

SAMUEL FOX &

COMPANY LTD.

STOCKSBRIDGE WORKS,

NEAR SHEFFIELD.

ENGLAND.



TRADE MARK.



SAMUEL FOX & COMPANY LTD.



TRADE



MARK.

A BRIEF DESCRIPTION
OF THE
STOCKSBRIDGE WORKS.

DECEMBER, 1917

SAMUEL FOX & CO. LIMITED.



**GENERAL VIEW OF THE STOCKSBRIDGE WORKS
IN 1848.**

TELEGRAPHIC ADDRESS:
"FOX, DEEPCAR."

SAMUEL FOX & CO. LIMITED.

TELEPHONE NOS.
15 & 16 CENTRAL,
9 & 9 STOCKSBRIDGE



STOCKSBRIDGE WORKS,

GENERAL VIEW OF WORKS, 1916.

SAMUEL FOX & CO LIMITED.

**Acid & Basic
Open Hearth**

and

**Acid —
Bessemer**

STEELS

IN ALL QUALITIES AND TEMPER.

Supplied in

Ingots, Blooms, Billets, Slabs,
Rails, Bars, Sections, Strips,
Wire, etc., etc.

STOCKSBRIDGE WORKS, NEAR SHEFFIELD.

London Office :

SAMUEL FOX & CO. Limited,
1, Victoria Street,
LONDON, S.W.1.

Phone No. 3013 Victoria.

Telegraphic Address : "FOXOFERED, VIC, LONDON."

Birmingham Office :

SAMUEL FOX & CO. Limited,
Daimler House,
Paradise Street,
BIRMINGHAM.

Phone No. 3041 and Birmingham 1050.

Telegraphic Address : "RENSAWD, BIRMINGHAM."

Agents :

D. DONCASTER & SONS Limited,
SHEFFIELD.

MORRIS, WARDEN & CO. Limited,
21, West Nile Street,
GLASGOW.

Australia, New Zealand & Tasmania :

Mr. M. F. BAKWELL,
MELBOURNE.

INTRODUCTION.



IN preparing this small handbook describing the **Stocksbridge Works of Messrs. SAMUEL FOX & CO. Ltd.**, difficulty has been experienced owing to the rapid development taking place in almost every department. The name of Samuel Fox & Co. Ltd. is well-known in a large variety of industries, owing to the fact that the works are engaged in the production of steel for both heavy and light industries. The heavy steel trade embraces Ingots, Blooms, Billets, Slabs, Rails, Springs, Tyres, Axles, Bars, etc., whilst the lighter trades include the production of all kinds of high-class Wire, Cold Rolled Strip, and the famous "Fox" Umbrella Frames.

The Stocksbridge Railway Company link up the works with the Great Central Railway Company's main line at Deepcar, and the volume of traffic handled by this line now approaches 4,000 tons per day.

The works are exceptionally situated, in that they contain coal, ganister, and clay pits, and recently a fine Bye-product Coking Plant has been installed, of which more will be said later. The works also contain a gas-making plant, which supplies gas for furnace and lighting purposes in the works, as well as to the township of Stocksbridge.

It is hard to realise that these immense works developed from one of the small wire mills driven by a water wheel, and typical of the district, in which the late Samuel Fox commenced work in 1841 (see view of works in 1848).

STEEL-MAKING PLANT.

SIEMENS STEEL Siemens steel-making was (OPEN HEARTH), started in 1899, and seven Siemens furnaces are now in operation. The nominal capacities of these furnaces are, one 20-ton, two 25-ton, one 35-ton, one 40-ton, and two 50-ton, representing an average weekly output of ingots of about 2,600 tons, all for Special Steels.

Further schemes of development are in hand, including the immediate erection of two further 50-ton furnaces, which will produce basic steel. The Company had much experience in the manufacture of basic steel of high-class quality, ranging in carbon contents from dead soft to 0.90 per cent., supplying same regular in quality and very low in sulphur and phosphorus.

The new Siemens plant recently completed, and consisting of two 50-ton and one

**Nickel Steel,
Nickel Chrome,
Chrome Vanadium
and
Silicon Chrome**

STEELS for all
Purposes.

**ALLOY STEELS for
AERONAUTICAL and
AUTOMOBILE INDUSTRIES**

A Speciality.

Heat Treatment to any Standard Specification.

Tool Steels

A Speciality.

Lines No. 10	SAMUEL FOX & COMPANY LIMITED. Sheffield Works, SHEFFIELD.		HOT PLUMMER'S SPECIAL CAST STEEL for TOOLS for GRINDING, BORING, DRILLING, PLAINING MADE IN WATER.
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CARBON TOOL STEEL

For Engineers' Work.

