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NORFOLK
WORKS.

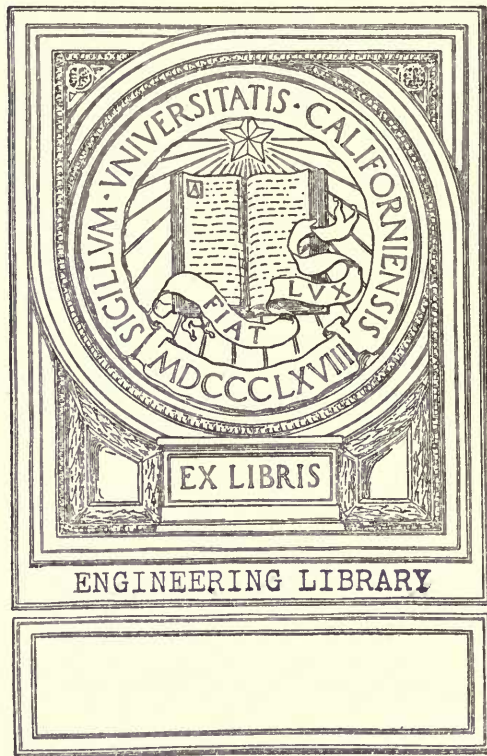


THO^S FIRTH & SONS LTD



SHEFFIELD,
ENGLAND.





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NORFOLK WORKS,

SHEFFIELD, ENGLAND.

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ENGINEERING LIBRARY

THOS. FIRTH & SONS, LIMITED,

NORFOLK WORKS,

SHEFFIELD, ENGLAND.

THE original Firm of THOS. FIRTH & SONS was founded in about the year 1840, by Mr. MARK FIRTH and his Father Mr. THOMAS FIRTH. They were afterwards joined by Mr. THOMAS FIRTH, Jun., Mr. JOHN FIRTH, Mr. EDWARD FIRTH, and Mr. CHAS. HENRY FIRTH. The Company, though now "Limited" is still a private business.

The business, which started in only a very small way, advanced rapidly, principally owing to the high and uniform quality of the Steel and Steel Goods produced, and there are now Agencies in Paris, Berlin, Frankfort, Hamburg, Brussels, Copenhagen, Barcelona, Turin, St. Petersburg, Moscow, Odessa, Montreal, New York, Boston, San Francisco, Mexico City, Johannesburg, Freemantle, and other places.

The Works consist of the following separate departments:—Norfolk Steel Works, Shot Forge, Clay Wheel Forge, West Gun Works, East Gun Works, Foundry, and File,

M245949

Saw and Edge Tool Works, and cover nearly 20 acres of ground. The number of men employed is about 2000. The total steam power is 3000 I.H.P. and there are 37 Steel Boilers, mostly 30 feet long, and $7\frac{1}{2}$ to 8 feet in diameter.

The annual output of FIRTH'S Crucible Steel is from 5000 to 6000 tons. This is used for general engineering work, and especially for turning tools, twist drills, reamers, punches, dies, hammers, axes, &c. Die blocks of all sizes and shapes for stamping out drop forgings, parts of small arms, bicycle and sewing machine work, etc. are made in very large quantities and have a high reputation. The firm has also for many years supplied to the English and many Foreign Governments, Steel for swords, bayonets, rifle barrels, and the component parts of small arms of every description.

Mining supplies are a speciality, large shipments being regularly sent to South Africa, Australia, Mexico, United States, Canada, and other Countries. These include Crucible Steel for Mining tools, drills, etc., and steel shoes, dies, cams, cam shafts, tappets, heads, stems, etc., the high and uniform quality of which is everywhere admitted.

It is unnecessary to mention here all the other purposes including clock and watch springs, shear blades, milling cutters, saws, edge tools, etc., etc., for which the material is produced, but from their position and experience the Firm can turn out anything that may be required in the finest crucible steel. They are direct importers of Bar Iron from Sweden, having an intimate knowledge of the quality of the various brands on the Market, from the highest class of Dannemora Iron to the ordinary Swedish Bar, owing to their many years experience in the special quality and temper required for each purpose.

The Rolling Mills accommodate 15 gangs of men, who work both night and day,

and produce sheets for circular saws, cylinder laggings, shovels, tools, drills, scale beams, razors, cutlery, planer knives, etc., etc. There are seven 10-cwt. hammers and fifteen of a smaller size, for working up crucible steel into square, flat, octagon, and special-section bars.

The manufacture of Files, is an important industry. Saws and Edge Tools of all kinds are also extensively produced. These various goods bear a high reputation in the Markets of the World.

Up to the year 1880 when Crucible Steel was still used for heavy ordnance, shafting, cranks, tyres, etc., single ingots were cast up to 30 tons in weight and at the same time there were being turned out at these works pieces of every size from wire for needles up to tubes for the 110-ton gun.

The firm's high-speed steel, so well known as "FIRTH'S SPEEDICUT" has already made a world-wide reputation for itself. Twist Drills and Cutters of all descriptions are now regularly being made from "FIRTH'S SPEEDICUT" Steel by THOS. FIRTH & SONS, LIMITED.

Messrs. Firth were the first manufacturers of steel for Ordnance, and the material for the celebrated "Woolwich Infant" was made at their Works. The ingot for these pieces required about 1000 crucibles.

Steel for ordnance, shafting, cranks, tyres, etc., and in fact most forgings of any size, are now made by the Siemens-Martin process, unless otherwise specified. For the manufacture of this quality of steel there are the following furnaces :—One of 45 tons, two of 25 tons each, and one of 10 tons, with which ingots upwards of 100 tons in weight can be produced.

These furnaces are served by a 100 ton travelling crane, as well as by several smaller ones used for the lighter work.

In the West Gun Works there are two hammers of 30 tons each, which were considered an enormous size when they were put down in 1866. They are served by a crane capable of lifting 100 tons. There are other hammers of 12, 10, 7, 5, and $3\frac{1}{2}$ tons, also of 30, 20, and 15 cwt.

An interesting feature of these Works is the Oil Hardening Tank, which is 75 feet deep, and served by a 50 ton swing crane. It is here that the Tubes for the heavy guns are oil hardened. This Tank holds 15,000 gallons of oil.

There is also a two-bay Machine Shop, each bay being 236 feet long, the widths being 37 feet and 48 feet respectively. In this large Shop there are large boring lathes capable of taking gun or shaft forgings 60 to 80 feet long. A double ended 30in. centre lathe, capable of turning a forging 100 feet long, a 40in. centre lathe 62 feet long, a 54in. centre lathe 26 feet long, are amongst the other powerful tools capable of dealing with the extremely heavy work manufactured here. In addition there is a smaller Machine Shop, 80 feet long by 30 feet wide, containing about 30 powerful lathes for dealing with the heaviest natures of "Projectiles."

In the East Gun Works there is a 3,000 tons Hydraulic Forging Press, of the continuous acting type, worked direct from the Pumps. This Press is entirely of Firth's own design, materials and manufacture throughout, and is capable of forging the largest pieces likely to be required. In addition, there is a 2000 tons Hydraulic Forging Press, also of the continuous acting type, made from Firth's own designs and materials, but, owing to pressure of work on the machining and fitting branches of the Works, was fitted up by an outside manufacturer.

Marine Shafting up to 30in. diameter and 40 ton forgings for the Tube of the 110 tons gun have already been turned out, and amongst many other important forgings should be stated cylinders, 30in. internal diameter by 10ft. long, for hydraulic presses for cartridge case making. Special mention may be made of the crank and propeller shafting manufactured for H.M. first class cruiser, "Minotaur," the propellor shafts for which were 75 feet long, weighed 27 tons each when finished, and required ingots of upwards of 80 tons in weight. The two presses are served by two 40 tons and one 70 tons combined hydraulic and electric cranes and two 50 tons hydraulic cranes.

In the East Gun Works are also several machine shops and an erecting shop, viz., one 100 feet by 20 feet, one 170 feet by 30 feet, and a two-bay shell machining shop 90 feet long, each bay 30 feet wide, and amongst the most powerful tools here may be mentioned a double ended lathe for trepanning ingots up to 60in. diameter and 70 tons in weight. A large lathe taking up to 12 feet diameter, a circular saw with 10 feet diameter cutting plate, a large slotting machine with 10 feet stroke. Besides very many other machines for general work there are 50 in the shell shop alone used for shell turning, and here also is the necessary banding, lacquering and gauging plant. In the erecting shop is coupled up crank and propellor shafting.

A speciality of the firm, for which it has a high reputation, is the manufacture of all natures of projectiles, comprising high explosive (common), shrapnel, cast steel shell, armour piercing shot and shell, and the latest type of projectile introduced by the firm, *i.e.*, capped armour piercing shell of the Firth-Rendable type, which, when filled with a bursting charge, will successfully perforate Krupp Cemented Armour Plate, one calibre in thickness, and be in a condition for bursting in the rear of the plate. At the works types of all these shells may be seen of all calibres from 4.7 inch to 16.25 inch, some of which are practically undamaged after passing the firing test against Krupp Cemented Armour Plate.

In the Foundry, where steel castings of all kinds weighing up to 45 tons are made, there are 1·45-ton, one 30-ton travelling cranes and one of 25 tons besides numerous smaller ones. The output of steel castings for locomotive, hydraulic, marine, and general engineering purposes, is upwards of 2,000 tons per annum.

A considerable portion of the material required by the War Office and Admiralty, as well as by private shipbuilding and engineering firms, is supplied from these works.

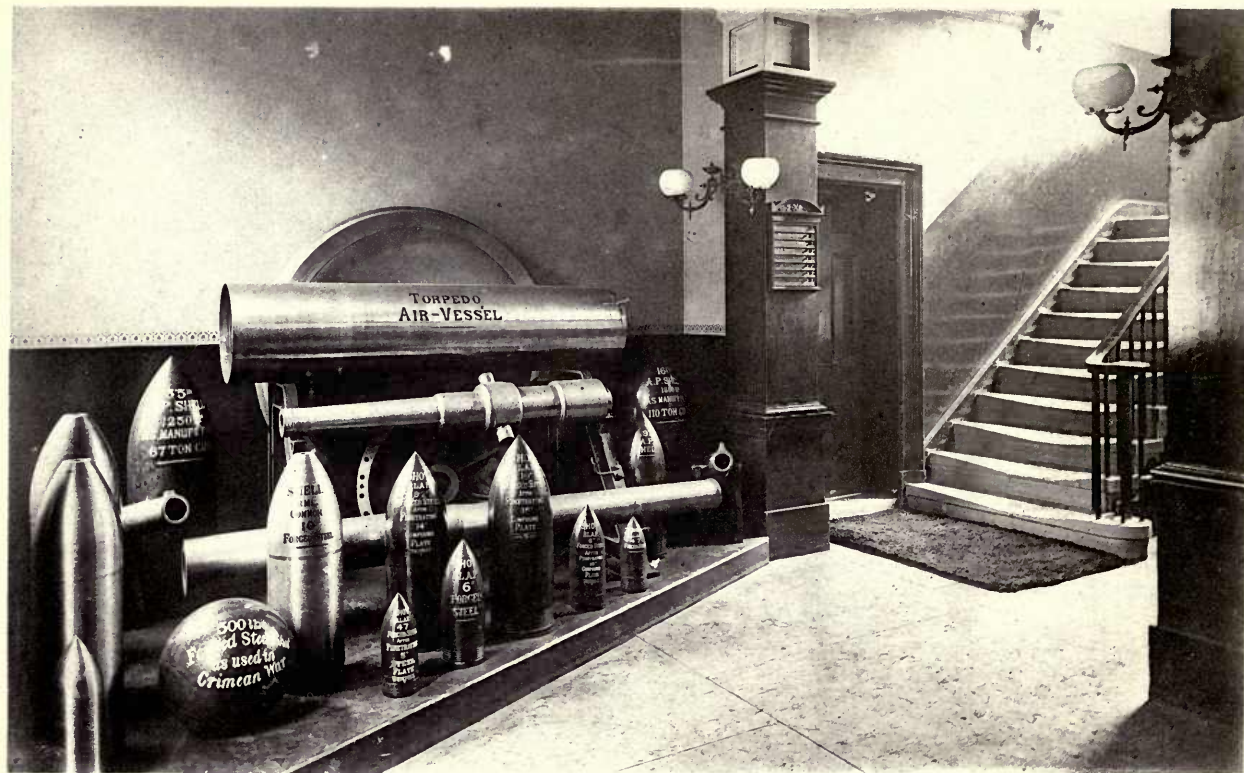
The manufacture of Steel Turbine Castings for Marine Engines is one of the most important lines in this Department.

The Turbine Engine Castings for the Cunard boat "Carmania" were made here, and still larger castings for the New Subsidised Cunard Express Boat of 65,000 I.H.P. are now being made. Practically all the castings for the Turbine Engines built up to date by the Parsons Marine Steam Co. Ltd., including those for the Battleship "Dreadnought," and for 12 Torpedo Boat Destroyers are now being manufactured.

The reputation of the Company's products is freely admitted wherever their goods have been supplied, and it is only necessary to look through the Works and observe the up-to-date appliances for the various processes and the care taken in the manufacture to be convinced that this reputation is well deserved.



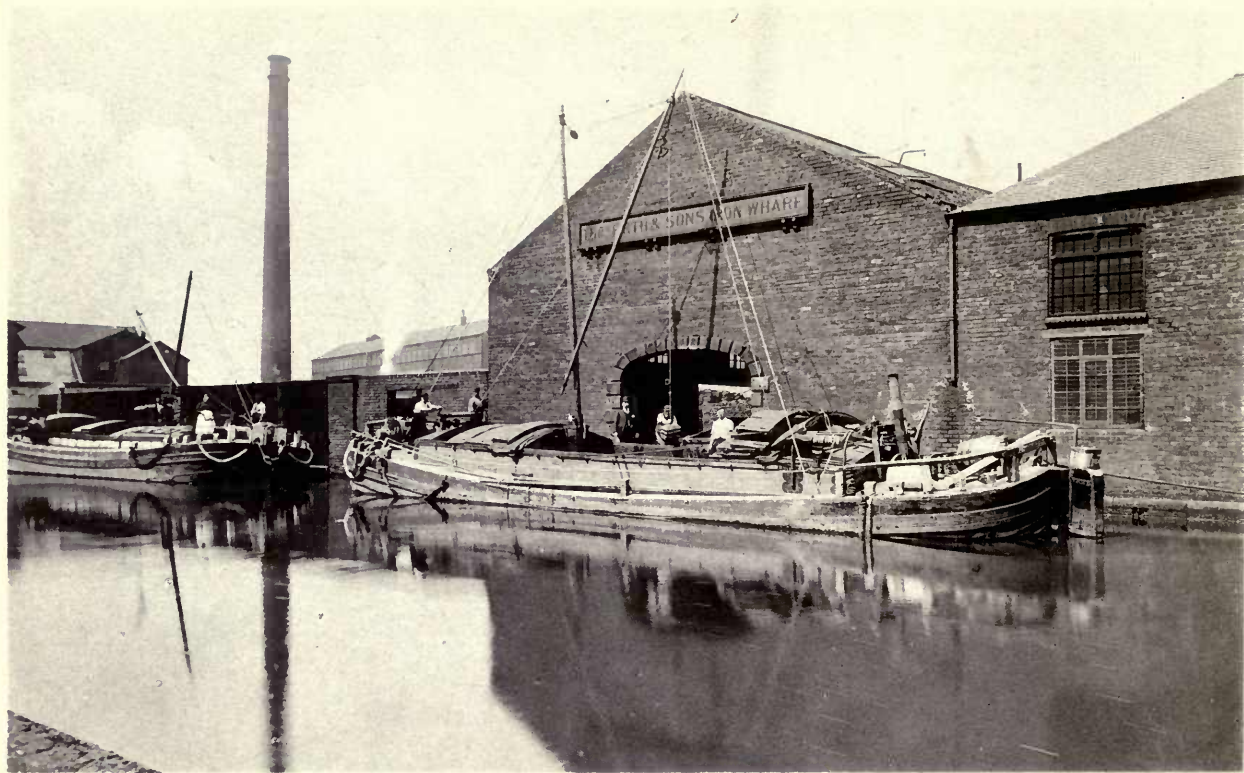
VIEW OF HEAD OFFICES AT NORFOLK WORKS.



ENTRANCE, NORFOLK WORKS.



BOARD ROOM, NORFOLK WORKS.



IRON WHARF, WITH BARGES SHOWING DELIVERY OF SWEDISH IRON.



YARD AT IRON WHARF, SHOWING ABOUT 6,000 TONS OF SWEDISH IRON.



SHED AT CANAL WHARF, WITH 2,000 TONS FINEST SWEDISH BAR IRON.



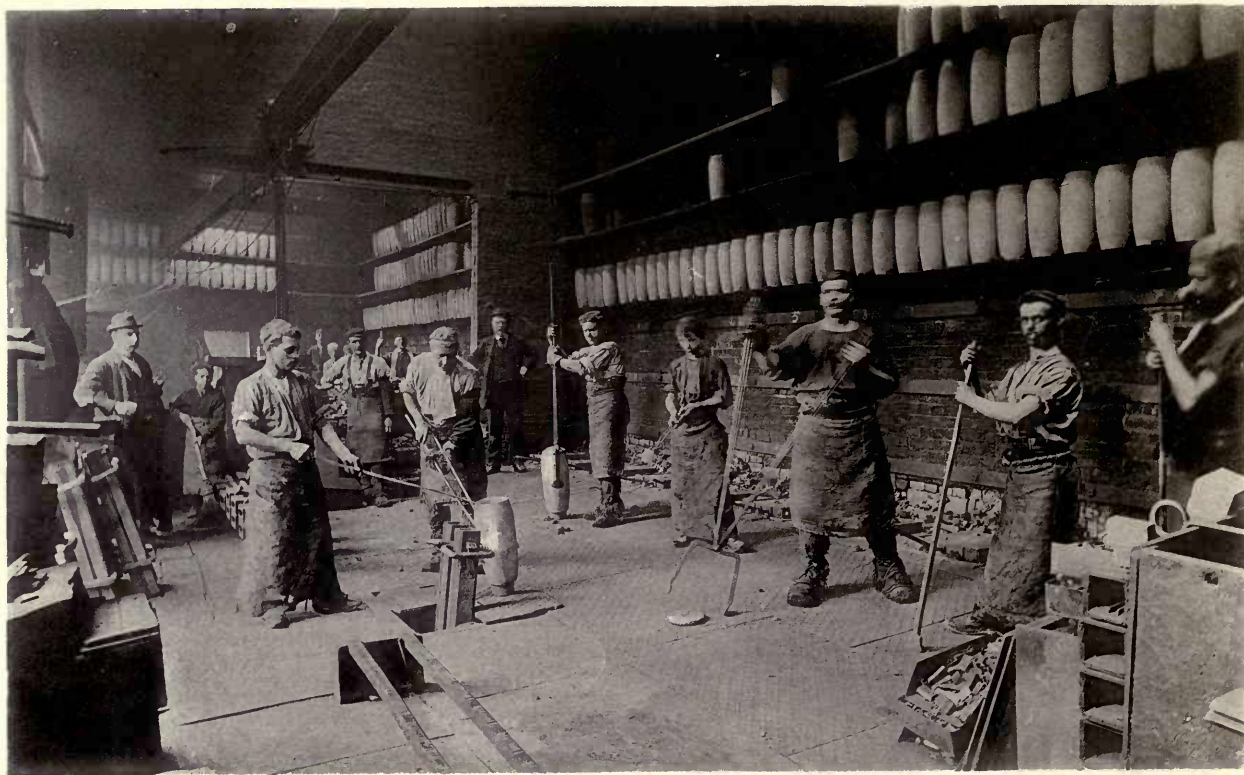
EXTERIOR VIEW OF CONVERTING FURNACES AT NORFOLK WORKS.



MAKING CRUCIBLES.



INTERIOR VIEW OF LARGE CRUCIBLE STEEL 100-HOLE MELTING FURNACE AT NORFOLK WORKS.
163 feet long $\times$ 70 feet wide. Area 1,269 square yards.



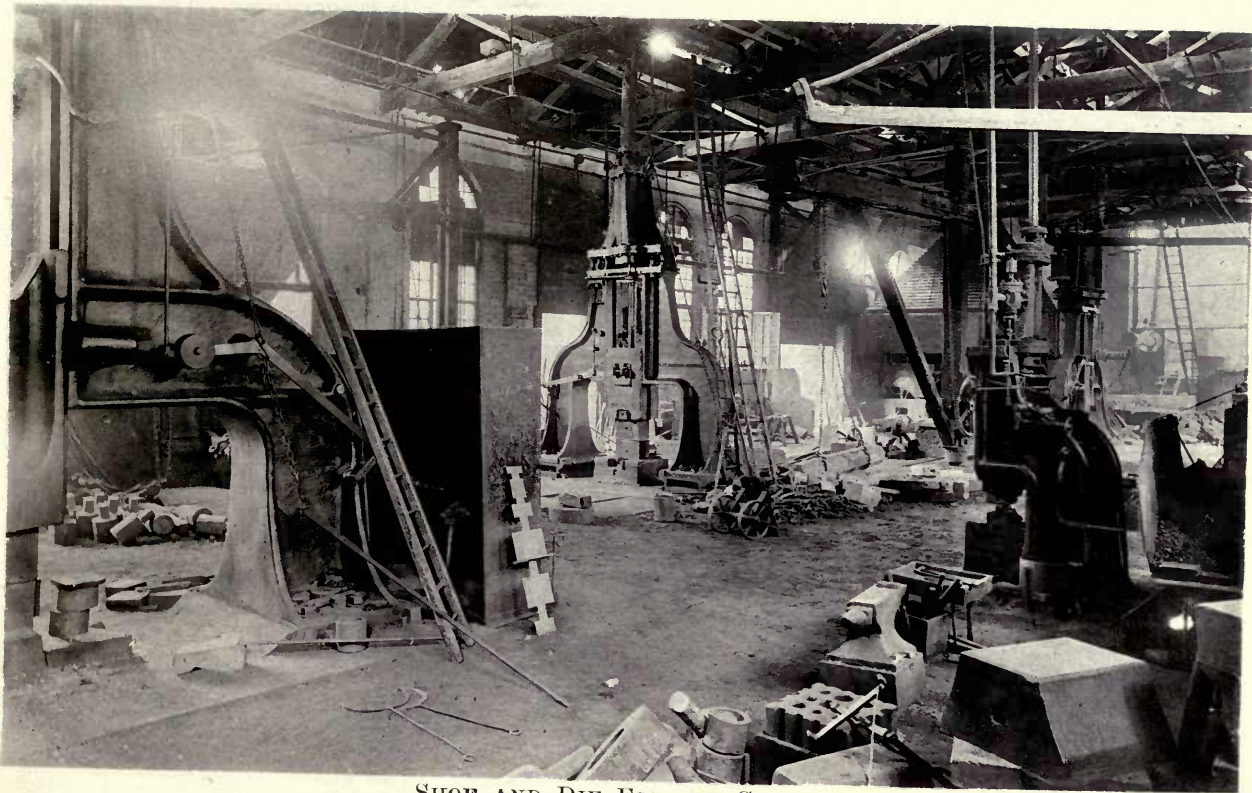
INTERIOR CRUCIBLE FURNACE, "TEEMING."



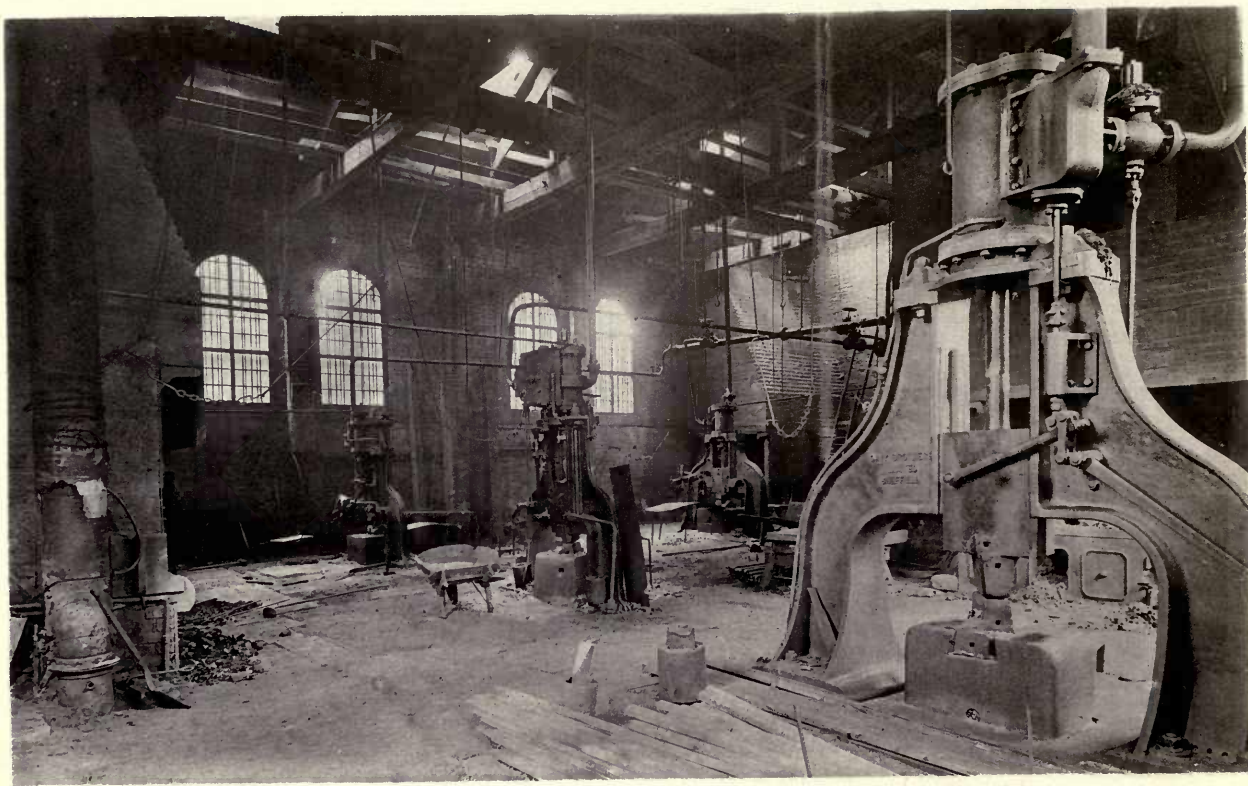
“TOPPING” INGOTS.



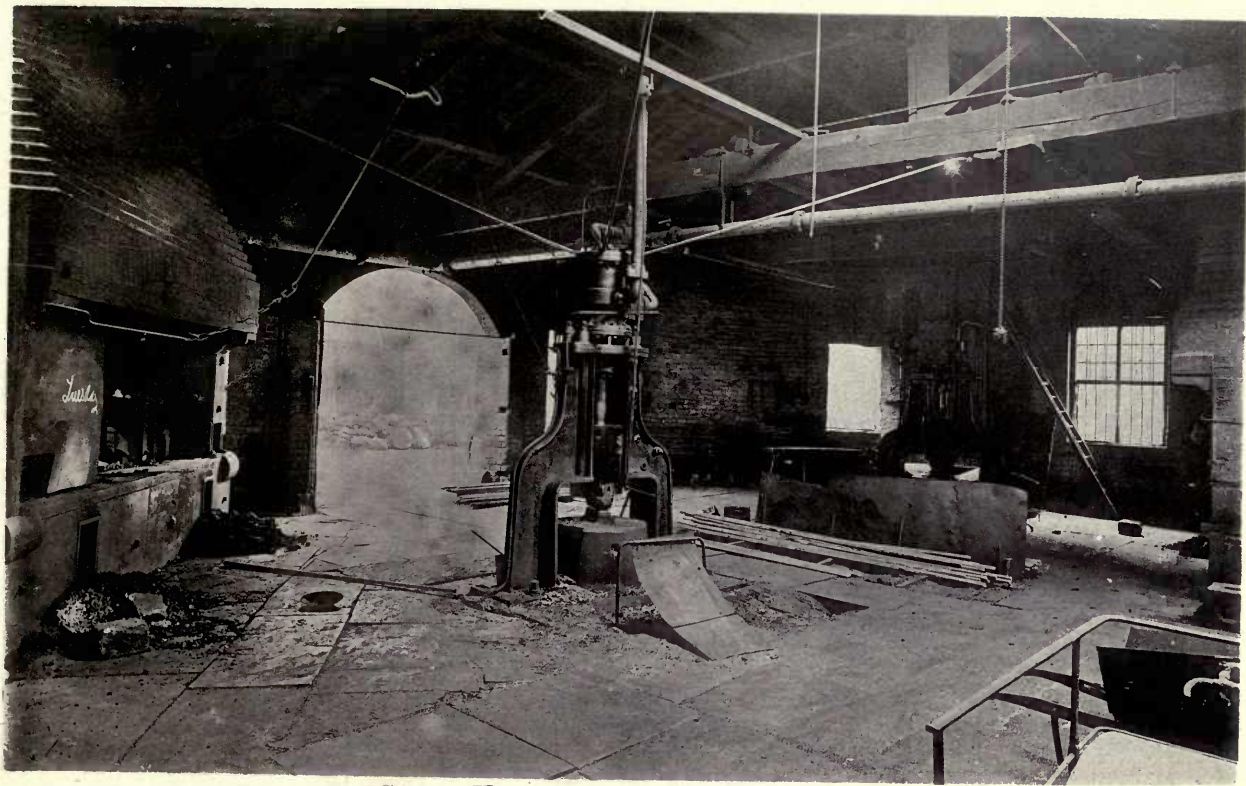
"GRADING" INGOTS.



