welding. This scale is strongly electro-negative to iron, like copper, and should therefore be removed. For a number of years efforts have been directed to accomplish this object and a scale removing process has finally been worked out, which is in effect a further application of the process of laterally working the steel above mentioned, but in this process the work is applied to the hot pipe in the finishing operations at a temperature below the welding heat. When the skelp has reached the proper temperature for welding, it is drawn through the customary type of welding bell forming an unfinished pipe of larger size than is usual. The pipe is then held on a cooling table until the temperature is reduced to about 1800 deg. fahr. It then passes through a series of rolls where it is reduced in size and elongated. These rolls reduce the pipe to its correct finished size. The reduction in the size of the pipe which it receives in passing through the series of rolls cracks the hardened welding-scale from both the interior and exterior surfaces of the pipe, leaving them clean and smooth.

After a pass through a set of cross rolls, to take care of any straightening that may remain to be done and to give the exterior a smooth, clean finish, the pipe is taken to a tank of water where it is dipped, lifted to a slanting position and the water allowed to rush out, carrying with it the loose scale from the pipe. Certain sizes have the loose scale blown out by a blast of compressed air instead of being dipped in the water.

The advantages of scale-free pipe are, its clean, smooth surfaces present and ideal base for the adherence of a galvanizing coating—full working capacity is assured, the interior being free from any obstructions tending to reduce the flow. This is important in heating and other piping work. Troubles caused by the deposit of scale in valves and strainers, and other apparatus, are practically eliminated, while pitting by corrosion is materially reduced.

These improvements narurally give rise to the thought that a longer life might reasonably be expected from the pipe under certain conditions, and while this has been the object of most of the research, experiments and perfection of processes, considerable improvement has been attained in this respect, the fact still remains that the life of pipe is governed largely by installation conditions, and no matter how well made or uniform the pipe may be, the life of pipe, particularly under severe corrosion conditions; such as, hot water supply lines, boiler feed and return lines, is limited, and some protective measures are necessary to secure a longer life.

For some years past considerable research and experimental work has been carried on to determine the causes of failure in pipe lines, and to ameliorate the effects of corrosion; to investigate unusual conditions of service, and to determine a practical means of corrosion prevention.

The electrolytic theory of corrosion as formulated in 1903 by Dr. Whitney has led to the development of certain protective systems which are based on the removal of dissolved oxygen from water. Careful experiments in various research laboratories have demonstrated that the amount of corrosion found is almost directly proportional to the amount of oxygen in solution, and varies directly as the temperature. The

predominating influence of free oxygen in water was suspected before this, as a result of the early study of pipe corrosion, for the most striking fact in practical pipe experience is that hot-water-heating systems invariably showed no corrosion to speak of after 35 or 40 years' use; whereas, frequently, hot-water-supply systems operating at the same average temperature with the same water lasted less than half this time. That this was independent of whether the material was iron or steel was fully demonstrated by many service tests which were conducted for a period of more than ten years, in which representative pipes of each class were installed alternately in hot-water lines.

TABLE 88. STANDARD PIPE—BLACK AND GALVANIZED*

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per Foot		Threads per inch	Couplings			Test Pressure in Pounds	
	External	Internal		Plain ends	Threads and couplings		Diameter	Length	Weight	Butt	Lap
⅛	0.405	0.269	0.068	0.244	0.245	27	0.562	⅜	0.029	700	.....
¼	0.540	0.364	0.088	0.424	0.425	18	0.685	1	0.043	700	.....
⅜	0.675	0.493	0.091	0.567	0.568	18	0.848	1⅛	0.070	700	.....
½	0.840	0.622	0.109	0.850	0.852	14	1.024	1⅜	0.116	700	.....
¾	1.050	0.824	0.113	1.130	1.134	14	1.281	1½	0.209	700	.....
1	1.315	1.049	0.133	1.678	1.684	11½	1.576	1⅝	0.343	700	.....
1¼	1.660	1.380	0.140	2.272	2.281	11½	1.950	2⅛	0.535	700	1000
1½	1.900	1.610	0.145	2.717	2.731	11½	2.218	2⅜	0.743	700	1000
2	2.375	2.067	0.154	3.652	3.678	11½	2.760	2⅝	1.208	700	1000
2½	2.875	2.469	0.203	5.793	5.819	8	3.276	2⅞	1.720	800	1000
3	3.500	3.068	0.216	7.575	7.616	8	3.948	3⅛	2.498	800	1000
3½	4.000	3.548	0.226	9.109	9.202	8	4.591	3⅜	4.241	.....	1000
4	4.500	4.026	0.237	10.790	10.889	8	5.091	3⅝	4.741	.....	1000
4½	5.000	4.506	0.247	12.538	12.642	8	5 591	3⅝	5.241	.....	1000
5	5.563	5.047	0.258	14.617	14.810	8	6.296	4⅛	8.091	.....	1000
6	6.625	6.065	0.280	18.974	19.185	8	7.358	4⅛	9.554	.....	1000
7	7.625	7.023	0.301	23.544	23.769	8	8.358	4⅛	10.932	.....	1000
8	8.625	8.071	0.277	24.696	25.000	8	9.358	4⅝	13.905	.....	800
8	8.625	7.981	0.322	28.554	28.809	8	9.358	4⅝	13.905	.....	1000
9	9.625	8.941	0.342	33.907	34.188	8	10.358	5⅛	17.236	.....	900
10	10.750	10.192	0.279	31.201	32.000	8	11.721	6⅛	29.877	.....	600
10	10.750	10.136	0.307	34.240	35.000	8	11.721	6⅛	29.877	.....	800
10	10.750	10.020	0.365	40.483	41.132	8	11.721	6⅛	29.877	.....	900
11	11.750	11.000	0.375	45.557	46.247	8	12.721	6⅛	32.550	.....	800
12	12.750	12.090	0.330	43.773	45.000	8	13.958	6⅛	43.098	.....	600
12	12.750	12.000	0.375	49.562	50.706	8	13.958	6⅛	43.098	.....	800
14 O. D.	14.000	13.250	0.375	54.568	55.824	8	15.208	6⅛	47.152	.....	700
15 O. D.	15.000	14.250	0.375	58.573	60.375	8	16.446	6⅛	59.493	.....	700
16 O. D.	16.000	15.250	0.375	62.579	64.500	8	17.446	6⅛	63.294	.....	600
17 O. D.	17.000	16.214	0.393	69.704	72.602	8	18.683	7⅛	90.941	.....	600
18 O. D.	18.000	17.182	0.409	76.840	80.482	8	19.921	7⅛	108.672	.....	600
20 O. D.	20.000	19.182	0.409	85.577	89.617	8	21.931	7⅛	120.187	.....	500

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-in. diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 ft., including the coupling, but shipping lengths of small sizes will usually average less than 20 ft.

All weights given in pounds. All dimensions given in inches.

On sizes made in more than one weight, weight desired must be specified.

*From National Tube Co.'s "Book of Standards."