Lines No. 11	SAMUEL FOX & COMPANY LIMITED. Sheffield Works, SHEFFIELD.		HOT PLUMMER'S SPECIAL CAST STEEL for GRINDING, BORING, DRILLING, PLAINING MADE IN WATER.
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MAGNET STEEL.

HACK SAW SHEETS.

WIRE DRAWERS' PLATES

and WORTLE PLATES.

CRUCIBLE SPECIAL

ALLOY STEELS,

Etc., Etc., Etc.

25-ton furnaces, represents the last word in up-to-date Siemens plant. It has always been the aim of the Company to maintain the highest quality, whilst at the same time every advantage has been taken in the adoption of modern plant to secure the maximum output.

All types of steel are manufactured, including carbon steels from dead soft to 1.50 per cent. Carbon, Cr-V steels, Nickel, Nickel-Chrome, Silico-Chrome, Silico-Manganese, special Tungsten steels, in fact, all qualities which can satisfactorily be made in the Siemens furnace. The fact of the firm being large users, as well as makers of steel, ensures a first hand experience of the quality of their products.

**BESSEMER
STEEL.**

The manufacture of Bessemer Acid Steel was commenced in 1863, under the supervision of Sir Henry Bessemer, the Company being the second to take out a license for the manufacture of Bessemer steel. The plant consists of two

10-ton acid vessels, with the necessary accessory cupolas. In normal times the output is taken up in the manufacture of rails, tyres, axles, blooms, and billets, in carbons ranging from 0.15 per cent. to 1.20 per cent. **The Bessemer Plant has a capacity of approximately 50,000 tons per year, and it should be remarked that all the steel is of the highest special quality.**

CRUCIBLE STEEL.

Crucible Steel was the first steel-making process introduced at Stocksbridge, being established in 1855. The Department now contains 48 melting holes of the usual Huntsman type, and has a capacity of 1,500 tons per year of high-class crucible steel. The output now mainly consists of high-speed steel of the well-known "**Fox Superior,**" "**Fox Special,**" "**Fox Extra,**" and "**Fox Ordinary**" high-speed steel brands, self-hardening steel, high-class carbon Tool Steel, and steel for the preparation of the many special qualities of wire and cold rolled strip in which the Company excel.

Spring Steel Bars

OF ALL SECTIONS.

SUPPLIED TO ALL SPECIFICATIONS.

ROUND, SQUARE,
AND
SECTIONAL BARS,

FOR

**Aeronautical & Automobile
Purposes.**

SPECIAL SECTIONS ROLLED,

Including CHAIN and BEVEL, etc.

Contractors to the principal Railways of the World.

Wire Rods

IN ALL QUALITIES.

**Crucible,
Siemens Acid,
and Basic or
Acid Bessemer.**

Supplied in all Tempers for
**ROPES,
RIVETS,
HIGH CLASS WIRES,**
ETC., ETC., ETC.

ROLLING PLANT.

BLOOM AND BILLET MILL.

This mill was originally installed with three sets of housings, driven from one engine. It has recently been entirely remodelled, and is now a thoroughly modern heavy rolling plant. The original engine of 9,000 H.P. now serves the cogging rolls, whilst a new Galloway engine of 12,000 H.P. drives three sets of finishing rolls. The mill is worked on the two-high principle with 36" cogging rolls and 32" finishing rolls; is also well equipped with the necessary shears and saws, to enable rapid handling of the rolled product.

The heating equipment consists of eight coal-fired soaking pits, each taking 18 ingots at a time, with a large gas-fired continuous furnace, which is used to give the ingots a preliminary heating before charging into the soaking pits, and thus not only increases the heating capacity, but also improves the quality of the product.

The Company's engineering staff have made a special study of the utilisation of waste heat, and Stirling boilers, having a total heating surface of 16,420 square feet, are served from the soaking pits.

This mill now has a capacity for dealing with approximately 175,000 tons of ingots per annum.

ROD MILL. The Rod Rolling Plant has recently been entirely remodelled and specially designed for the handling of high-class material. It consists of a cogging and finishing train driven by an engine of 1,200 H.P. of the latest type. **The plant has a capacity of about 15,000 tons of 5-G. rods per annum;** but, of course, numerous other sizes are rolled to suit requirements of the Wire Department and customers. It is a three-high mill.