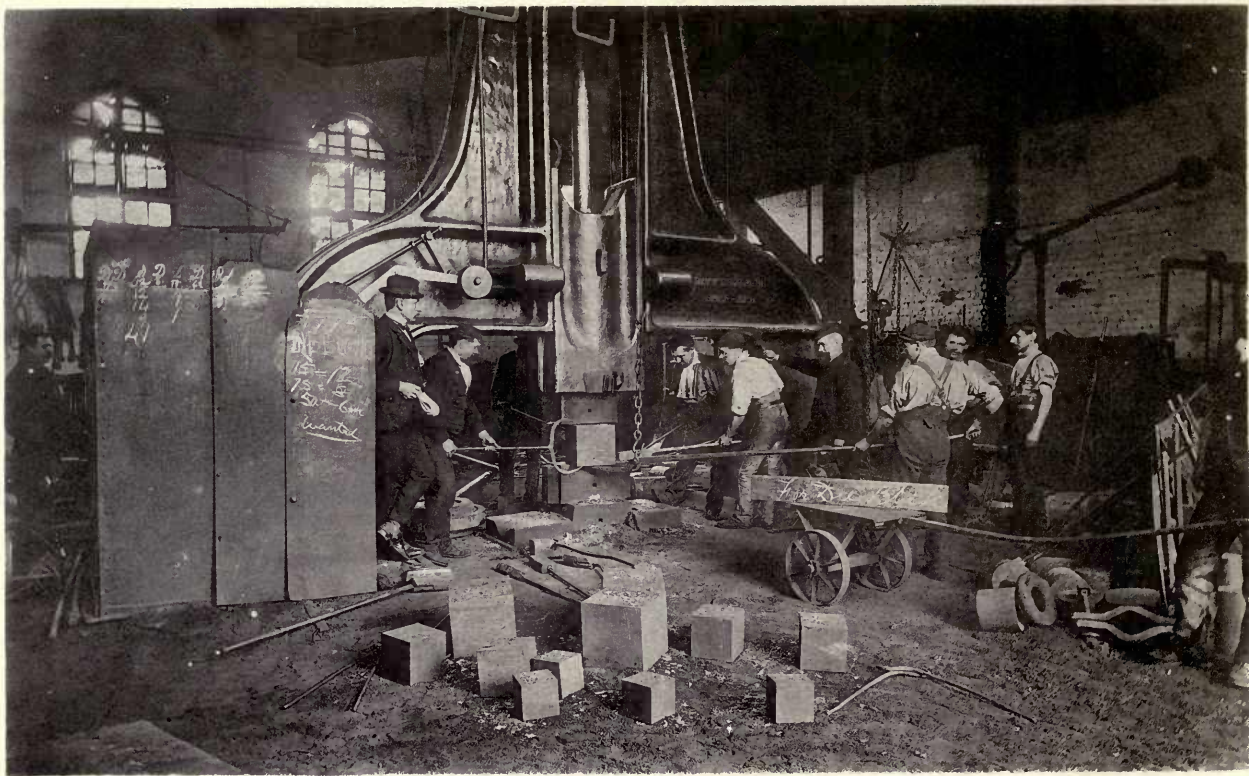
SHOE AND DIE FORGING SHOPS.



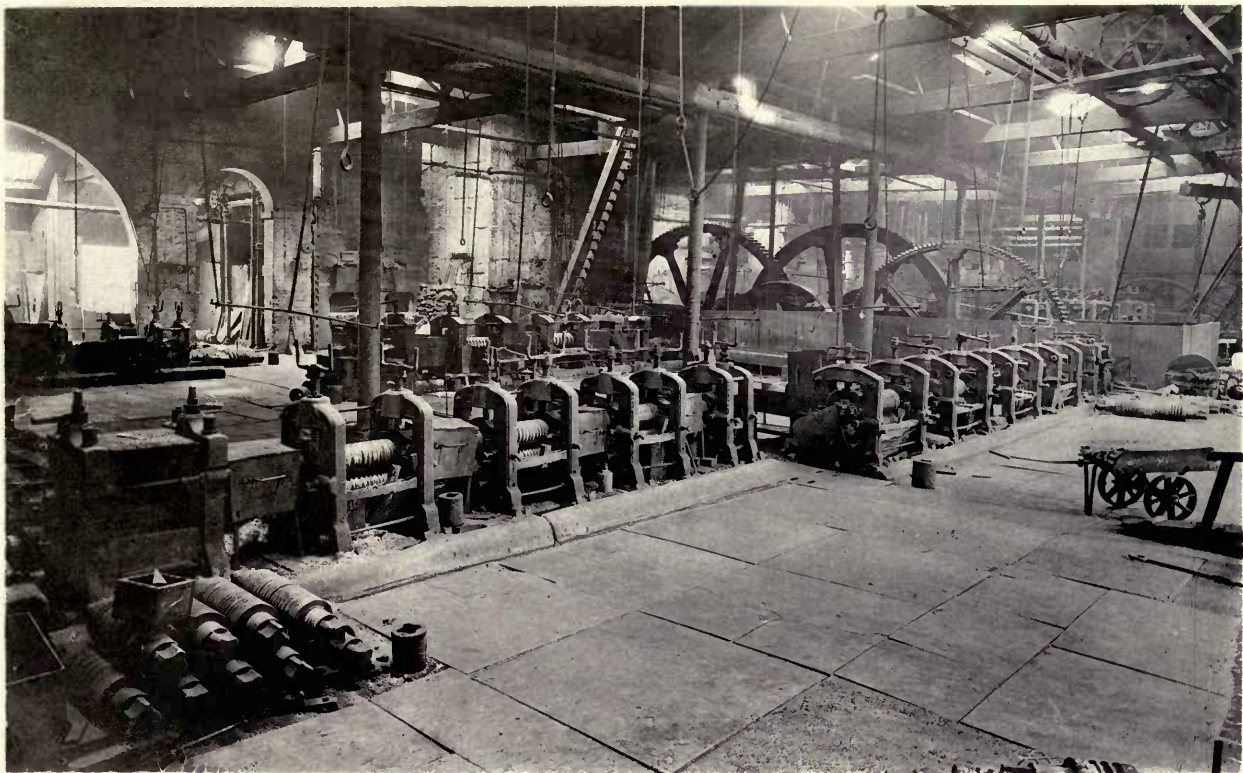
SMALL HAMMERS FOR CRUCIBLE STEEL FORGING AND TILTING.



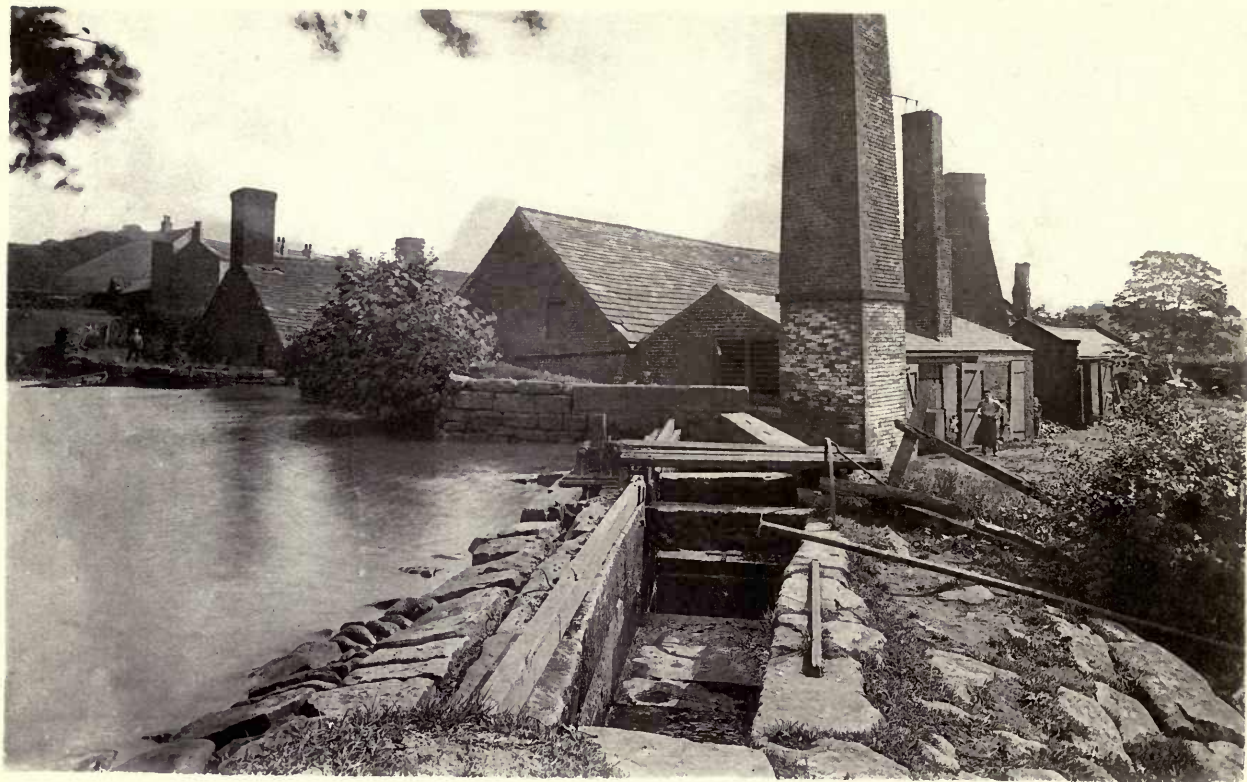
SMALL HAMMERS FOR MINING STEEL.



FORGING BLOCKS FOR PRESSING AND STAMPING DIES.



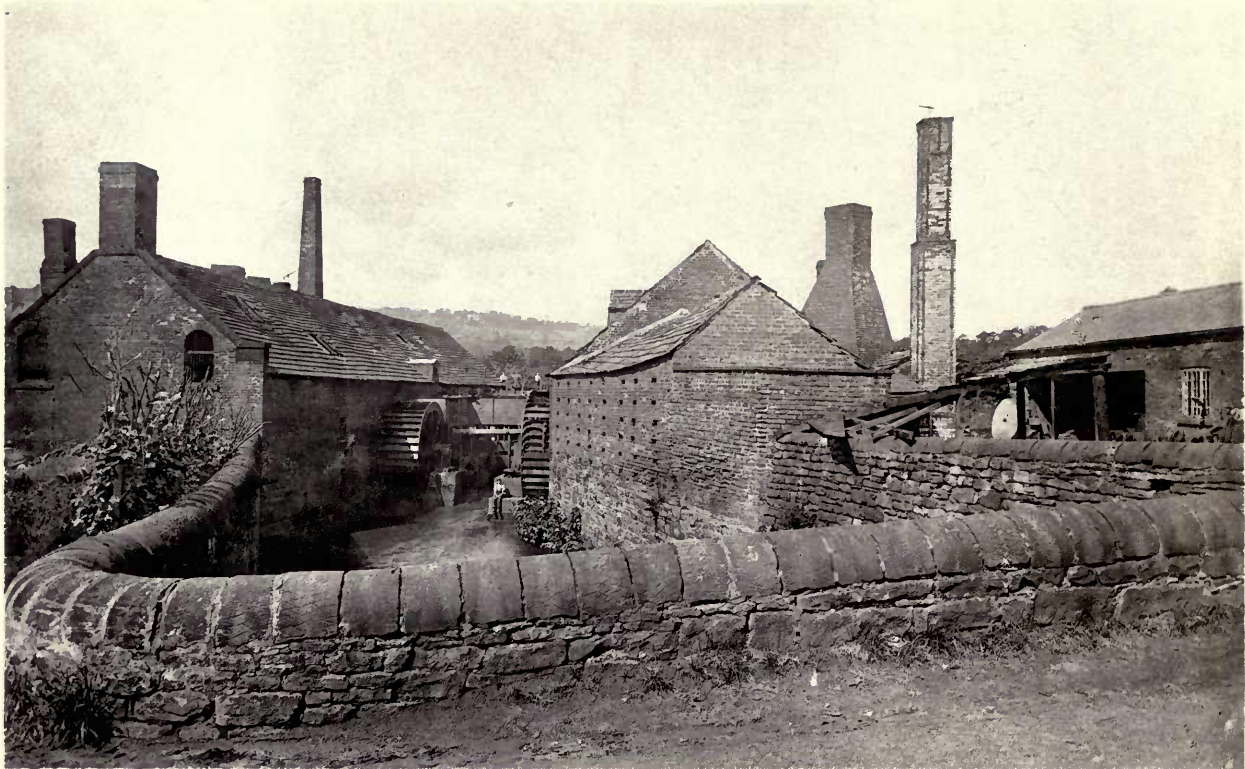
CRUCIBLE STEEL ROLLING MILLS AT NORFOLK WORKS.



DAM HEAD CLAY WHEEL FORGE.



FORGES AT CLAY WHEEL.



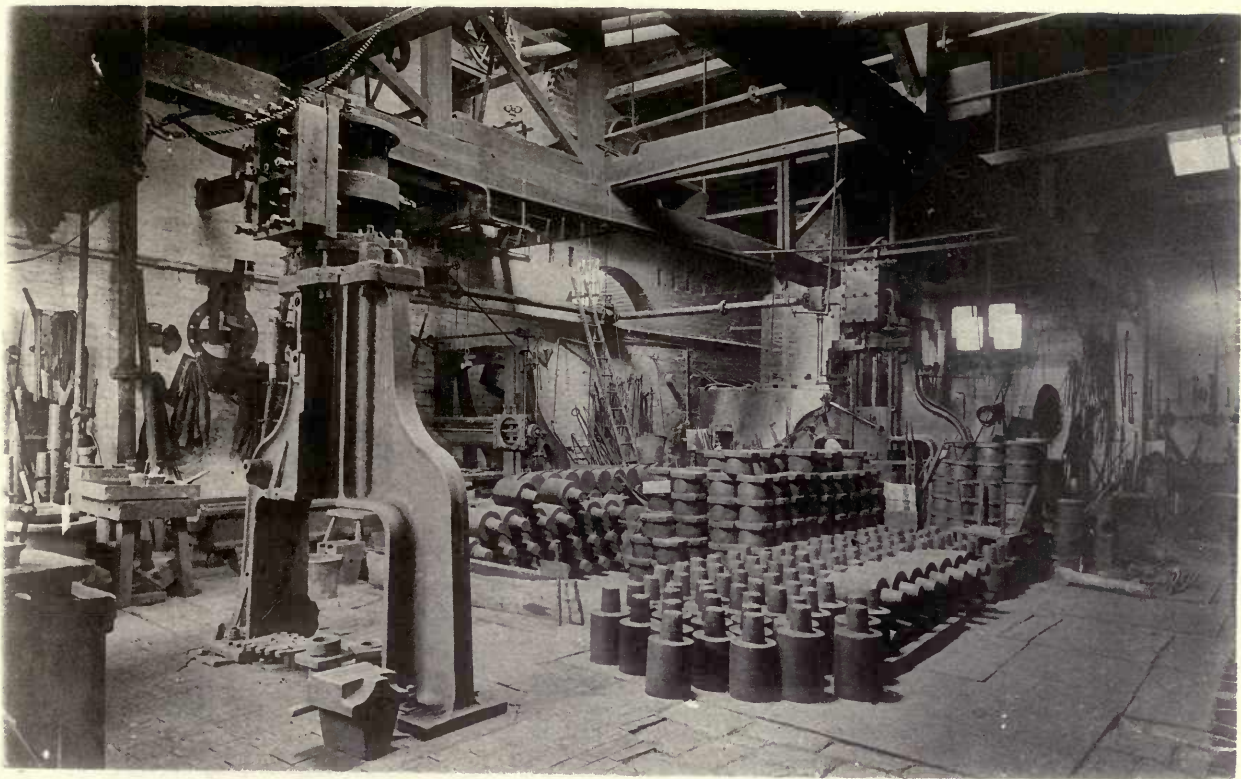
WATER-WHEELS RACE AT CLAY WHEEL FORGES.



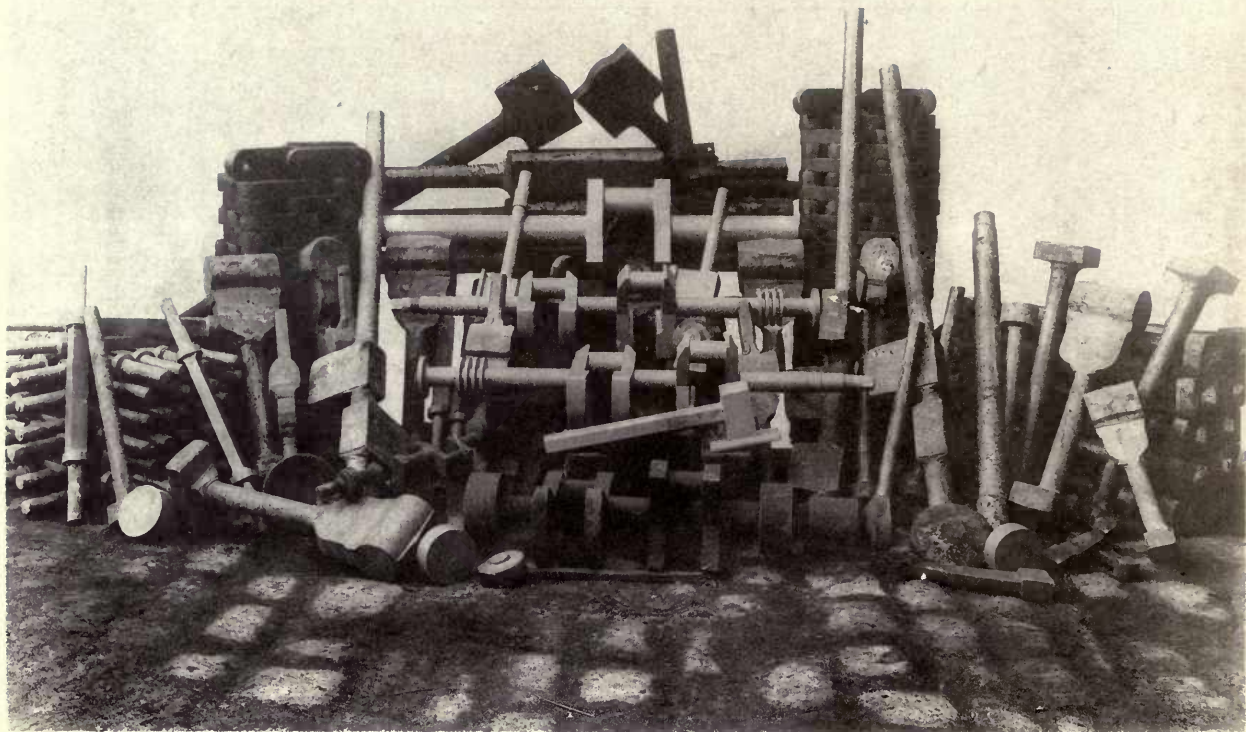
DAM AT CLAY WHEEL FORGES.



EXPORT CRUCIBLE STEEL WAREHOUSE.



SHOES AND DIES FOR STAMP BATTERIES.



GROUP OF SMALL MARINE FORGING.



SIEMENS-MARTIN FURNACES, 1 45 TON., 2 30 TON..



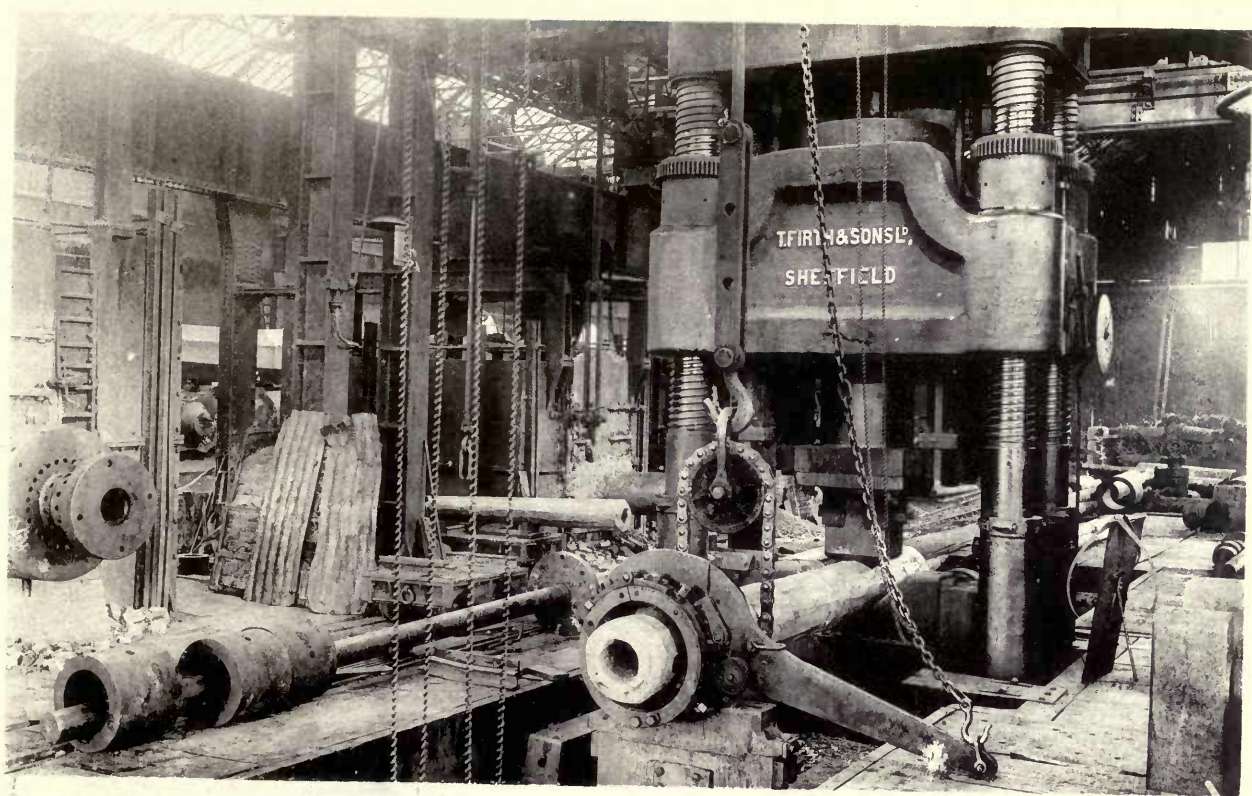
EXTERIOR VIEW, WEST GUN WORKS, MACHINE SHOPS.



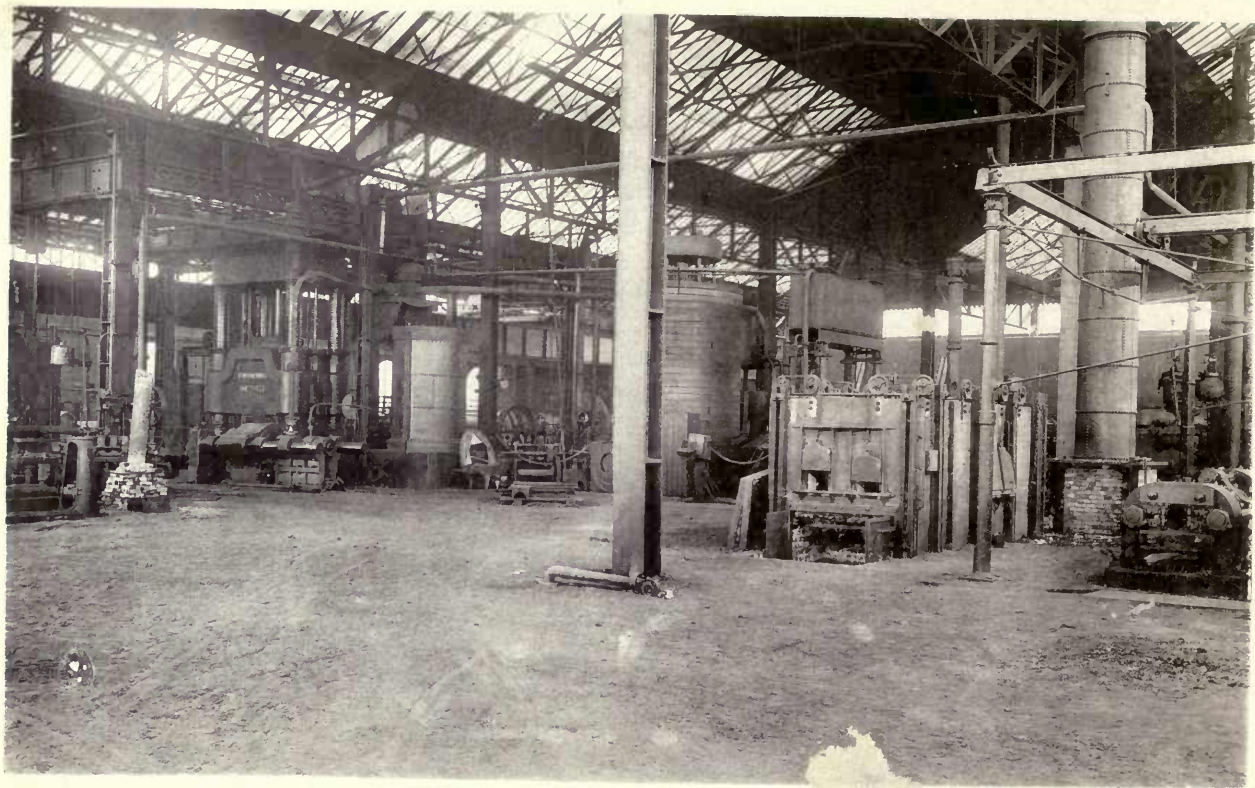
OFFICES AND MAIN ENTRANCE, EAST GUN WORKS.



