5	..	..	..	..	1,000,000	.....
" rolled sheets	3.3	..	..	..	..	720,000	.....
Tin, cast	3.5–4.6	1.5–1.8	6	4	..	4,000,000	.....
" antimony, 10 Sn, 1 Sb	11	..	..	..	..	.....	.....
Zinc, cast	4–6	4	18	7	..	13,000,000	.....
" rolled sheets	7–16	..	..	..	..	.....	.....
Steel							
Shapes, Plates, Bars*							
" bridges	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27.3–23.0
" buildings	55–65	"	"	"	"	29,000,000	25.4–21.5
" cars	50–65	"	"	"	"	29,000,000	30.0–23.0
" locomotives	55–65	"	"	"	"	29,000,000	27.3–23.0
" ships	58–68	"	"	"	"	29,000,000	25.9–22.1
Boiler Plates*							
" " fire box	55–65	½ tens.	tensile	tensile	¾ tens.	29,000,000	27.3–23.0
" " flange plates	52–62	"	"	"	"	29,000,000	28.8–24.2
Rivets*							
" boilers	45–55	½ tens.	tensile	tensile	¾ tens.	29,000,000	33.3–27.3
" bridges	46–56	"	"	"	"	29,000,000	32.6–26.8
" buildings	46–56	"	"	"	"	29,000,000	30.4–25.0
" cars	48–58	"	"	"	"	29,000,000	31.3–25.9
" ships	55–65	"	"	"	"	29,000,000	27.3–23.0
Concrete Bars*							
" plain, structural grade	55–70	33	tensile	tensile	¾ tens.	29,000,000	25.4–20.0
" " intermediate	70–85	40	"	"	"	29,000,000	18.6–15.3
" " hard	80	50	"	"	"	29,000,000	15.0
" deformed,struc'l grade	55–70	33	"	"	"	29,000,000	22.7–17.9
" " intermediate	70–85	40	"	"	"	29,000,000	16.1–13.2
" " hard	80	50	"	"	"	29,000,000	12.5
" cold twisted	..	55	"	"	"	29,000,000	5.0
Castings*							
" soft	60	27	tensile	tensile	¾ tens.	29,000,000	22.0
" medium	70	31.5	"	"	"	29,000,000	18.0
" hard	80	36	"	"	"	29,000,000	15.0
Forgings*	..	..	..	..	..	.....	.....

*See Specifications of the Society of Testing Materials.

STRENGTH OF MATERIALS

STRESSES IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Stresses					Modulus of Elasticity, Pounds	Elongation, %
	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultmate	Shearing, Ultimate		
Steel Alloys							
Nickel Steel,* 3.25% Ni.							
" shapes, plates, bars	85–100	50	tensile	tensile	¾ tens.	29,000,000	17.6–15.0
" rivets	70–80	45	"	"	"	29,000,000	21.4–18.8
" eye bars, unannealed	95–110	55	"	"	"	29,000,000	15.8–13.6
" " " annealed	90–105	52	"	"	"	29,000,000	20.0
Copper Steel, 0.50% Cu	60–68	37 38	"	"	"	29,000,000	29.0–23.0
Steel Springs and Wire							
Springs, untempered	65–110	40 70	..	..	..		
Wire, unannealed	120	60	..	..	..		
" annealed	80	40	..	..	..		
" bridge cable	200	95	..	..	..		
Wrought Iron							
Shapes	48	26	tensile	tensile	5/6 tens	28,000,000	
Bars	50	27	"	"	"	28,000,000	
Wire, unannealed	80		..	..	..	15,000,000	
" annealed	60	27	..	..	..	25,000,000	
Cast Iron							
Common	15–18	6	80	30	18–20	12,000,000	
Gray	18–24		..	25–33	..		
Malleable	27–35	15–20	46	30	40		