BAR AND SHEET MILL. This is an exceptionally fine Rolling Plant, built on the double duo principle, and is electrically driven by a 750 H.P. Westinghouse motor. It is a 14" mill, equipped with all the necessary accessories for the rolling of strip steel (for subsequent cold rolling), and all types of section bars. **The output depends upon the size of material being rolled, but is approximately 20,000 tons per annum.**

OLD BAR MILL. The old Bar Rolling Plant is a 14" mill, driven by a 300 H.P. engine, and specializing in the rolling of spring steel and bars. This mill is very useful for the rolling of special sections.

SAMUEL FOX & CO. LIMITED.

**LOCO. CARRIAGE
and WAGON**

Tyres & Axles

IN

Siemens Acid

AND

Bessemer Steel.

Supplied to all the Principal Railways of the World.

STOCKBRIDGE WORKS, WEAVER SHEPHERD

TYRE, AXLE AND FORGE DEPARTMENT.

Samuel Fox & Co. Ltd. have long held a high reputation for tyres and axles. The tyre plant consists of one 1,250-ton press, one becking hammer, and a tyre mill operated by an engine of 600 H.P. A special study has been made of the heat treatment of tyres, and the plant is well equipped for annealing, oil-quenching and tempering. A very wide range of work is undertaken, ranging from low tensile wagon tyres to the highest quality of special loco. tyres.

The Axle Department is equipped with two hammers, 4-ton and 6-ton respectively, and the men are highly skilled in the forging of loco. axles and general forge work. This department is also equipped for oil-quenching and heat treatment of forgings. A 40-ft. drop test is built adjoining this department, thus providing for efficient and expedient

testing of tyres and axles. "Fox" tyres and axles are in service on practically every railway in this country, in the Colonies, and in the Indian Empire.

A new Forge Department has recently been installed adjoining the crucible melting shop, and is equipped with two hammers of 50-cwt. and 15-cwt. respectively. This shop specializes in the forging and tilting of high-speed and cast steel, although other work suitable for these hammers is also undertaken.

HEAT TREATMENT PLANT.

In addition to the heat treatment plant mentioned above, two gas-fired Richmond furnaces work exclusively on the treatment of bars for aircraft and automobile purposes. The Company have been very successful in developing the manufacture and treatment of the special types of steel used for this work.

Laminated Loco. Carriage,
Wagon-Bearing and
Buffing **SPRINGS.**

Spiral, Volute, and
Conical **SPRINGS.**

Special
"Fox" Chrome Vanadium
SPRINGS.

For Motor Transport Vehicles, etc., etc.

GUN RECOIL SPRINGS,

Etc., Etc.

SPRING DEPARTMENT.

The Spring Department deals with every description of Springs for railway work, and has recently developed with success, the manufacture of Gun Springs and Bearing Springs for road vehicles. The department is thoroughly up-to-date and well equipped for the manufacture of Spiral, Volute, and Laminated Springs. It is also equipped with the necessary machines for testing all classes of springs to the satisfaction of inspectors representing the British, Indian and Colonial, South American, Italian, Chinese, and Japanese railways. All Laminated Springs made by the firm are hand-fitted by skilled men.

POWER PLANT.

The gradual substitution of electric driving in place of steam has been a special feature of the works development in recent years, and the power plant now consists of three sets of generating D.C. at 500 volts, of 1,000, 500 and 312 kw. respectively. The Company also have one set of 120 kw. generating D.C. at 220 volts for lighting purposes. A further three sets, driven by Coke Oven Gas, are in course of erection.

**CASE
HARDENING
STEELS**

OF ALL KINDS.

**In Carbon, Nickel,
or Nickel Chrome
Qualities.**

FOR AUTOMOBILE WORK AND GEARS
OF ALL KINDS.

STEEL WIRE

FOR ALL PURPOSES.

All sizes up to 36 S.W.G., including

ROUND, FLAT

and SECTIONAL,

In Crucible, Siemens, and Bessemer Steels.

WIRE SUPPLIED FOR :

Needles, Fish Hooks,
Springs, Piano Wire,
Crochet Hooks,
Toilet and Hat Pins,
Brushes, etc.

Gun-wrapping Wire

A SPECIALITY.

WIRE DEPARTMENT.

Turning to the lighter industries in which SAMUEL FOX & Co. LTD. are engaged, the first department for attention is that of **Wire Drawing**, which is the oldest business of the Company.