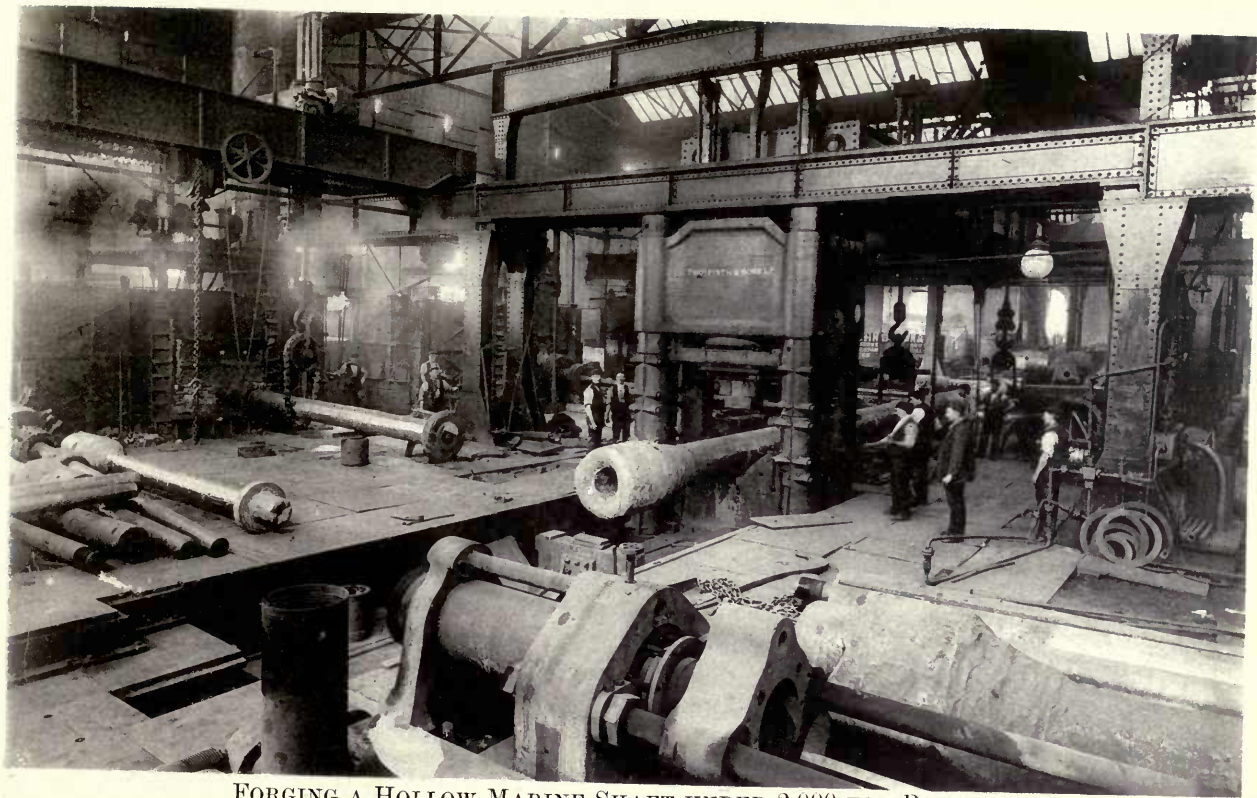
EXTERIOR VIEW OF HYDRAULIC FORGING SHOP, EAST GUN WORKS.



3000 TON HYDRAULIC PRESS WITH GUN TUBE FORGING.



INTERIOR OF HYDRAULIC FORGING PRESS SHOPS, 250ft. x 200. 555 SQUARE YARDS.



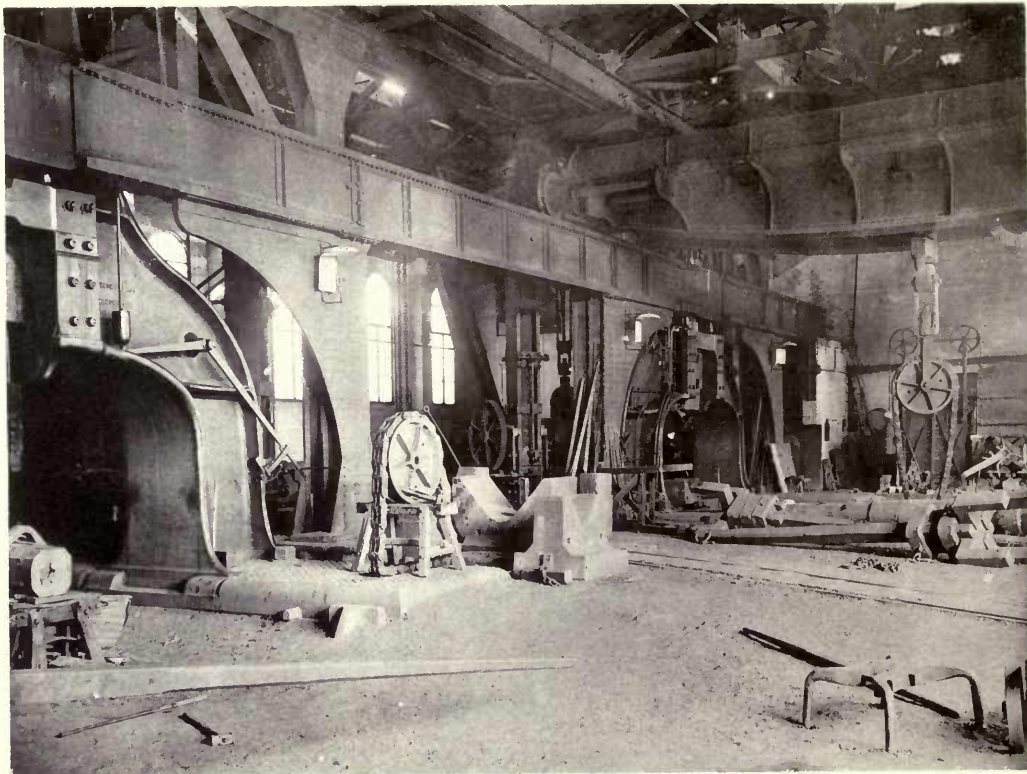
FORGING A HOLLOW MARINE SHAFT UNDER 2,000 TON PRESS.



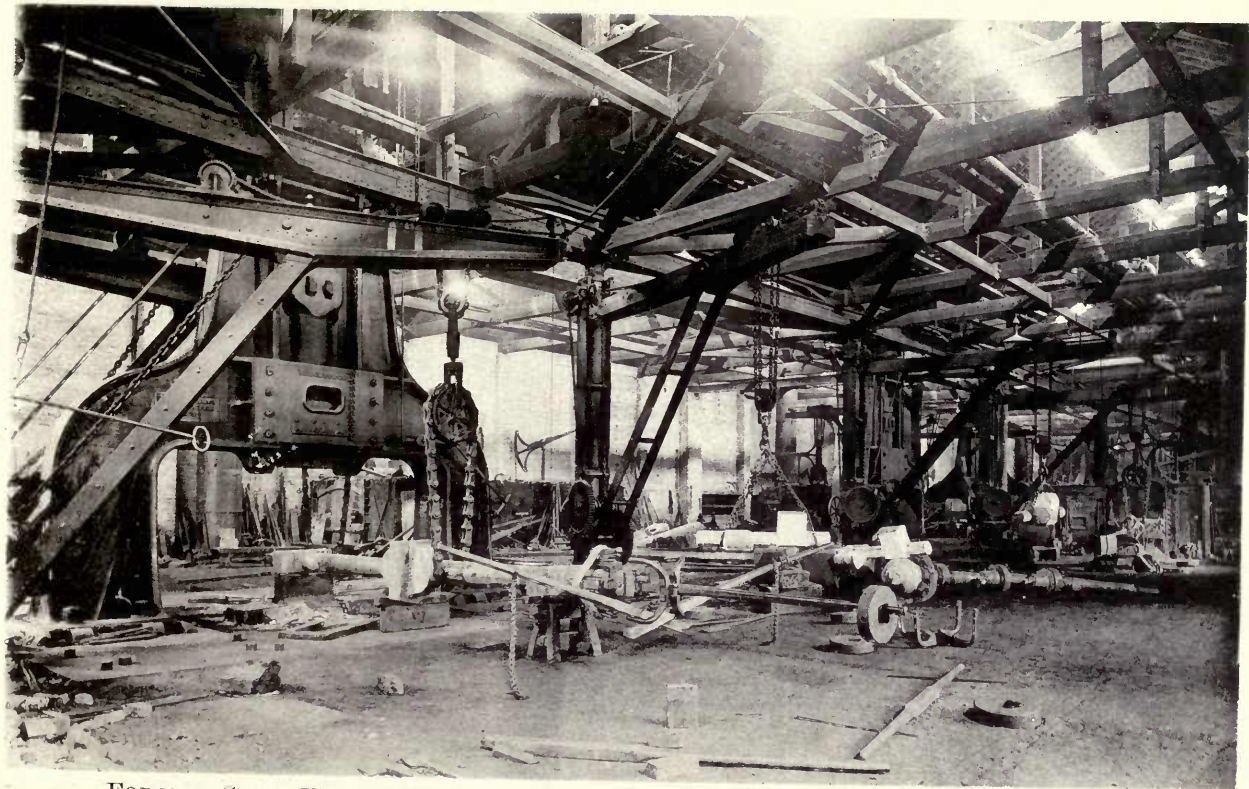
50 TON STEEL INGOT, 53 in. DIAM. $\times$ 180 in. LONG.



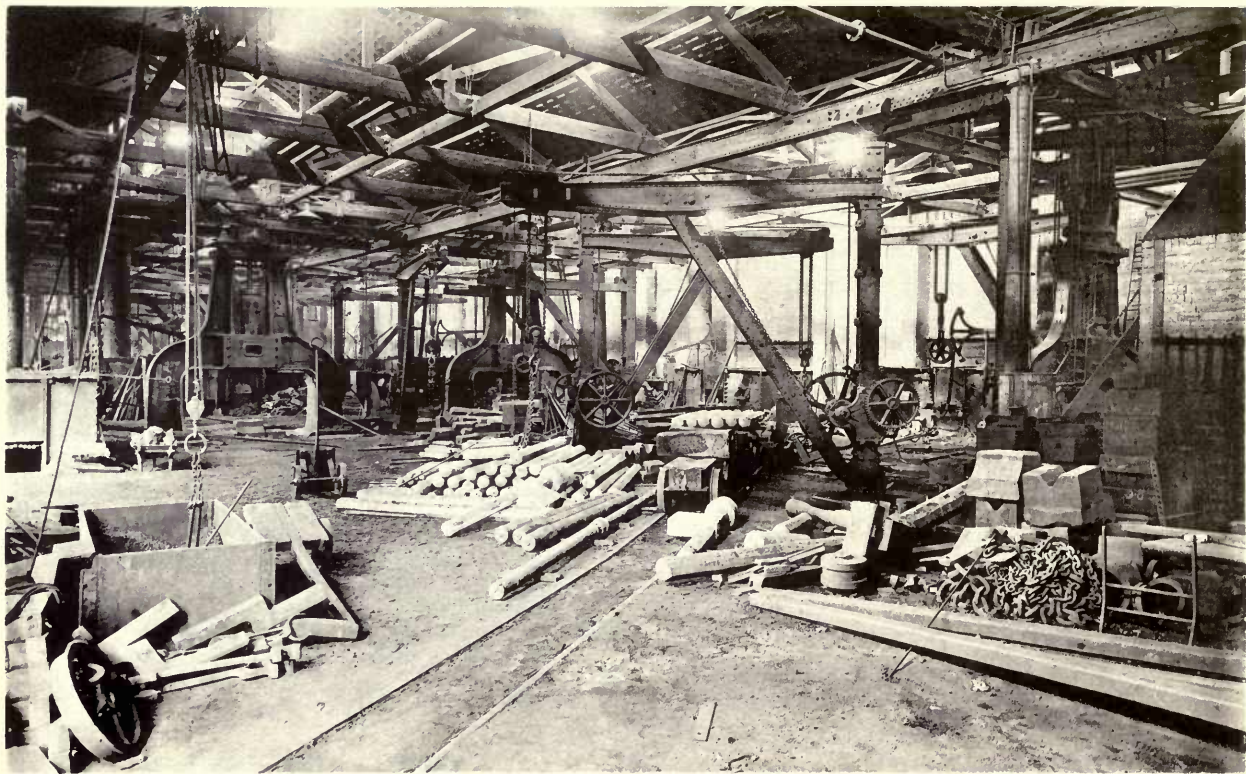
GROUPS OF INGOTS AT EAST GUN WORKS WEIGHING UP TO 56 TONS EACH, ALSO SHOWING
70 TONS, OVERHEAD TRAVELLING CRANE.



LARGE FORGE SHOWING 25 AND 30 TON STEAM HAMMERS WITH 100 TON TRAVELLING CRANE.



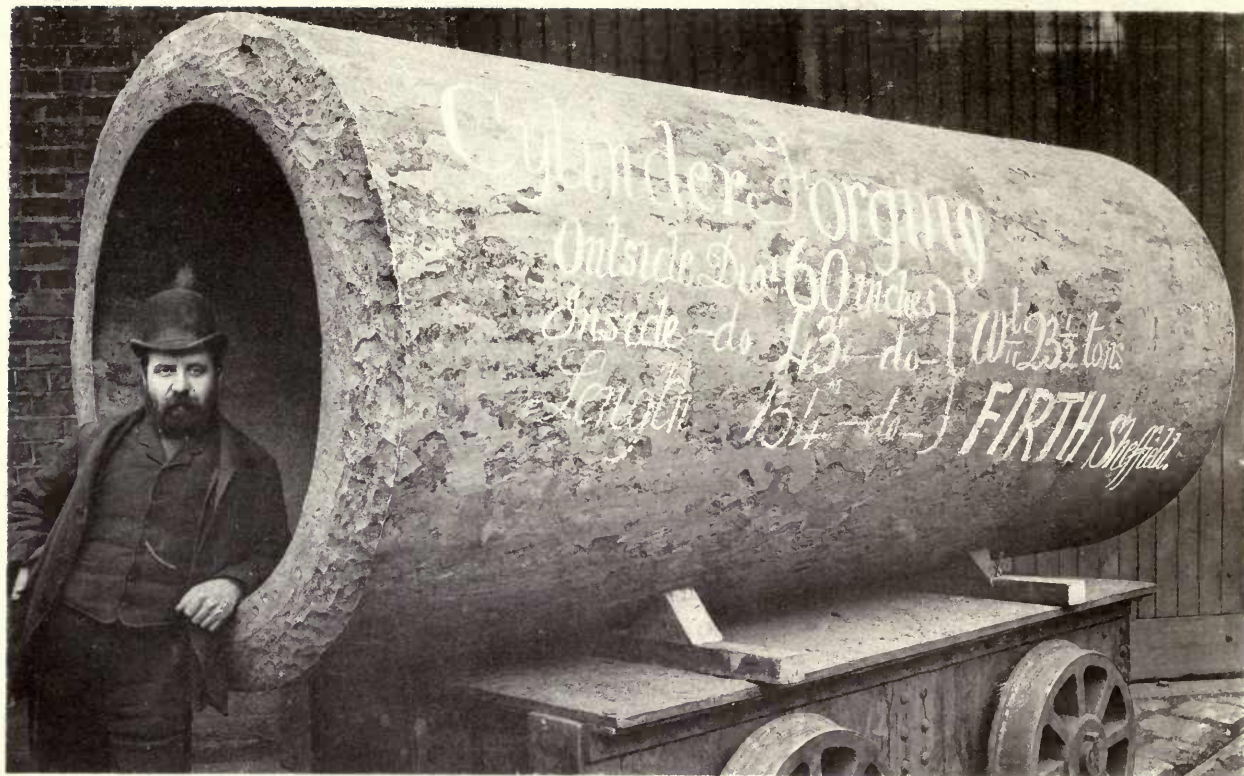
FORGING SHOP, WEST GUN WORKS, SHOWING 12 TON, 7 TON AND 5 TON STEAM HAMMERS.



FORGING SHOP, WEST GUN WORKS, SHOWING 7 TON, 5 TON, AND 3 TON STEAM HAMMERS.



3½ TON STEAM HAMMER, WEST GUN WORKS.



HOLLOW FORGING FOR HYDRAULIC CYLINDER.



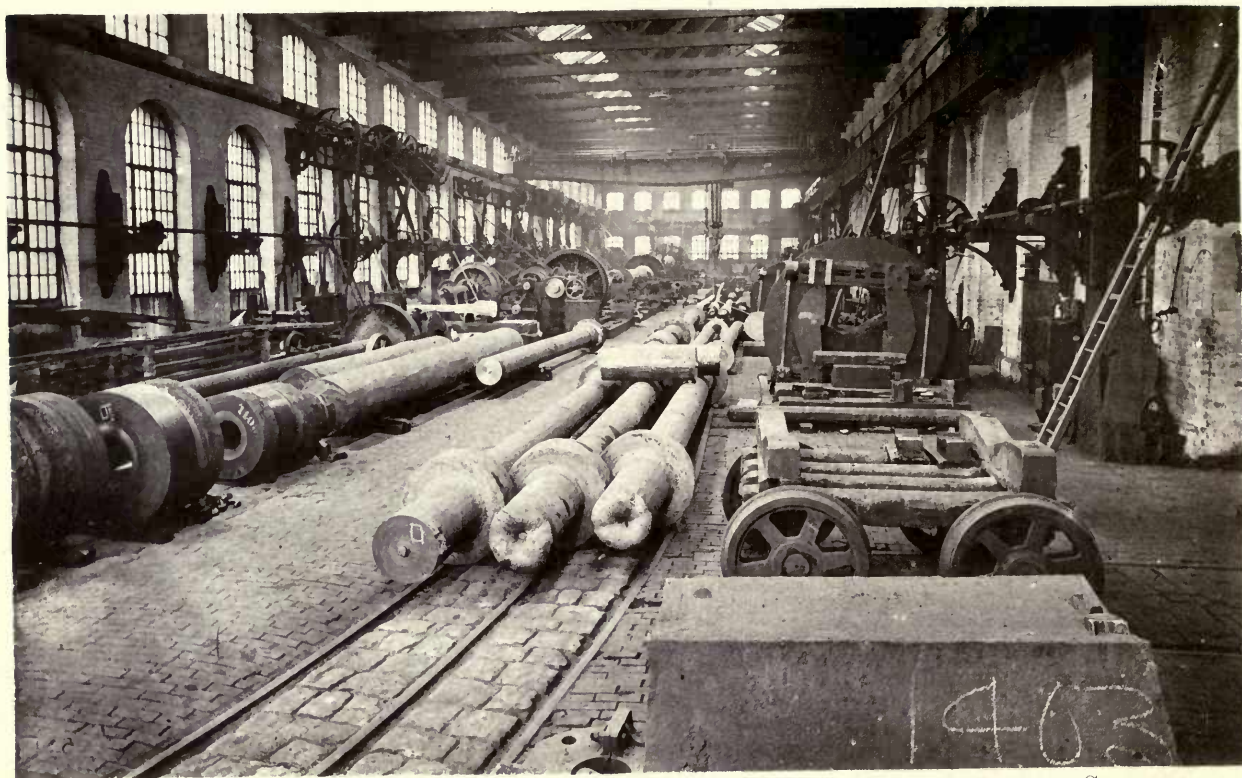
COUPLE OF HOLLOW FORGINGS FOR 12in. B.L. GUN.



HOLLOW GUN TUBE FORGING.



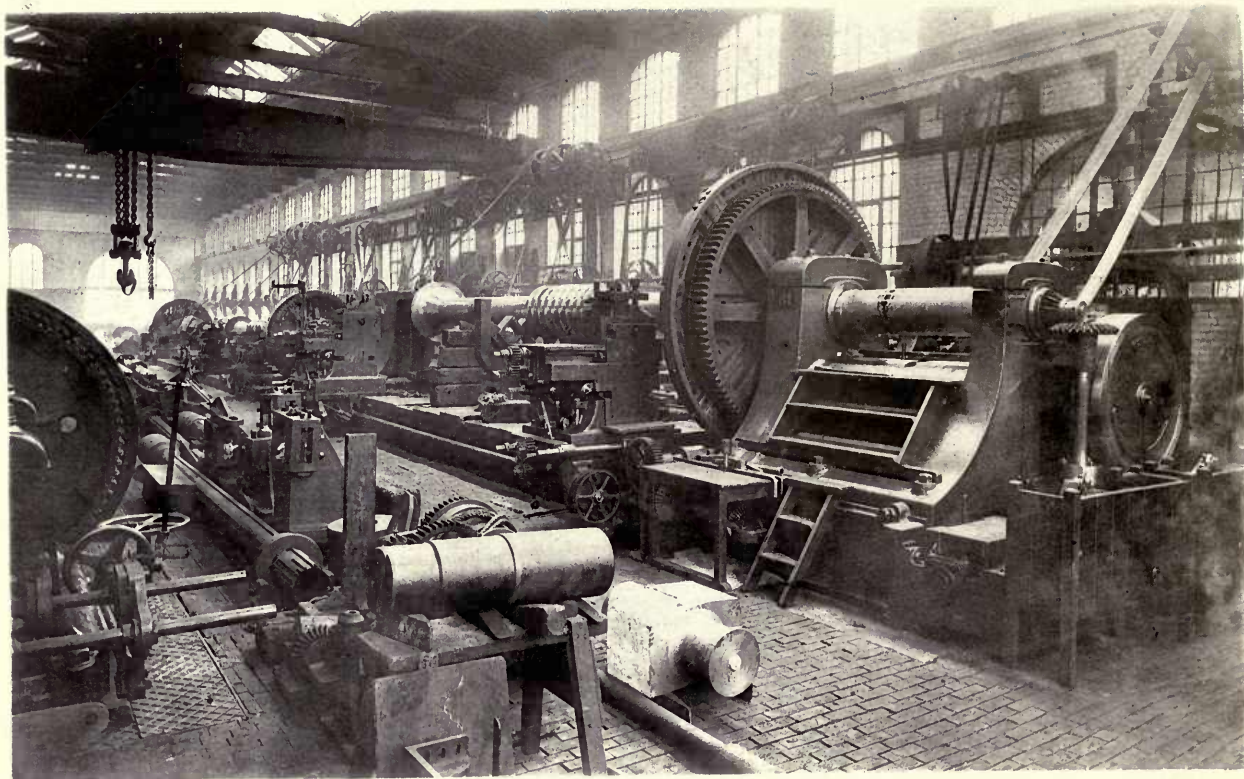
FORGED STEEL CYLINDER FOR H.P. TURBINE DRUM 96in. DIAM. OUTSIDE, 88in. INSIDE, 88in. LONG.



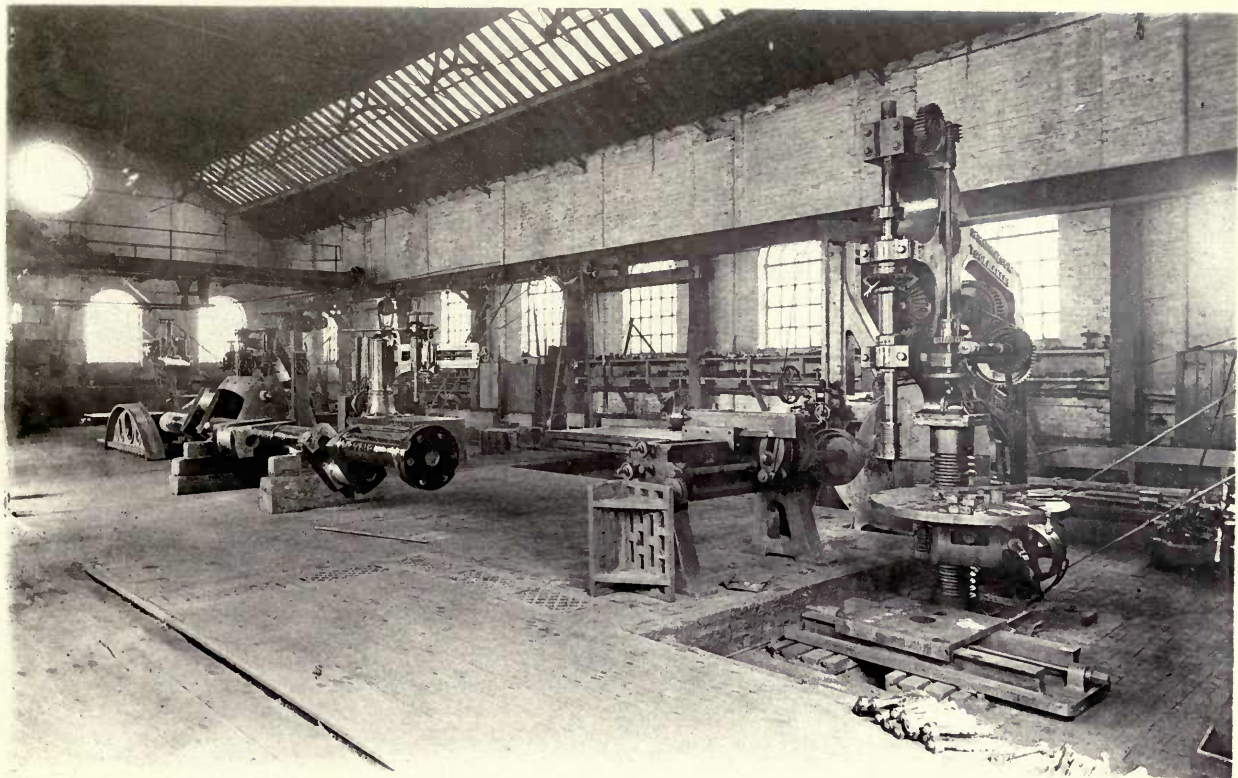
LARGE MACHINE SHOP, 250ft. LONG $\times$ 50ft. WIDE, AT WEST GUN WORKS, SHOWING GUN AND
MARINE SHAFT FORGINGS.



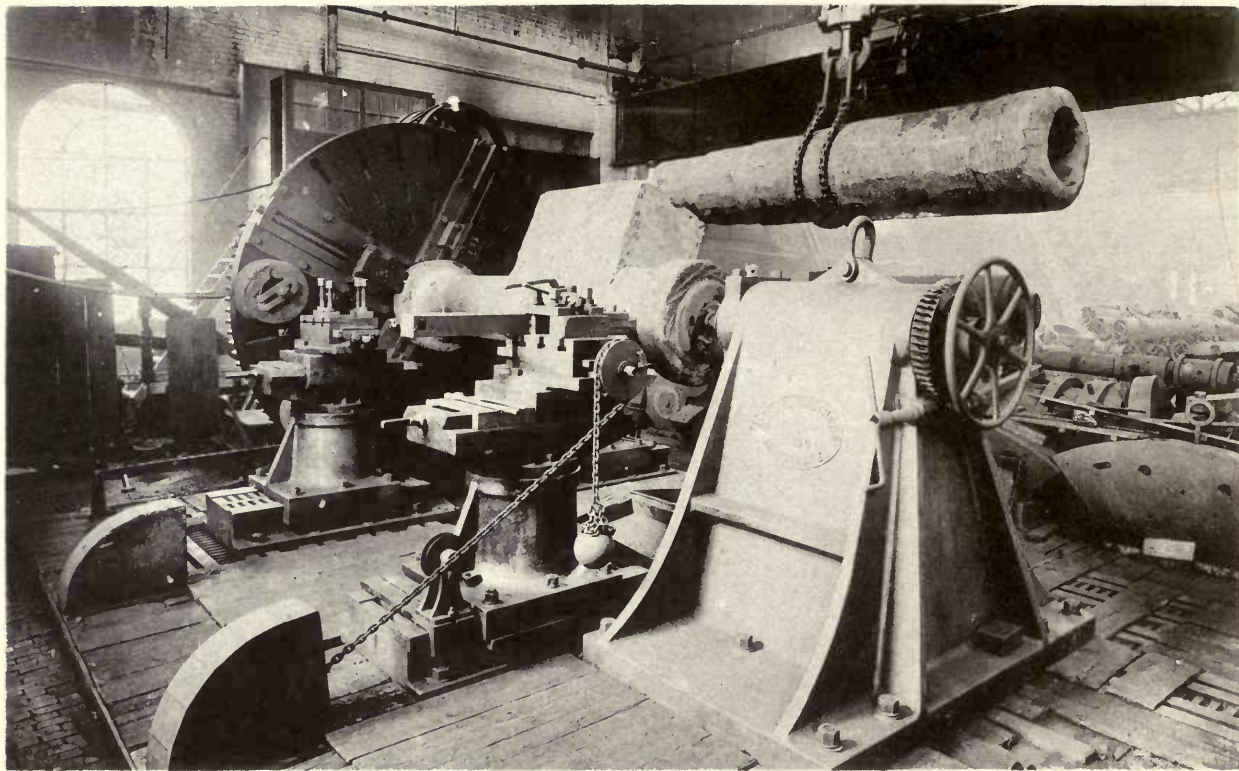
MACHINE SHOP AT WEST GUN WORKS, 200ft. LONG $\times$ 45ft. WIDE, WITH 30 TON TRAVELLING CRANE



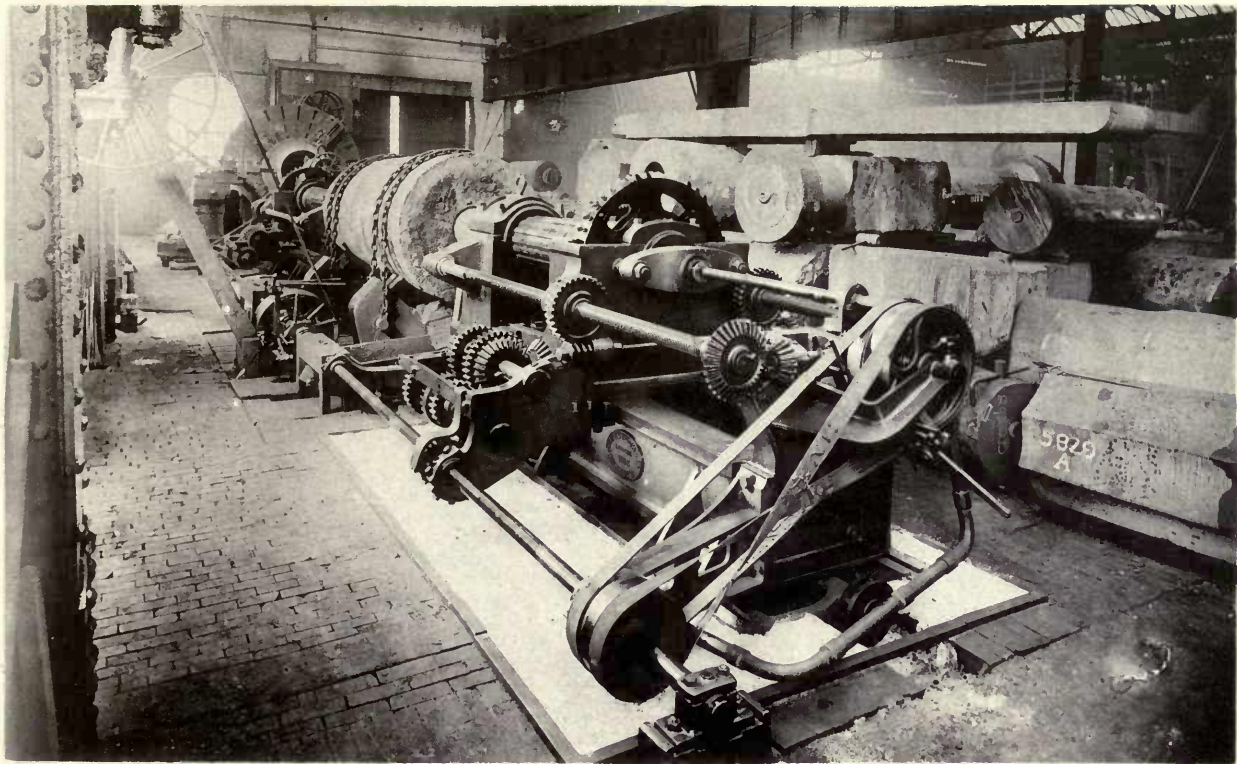
LARGE MACHINE SHOP AT WEST GUN WORKS, SHOWING 18½in. THRUST SHAFT, WITH 42in.
[44] COLLARS IN 54in. CENTRE LATHE; ALSO 50 TON TRAVELLING CRANE.