STRESSES IN POUNDS PER SQUARE INCH

Building Materials	Ultimate Average Stresses			Modulus of Elasticity	Safe Working Stresses		
	Compress.	Tension	Bending		Compress	Bearing	Shearing
Stone							
Blue Stone	12,000	1,200	2,500	7,000,000	1,200	1,200	200
Granite, gneiss	12,000	1,200	1,600	7,000,000	1,200	1,200	200
Limestone, marble	8,000	800	1,500	7,000,000	800	800	150
Sandstone	5,000	150	1,200	3,000,000	500	500	150
Slate	10,000	3,000	5,000	14,000,000	1,000	1,000	175
Brick							
Common, good	10,000	200					
" medium burned	11,000						
" hard burned	15,000						
Pressed and paving	6,000						
Cement, Portland							
Neat, 28 days	7,040	740					
" 90 days	7,350	740					
1:3 Sand, 28 days	1,290	320					
" 90 days	1,490	340					
Masonry							
Granite					420	600	
Limestone, bluestone					350	500	
Sandstone					280	400	
Rubble					140	250	
" coursed					168	250	
Concrete, P.C., 1: 2 :4					350	600	
" " 1:2½:5					280	500	
Brick, common					168	300	
" hard burned					210	300	
Miscellaneous							
Glass, common	30,000	3,000	3,000	8,000,000			
" flooring	10,000	3,000	3,000				
Plaster	700	70					
Terra cotta	5,000						
Ropes, cast steel hoisting		80,000					
" standing, derrick		70,000					
" manila		8,000					
Belts, solid woven, cotton		7,300					
" " " flax		9,900					

*See Specifications of the Society of Testing Materials.

EXPANSION OF BODIES BY HEAT

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with an increase of unit or one degree of temperature; the square surface coefficient of expansion is, approximately, two times, and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length = ltn, where l is the length of the bar in inches, t the number of degrees, n the corresponding linear coefficient; if fixed at both ends, the internal stress per unit of area = tnE, pounds per square inch, where E is the modulus of elasticity, and the total temperature stress = AtnE, pounds, where A is the cross section of the bar in square inches.

To find the increase of a bar due to an increase in temperature, from the table, multiply the length of the bar by the increase in degrees and by the coefficient for 100 degrees, and divide by 100.

COEFFICIENTS OF EXPANSION FOR 100 DEGREES = 100n

Substance	Linear Expansion		Substance	Linear Expansion	
	Centigrade	Fahrenheit		Centigrade	Fahrenheit
Metals and Alloys			**Stone and Masonry**		
Aluminum, wrought	.00231	.00128	Ashlar masonry	.00063	.00035
Brass	.00188	.00104	Brick masonry	.00055	.00031
" wire	.00193	.00107	Cement, Portland	.00107	.00059
Bronze	.00181	.00101	Concrete	.00143	.00079
Copper	.00168	.00093	" masonry	.00120	.00067
German Silver	.00183	.00102	Granite	.00084	.00047
Gold	.00150	.00083	Limestone	.00080	.00044
Iron, cast, gray	.00106	.00059	Marble	.00100	.00056
" wrought	.00120	.00067	Plaster	.00166	.00092
" wire	.00124	.00069	Rubble masonry	.00063	.00035
Lead	.00286	.00159	Sandstone	.00110	.00061
Nickel	.00126	.00070	Slate	.00104	.00058
Platinum	.00090	.00050	**Timber**		
Platinum-Iridium, 15% Ir	.00081	.00045	Fir (parallel to fibre)	.00037	.00021
Silver	.00192	.00107	Maple (parallel to fibre)	.00064	.00036
Steel, cast	.00110	.00061	Oak (parallel to fibre)	.00049	.00027
" hard	.00132	.00073	Pine (parallel to fibre)	.00054	.00030
" medium	.00120	.00067	Fir (perpendicular to fiber)	.0058	.0032
" soft	.00110	.00061	Maple (perpendicular to fiber)	.0048	.0027
Tin	.00210	.00117	Oak (perpendicular to fiber)	.0054	.0030
Zinc, rolled	.00311	.00173	Pine (perpendicular to fiber)	.0034	.0019
Miscellaneous Solids			**Liquid Substances**	Volumetric Expansion	
Glass	.00085	.00047	Alcohol	.104	.058
Graphite	.00079	.00044	Acid, nitric	.110	.061
Gutta-percha	.05980	.03322	" sulphuric	.063	.035
Paraffin	.02785	.01547	Mercury	.018	.010
Porcelain	.00036	.00020	Oil, turpentine	.090	.050