This very extensive department deals with practically every grade of high-class wire. A rod patenting plant is attached to the department, and in conjunction with this the Company has specialized in the production of gun wire for wrapping all naval and some field howitzers. A small quantity of piano wire is also drawn for manufacture of springs and similar articles. The bulk of the output, however, is annealed wire in sizes ranging from $\frac{1}{2}$ " to 36 S.W.G. Large quantities of this wire are used in the manufacture of hand, machine, hosiery and latch needles, hackle pins, fish-hooks, springs, and a multitude of other similar articles, and the department has also recently developed the drawing of high-speed steel and other special alloy steels for the manufacture of high tension wires.

The Company also have an old-standing reputation for the manufacture of card wire, hat wire, etc.

Another speciality is that of the drawing of special section wires for the manufacture of chain parts, etc. Flat wire rolling is undertaken in a separate department attached to the wire department and apart from a large tonnage of wire subsequently used in the firm's Umbrella Department. A large trade in flat wire for general purposes has also been developed.

Another supplementary plant goes by the name of the **Crinoline Department**. This department is equipped with the necessary plant for hardening and tempering wire and strip steel. As the name will convey, this department owed its origin and development to the manufacture of crinoline steel, which gave a great impetus to the industry at Stocksbridge. The chief output of this department consists of rule and tape steel, safety razor steel, and of steel for numerous other purposes employing high-class hardened and tempered wire and strip. This paragraph must not be closed without a reference to a very fine cutting shop recently installed by the present management. This shop specialises in the straightening and cutting of wire to the specified lengths, chiefly for the manufacture of needles, pins and fish-hooks, and is probably one of the finest shops of its kind in the country.

Treatment Instructions

OF

"Fox" High Speed Steel.

CUTTING TOOL LENGTHS. The bars are supplied in a thoroughly annealed condition, and we advise sawing the bars to the desired length. If this cannot be done, the bars should be slowly heated up to a **full cherry red**, and cut hot. It must be realised that this latter treatment leaves the bar in a hardened condition, and care must be taken in subsequently re-heating for forging.

FORGING. Heat up slowly and thoroughly to a **lemon heat** (1000° to 1050° C. or 1830° to 1925° Fah.) for forging. Do not forge the steel **below a bright cherry red** (880° C. or 1560° Fah.) Allow the steel to cool naturally after forging. We advise that tools be re-heated to a full cherry red, and allowed to cool normally after forging, as this greatly lessens the liability to crack in hardening.

HARDENING. In the case of turning, planing, and similar tools, the nose of the tool should be heated very carefully to a **full cherry red**, and then the cutting edge heated rapidly to a **glistening white heat** (1350° C. or 2450° Fah.). Soak at this temperature for about five seconds, withdraw from the fire, allow to stand for five seconds, and quench out in whale oil. If an oil bath is not available, the tool may be quenched in a dry air blast or in boiling water. We recommend the oil quenching treatment. If extremely severe stress is to be put upon the tool, it is often advisable to temper for a short time at about 150° to 200° C. or 300° to 400° Fah. in an oil bath. This relieves hardening strains without appreciably affecting the cutting properties. The cutting efficiency can be increased considerably by re-heating, after hardening, to 620° to 630° C. or 1150° to 1165° Fah. for 10 to 15 minutes according to size of tool, followed by cooling normally in air.

GRINDING. We recommend a wet sandstone. If any emery wheel is used the tool must be ground dry; otherwise there is great danger of the tool cracking in this operation owing to the intense local heat developed.

Cold Rolled Strip Steels,

FOR

Cycle Parts and Rims,
Pens,
Cartridge Clips,
Maxim Gun Clips,
Deep Stamping, etc., etc.

Sizes from 0·001 inch to 0·25 inch thick,
in widths up to 10 inches wide,

In SIEMENS ACID, BASIC,
BESSEMER, and CRUCIBLE.

Hardened & Tempered Strip

(Black, Blue, Straw, or Polished.)

COLD ROLLING DEPARTMENT.

The Cold Rolling Department includes three large factories containing many sets of rolls, all electrically driven. A very large variety of work is undertaken in sizes from .001" thick by 2¼" maximum width to .25" thick. This plant can undertake up to 10" wide cold rolled strip of thickness up to .03". Large tonnages of cold rolled steel go into cartridge clips, pens, cycle parts, band-saws (wood and metal), deep stamping and press work, watch springs and cases, razor blades, adding and registering machine parts, etc.

A special study has been made of annealing conditions, and the Company have eight large ovens, all pyrometrically controlled, thus ensuring the material being put into the best condition to meet the user's demands.

SAMUEL FOX & CO. LIMITED.

Fox's Frames.

FOR
UMBRELLAS
AND
SUNSHADES.

REGISTERED

S. FOX & CO. LIMITED

PARAGON 



STOCKS BRIDGE WORKS, NIKKI, SHEFFIELD.