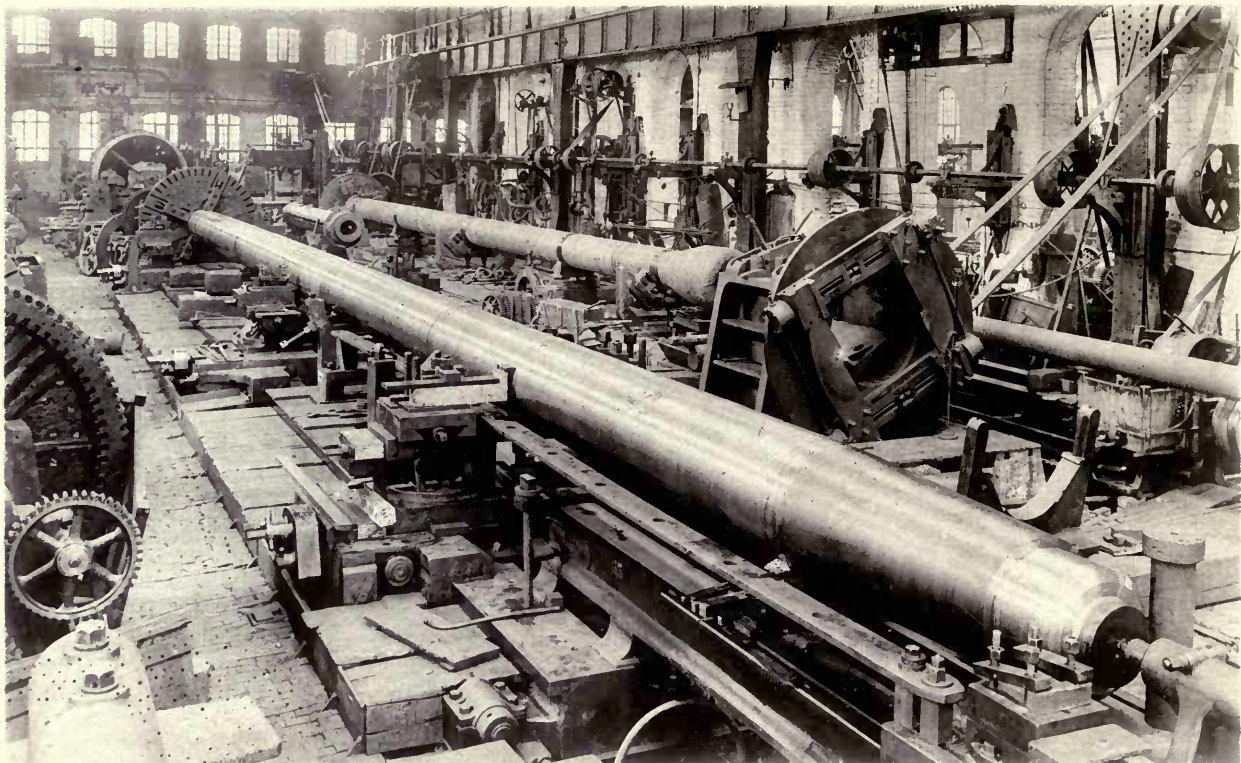
ERECTING SHOP AT EAST GUN WORKS.



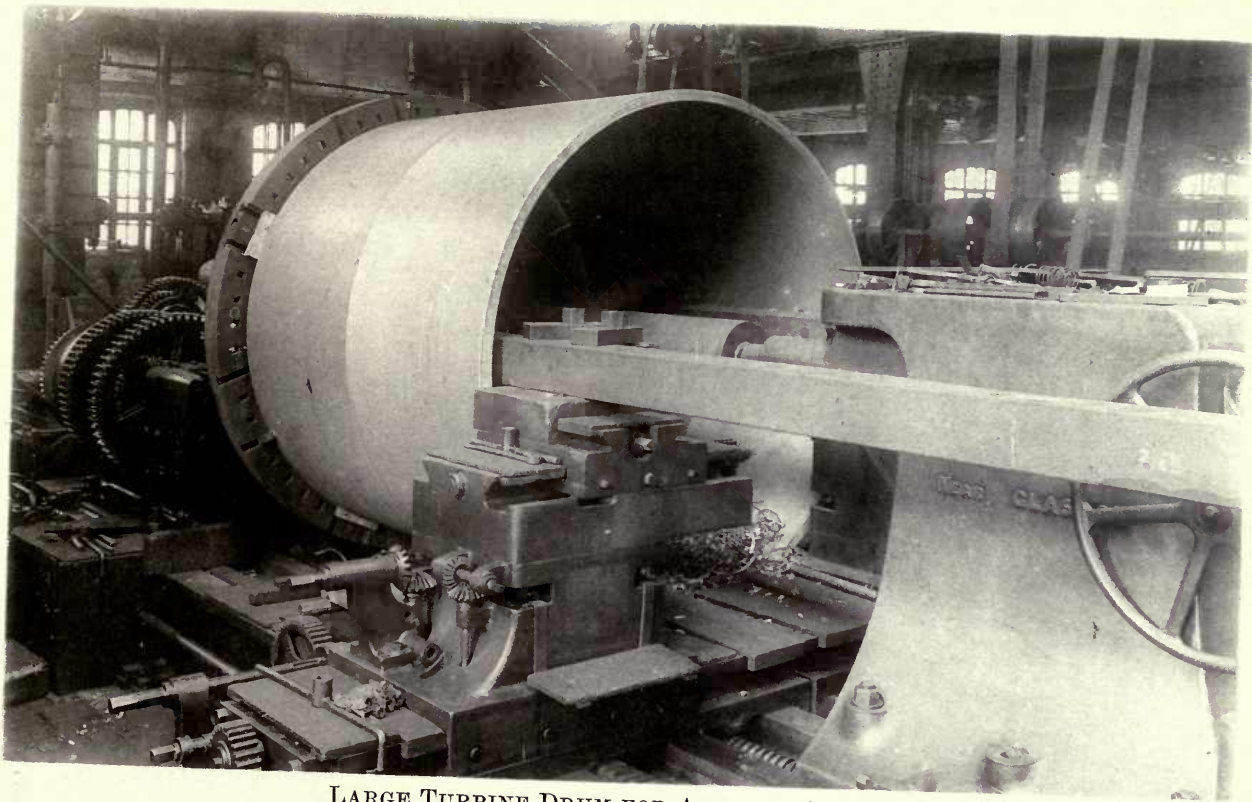
LARGE LATHE, EAST GUN WORKS, WITH CRANK SHAFT FORGING FOR FIRST CLASS CRUISER,
[46] "MINOTAUR."



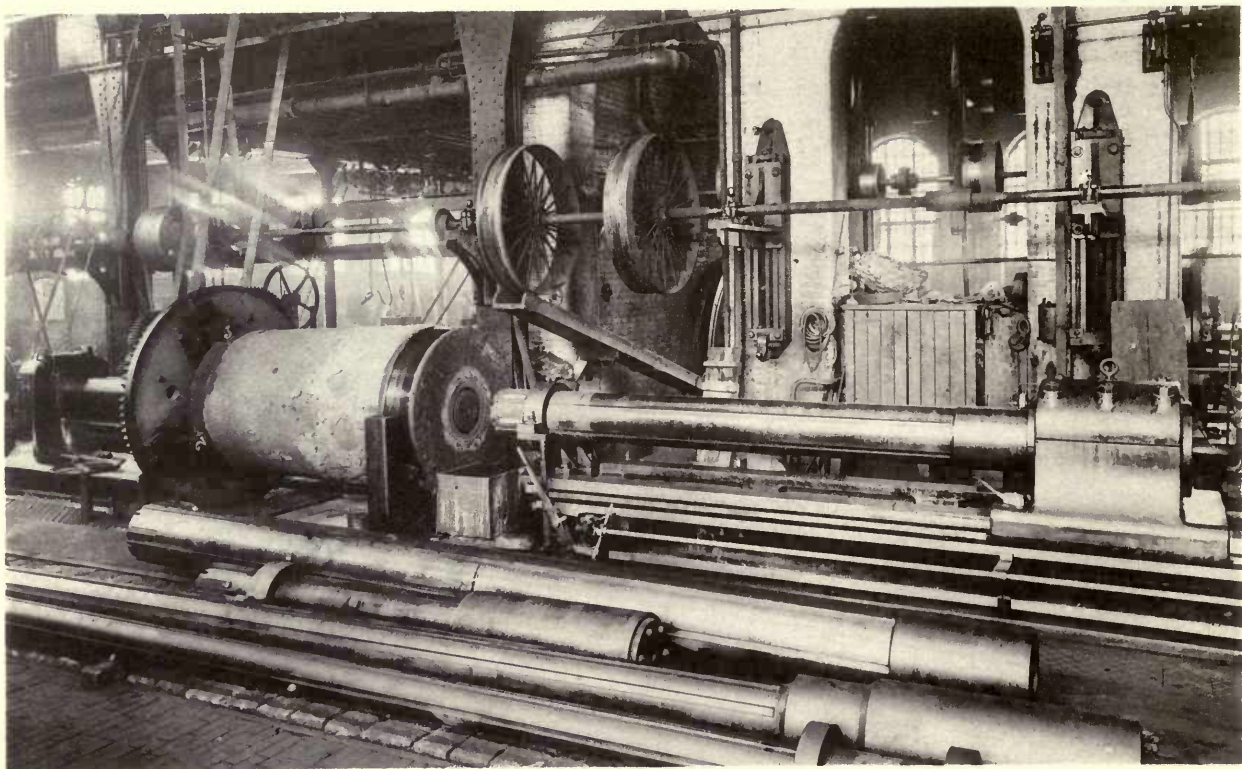
TREPPANNING LATHE, EAST GUN WORKS.



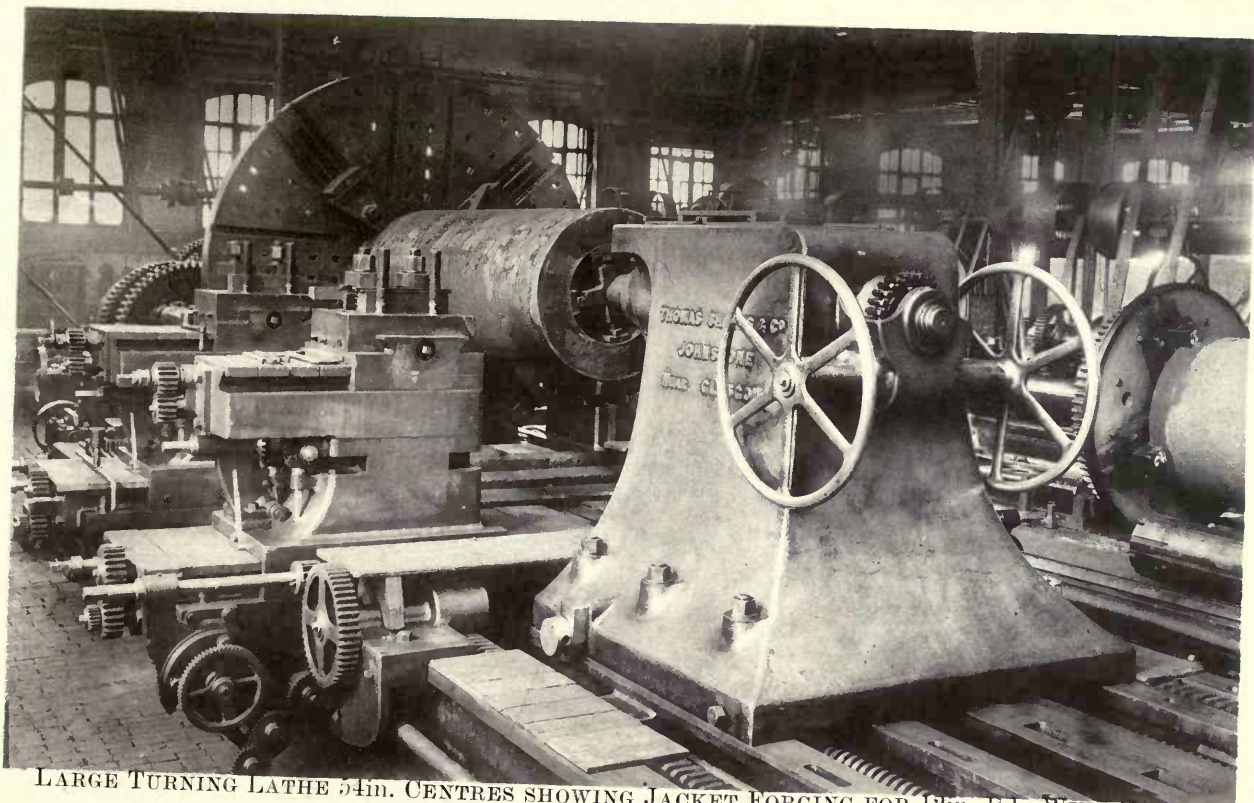
LARGE MACHINE SHOP, WEST GUN WORKS, SHOWING TWO LARGE PROPELLER SHAFTS FOR
[48] FIRST CLASS CRUISER "MINOTAUR," FINISHED WEIGHT OF ONE SHAFT 26 TONS.



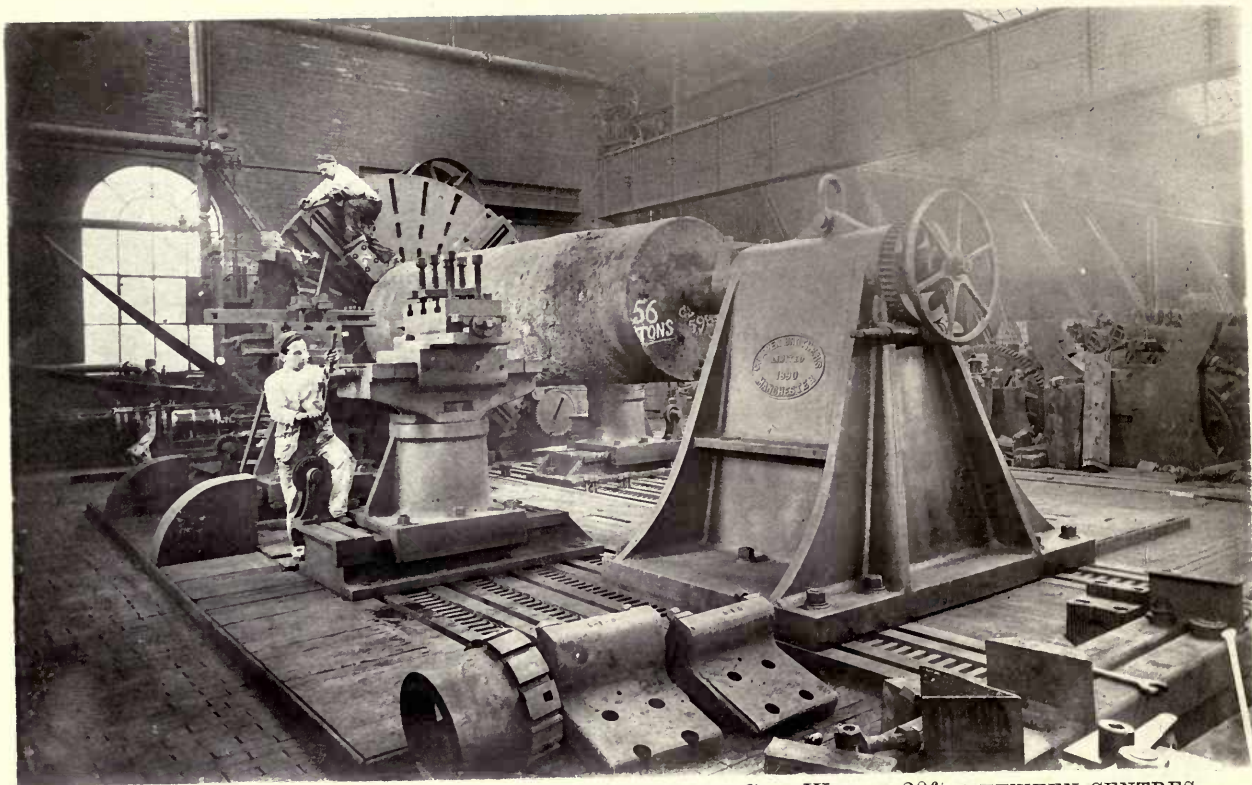
LARGE TURBINE DRUM FOR ATLANTIC LINER.



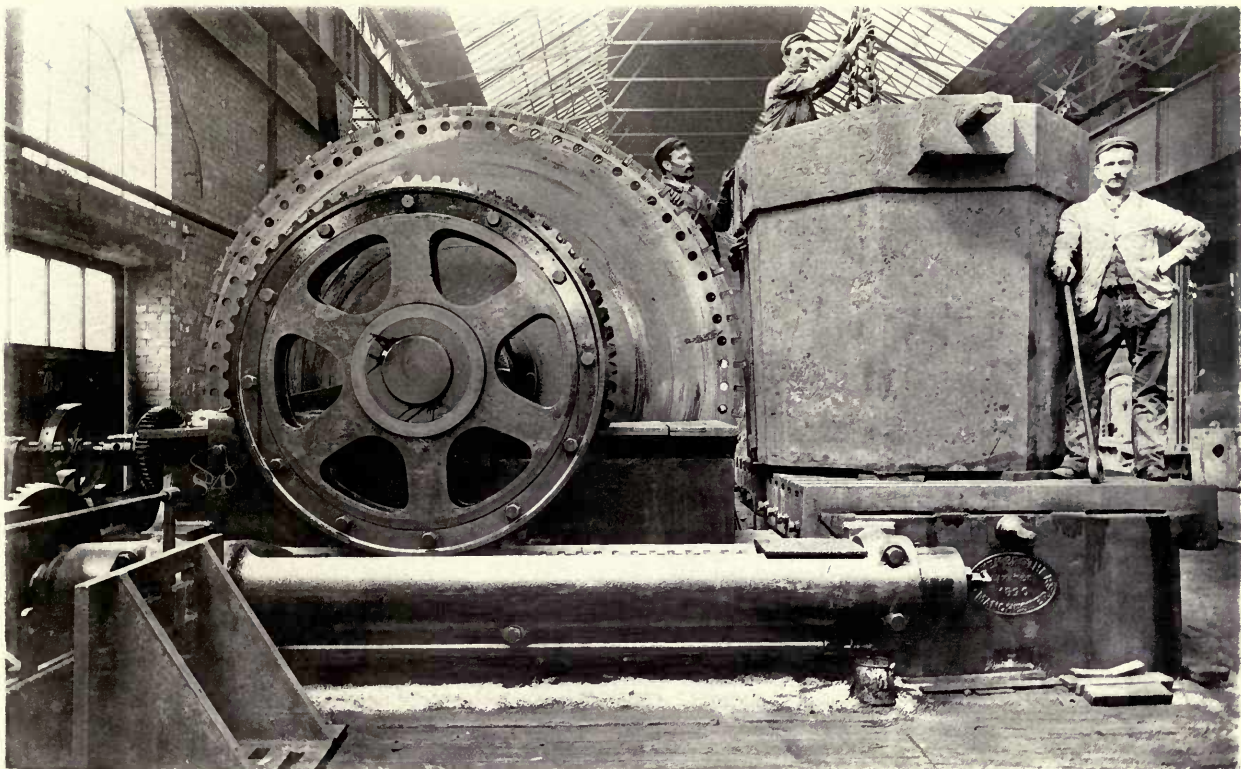
TREPPANNING LATHE, WEST GUN WORKS.



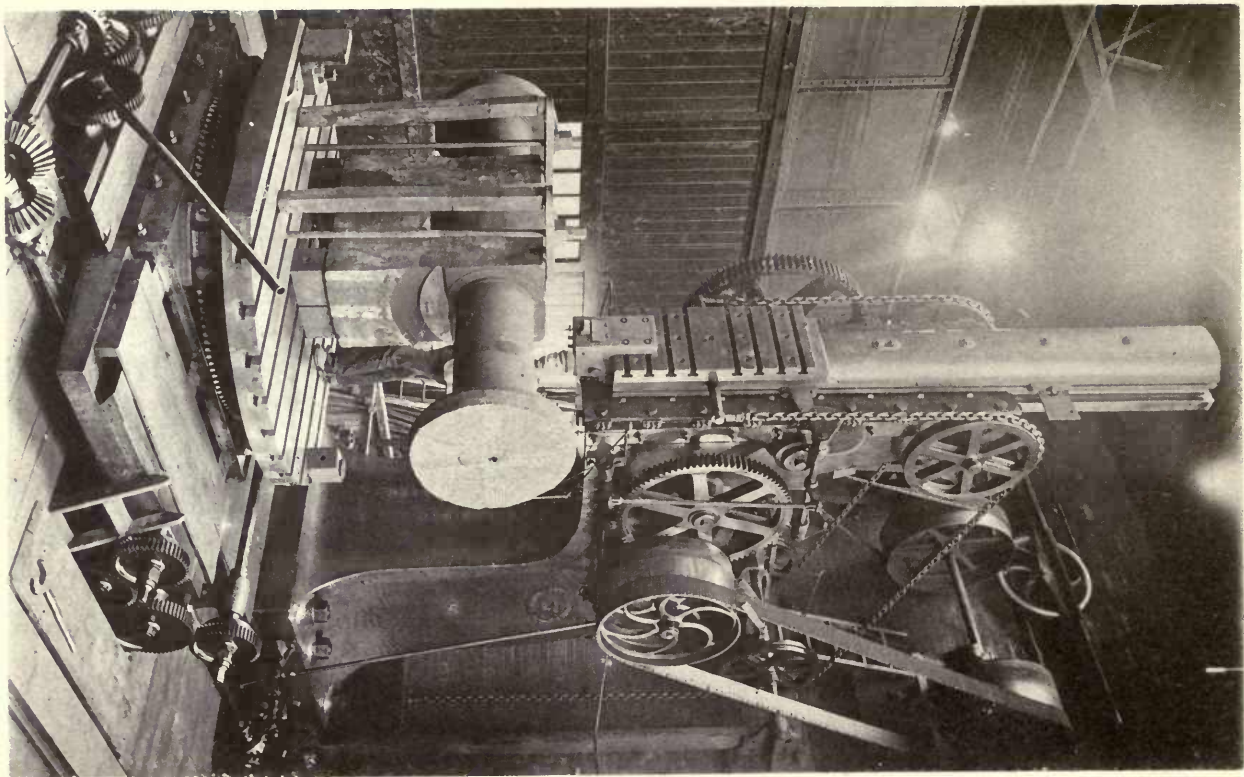
LARGE TURNING LATHE 54in. CENTRES SHOWING JACKET FORGING FOR 12in. B.L. WIRE GUN.



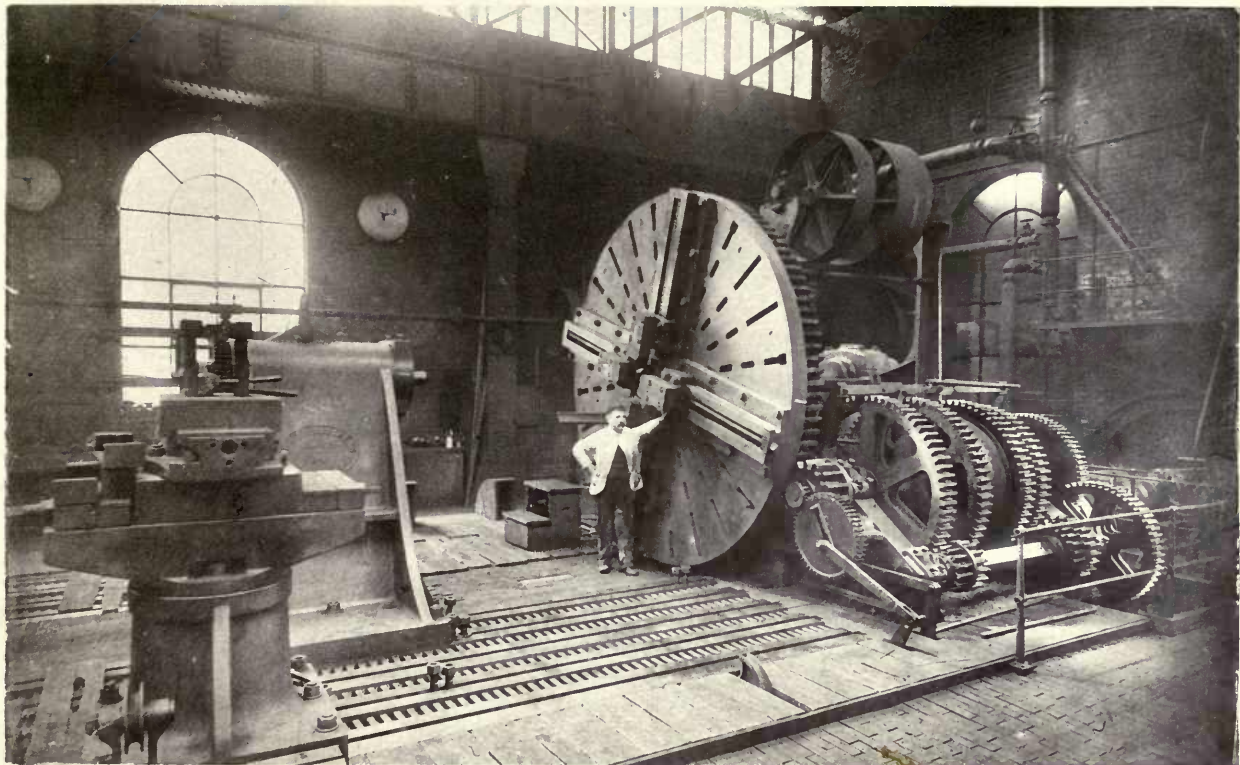
LARGE 72in. CENTRE INGOT TURNING LATHE AT EAST GUN WORKS 20ft. BETWEEN CENTRES,
[52] SHOWING 56 TON INGOT IN LATHE.