EXPANSION OF WATER, MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

DECIMALS OF AN INCH AND OF A FOOT

Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions	Fractions of Inch or Foot		Inch Equivalents to Foot Fractions
64ths			64ths			64ths			64ths		
	.0052	$\frac{1}{16}$		.2552	$3\frac{1}{16}$		.5052	$6\frac{1}{16}$		.7552	$9\frac{1}{16}$
	.0104	$\frac{1}{8}$		.2604	$3\frac{1}{8}$		.5104	$6\frac{1}{8}$		.7604	$9\frac{1}{8}$
1	.015625	$\frac{3}{16}$	17	.265625	$3\frac{3}{16}$	33	.515625	$6\frac{3}{16}$	49	.765625	$9\frac{3}{16}$
	.0208	$\frac{1}{4}$		.2708	$3\frac{1}{4}$		.5208	$6\frac{1}{4}$		.7708	$9\frac{1}{4}$
	.0260	$\frac{5}{16}$		.2760	$3\frac{5}{16}$		.5260	$6\frac{5}{16}$		.7760	$9\frac{5}{16}$
2	.03125	$\frac{3}{8}$	18	.28125	$3\frac{3}{8}$	34	.53125	$6\frac{3}{8}$	50	.78125	$9\frac{3}{8}$
	.0365	$\frac{7}{16}$		.2865	$3\frac{7}{16}$		.5365	$6\frac{7}{16}$		.7865	$9\frac{7}{16}$
	.0417	$\frac{1}{2}$		.2917	$3\frac{1}{2}$		.5417	$6\frac{1}{2}$		.7917	$9\frac{1}{2}$
3	.046875	$\frac{9}{16}$	19	.296875	$3\frac{9}{16}$	35	.546875	$6\frac{9}{16}$	51	.796875	$9\frac{9}{16}$
	.0521	$\frac{5}{8}$		.3021	$3\frac{5}{8}$		.5521	$6\frac{5}{8}$		.8021	$9\frac{5}{8}$
	.0573	$\frac{11}{16}$		.3073	$3\frac{11}{16}$		.5573	$6\frac{11}{16}$		.8073	$9\frac{11}{16}$
4	.0625	$\frac{3}{4}$	20	.3125	$3\frac{3}{4}$	36	.5625	$6\frac{3}{4}$	52	.8125	$9\frac{3}{4}$
	.0677	$\frac{13}{16}$		.3177	$3\frac{13}{16}$		.5677	$6\frac{13}{16}$		.8177	$9\frac{13}{16}$
	.0729	$\frac{7}{8}$		.3229	$3\frac{7}{8}$		.5729	$6\frac{7}{8}$		.8229	$9\frac{7}{8}$
5	.078125	$\frac{15}{16}$	21	.328125	$3\frac{15}{16}$	37	.578125	$6\frac{15}{16}$	53	.828125	$9\frac{15}{16}$
	.0833	1		.3333	4		.5833	7		.8333	10
	.0885	$1\frac{1}{16}$		.3385	$4\frac{1}{16}$		.5885	$7\frac{1}{16}$		.8385	$10\frac{1}{16}$
6	.09375	$1\frac{1}{8}$	22	.34375	$4\frac{1}{8}$	38	.59375	$7\frac{1}{8}$	54	.84375	$10\frac{1}{8}$
	.0990	$1\frac{3}{16}$		.3490	$4\frac{3}{16}$		.5990	$7\frac{3}{16}$		.8490	$10\frac{3}{16}$
	.1042	$1\frac{1}{4}$		.3542	$4\frac{1}{4}$		.6042	$7\frac{1}{4}$		.8542	$10\frac{1}{4}$
7	.109375	$1\frac{5}{16}$	23	.359375	$4\frac{5}{16}$	39	.609375	$7\frac{5}{16}$	55	.859375	$10\frac{5}{16}$
	.1146	$1\frac{3}{8}$		.3646	$4\frac{3}{8}$		.6146	$7\frac{3}{8}$		.8646	$10\frac{3}{8}$
	.1198	$1\frac{7}{16}$		.3698	$4\frac{7}{16}$		.6198	$7\frac{7}{16}$		.8698	$10\frac{7}{16}$