UMBRELLA DEPARTMENT.

SAMUEL FOX & CO. Ltd. have for many years had a very high reputation for the manufacture of umbrella frames and tubes. The work occupies some 300 workpeople, mostly girls. The steel is specially selected for the purpose, and is of the highest quality. The fact of the firm making their own steel and working the same down through every process obviously confers a great benefit upon these articles. All the tubes are hardened and tempered, and possess very distinct advantages over the cheap imported qualities of the soft steel tubes. A very elaborate system of inspection and testing is in vogue, and it is absolutely impossible for a defective tube rib or stretcher to be put into service.

The life of an umbrella depends entirely upon the quality of the frame, and the wisdom of looking for the firm's well-known trade mark on one of the ribs of the frame, and for their name on the tube, is now apparent to everyone. The trade marks now in use are





on the troughed ribs and stretchers, and



on solid ribs.

HIGH SPEED STEELS

A Speciality.

Made in Three Standard Qualities, viz.:

CLASS No. 1 MS 1015	"FOX" HIGH SPEED STEEL 10% CO. SAMUEL FOX & CO. LTD., STOCKBRIDGE WORKS, SHEFFIELD, ENGLAND.	 For cutting tools and machine tools when extreme high speeds are required. For all "The Motor" type applications specified.
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CLASS No. 2 MS 1020	"10% LATEX" HIGH SPEED STEEL 10% CO. SAMUEL FOX & CO. LTD., STOCKBRIDGE WORKS, SHEFFIELD, ENGLAND.	 This grade, which will be light or strong as required, is especially adapted for use in tools for cutting light gauge sheet of the standard 10% alloy. It will produce excellent results when the full length alloy is used in tool applications.
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CLASS No. 3 MS 1025	"FOX SPECIAL" HIGH SPEED STEEL 10% CO. SAMUEL FOX & CO. LTD., STOCKBRIDGE WORKS, SHEFFIELD, ENGLAND.	 Specially made to meet the demand for alloys containing 10% cobalt, which enables tooling to be used at higher speeds and heavy cuts.
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For Heavy Turning Work, etc., the "FOX" HIGH SPEED STEELS are extremely satisfactory, excellent results being obtained by our customers.

" Fox "
Self Hardening Steels.

COLLIERIES AND COKE OVENS.

The collieries, which are situated within the works, are capable of raising 4,000 tons of coal per week, the greater portion of which is Halifax Soft Seam. A portion is consumed by the various departments in the works, and beyond this a ready market is found for gas-making. The coal is of a very high character for this work. The Company will shortly have completed a battery of 60 Simon-Carves coke ovens, which will be one of the finest coking plants in the world, and will deal with 150,000 tons of coal per year, produce about 100,000 tons per year of first-class coke, 2,500 tons per year of ammonium sulphate, 6,000 tons per year of tar, and 450,000 gallons per year of crude benzol.

Four Westinghouse gas engine sets are being installed, each of which will generate 450 kw. A.C., being served by surplus gas from the coking plant. This current will be used for power in the works, and the introduction of electric steel-making is contemplated.

The necessary plant for the rectification of benzol is also contemplated as an addition to this plant.

CHEMICAL LABORATORY, TEST HOUSE AND RESEARCH DEPARTMENT.

Special attention has been paid in recent years to the development of the technical control of manufacturing processes. The Chemical Laboratory, employing 22 chemists, undertakes the testing of all raw material for purity and suitability, and controls the whole of the steel production. It will therefore be realised that no difficulty is experienced in the manufacture of steel by any of the processes employed to any reasonable specification. A considerable amount of work is also done in the analysis of slags, refractories, water, oils, gases, fuels, etc.

The Testing Department has recently been entirely reorganised, and is equipped with a modern 50-ton Buckton testing machine, hydraulically controlled, and arranged to carry out tests by tension, bending, compression, shearing, and torsion. The necessary machinery for the cutting out and preparation of test pieces is entirely under the control of the test-house manager.

A new 120 ft.-lbs. Izod impact testing machine has been installed, and embodies recent improvements, notably in the suspension of the pendulum on ball bearings, and an improved form of gripping device.

A spring testing machine has recently been built for testing in compression by dead weight, springs with a range of 30" of action, up to 1-ton load.

This department, together with the Chemical Laboratory, co-operates closely with the Research Department.