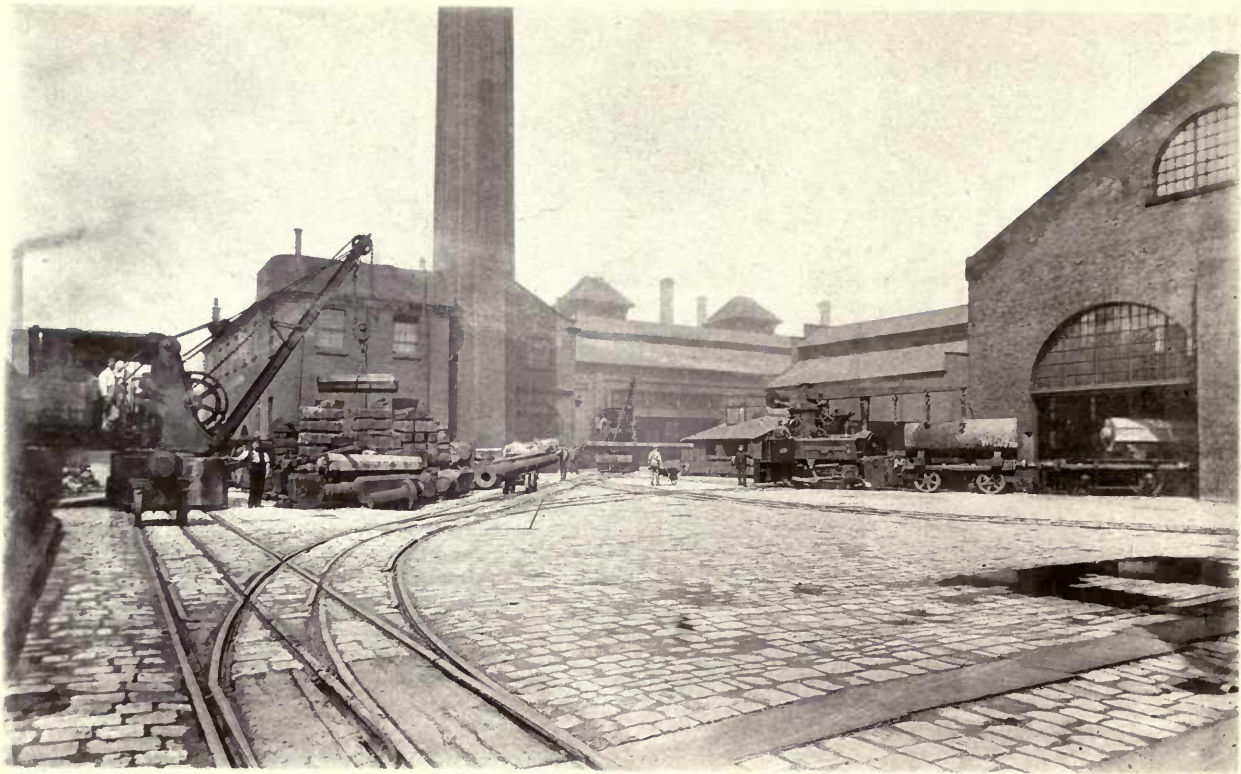
LARGE CIRCULAR SAW 10ft. DIAM., AT EAST GUN WORKS, FOR CUTTING COLD STEEL.



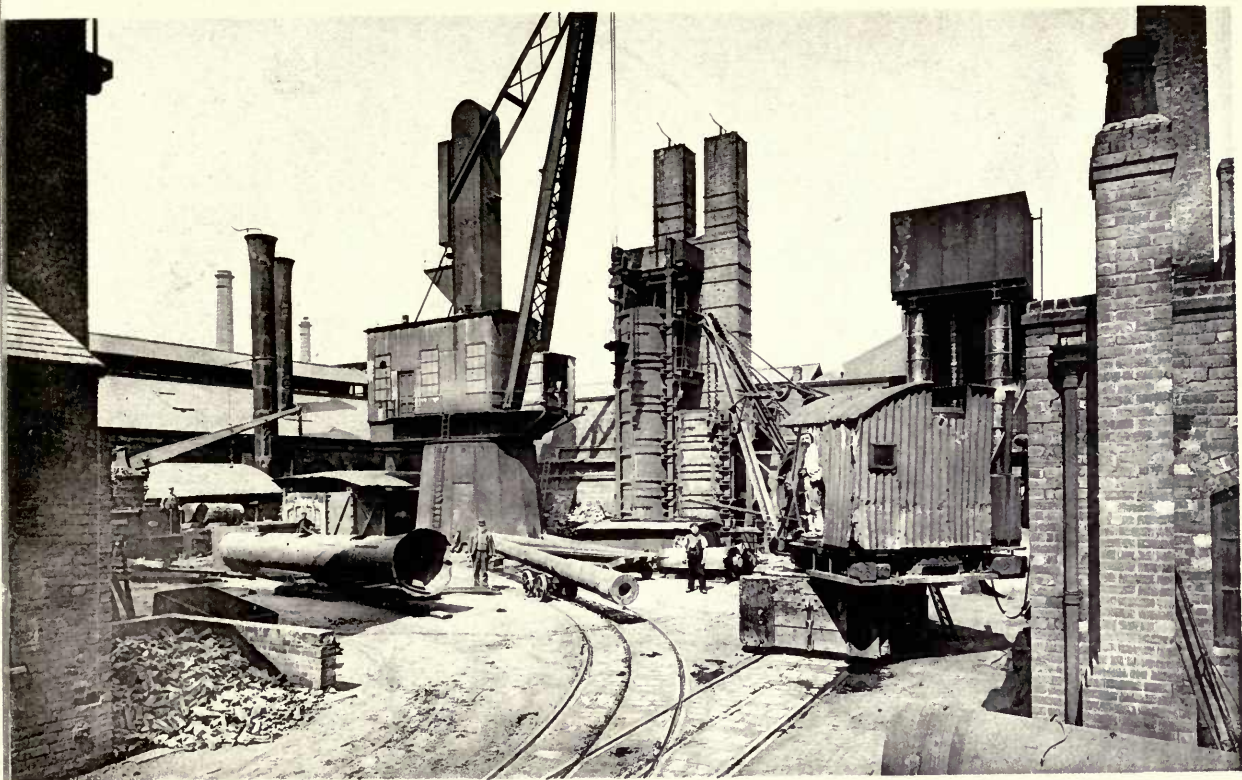
LARGE SLOTTING MACHINE, WITH 8ft. STROKE, AT EAST GUN WORKS, SHOWING MARINE CRANK.



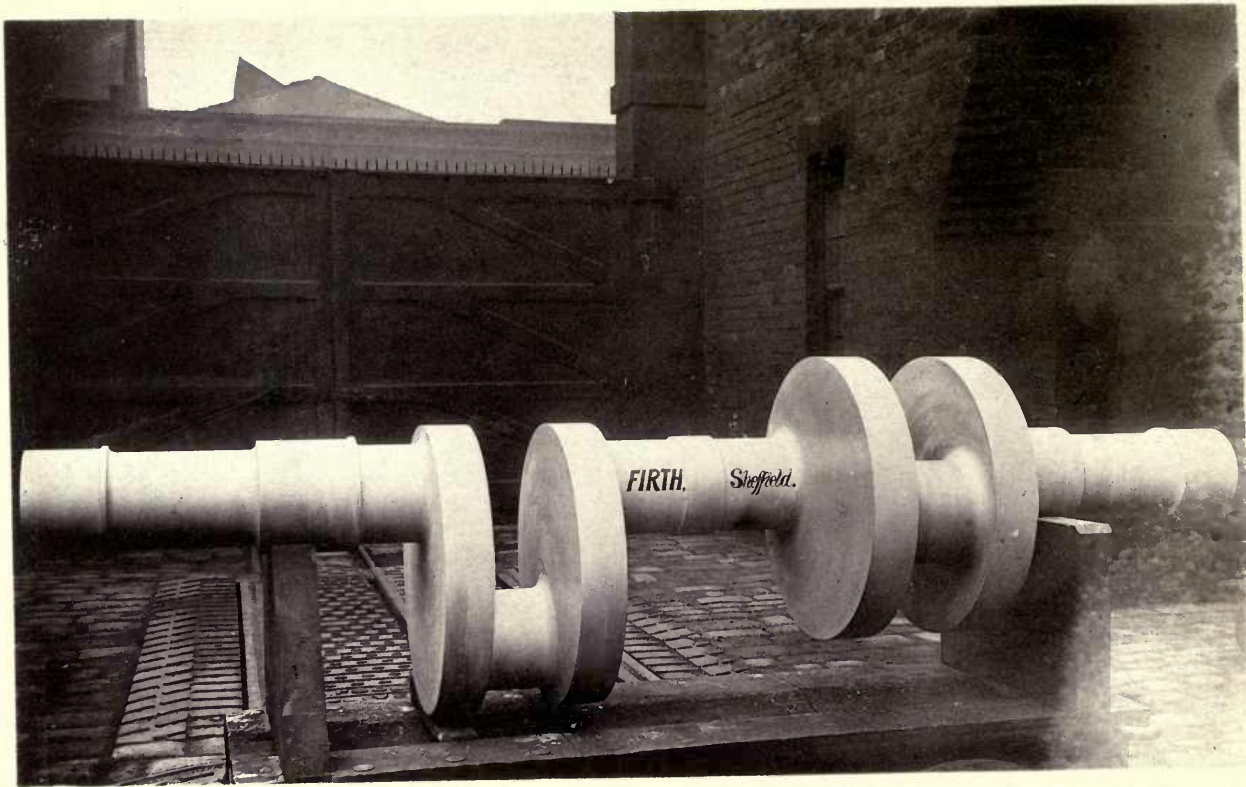
LARGE INGOT TURNING LATHE WITH $12\frac{1}{2}$ ft. FACE PLATE.



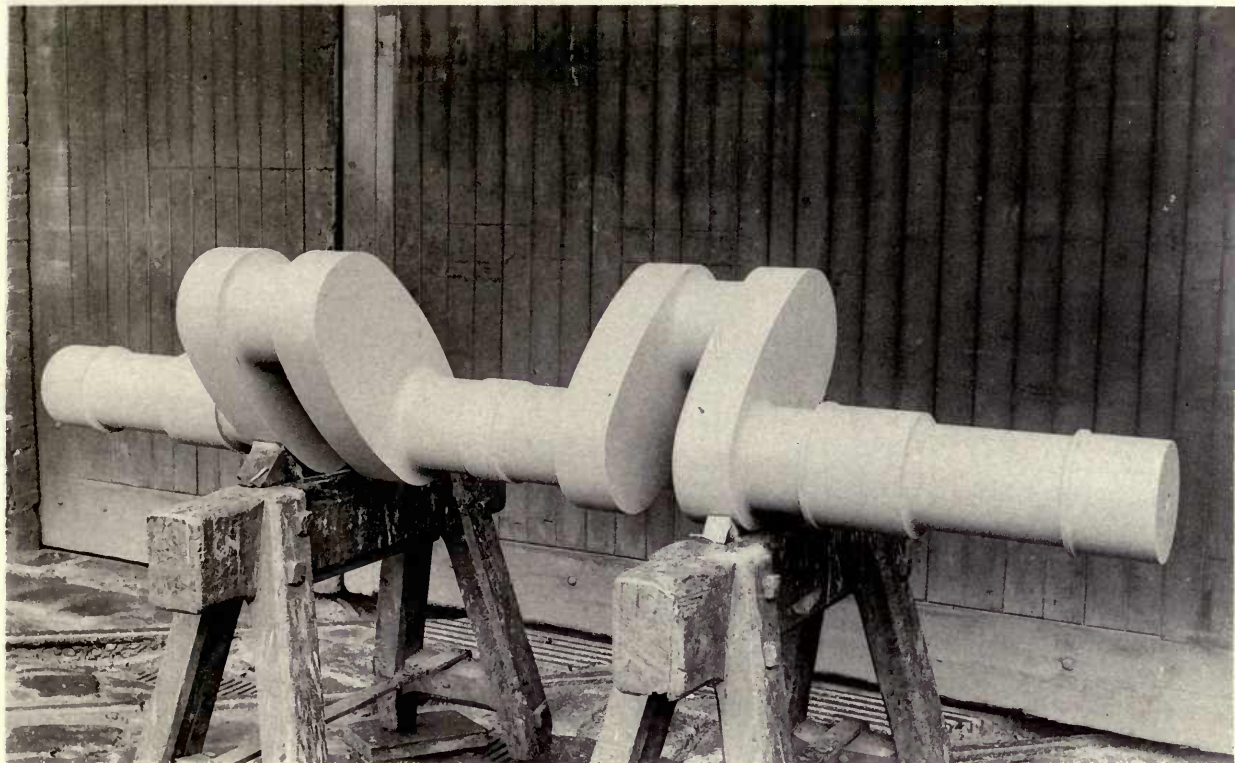
YARD IN WEST GUN WORKS.



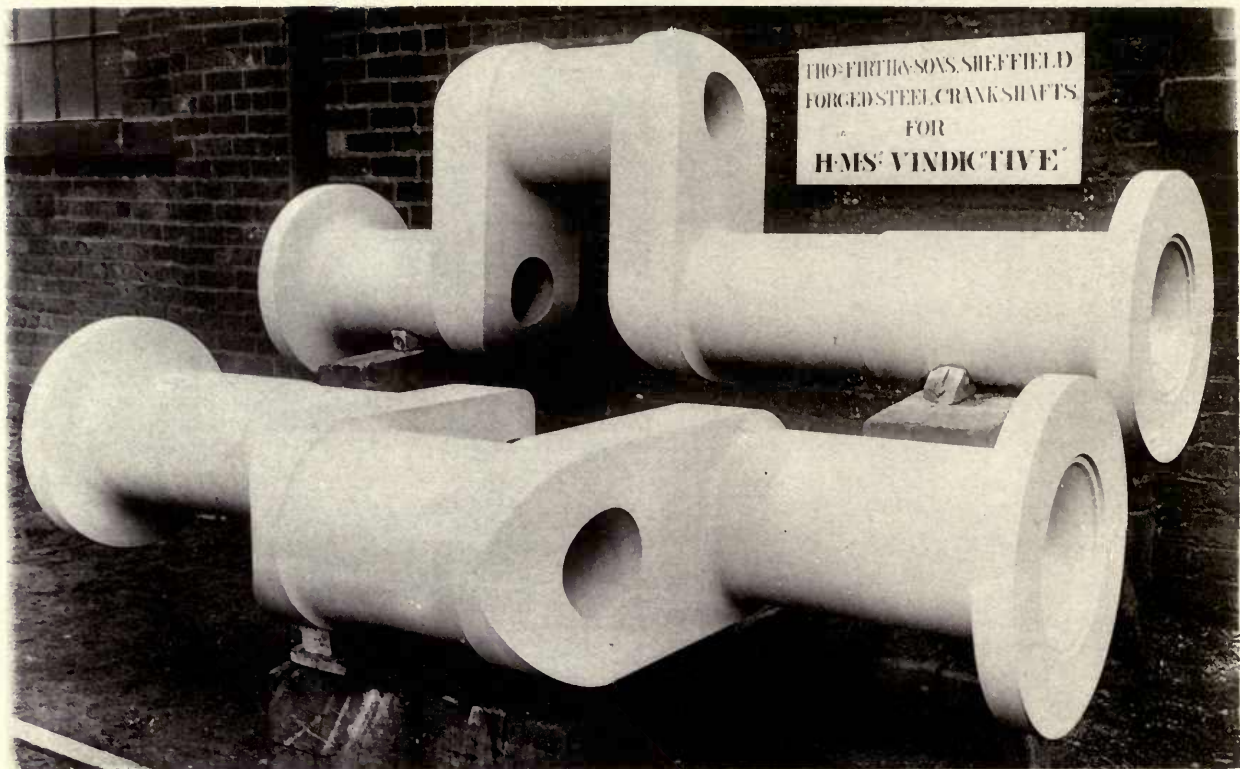
VIEW AT WEST GUN WORKS, SHOWING 50 TONS HYDRAULIC CRANE, FURNACES AND OIL TANKS
FOR TEMPERING GUNS, &c. [57]



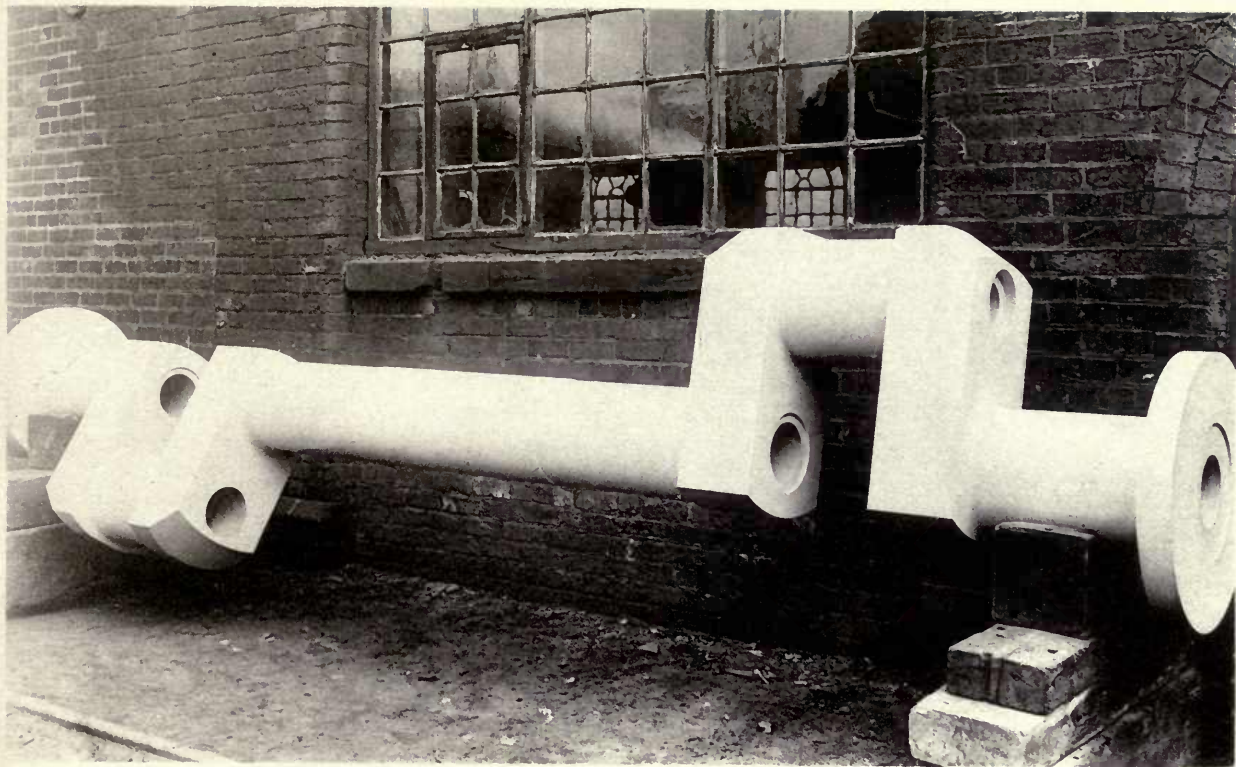
LOCOMOTIVE CRANK AXLE WITH CIRCULAR WEBS.



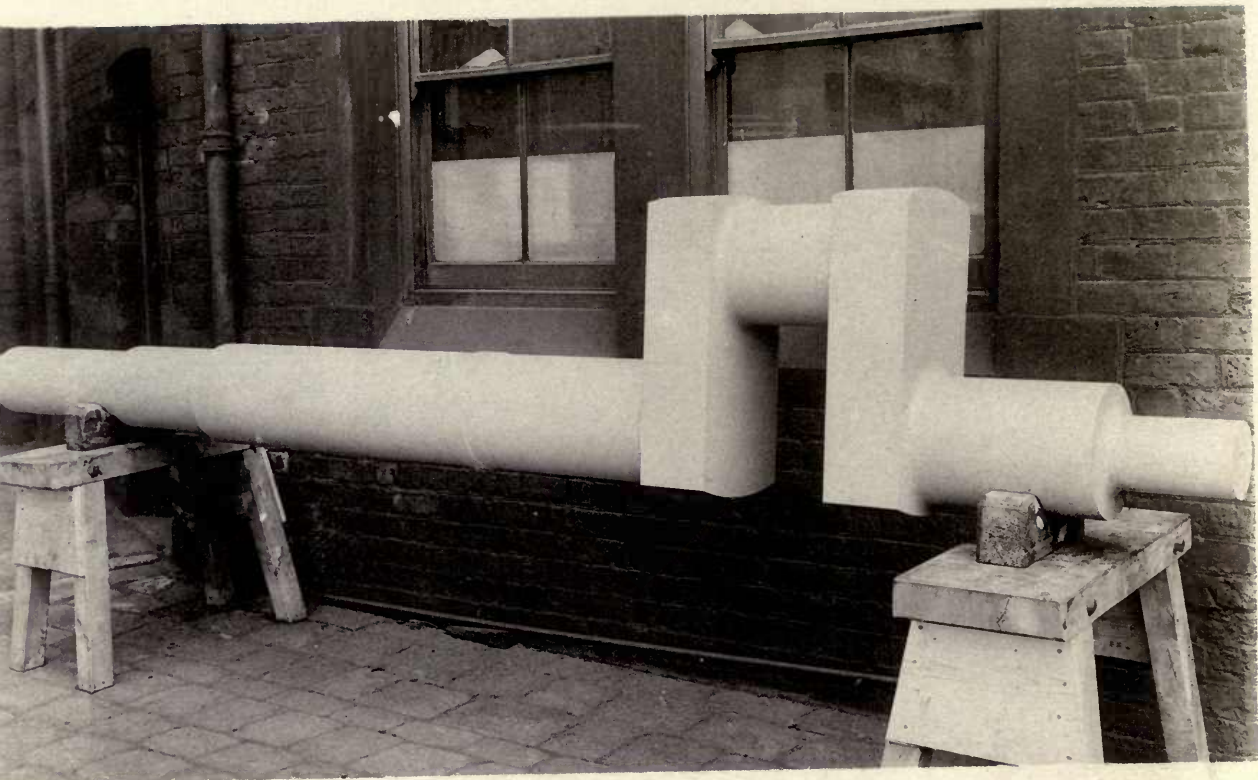
LOCOMOTIVE CRANK FOR NORTHERN RAILWAYS OF FRANCE.



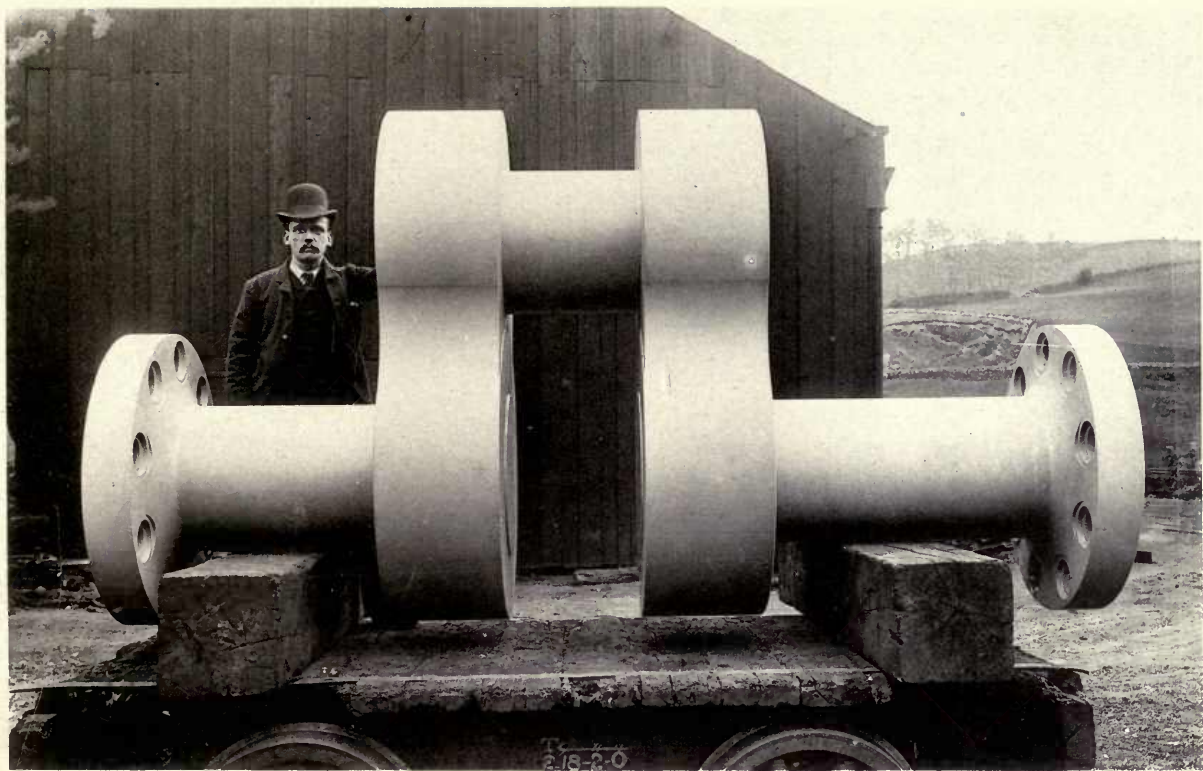
CRANK SHAFTS FOR H.M.S. "VINDICTIVE."



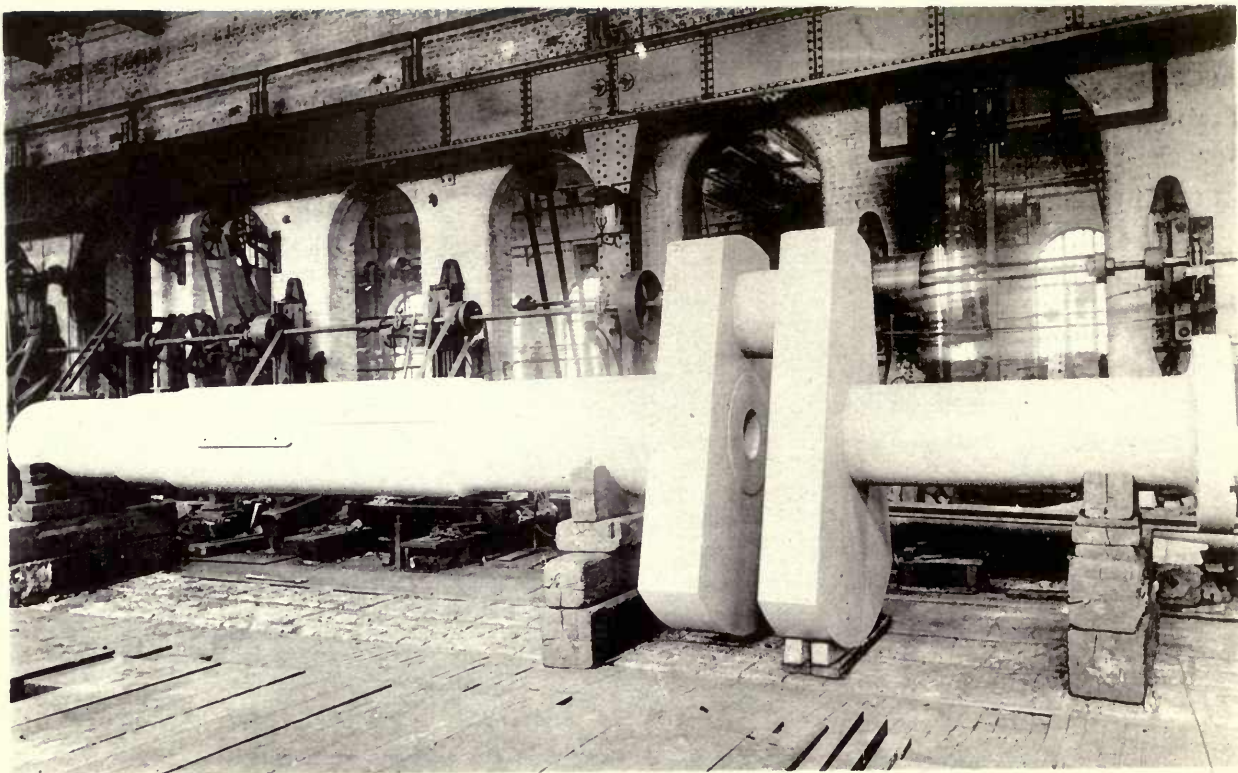
CRANK SHAFT FOR CHILIAN CRUISER "O'HIGGINS."