8	.1250	$1\frac{1}{2}$	24	.3750	$4\frac{1}{2}$	40	.6250	$7\frac{1}{2}$	56	.8750	$10\frac{1}{2}$
	.1302	$1\frac{9}{16}$		.3802	$4\frac{9}{16}$		.6302	$7\frac{9}{16}$		.8802	$10\frac{9}{16}$
	.1354	$1\frac{5}{8}$		.3854	$4\frac{5}{8}$		.6354	$7\frac{5}{8}$		.8854	$10\frac{5}{8}$
9	.140625	$1\frac{11}{16}$	25	.390625	$4\frac{11}{16}$	41	.640625	$7\frac{11}{16}$	57	.890625	$10\frac{11}{16}$
	.1458	$1\frac{3}{4}$		.3958	$4\frac{3}{4}$		.6458	$7\frac{3}{4}$		.8958	$10\frac{3}{4}$
	.1510	$1\frac{13}{16}$		.4010	$4\frac{13}{16}$		.6510	$7\frac{13}{16}$		.9010	$10\frac{13}{16}$
10	.15625	$1\frac{7}{8}$	26	.40625	$4\frac{7}{8}$	42	.65625	$7\frac{7}{8}$	58	.90625	$10\frac{7}{8}$
	.1615	$1\frac{15}{16}$		.4115	$4\frac{15}{16}$		.6615	$7\frac{15}{16}$		.9115	$10\frac{15}{16}$
	.1667	2		.4167	5		.6667	8		.9167	11
11	.171875	$2\frac{1}{16}$	27	.421875	$5\frac{1}{16}$	43	.671875	$8\frac{1}{16}$	59	.921875	$11\frac{1}{16}$
	.1771	$2\frac{1}{8}$		.4271	$5\frac{1}{8}$		.6771	$8\frac{1}{8}$		.9271	$11\frac{1}{8}$
	.1823	$2\frac{3}{16}$		.4323	$5\frac{3}{16}$		.6823	$8\frac{3}{16}$		.9323	$11\frac{3}{16}$
12	.1875	$2\frac{1}{4}$	28	.4375	$5\frac{1}{4}$	44	.6875	$8\frac{1}{4}$	60	.9375	$11\frac{1}{4}$
	.1927	$2\frac{5}{16}$		.4427	$5\frac{5}{16}$		.6927	$8\frac{5}{16}$		.9427	$11\frac{5}{16}$
	.1979	$2\frac{3}{8}$		.4479	$5\frac{3}{8}$		.6979	$8\frac{3}{8}$		.9479	$11\frac{3}{8}$
13	.203125	$2\frac{7}{16}$	29	.453125	$5\frac{7}{16}$	45	.703125	$8\frac{7}{16}$	61	.953125	$11\frac{7}{16}$
	.2083	$2\frac{1}{2}$		.4583	$5\frac{1}{2}$		.7083	$8\frac{1}{2}$		.9583	$11\frac{1}{2}$
	.2135	$2\frac{9}{16}$		.4635	$5\frac{9}{16}$		.7135	$8\frac{9}{16}$		.9635	$11\frac{9}{16}$
14	.21875	$2\frac{5}{8}$	30	.46875	$5\frac{5}{8}$	46	.71875	$8\frac{5}{8}$	62	.96875	$11\frac{5}{8}$
	.2240	$2\frac{11}{16}$		.4740	$5\frac{11}{16}$		.7240	$8\frac{11}{16}$		.9740	$11\frac{11}{16}$
	.2292	$2\frac{3}{4}$		.4792	$5\frac{3}{4}$		.7292	$8\frac{3}{4}$		.9792	$11\frac{3}{4}$
15	.234375	$2\frac{13}{16}$	31	.484375	$5\frac{13}{16}$	47	.734375	$8\frac{13}{16}$	63	.984375	$11\frac{13}{16}$
	.2396	$2\frac{7}{8}$		.4896	$5\frac{7}{8}$		.7396	$8\frac{7}{8}$		.9896	$11\frac{7}{8}$
	.2448	$2\frac{15}{16}$		.4948	$5\frac{15}{16}$		.7448	$8\frac{15}{16}$		.9948	$11\frac{15}{16}$
16	.2500	3	32	.5000	6	48	.7500	9	64	1.0000	12

INDEX

INDEX

INDEX

INDEX

INDEX

MEMORANDA