A number of other testing machines, installed for experimental purposes, have also been found to be of great value. In this direction we would mention a rotary fatigue machine, in which the specimen is revolved at 2,000 revolutions per minute, under a known stress. This machine tests the properties of the steel in resisting pure fatigue. A repeated impact bending machine subjects the specimen to the well-known Stanton repeated impact test. A grooved specimen is subjected to a blow of known magnitude about 90 times per minute, the test piece being reversed between each blow. The load and height of fall are under control, and specimens

can therefore be subjected to tests under various ranges of stress. This machine is exceptionally useful in testing steel for its resistance to repeated impact. This combination of tests allows us to examine a specimen under conditions as nearly as possible similar to those which the steel will be called upon to meet in service, and it may be here remarked that the greater care should be exercised in interpreting results of shock or fatigue tests, unless due care is taken to consider the actual purposes for which the steel is required.

The department is also equipped with the standard Brinell hardness testing machine, and the Shore scleroscope, the latter being used mainly for the hardness testing of strip steel.

The Research Department also includes a very fine recalcence apparatus, by means of which the constitution of special steels are studied. This plant is also used for the regular calibration of the numerous works pyrometers. It is especially noted that every operation involving heat treatment in the works is under the control of skilled men using suitable pyrometers. In this department a small heat treatment plant for experimental purposes has been erected, a spring

testing machine for wire springs, and plant for the testing of magnetic and electrical properties of steel. The latter includes a flux-meter with accessories for determining coercive force of magnets, and a very fine "Thomson" double bridge for resistivity.

For many years a special study of the microscopical structure and constitution of our products has been made, and the department is equipped with a Zeiss photo-micrographic outfit, capable of photographing microstructures at anything from 5 to 3,000 diameters magnification; a Ross microscope for visual examination, mechanical polishing plant, dark room, and general accessories.

The Research Department and Laboratories deal in a spirit of real co-operation with every department in the works, and it will be recognised that this tends to the highest development of quality, together with the best work's practice.

The modern spirit actuating the management of the works preserves the best traditions of the past, and takes full advantage of the wealth of accumulated practical experience which such a works as this undoubtedly possesses.

GENERAL.

Practically the whole of the workpeople live in the villages of Stocksbridge and Deepcar, and the Company own about 380 houses in the district, being always alive to the importance of studying the comfort and housing conditions of the workpeople. The Company are just commencing to lay out a large "garden city," which will allow for about a further 300 houses. Canteens have also been erected since the war started, adding considerably to the comfort of the workpeople.

AMALGAMATION.

It should be pointed out that Messrs. Samuel Fox & Co. Ltd., of Stocksbridge Works, near Sheffield, have amalgamated with Messrs. Steel, Peech & Tozer, The Ickles, Sheffield, and that the joint output of steel from the amalgamated firms is expected to approximate 1,000,000 tons per year by December, 1917.

These two firms have recently acquired the well known Frodingham Iron & Steel Works, Frodingham, together with that Company's interest in The Appleby Iron Co.

The above Companies have now amalgamated with The Workington Iron and Steel Co., Workington.

APPROXIMATE TABLE OF EQUIVALENTS.

Tons per sq. in.	Kilos per sq. %	Dia. of Ball Imprsn.	Brinell Numeral	Tons per sq. in.	Kilos per sq. %	Dia. of Ball Imprsn.	Brinell Numeral
25	40	5-60	111	74	117		
26	41			75	118	3-30	340
27	43	5-50	116	76	120		
28	44	5-40	121	77	121		
29	46	5-30	126	78	123		
30	47	5-20	131	79	125		
31	49	5-00	143	80	126	3-20	354
32	51	4-90	149	81	128		
33	52			82	129		
34	54	4-80	156	83	131		
35	55	4-70	163	84	132		
36	57	4-60	170	85	134	3-10	367
37	59			86	136		
38	60			87	137		
39	62	4-50	179	88	139	3-05	402
40	63			89	140		
41	65	4-40	187	90	142		
42	66			91	143		
43	68	4-30	196	92	145	3-00	418
44	69			93	146		
45	71	4-20	207	94	148		
46	73	4-15	212	95	150		
47	74			96	151		
48	76	4-10	217	97	153		
49	77	4-05	223	98	155	2-90	444
50	79	4-00	228	99	156		
51	81	3-95	235	100	158		
52	82			101	160		
53	84	3-90	241	102	161		
54	85			103	162		
55	87	3-85	248	104	164		
56	89	3-80	255	105	165	2-80	477
57	90			106	167		
58	91	3-75	262	107	169		
59	93	3-70	269	108	170		
60	94			109	172		
61	96	3-65	277	110	173		
62	98			111	174		
63	99	3-60	286	112	176	2-70	515
64	101	3-55	293	113	178		
65	102			114	180		
66	104	3-50	302	115	181		
67	106			116	182		
68	107	3-45	311	117	184		
69	109			118	186		
70	110			119	187		
71	111	3-40	321	120	189		
72	113			122	192	2-60	558
73	115			132	208	2-50	600

WEIGHTS OF STEEL BARS.