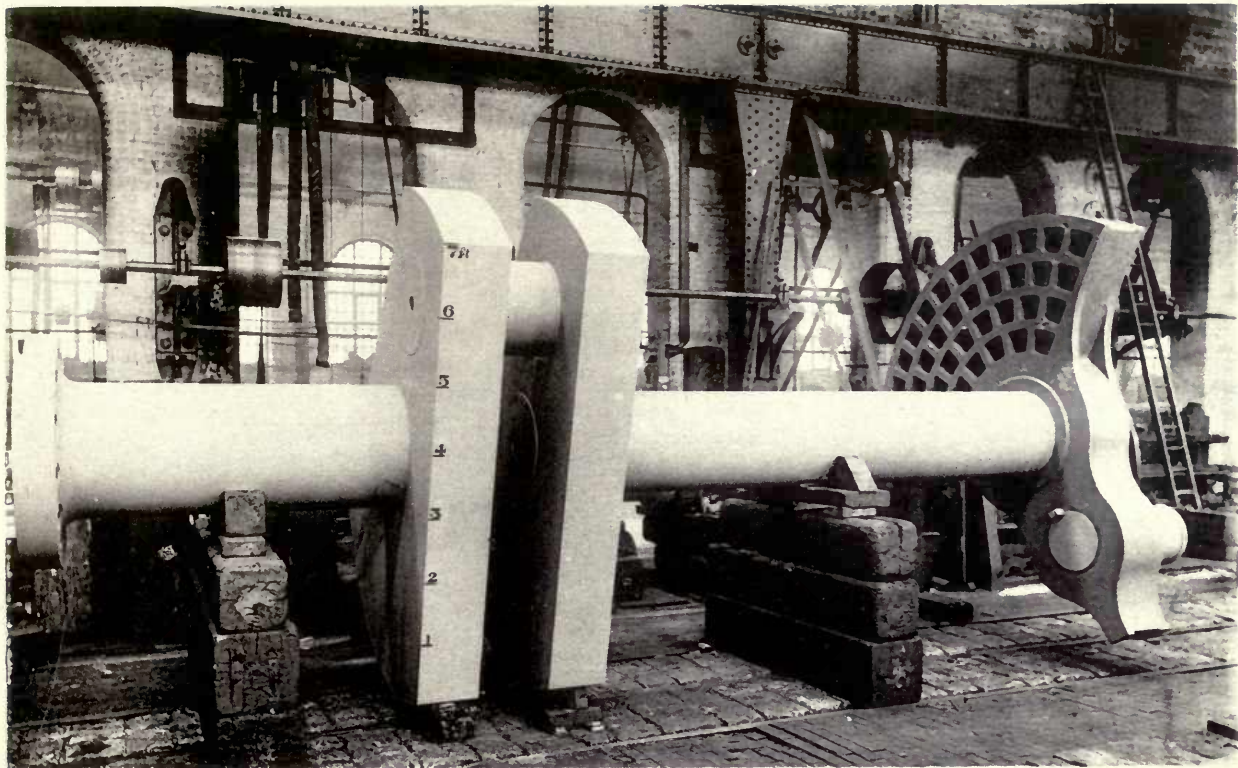
LARGE CRANK SHAFT FOR GAS ENGINE.



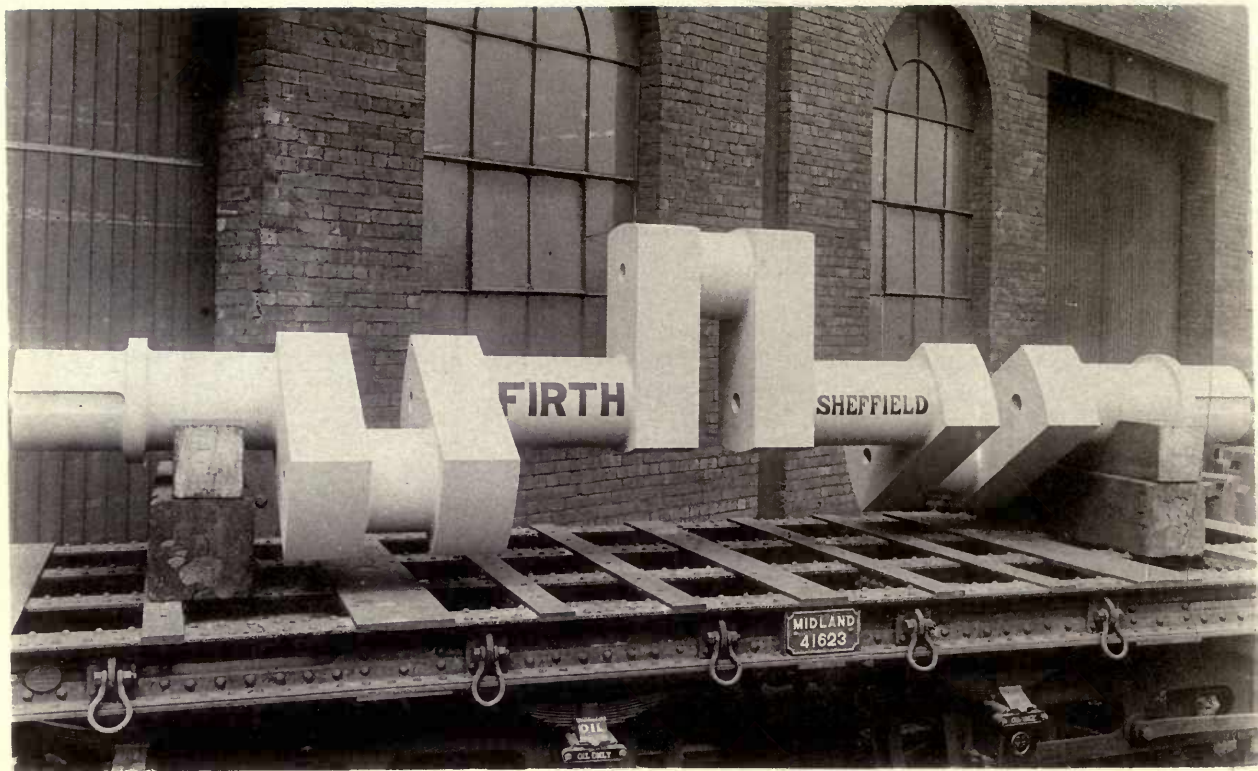
FORGED STEEL "BUILT UP" CRANK SHAFT, FOR INMAN LINER, "CITY OF BERLIN,"
Flanges 40in., Shaft and Pin 20½in. diam., Centres 33in., Length 11ft. 3in., Weight 15½ tons.



PORTION OF LARGE CRANK SHAFT FOR GLASGOW TRAMWAY POWER STATION.



PORTION OF LARGE CRANK SHAFT FOR GLASGOW TRAMWAY POWER STATION.



LARGE THREE THROW CRANK SHAFT FOR HORIZONTAL REVERSING MILL ENGINE,
FINISHED WEIGHT, 14 TONS 6 CWTs.



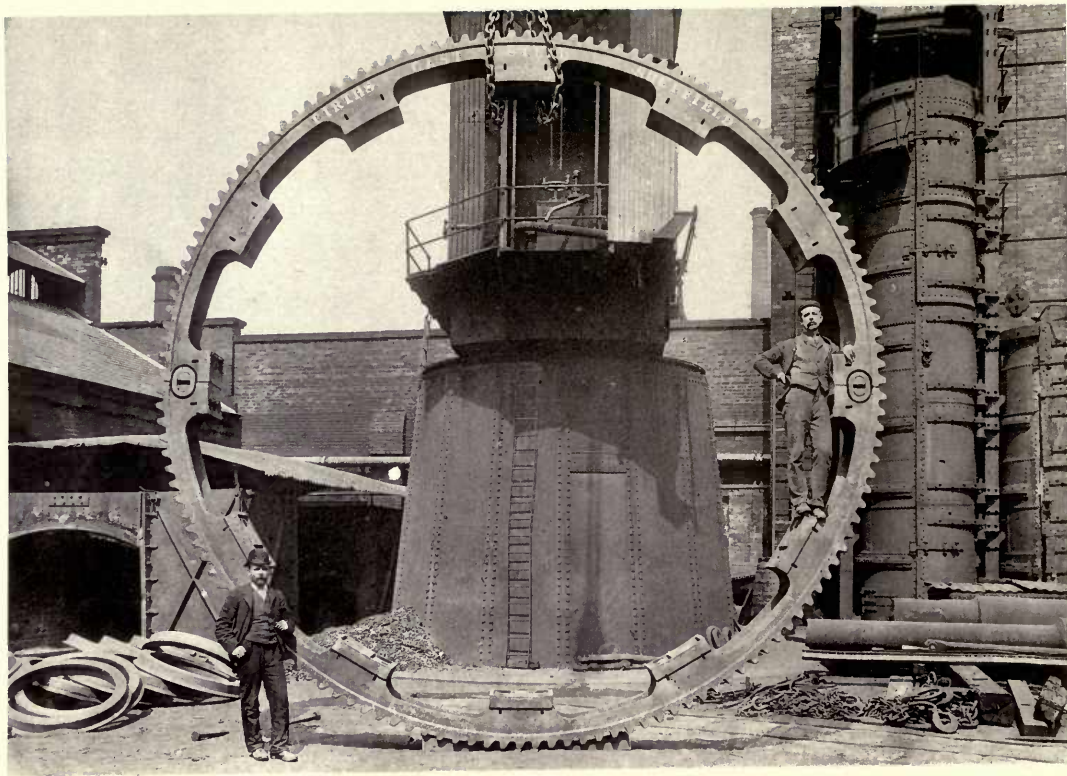
LARGE INGOT CASTING SHOP, WITH 100 TON TRAVELLING CRANE, AT NORFOLK WORKS.



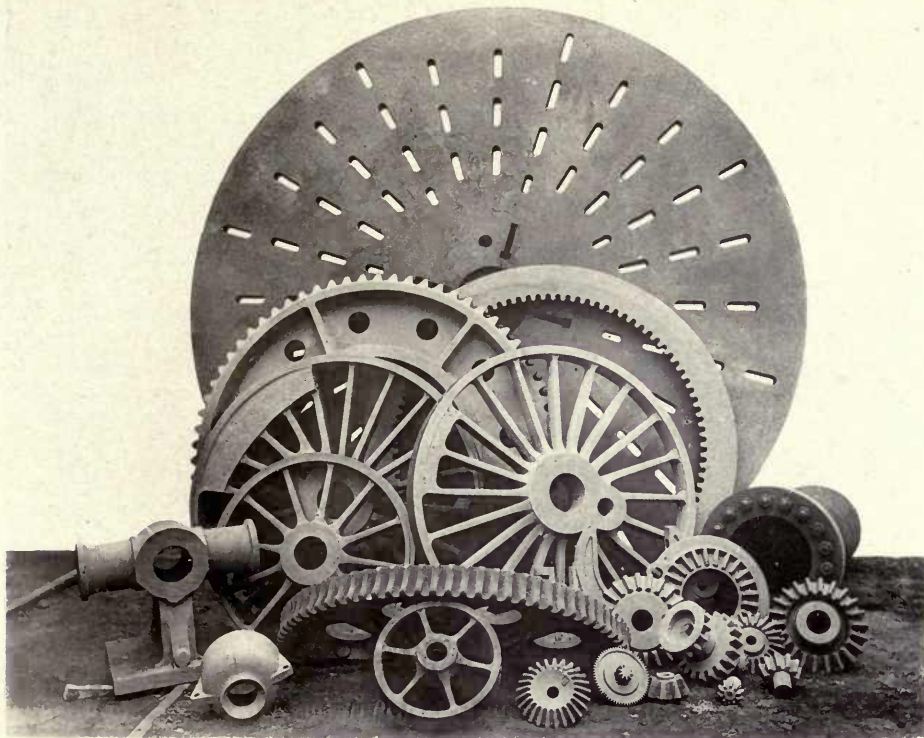
STEEL FOUNDRY, AT NORFOLK WORKS.



ANNEALING FURNACE AT EAST GUN WORKS BEING CHARGED.



CAST STEEL SPUR WHEEL RIM, 18ft. 10in. DIAM., 5in. PITCH, 15in. FACE ;
WEIGHT $7\frac{3}{4}$ TONS.



GROUP OF STEEL CASTINGS FOR LOCOMOTIVE AND OTHER PURPOSES.

THOS FIRTH & SONS LIM^D

(SHEFFIELD)

DROPPED ON 10 TON STEEL SLAB

A	No 1	DROP	10 FT	UNBROKEN
B	No 2	..	15 ..	BALANCE WEIGHT CRACKED BUT RIM-
A	No 3	..	20 ..	UNBROKEN [EIGHT CRACKS] - UNBROKEN
A	No 4	..	25 ..	CRACKED THROUGH RIM AND ARM
C	No 5	..	30 ..	UNBROKEN
D	No 6	..	30 ..	UNBROKEN

FOUNDRY

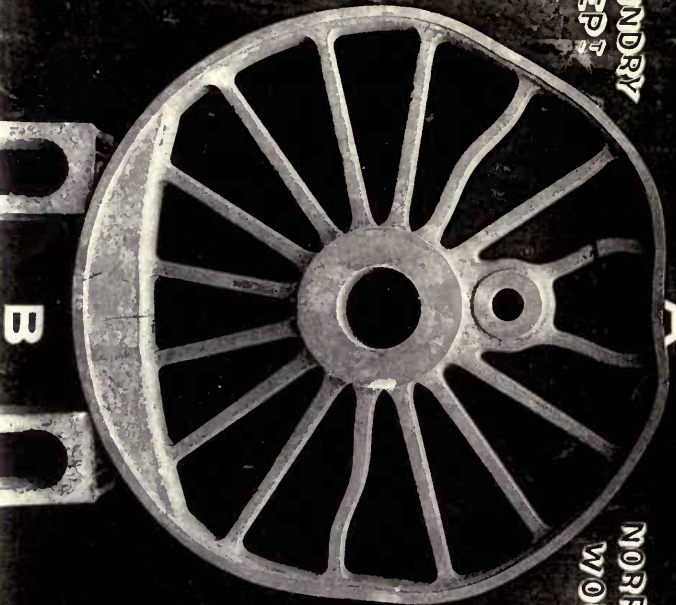
DEPT

A

NORFOLK
WORKS

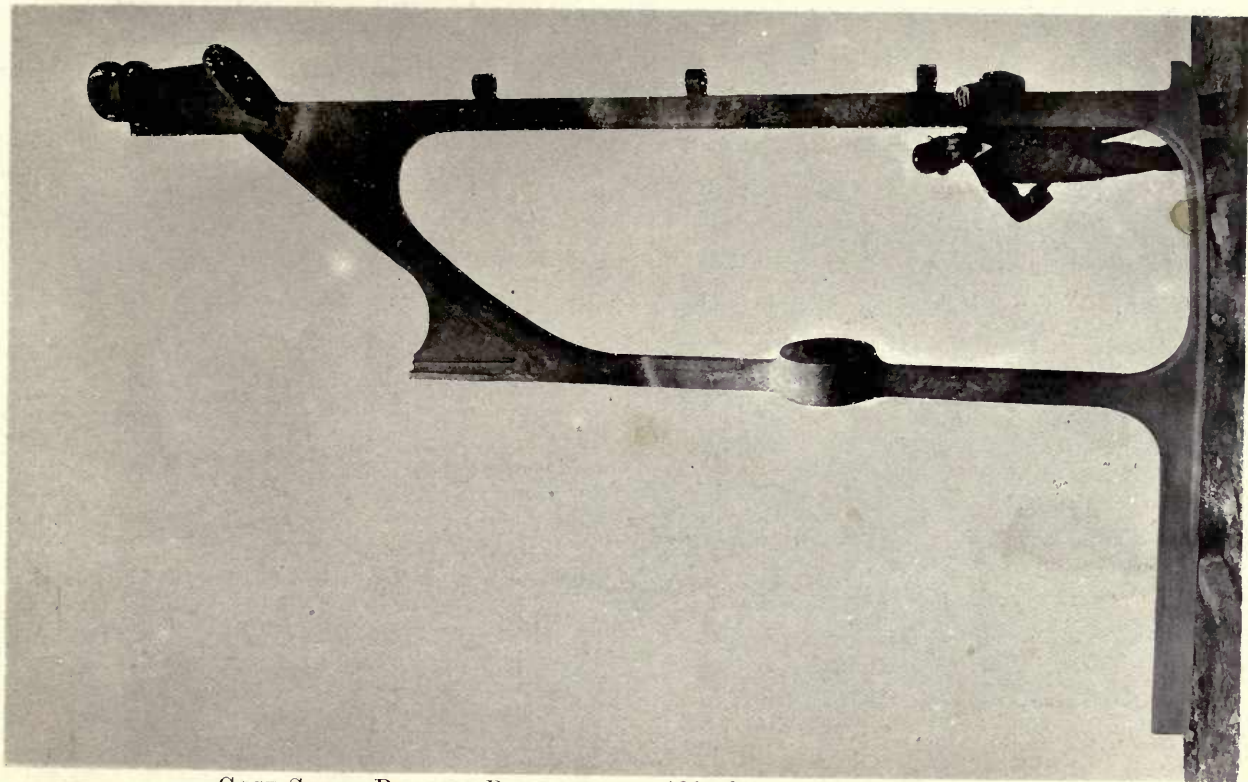
C

D

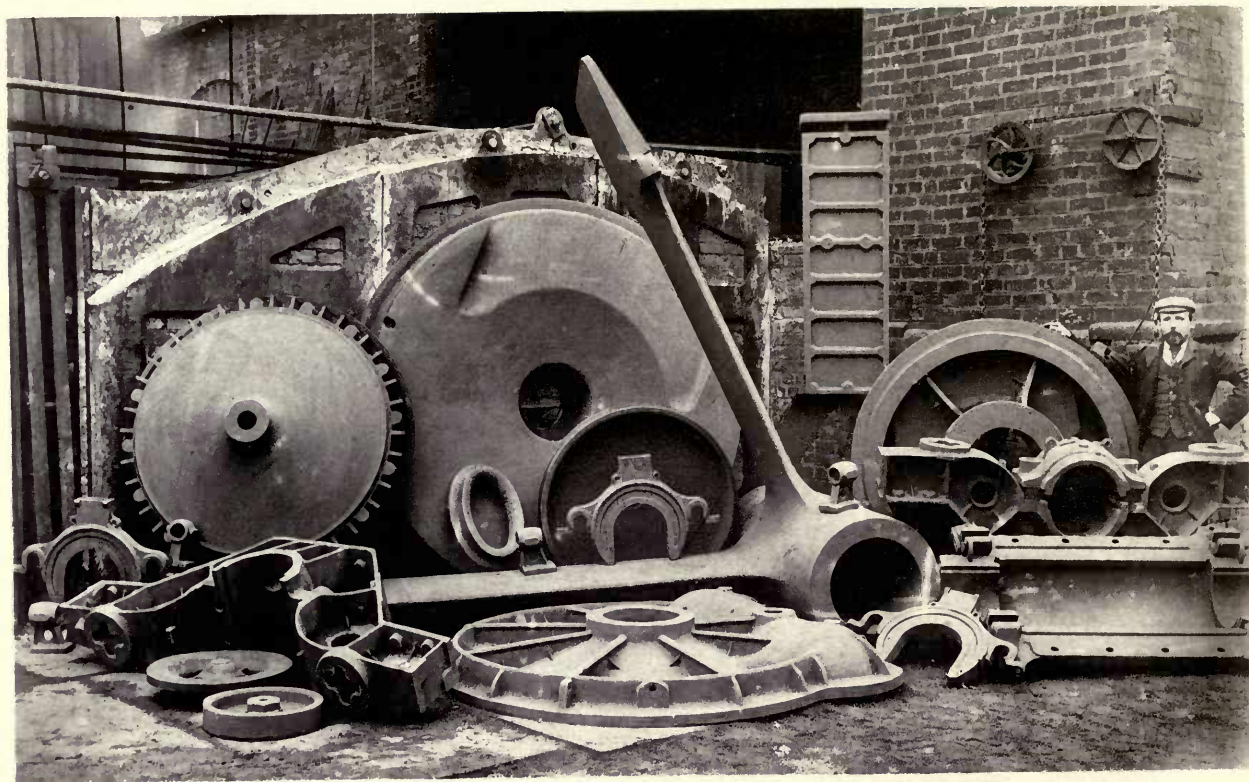


B

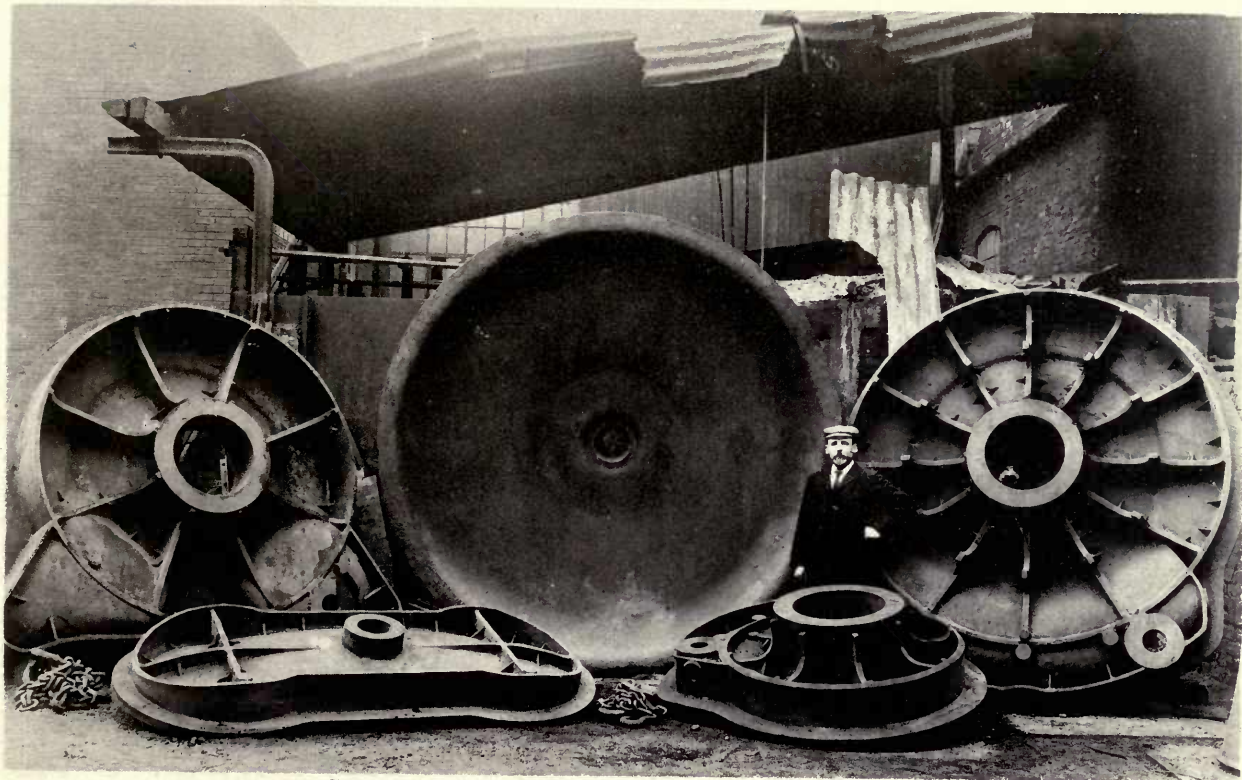
TESTED LOCO WHEEL CENTRE.



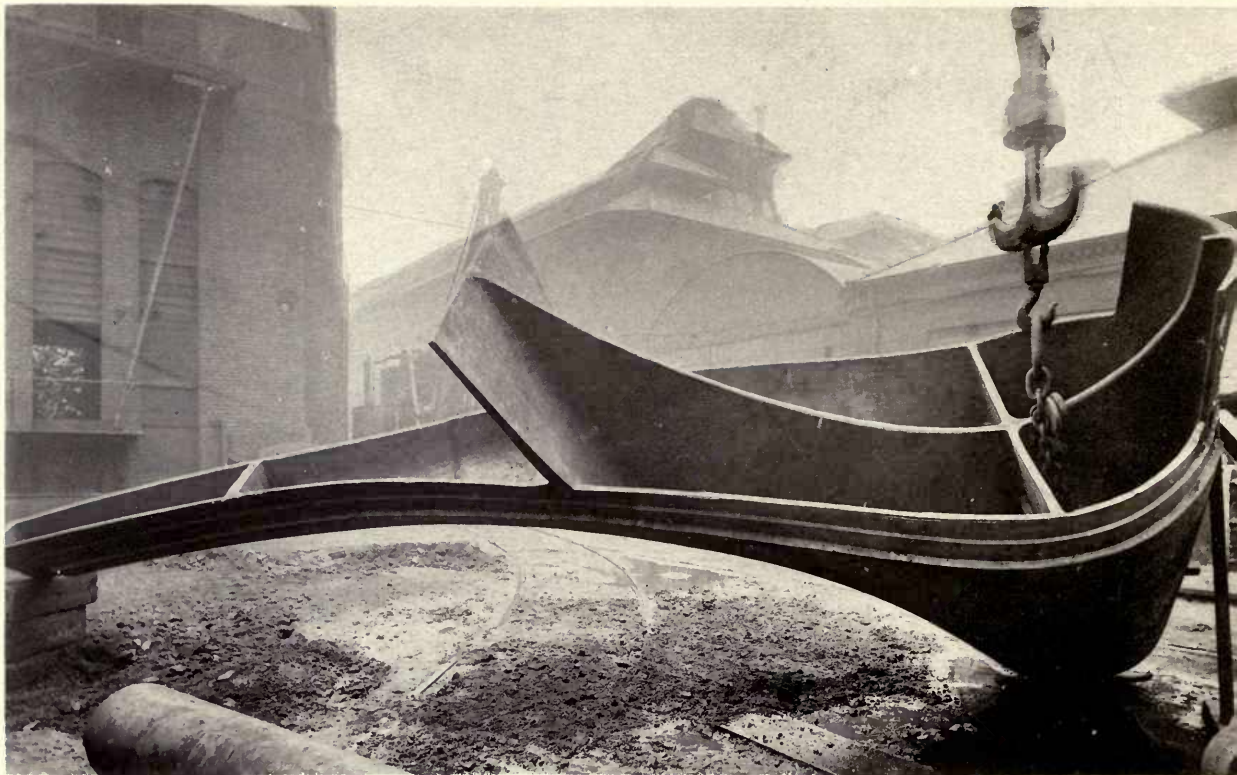
CAST STEEL RUDDER POST, HEIGHT 19ft. 6in. ; WEIGHT $206\frac{1}{2}$ CWTs.



GROUP OF STEEL CASTINGS FOR MARINE PURPOSES.



GROUP OF STEEL CASTINGS FOR MARINE PURPOSES.