ROUNDS, SQUARES & OCTAGONS.

Lbs. per Lineal Foot.

Size	Round	Square	Octagon	Size	Round	Square	Octagon
	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.
$\frac{1}{8}$	0.940	1.200	1.000	$1\frac{1}{8}$	7.051	8.978	7.610
$\frac{1}{4}$	1.670	2.130	1.800	$1\frac{1}{4}$	7.650	9.720	8.200
$\frac{3}{8}$	2.610	3.320	2.800	$1\frac{3}{8}$	8.178	10.412	8.820
$\frac{1}{2}$	3.760	4.780	4.100	$1\frac{1}{2}$	8.830	11.210	9.640
$\frac{5}{8}$	5.110	6.510	5.500	$1\frac{5}{8}$	9.388	11.953	10.120
$\frac{3}{4}$	6.680	8.400	7.200	$1\frac{3}{4}$	10.090	12.810	10.810
$\frac{7}{8}$	8.450	10.76	9.100	2	10.681	13.600	11.520
1	10.43	13.28	11.20	$2\frac{1}{8}$	12.140	15.410	13.000
$1\frac{1}{8}$	12.62	16.070	13.60	$2\frac{1}{4}$	13.610	17.280	14.580
$1\frac{1}{4}$	15.02	19.012	16.20	$2\frac{1}{2}$	15.160	19.250	16.240
$1\frac{3}{8}$	17.63	22.245	19.00	$2\frac{3}{8}$	16.800	21.330	18.000
$1\frac{1}{2}$	20.44	26.03	22.200	$2\frac{1}{2}$	18.522	23.520	19.840
$1\frac{3}{4}$	23.47	29.88	25.30	$2\frac{7}{8}$	20.330	25.810	21.780
2	26.70	34.00	28.70	3	22.220	28.210	23.800
$2\frac{1}{8}$	30.30	38.50	32.250	3	24.190	30.720	25.920
$2\frac{1}{4}$	33.80	43.03	36.40	$3\frac{1}{4}$	28.390	36.050	30.420
$2\frac{1}{2}$	37.90	48.10	40.60	$3\frac{1}{2}$	32.930	41.810	35.280
$2\frac{3}{8}$	41.72	53.12	45.00	$3\frac{3}{4}$	37.800	48.000	40.500
$2\frac{1}{2}$	46.30	58.80	49.60	4	43.010	54.610	46.080
$2\frac{7}{8}$	50.69	64.28	54.50	$4\frac{1}{4}$	48.550	61.650	52.020
3	55.50	70.50	59.50	$4\frac{1}{2}$	54.430	69.120	58.320
$3\frac{1}{8}$	60.08	77.50	64.80	$4\frac{3}{4}$	60.650	77.010	64.980
$3\frac{1}{4}$	65.60	83.30	70.90	5	67.260	85.330	72.000

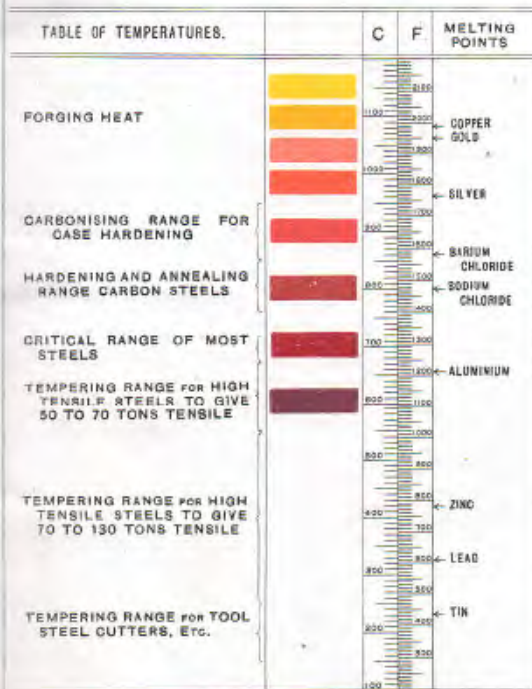
WEIGHTS OF STEEL BARS.

FLATS.

Lbs. per Lineal Foot.