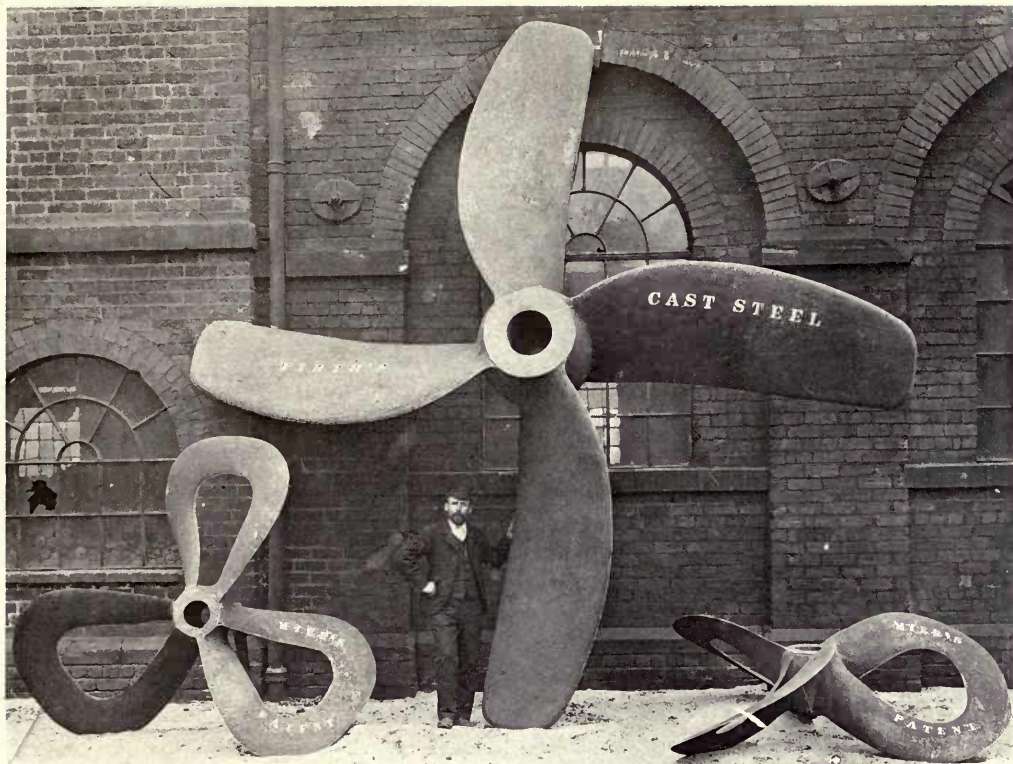
CAST STEEL STEM OR RAM, SUPPLIED TO THE PORTSMOUTH, DEVENPORT & CHATHAM DOCK YARDS
[76] FOR H.M.S. "BRITANNIA," "HIBERNIA," AND "AFRICA."



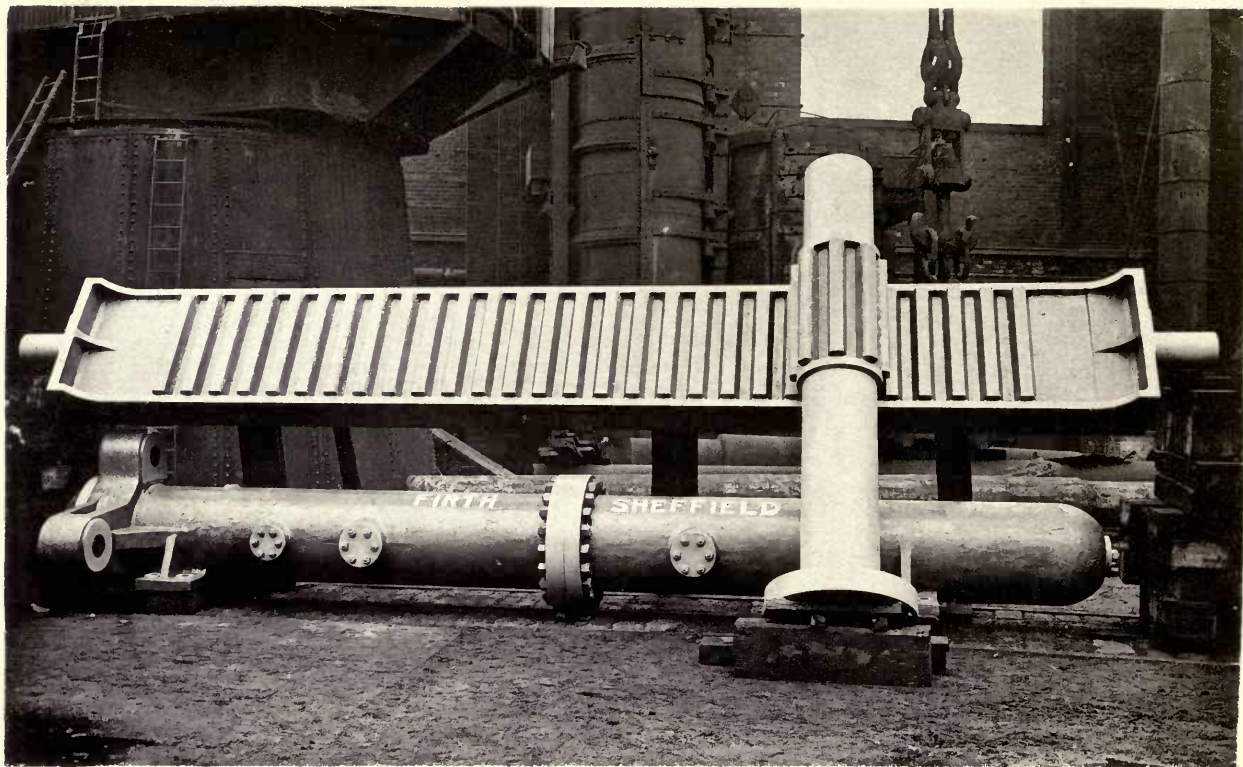
CAST STEEL STEM OR RAM, SUPPLIED TO THE PORTSMOUTH, DEVENPORT & CHATHAM DOCK YARDS
FOR H.M.S. "BRITANNIA," "HIBERNIA," AND "AFRICA."



CAST STEEL LOW PRESSURE MARINE PISTON FOR H.M.S. "MONARCH,"
9ft. 4in. diam., weight $3\frac{3}{4}$ ton.

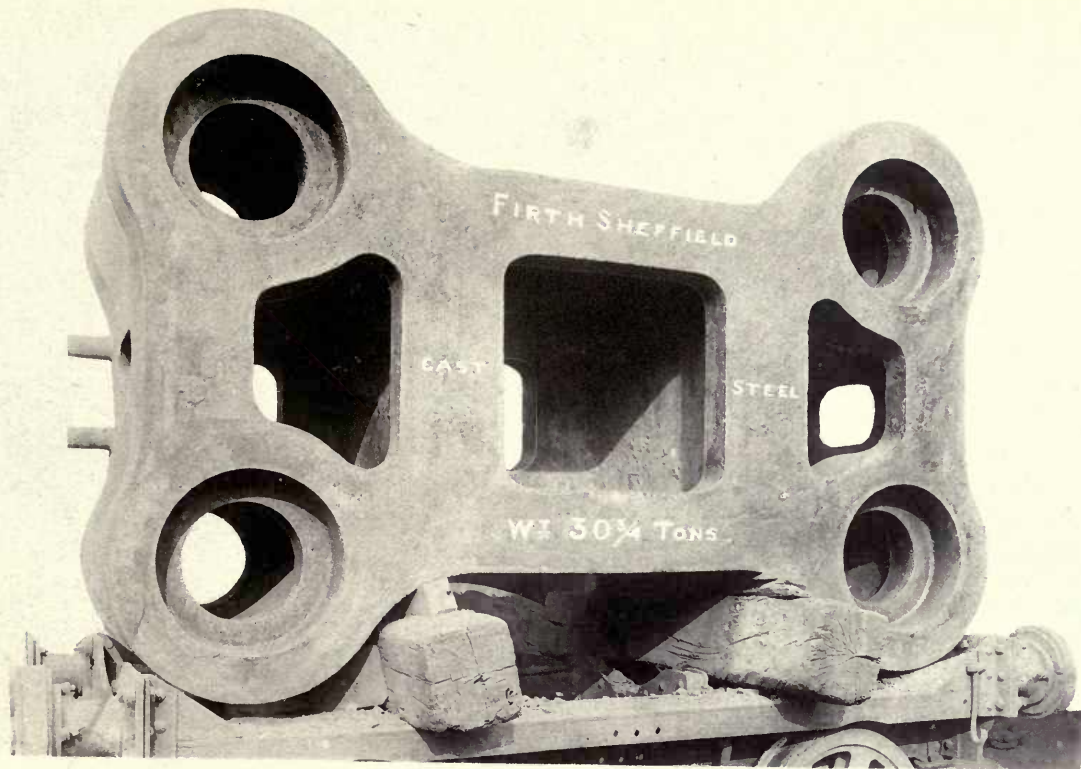


GROUP OF PROPELLER BLADES.



CAST STEEL RACK, SHAFT AND PINION, AND HYDRAULIC CYLINDER.

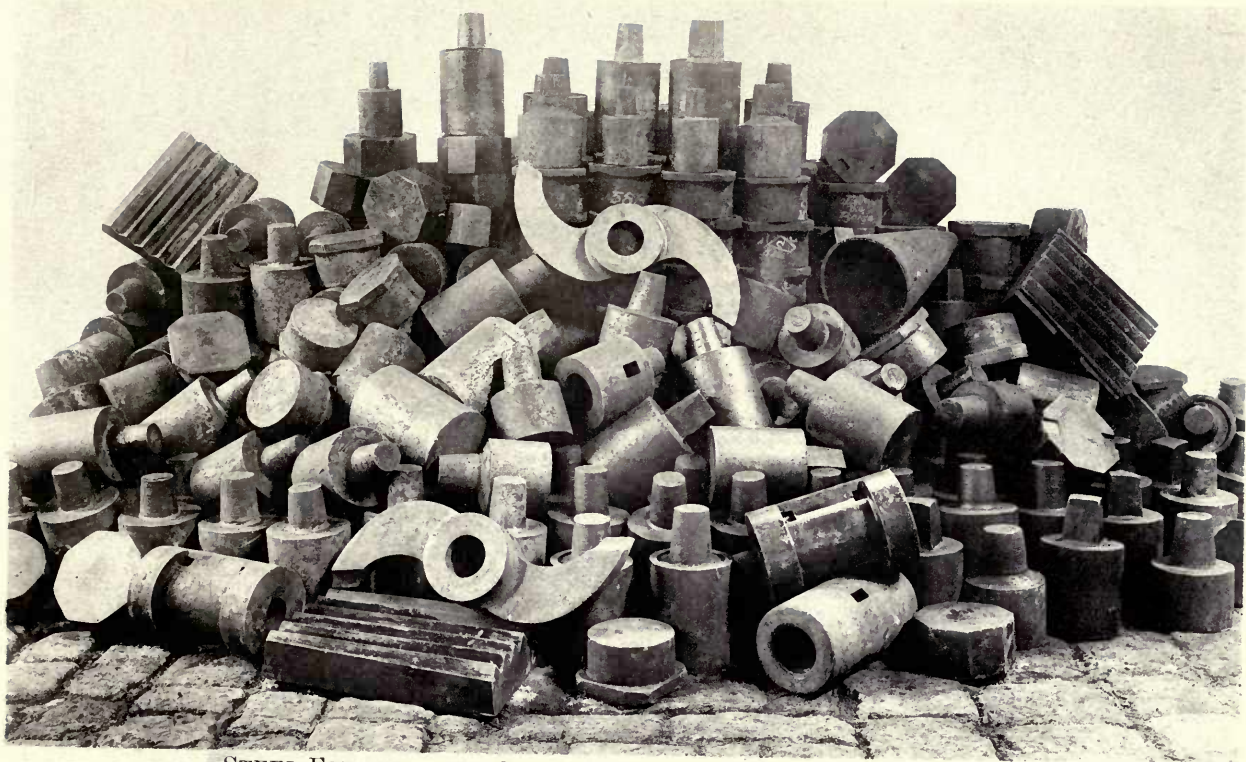
Rack 27ft. long $\times$ 38in. wide, 8in. pitch; weight $204\frac{1}{2}$ cwts. Shaft 18 in. diam $\times$ 10ft. 5in. long. Collar 34in. diam. with Pinion 8in. pitch; weight $88\frac{1}{4}$ cwts. Cylinder 22ft. long $\times$ $25\frac{3}{4}$ in. diam., weight $202\frac{1}{2}$ cwts.



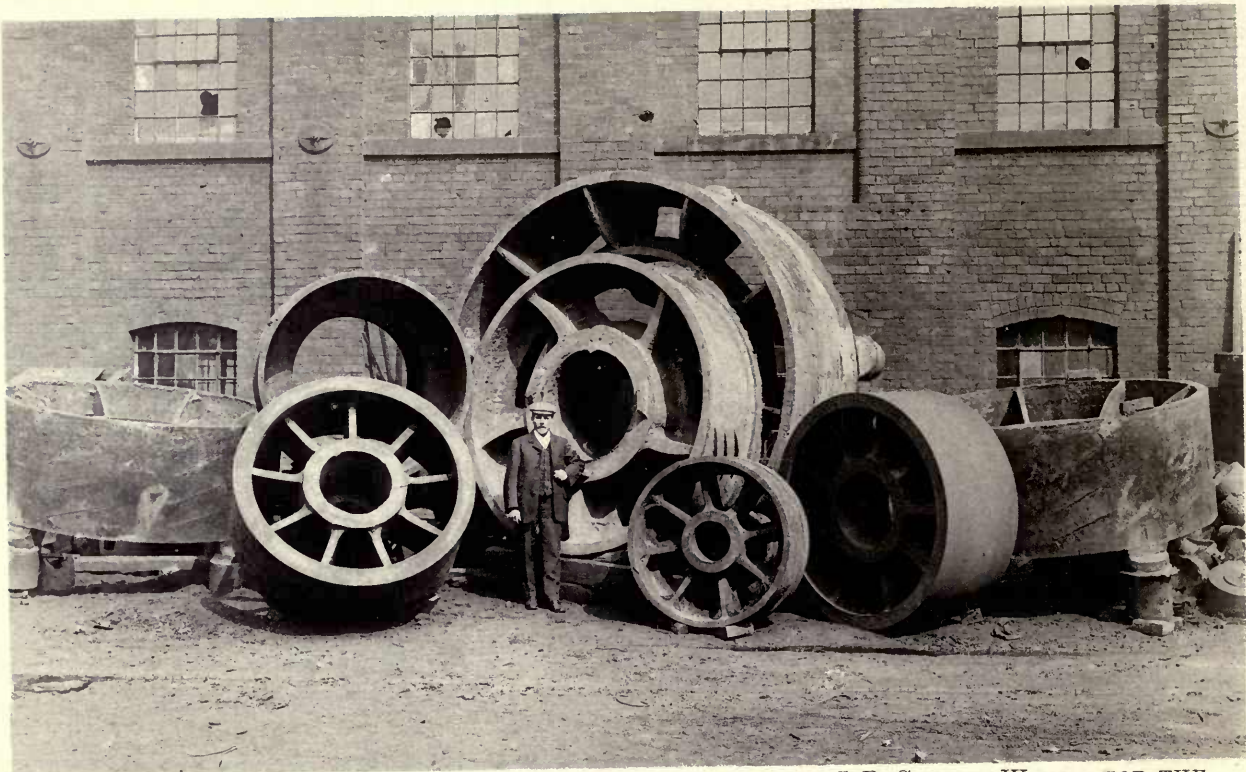
CAST STEEL PRESS HEAD.



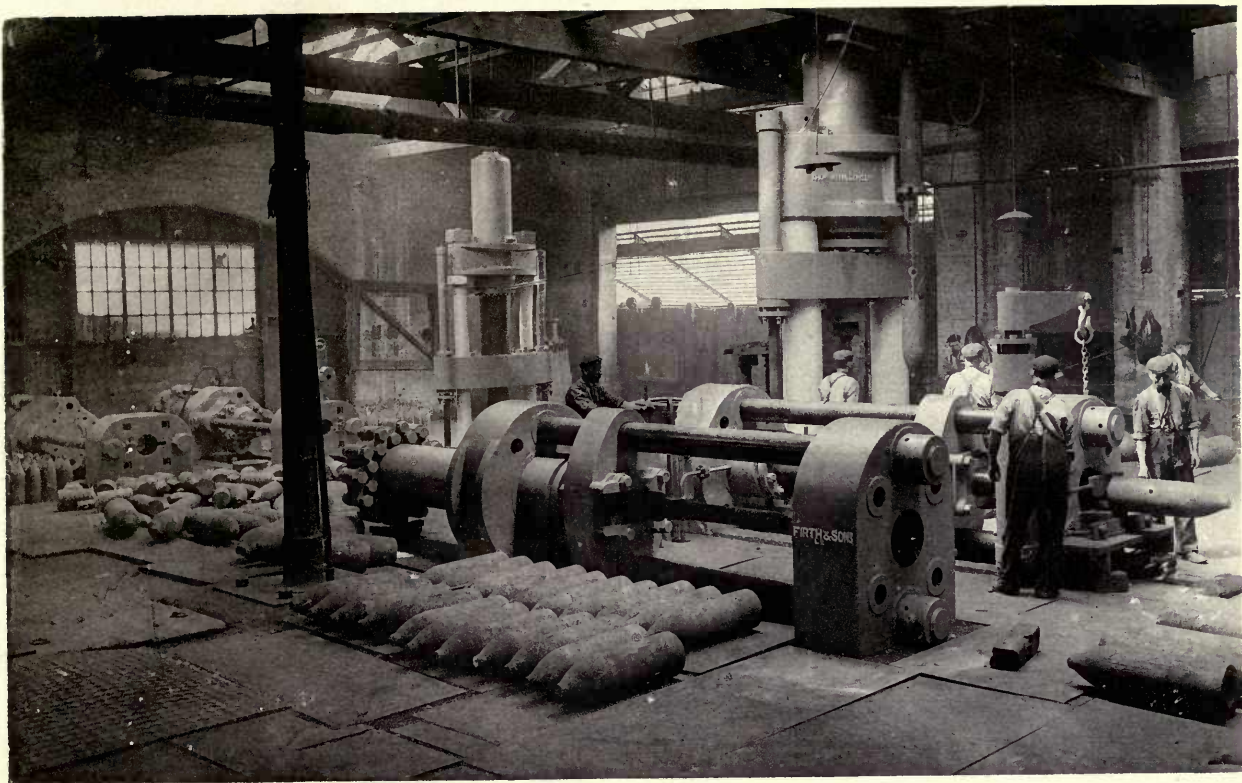
STEEL CASTING, WEIGHT $18\frac{1}{2}$ TONS.



STEEL FORGINGS AND CASTINGS FOR GOLD MINING MACHINERY..



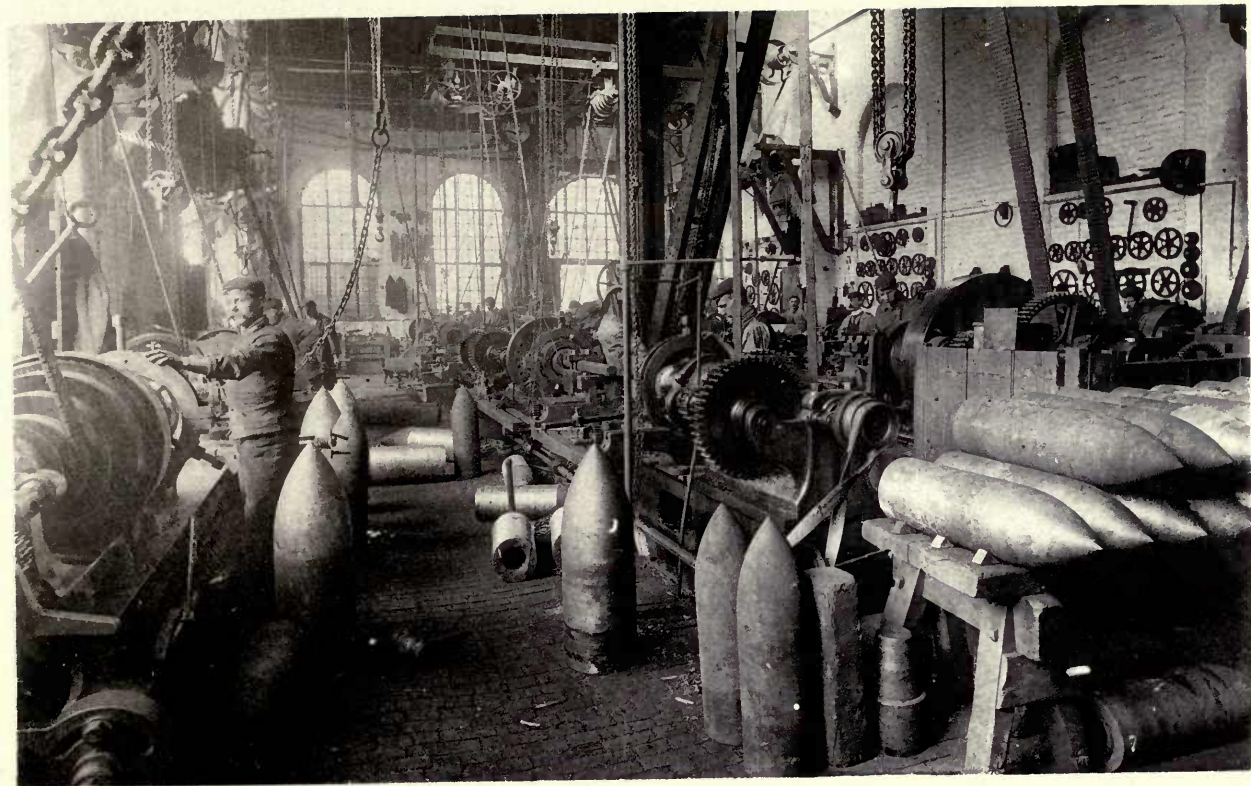
GROUP OF TURBINE MARINE ENGINE CASTINGS, INCLUDING ONE L.P. CENTRE WHEEL FOR THE
[84] NEW SUBSIDISED FAST CUNARD TURBINE STEAMER OF 75,000 I.H.P.



SHELL PRESS SHOP.



SHELL MACHINING SHOP.



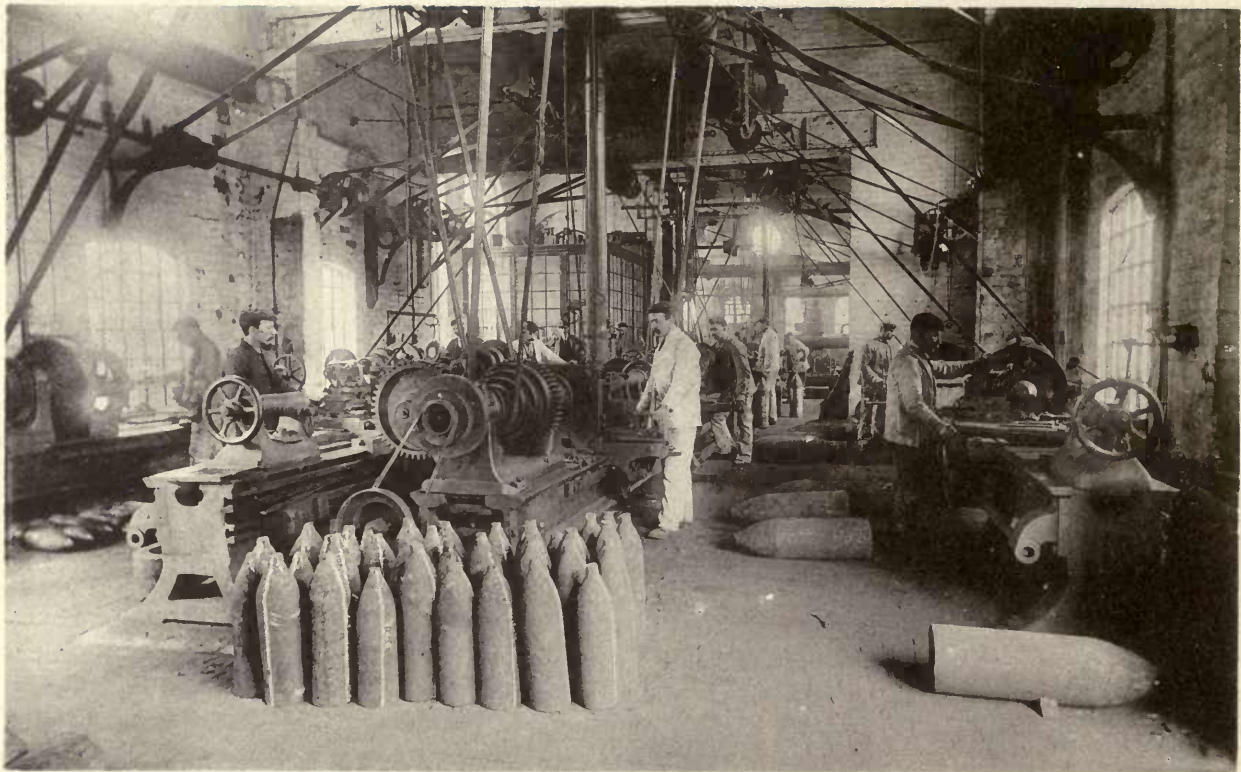
MACHINE SHOP FOR LARGE SHELLS.-



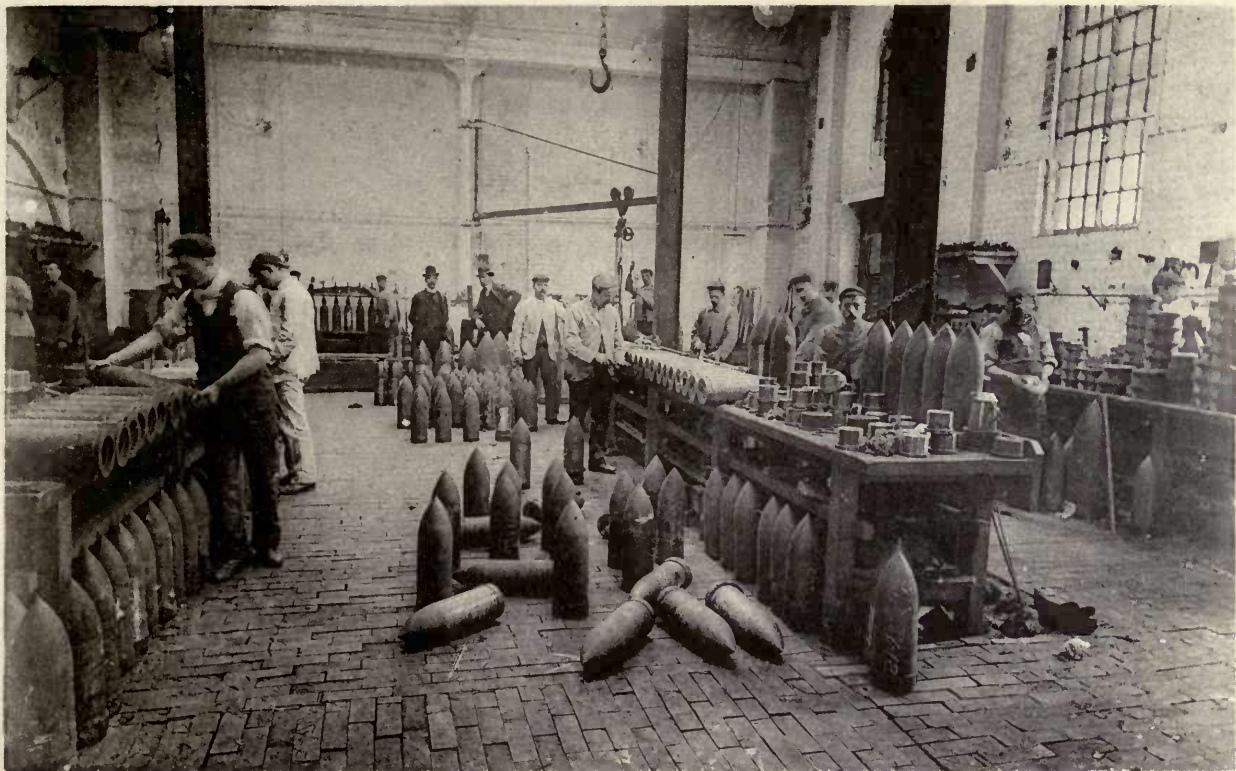
SHELL SHOP.