In.	1°	1½°	1¾°	1½°	1½°	1¾°	2°
½	.426	.479	.530	.585	.640	.745	.850
¾	.639	.718	.790	.878	.960	1.12	1.28
1	.852	.958	1.06	1.17	1.28	1.49	1.70
1¼	1.06	1.20	1.33	1.46	1.60	1.86	2.13
1½	1.28	1.33	1.59	1.75	1.91	2.23	2.55
1¾	1.49	1.67	1.86	2.05	2.33	2.60	2.98
2	1.70	1.91	2.13	2.34	2.55	2.98	3.40
2¼	1.91	2.15	2.39	2.63	2.87	3.35	3.83
2½	2.12	2.39	2.66	2.92	3.19	3.72	4.26
2¾	2.34	2.63	2.92	3.22	3.51	4.09	4.68
3	2.55	2.86	3.19	3.50	3.83	4.46	5.10
3¼	2.76	3.11	3.45	3.80	4.14	4.83	5.53
3½	2.98	3.34	3.72	4.09	4.46	5.21	5.96
3¾	3.19	3.59	3.98	4.38	4.78	5.58	6.38
4	..	3.82	4.25	4.68	5.10	5.96	6.80
4¼	..	..	4.78	5.27	5.74	6.71	7.65
4½	..	..	..	5.85	6.38	7.45	8.50
4¾	..	..	..	7.02	7.67	8.94	10.07
5	2½	2½	2½	3	3½	4	5
5	.955	1.07	1.18	1.28	1.49	1.70	2.13
5¼	1.43	1.60	1.76	1.92	2.24	2.55	3.20
5½	1.91	2.13	2.34	2.56	2.98	3.40	4.26
5¾	2.39	2.66	2.92	3.19	3.72	4.25	5.32
6	2.87	3.20	3.51	3.83	4.46	5.10	6.40
6¼	3.35	3.72	4.09	4.46	5.21	5.95	7.44
6½	3.83	4.26	4.68	5.10	5.96	6.80	8.52
6¾	4.30	4.78	5.26	5.74	6.69	7.65	9.56
7	4.79	5.32	5.86	6.39	7.44	8.52	10.64
7¼	5.26	5.84	6.43	7.01	8.18	9.35	11.70
7½	5.74	6.40	7.02	7.65	8.92	10.20	12.80
7¾	6.22	6.91	7.60	8.29	9.67	11.10	13.80
8	6.70	7.46	8.19	8.94	10.42	11.92	14.92
8¼	7.17	7.97	8.77	9.56	11.20	12.80	15.90
8½	7.66	8.52	9.36	10.20	11.92	13.60	17.04
8¾	8.61	9.59	10.54	11.48	13.41	15.30	19.17
9	9.57	10.65	11.71	12.76	14.90	17.00	21.30
9¼	11.49	12.78	14.04	15.30	17.88	20.40	25.56

HEAT TREATMENT OF STEELS.



TO CONVERT F TO C $\frac{1}{2}(F-32)=C$ C TO F $\frac{3}{2}C+32=F$

IMPERIAL STANDARD WIRE GAUGE.

Descriptive number	Equivalent in parts of an inch	Metric equivalent millimetres	Descriptive number	Equivalent in parts of an inch	Metric equivalent millimetres
7/0	.500	12.700	23	.024	.610
6/0	.464	11.785	24	.022	.559
5/0	.432	10.973	25	.020	.508
4/0	.400	10.160	26	.018	.457
3/0	.372	9.449	27	.0164	.4166
2/0	.348	8.839	28	.0148	.3759
0	.324	8.229	29	.0136	.3454
1	.300	7.620	30	.0124	.3150
2	.276	7.010	31	.0116	.2946
3	.252	6.401	32	.0108	.2743
4	.232	5.893	33	.0100	.2540
5	.212	5.385	34	.0092	.2337
6	.192	4.877	35	.0084	.2134
7	.176	4.470	36	.0076	.1930
8	.160	4.064	37	.0068	.1727
9	.144	3.658	38	.0060	.1524
10	.128	3.251	39	.0052	.1321
11	.116	2.946	40	.0048	.1219
12	.104	2.642	41	.0044	.1118
13	.092	2.337	42	.0040	.1016
14	.080	2.032	43	.0036	.0914
15	.072	1.829	44	.0032	.0813
16	.064	1.626	45	.0028	.0711
17	.056	1.422	46	.0024	.0610
18	.048	1.219	47	.0020	.0508
19	.040	1.016	48	.0016	.0406
20	.036	.914	49	.0012	.0305
21	.032	.813	50	.0010	.0254
22	.028	.711			