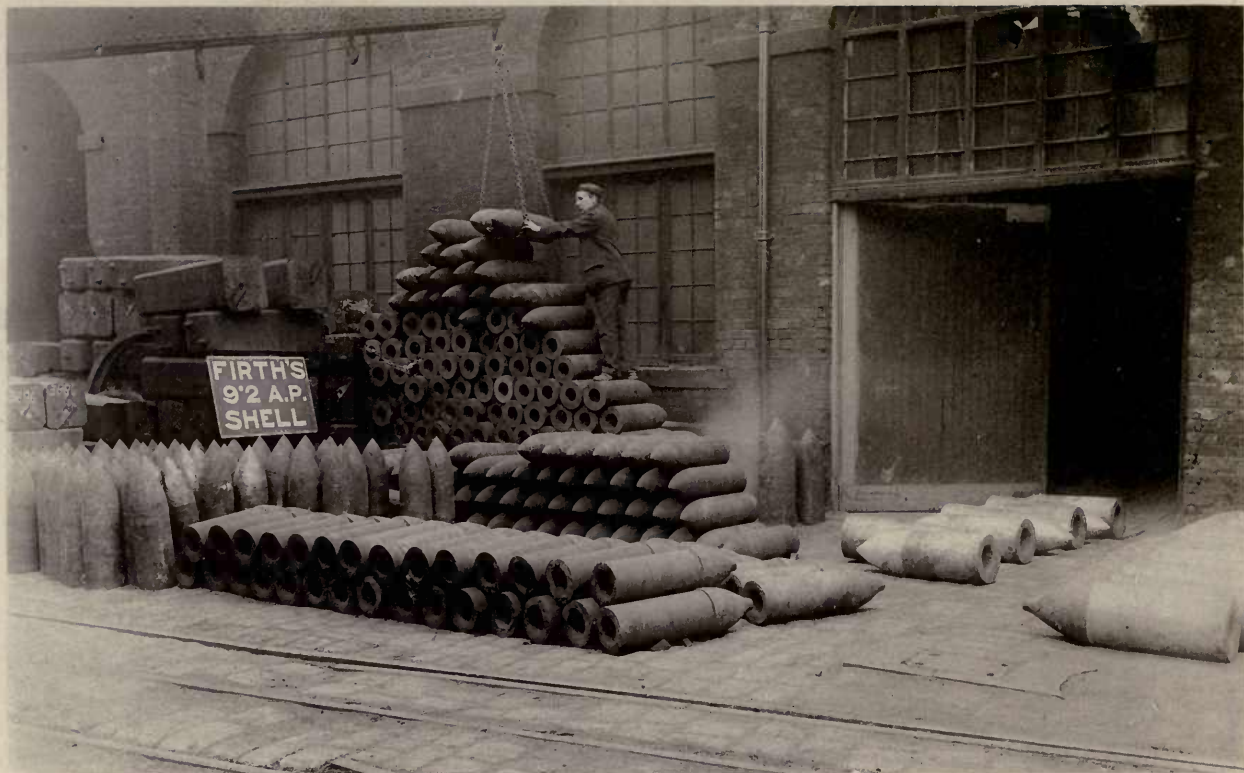
SHELL MACHINING SHOP.



SHELL MACHINING SHOP.



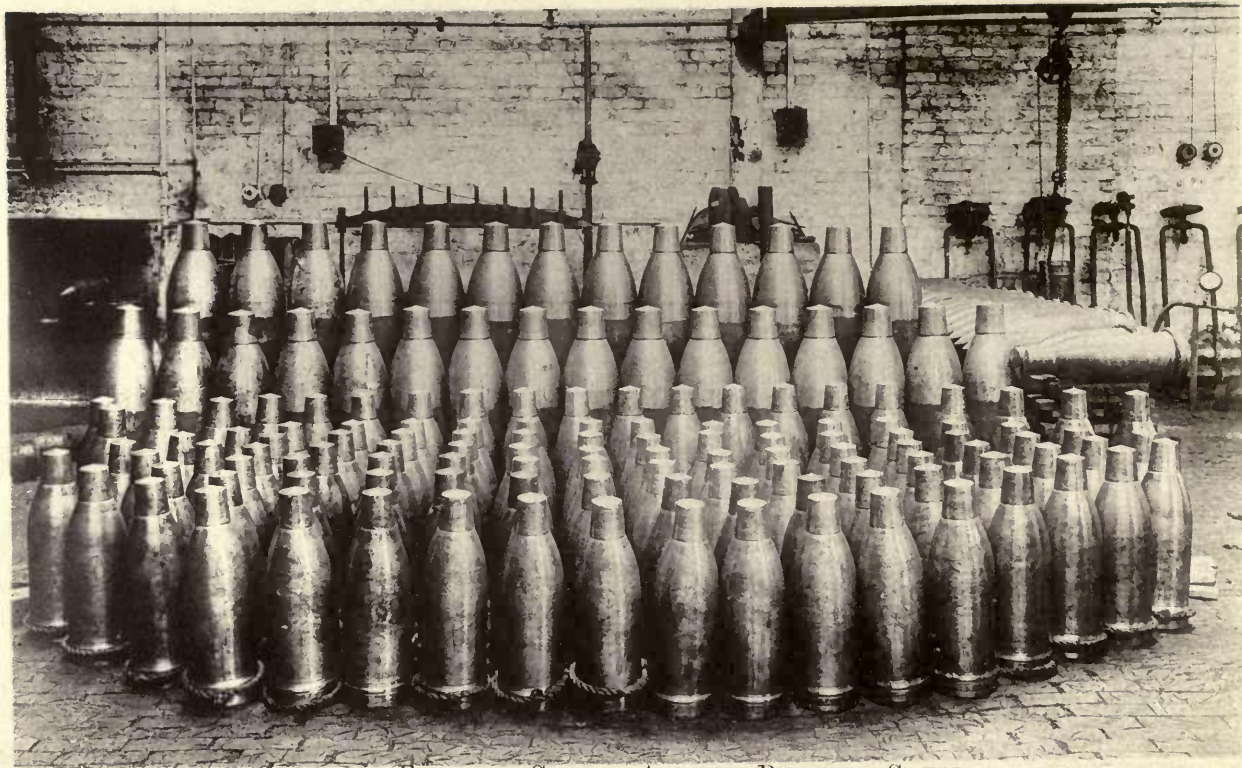
SHELL INSPECTING SHOP.



GROUP OF 9.2in. CAPPED A.P. SHELL PARTIALLY MACHINED.



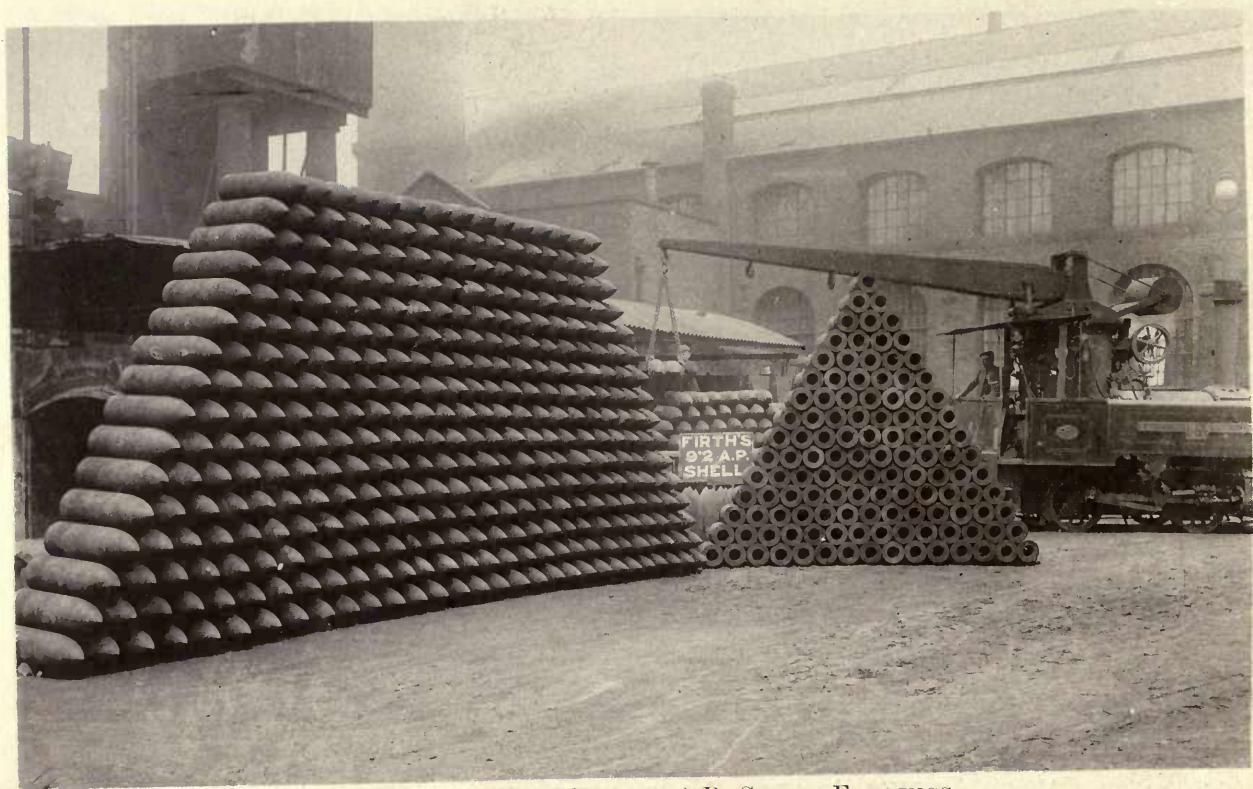
SHELL FORGINGS. 9.2in. AND 12in. CAPPED A.P.



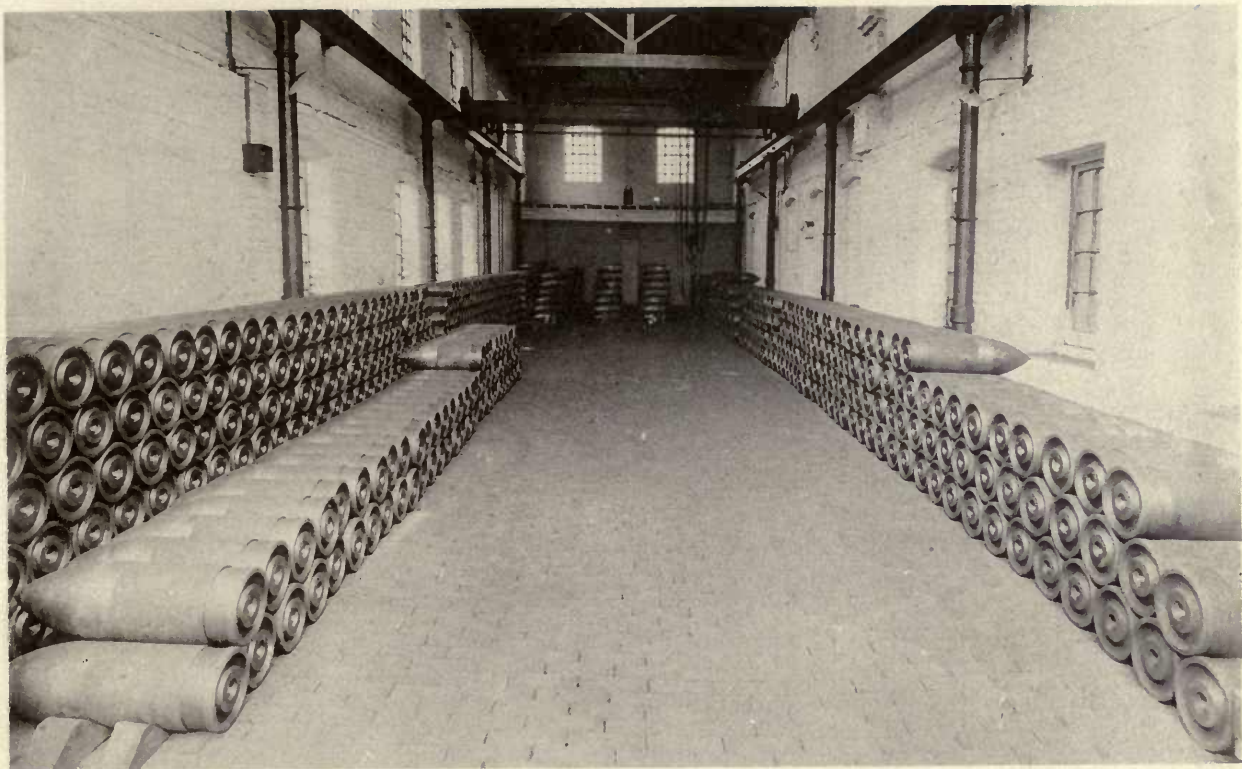
GROUP OF FINISHED CAPPED ARMOUR PIERCING SHELL.



400 7.5in. CAPPED ARMOUR PIERCING SHELL, ACCEPTED AFTER FIRING TRIAL. READY FOR
BANDING AND CAPPING.



GROUP OF 9.2in CAPPED A.P. SHELL FORGINGS.



ARMOUR PIERCING SHELLS IN BONDED STORE.



GROUP OF 4.7in. CAST STEEL SHELLS.



THOS. FIRTH & SONS LTD.
SAMPLES
OF
ARMOUR-PIERCING PROJECTILES.

GROUP OF ARMOUR PIERCING PROJECTILES.



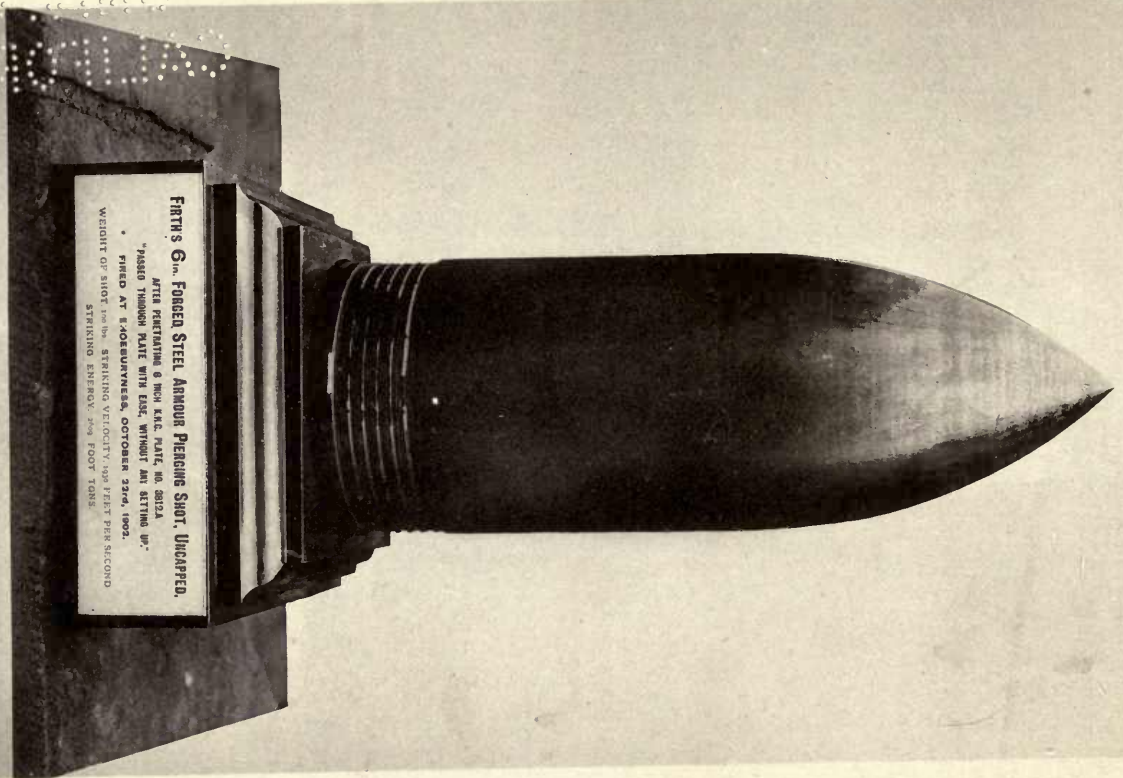
GROUP OF FIRED CAPPED A.P. SHELLS.



9.2" CAPPED
A.P. SHELL

AFTER
PENETRATING
9" K.C. PLATE
AT A
VELOCITY OF
2009 F.S.
FIRED 25.8.04

FIRED 9.2in. CAPPED A.P. SHELL.



FIRTH'S 6" FORGED STEEL ARMOUR PIERCING SHOT, UNCAPPED.

AFTER PENETRATING 6 INCH K.L.C. PLATE, NO. 3812A.

"PASSED THROUGH PLATE WITH EASY, WITHOUT AN SETTING UP."

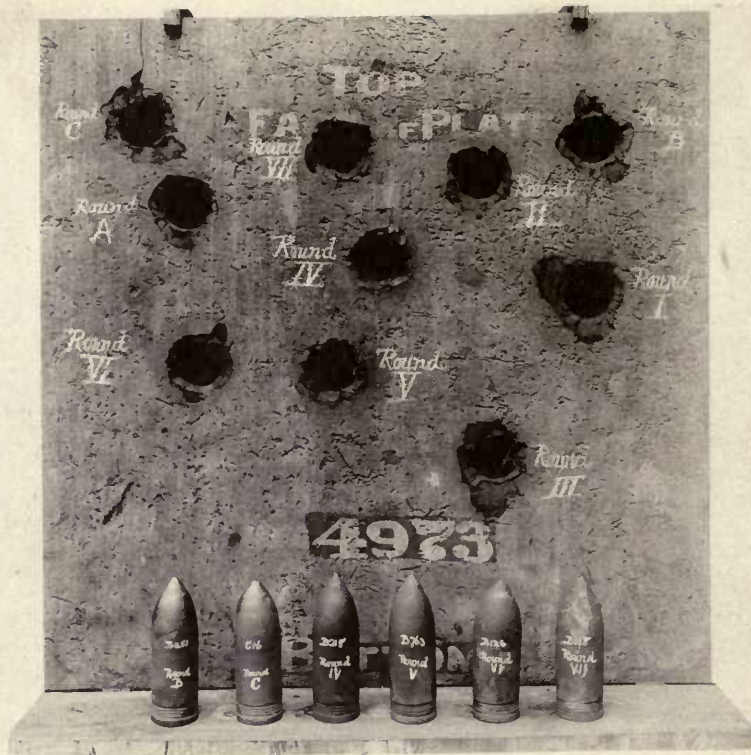
* FIRED AT 8400 YARDS, OCTOBER 27th, 1902.

WEIGHT OF SHOT 100 lbs. STRIKING VELOCITY 1200 FEET PER SECOND.

STRIKING ENERGY 200 FOOT TONS.



METHOD OF FASTENING CAP ON SHELL.



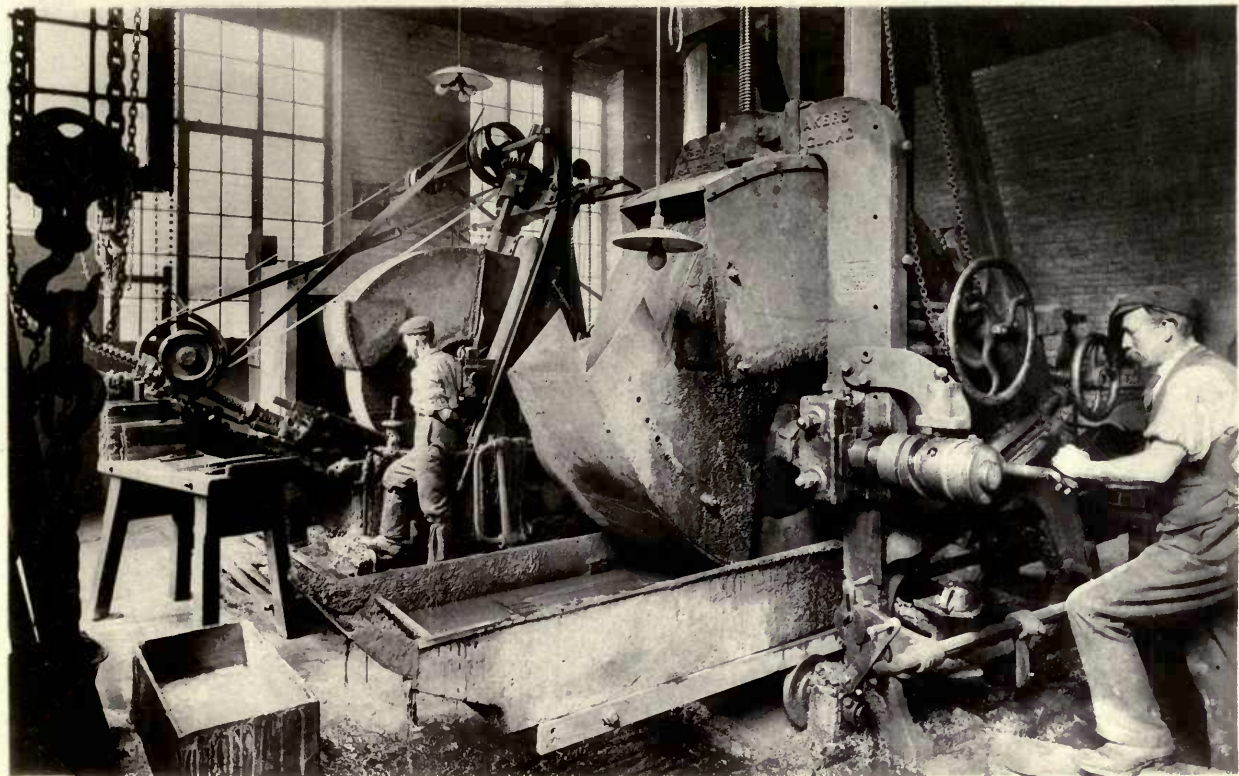
4-7 INCH CAPPED "FIRTH-RENDABLE" A.P. SHELL WITH 4½ K.C. PLATE. SHELL PERFORATED
 [104] THE PLATE AND WERE RECOVERED WHOLE.



NEW FILE FACTORY.



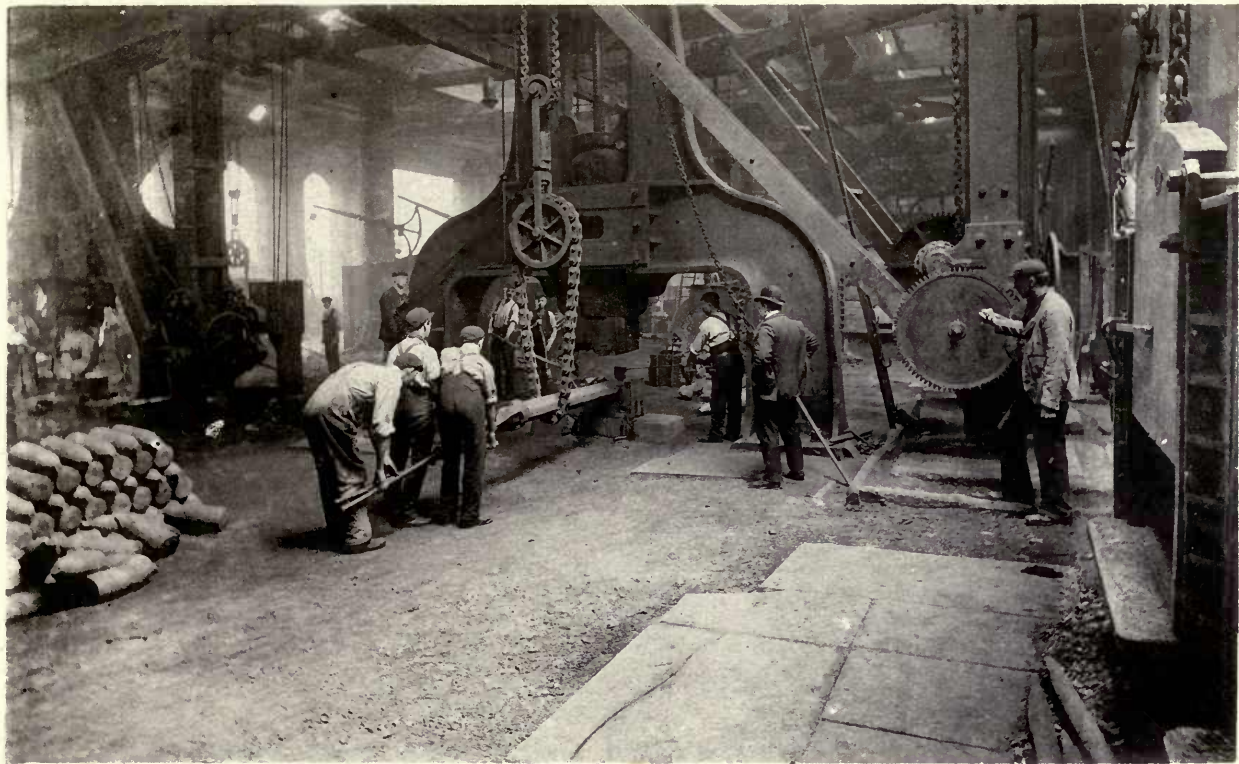
FILE FORGING.



MACHINE FILE GRINDING.



HAND FILE GRINDING.



SHELL FORGING HAMMER.



ONE OF THE MACHINE FILE CUTTING SHOPS.



INTERIOR, OLD FILE FACTORY..



FILE HARDENING SHOP.



FILE EXAMINING ROOM.



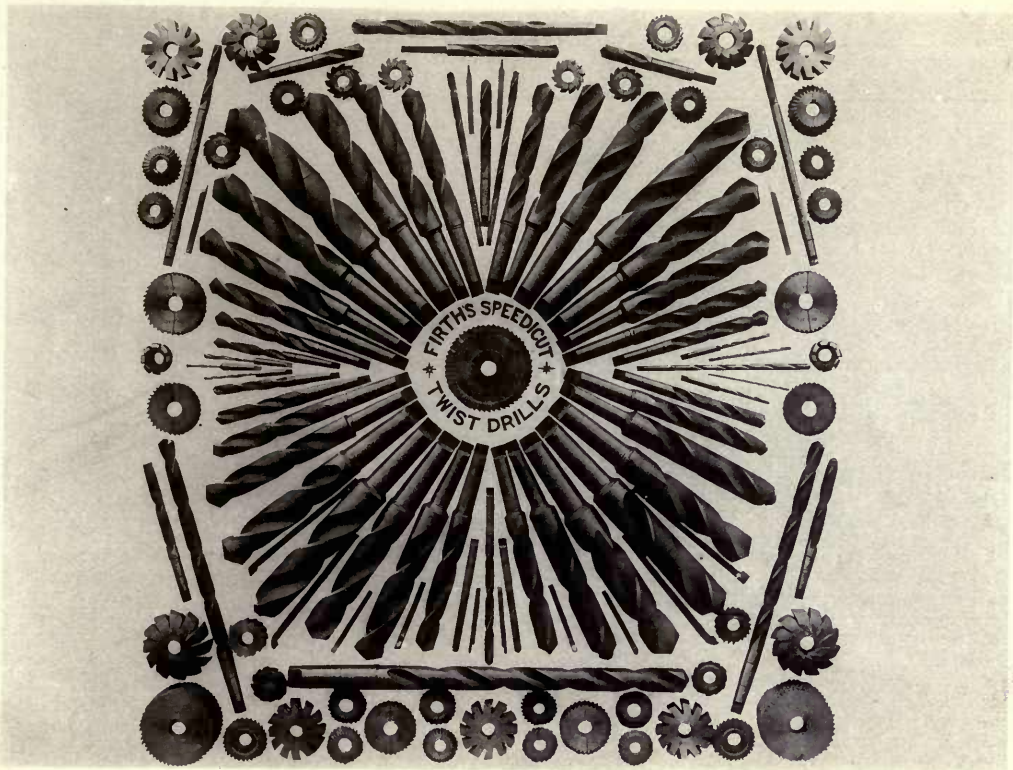
FILE WAREHOUSE.



PACKING ROOM.



INTERIOR, NEW FILE FACTORY.



TWIST DRILLS, CUTTERS, ETC., MADE OF FIRTH'S "SPEEDCUT" HIGH SPEED STEEL.



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